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## TABLE OF CONTENTS

### PART I

#### Chapter 1 – Materials

	Page
1.0	Materials
1.1	Water
1.2	Cement
1.3	Lime
1.4	Fine Aggregate for Concrete
1.5	Coarse Aggregate for Concrete
1.6	Building Sands from Natural Sources
1.7	Methods of Stacking
1.8	Other Materials

#### Chapter 2 – Site Preparation, Excavation & Earth work

1	
2.0	Site Preparation, Excavation & Earthwork
2.1	Site Work
2.1.1	Existing Services
2.1.2	Demolition of Existing Structures
2.1.3	Felling and Removal of Trees
2.1.4	Disposal of Waste Materials
2.1.5	Waterways
2.2	Excavations
2.2.1	Establishment of levels
2.2.2	Classification of Soils
2.2.3	Blasting
2.2.4	Antiquities and useful Materials
2.2.5	Protection
2.2.6	Reinstatement of damages during excavations
2.2.7	Anti-termite treatment
2.2.8	Stability of Excavation
2.2.9	Excavation of Foundation
2.2.10	Disposal of surplus materials
2.2.11	De-watering
2.2.12	Planking and Strutting
2.3	Filling around Foundations in pits, trenches plinths etc
2.4	Excavation and banking (of filling)
2.5	Excavation in Trenches for Pipes, Cables etc and Refilling
2.6	Filling under Floors
2.6.1	Earth Filling
2.6.2	Sand Filling
	Appendix

#### Chapter 3 – Mortar

3.0	Mortar
3.1	Lime Mortar
3.2	Cement Mortar
3.2.1	Machine Mixing
3.2.2	Hand Mixing
3.3	Lime-Cement-Sand Mortar (I.e. composite Mortar)

3.3.1	Proportioning	14
3.3.2	Mixing	14
3.3.2.1	Hand Mixing	14
3.3.3	Precautions	14

## Chapter 4 – Concrete

4.0	Concrete	15
4.1	Materials	16
4.1.1	Water	16
4.1.2	Cement	16
4.1.3	Aggregates	16
4.1.4	Admixtures	20
4.2	Lime Concrete	20
4.2.1	Proportioning	20
4.2.2	Mixing	20
4.2.3	Laying	21
4.2.4	Curing	21
4.3	Cement Concrete	21
4.3.1	Proportioning	21
4.3.2	Mixing	23
4.3.3	Consistency	26
4.3.4	Laying	26
4.3.4.1	Compaction	26
4.3.4.2	Temperature	27
4.3.4.3	Underwater Concreting	27
4.3.4.4	Continuation of Work	27
4.3.5	Curing and Protection	27
4.3.6	Form work	28
4.3.7	Testing and Acceptance	28
4.4	No Fines Concrete	28
4.5	Plum Concrete	28

## Chapter 5 – Reinforced Cement

5.0	Reinforced Cement	31
5.1	Materials	31
5.1.1	Concrete	31
5.1.2	Steel Reinforcement	31
5.2	Formwork	34
5.2.1	Materials for formwork	34
5.2.2	Formwork ties	35
5.2.3	Top Forms	35
5.2.4	Propping and Centering	35
5.2.5	Shuttering	36
5.2.6	Camber	36
5.2.7	Special Formwork	37
5.2.8	Approval of Formwork	37
5.2.9	Removal of Formwork	37
5.3	Steel Reinforcement	38
5.3.1	Bending, Lapping and Welding	38
5.3.2	Fixing in position	39
5.4	Concreting	41

5.4.1	Consistency	41
5.4.2	Placing of Concrete	41
5.4.3	Compaction	42
5.4.4	Construction Joints	43
5.4.5	Movement Joints	44
5.4.6	Curing and Protection	44
5.4.7	Finishing	45
5.4.8	Surface Finishes	46
5.4.9	Sampling and Strength test of concrete for Prescribed and volume batched mixes	61
	Appendix –5A + 5B	51-52

## Chapter 6 – Brick Work and Block Work

6.0	Brick Work and Block Work – Definitions	53
6.1	Materials	56
6.1.1	Common Burnt Clay Bricks	56
6.1.2	Precast Blocks /Brocks	57
6.2	Brickwork (Clay Bricks)	59
6.3	Masonry with Cast Block / Brick	59

## Chapter 7 – Woodwork

7.0	Woodwork – Definitions	64
7.1	Materials	69
7.1.1	Timber	69
7.1.2	Adhesives	70
7.1.3	Fasteners	71
7.1.4	Plywood, Hardboard, Block Board, Chip Board etc	71
7.2	Structural timber and timber roof work	72
7.2.1	Joints	72
7.2.2	Preservative Treatment of cut surfaces	73
7.2.3	Assemble of Structural Units	73
7.2.4	Storage	73
7.2.5	Painting	73
7.2.6	Transport	73
7.2.7	Handling, Hoisting and Fixing	73
7.2.8	Testing and Acceptance	74
7.3	Joinery	74
7.3.1	Dimensions	74
7.3.2	Exposed faces	74
7.3.3	Natural finish	74
7.3.4	Shrinkage	74
7.3.5	Fabrication	74
7.3.6	Joints	74
7.3.7	Mouldings	75
7.3.8	Bent work	75
7.3.9	Circular work	75
7.3.10	Veneering	75
7.3.11	Scribing	75
7.3.12	Weathering	75
7.4	Door and Window Frames	75
7.4.1	Joints	75

<b>7.4.2</b>	Surface Treatment	<b>75</b>
<b>7.4.3</b>	Fixing in Position	<b>76</b>
<b>7.5</b>	Sashes for Doors, Windows, Fanlights etc	<b>76</b>
<b>7.5.1</b>	Ledged, Braced and Battened sashes	<b>77</b>
<b>7.5.2</b>	Paneled, Glazed or Paneled and Glazed Sashes	<b>77</b>
<b>7.6</b>	Wood Floors	<b>78</b>
<b>7.7</b>	Skirtings, Picture Rails, Moldings etc	<b>78</b>
<b>7.8</b>	Wood Stairs	<b>78</b>
<b>7.9</b>	Shelving	<b>78</b>
<b>7.10</b>	Trellis Works	<b>78</b>
<b>7.10.1</b>	Plain Trellis	<b>78</b>
<b>7.10.2</b>	Trellis Door and Window sashes	<b>78</b>
<b>7.11</b>	Pelmets	<b>79</b>
<b>7.12</b>	Mild Steel Bars or Grills in Wooden Frames	<b>79</b>
<b>7.12.1</b>	Fixing of mild Steel Bars in Wooden Frames	<b>79</b>
<b>7.12.2</b>	Fixing of Steel Grills	<b>79</b>
	Appendix –7A – Tables A1 + A2	<b>80-81</b>

## Chapter 8 – Metal Works

<b>8.0</b>	Metal Works – Definitions	<b>82</b>
<b>8.1</b>	Materials	<b>82</b>
<b>8.2</b>	Fabrication and Erection – Shop Work	<b>83</b>
<b>8.2.1</b>	Preliminaries	<b>83</b>
<b>8.2.2</b>	Shop preparation	<b>83</b>
<b>8.2.3</b>	Shop assembly	<b>84</b>
<b>8.2.4</b>	Riveting	<b>85</b>
<b>8.2.5</b>	Bolting	<b>85</b>
<b>8.2.6</b>	Welding	<b>85</b>
<b>8.2.7</b>	Machining of butts, caps and bases	<b>89</b>
<b>8.2.8</b>	Slab bases and caps	<b>90</b>
<b>8.2.9</b>	Marking	<b>90</b>
<b>8.2.10</b>	Painting	<b>90</b>
<b>8.3</b>	Erection – Site Work	<b>90</b>
<b>8.3.1</b>	Plant and Equipment	<b>90</b>
<b>8.3.2</b>	Storing and Handling	<b>90</b>
<b>8.3.3</b>	Permission	<b>90</b>
<b>8.3.4</b>	Setting out	<b>90</b>
<b>8.3.5</b>	Security during Erection	<b>90</b>
<b>8.3.6</b>	Modification to fabrication	<b>91</b>
<b>8.3.7</b>	Painting after Erection	<b>91</b>
<b>8.3.8</b>	Bedding of stanchion bases and bearing of Beams and Girders on stone, brick or concrete (plain or reinforced)	<b>91</b>
<b>8.3.9</b>	Encasing steel work	<b>91</b>
<b>8.3.10</b>	Erection of Trusses	<b>92</b>
<b>8.4</b>	Rolling Shutters	<b>92</b>
<b>8.4.1</b>	Shutters	<b>92</b>
<b>8.4.2</b>	Guide Channels	<b>92</b>
<b>8.4.3</b>	Fixing	<b>93</b>
<b>8.5</b>	Tubular roofs and columns	<b>93</b>
<b>8.5.1</b>	Structural steel tubes	<b>93</b>
<b>8.5.2</b>	Fabrication	<b>93</b>
<b>8.5.3</b>	Hoisting and Fixing	<b>94</b>
<b>8.6</b>	Steel doors, windows, ventilators and composite units	<b>94</b>

<b>8.6.1</b>	Materials	<b>94</b>
<b>8.6.2</b>	Protection	<b>94</b>
<b>8.6.3</b>	Workmanship	<b>94</b>
<b>8.7</b>	Aluminum framed sliding doors	<b>94</b>
<b>8.8</b>	Aluminum windows	<b>94</b>

## **Chapter 9 – Iron Mongery**

<b>9.0</b>	Iron Mongery – Definitions	<b>95</b>
<b>9.1</b>	Hinges	<b>97</b>
<b>9.1.1</b>	Knuckle type Hinges	<b>97</b>
<b>9.1.2</b>	Spring Hinges	<b>98</b>
<b>9.2</b>	Door Closer	<b>98</b>
<b>9.3</b>	Door Bolts	<b>99</b>
<b>9.3.1</b>	Sliding Bolts (Aldrops)	<b>99</b>
<b>9.3.2</b>	Barrel Bolts/tower Bolts	<b>99</b>
<b>9.3.3</b>	Flush Bolts	<b>100</b>
<b>9.4</b>	Mortise latch/Mortise lock/Mortise latch and Rim latch/ Rim lock/ Rim latch and lock	<b>100</b>
<b>9.5</b>	Door Handle	<b>100</b>
<b>9.6</b>	Casement Fastener	<b>101</b>
<b>9.7</b>	Casement Stays	<b>101</b>
<b>9.8</b>	Hooks and Eyes	<b>101</b>
<b>9.9</b>	Hasp and Staples	<b>101</b>

## **Chapter 10 – Floor Finishes**

<b>10.0</b>	Floor Finishes	<b>103</b>
<b>10.1</b>	Floor finishes with cement concrete/tiles lay tiles including Ceramic floor tiles/precast concrete slabs/natural stone slabs/natural slabs/artificial stone slabs/wire cut bricks	<b>103</b>
<b>10.1.1</b>	Materials	<b>103</b>
<b>10.1.1.1</b>	Clay Flooring Tiles	<b>104</b>
<b>10.1.1.2</b>	Cement Concrete Tiles	<b>104</b>
<b>10.1.1.3</b>	Chequered Tiles	<b>105</b>
<b>10.1.1.4</b>	Chequered Tiles for Stair treads	<b>105</b>
<b>10.1.1.5</b>	Bricks	<b>105</b>
<b>10.1.1.6</b>	Natural stone slabs	<b>105</b>
<b>10.1.1.7</b>	Artificial Stone (cast stone or reconstituted stones)	<b>105</b>
<b>10.1.1.8</b>	Bedding Mortar	<b>105</b>
<b>10.1.1.9</b>	Separating Layers	<b>105</b>
<b>10.1.2</b>	Laying	<b>105</b>
<b>10.2</b>	Granolithic Floor Finishes	<b>106</b>
<b>10.3</b>	Cement mortar / cement concrete floor finishes	<b>110</b>
<b>10.4</b>	Base Concrete	<b>110</b>
<b>10.5</b>	Cast-in-situ terrazzo floor finishes	<b>110</b>
<b>10.6</b>	Cast-in-situ terrazzo skirtings and wall linings	<b>114</b>
<b>10.7</b>	Terrazzo tile flooring	<b>115</b>
<b>10.8</b>	Glazed Tile Flooring and Skirting	<b>118</b>
<b>10.9</b>	Parquet Flooring	<b>119</b>
<b>10.10</b>	Skirting For Cement Rendered Floors	<b>120</b>

## Chapter 11 – Roof Covering & Roof Drainage

11.0	Roof Covering and roof Drainage – General	121
11.1	Galvanised corrugated steel sheet roofing	121
11.1.1	Materials	121
11.1.2	Workmanship	121
11.2	Rigid PVC Profiled Sheets & Glass Fibre Reinforced Plastic (GRP)	123
11.2.1	Materials	123
11.2.2	Workmanship	123
11.3	Valley gutters of plain galvanised steel sheets	124
11.4	Flashing	124
11.5	Gutters	124
11.5.1	Gutters of Plain Galvanised Steel sheets	124
11.5.2	Asbestos Cement Gutters	125
11.5.3	UPVC Gutters	125
11.6	Rain water pipes	126
11.6.1	Galvanised Steel Rain water pipes	126
11.6.2	Asbestos Cement Rainwater Pipes	126
11.6.3	Cast iron rainwater pipes	126
11.6.4	UPVC Pipes	127

## Chapter 12 – Plastering

12.0	Plastering	128
12.1	Lime Plaster – 15 mm thick	128
12.2	Lime-cement Plaster – 15 mm thick	129
12.3	15 mm Thick Cement Plaster on Masonry/Brick Work	129
12.4	18 mm Thick Coloured Cement Plaster – 2 coat work	130
12.5	Cement Plaster on Concrete Surfaces	130
12.6	20 mm thick 2 coat work	131
12.7	20 mm thick rough cast plaster	132
12.8	Lath and Plaster	133

## Chapter 13 – Glazing

13.0	Glazing	134
13.1	Materials	134
13.2	Workmanship	135

## Chapter 14 – Painting and Decoration Definitions

14.0	Painting and Decoration Definitions	137
14.1	White washing and colour washing of new walls	143
14.2	White washing & Colour Washing of old walls	143
14.3	Distempering new surfaces with oil bound distemper	144
14.4	Distempering old walls with oil bound distemper	145
14.5	Cement Painting New Surfaces	145
14.6	Cement Painting old surfaces	145
14.7	Painting new surfaces with plastic emulsion paint	146
14.8	Painting of old surfaces with plastic emulsion paint	146
14.9	Painting	146
14.9.1	Painting new woodwork	148

<b>14.9.2</b>	Repainting old wood work	<b>149</b>
<b>14.9.3</b>	Painting new iron / steel surfaces	<b>149</b>
<b>14.9.4</b>	Repainting old iron/steel work	<b>150</b>
<b>14.9.5</b>	Painting of new plastered surfaces	<b>151</b>
<b>14.9.6</b>	Repainting of old plastered surfaces	<b>151</b>
<b>14.10</b>	Varnishing of new surfaces	<b>151</b>
<b>14.11</b>	Varnishing old surfaces	<b>153</b>
<b>14.12</b>	French Polishing of new surfaces	<b>153</b>
<b>14.13</b>	French Polishing of old surfaces	<b>153</b>
<b>14.14</b>	Wax polishing of new surfaces	<b>154</b>
<b>14.15</b>	Waxing old surfaces	<b>154</b>
<b>14.16</b>	Removing old paint	<b>154</b>
<b>14.17</b>	Painting cast iron Rainwater and steel pipes	<b>155</b>

## **Chapter 15 – Miscellaneous Building Works**

<b>15.0</b>	Miscellaneous Building Works	<b>156</b>
<b>15.1</b>	Damp proof course	<b>156</b>
<b>15.2</b>	Damp proofing of walls/tanking	<b>156</b>
<b>15.3</b>	Floor screeds/Roof screeds	<b>156</b>
<b>15.4</b>	Wall Tiling and Mosaic Work	<b>158</b>
<b>15.5</b>	Fiber Board Ceiling	<b>160</b>
<b>15.6</b>	Proprietary Ceiling System	<b>160</b>
<b>15.7</b>	Plastering for slab bearing	<b>160</b>
<b>15.8</b>	Plastering for Slab Bearing	<b>160</b>

## **Chapter 16 – Sanitary Installations**

<b>16.1</b>	General	<b>163</b>
<b>16.2</b>	Appliances	<b>163</b>
<b>16.3</b>	Pipe Work	<b>167</b>
<b>16.4</b>	Installation Of Sanitary Appliances	<b>167</b>

## **PART II**

### **Chapter 1 – General Requirements**

<b>1.1</b>	Introduction to the Specifications	<b>174</b>
<b>1.2</b>	Scope of Work	<b>174</b>
<b>1.3</b>	Drawings	<b>174</b>
<b>1.3.1</b>	Tender Drawings	<b>174</b>
<b>1.3.2</b>	Working Drawings or Shop Drawings	<b>174</b>
<b>1.4</b>	Standards and Regulations	<b>174</b>
<b>1.5</b>	Electricity Supply	<b>175</b>
<b>1.6</b>	Materials and Samples	<b>175</b>
<b>1.7</b>	Manufacturer's Data	<b>175</b>
<b>1.8</b>	Accessibility	<b>175</b>
<b>1.9</b>	Setting out of Works	<b>175</b>

## **Chapter 2 – Wiring System Using PVC for Sheathed Cables**

<b>2.1</b>	PVC Insulated and Sheathed Cables	<b>176</b>
<b>2.2</b>	Boxes for the Enclosure of Electrical Accessories	<b>176</b>
<b>2.3</b>	Electrical Accessories	<b>176</b>
<b>2.4</b>	Joint Boxes	<b>176</b>
<b>2.5</b>	Installation	<b>176</b>
<b>2.5.1</b>	Plastic Casings	<b>176</b>
<b>2.5.2</b>	Segregation of Service	<b>176</b>
<b>2.5.3</b>	Protection of Cables	<b>176</b>

## **Chapter 3 – Wiring Systems Using PVC Cables Enclosed in Conduit or Trunking**

<b>3.1</b>	Wiring System	<b>178</b>
<b>3.2</b>	Steel Conduit and Conduit Fittings	<b>178</b>
<b>3.2.1</b>	Protection against Corrosion	<b>178</b>
<b>3.2.2</b>	Adaptable and Junction Boxes of Metal	<b>178</b>
<b>3.2.3</b>	Termination of Conduits	<b>178</b>
<b>3.2.4</b>	Spacer Bar Saddles and Distance Saddles	<b>178</b>
<b>3.2.5</b>	Conduit Couplers and Bends	<b>179</b>
<b>3.3</b>	Rigid PVC and Conduit Fittings	<b>179</b>
<b>3.3.1</b>	Boxes (Adaptable for Accessories) of Plastic Material	<b>179</b>
<b>3.4</b>	Adhesive Tape	<b>179</b>
<b>3.5</b>	Installation	<b>179</b>
<b>3.5.1</b>	General	<b>179</b>
<b>3.5.2</b>	Trunking	<b>180</b>

## **Chapter 4 – Wiring System using Elastomer or PVC Insulated Multi Core Cables**

<b>4.1</b>	General	<b>181</b>
<b>4.2</b>	Elastomer – Insulated Cables Unarmoured	<b>181</b>
<b>4.3</b>	Elastomer – Insulated Cables – Wire Braided	<b>181</b>
<b>4.4</b>	PVC Insulated Cables – Unarmoured	<b>181</b>
<b>4.5</b>	PVC Insulated Cables – Armoured	<b>181</b>
<b>4.6</b>	Cable Supports	<b>181</b>
<b>4.7</b>	Cable Glands	<b>181</b>
<b>4.8</b>	Installation	<b>181</b>

## **Chapter 5 – Switchgear, Distribution Boards, Circuit Breakers, Contactors and Busbar Chambers**

<b>5.1</b>	Rated Voltage and Frequency	<b>182</b>
<b>5.2</b>	Enclosure	<b>182</b>
<b>5.3</b>	Fuses	<b>182</b>
<b>5.4</b>	Switchgear	<b>182</b>
<b>5.5</b>	Distribution Boards	<b>182</b>
<b>5.6</b>	Consumers Control Units	<b>182</b>
<b>5.7</b>	Moulded Case Circuit Breakers and Enclosures	<b>182</b>
<b>5.8</b>	Miniature Circuit Breakers	<b>183</b>
<b>5.9</b>	Busbar Chambers and Busbars	<b>183</b>
<b>5.10</b>	Iron Work for Switch Frames	<b>183</b>
<b>5.11</b>	Installation of Main Switch Gear and associated equipment	<b>183</b>
<b>5.12</b>	Identification of Switchgear and Distribution Boards	<b>183</b>



<b>5.13</b>	Surge Protectors and Arrestors	<b>184</b>
<b>5.14</b>	Current Transformers	<b>184</b>
<b>5.15</b>	Low Voltage Main Switch Board (110-1000V)	<b>184</b>

## **Chapter 6 – Apparatus Including Wiring Accessories**

<b>6.1</b>	Accessories	<b>185</b>
<b>6.2</b>	Switch Boxes, Socket Outlet Boxes	<b>185</b>
<b>6.3</b>	Switch Plates and Sockets Outlet Plates	<b>185</b>
<b>6.4</b>	Switches	<b>185</b>
<b>6.5</b>	Cord Operated Switches	<b>185</b>
<b>6.6</b>	Switch – Socket Outlets & Plugs	<b>185</b>
<b>6.7</b>	Light Dimmer and Fan Speed Control Switch	<b>185</b>
<b>6.8</b>	Socket Outlets and Plugs	<b>185</b>
<b>6.9</b>	Switch – Socket Outlets & Plugs	<b>185</b>
<b>6.10</b>	Fused connection units for Electric Clocks	<b>185</b>
<b>6.11</b>	Ceiling Fans	<b>186</b>
<b>6.12</b>	Exhaust Fans	<b>186</b>
<b>6.12.1</b>	Light Proof Cowls	<b>186</b>
<b>6.12.2</b>	Weather Proof Cowls	<b>186</b>
<b>6.13</b>	Shaver Sockets	<b>186</b>
<b>6.14</b>	Cooker Control Unit	<b>186</b>
<b>6.15</b>	Operating Theatre Power Column	<b>186</b>
<b>6.16</b>	Time Delay Switches	<b>186</b>
<b>6.17</b>	Insulated Terminal Blocks	<b>187</b>
<b>6.18</b>	Installation of Accessories	<b>187</b>
<b>6.19</b>	Emergency Generators/UPS Systems	<b>187</b>
<b>6.20</b>	Power Factor Correction/Harmonic Filters	<b>187</b>
<b>6.21</b>	Distribution Transformers	<b>187</b>

## **Chapter 7 – Lighting Fittings and Ancillary Equipment and Lamps**

<b>7.1</b>	Lighting fitting for use with Tungsten Filament Lamps	<b>188</b>
<b>7.1.1</b>	General	<b>188</b>
<b>7.1.2</b>	Bracket Fittings	<b>188</b>
<b>7.1.3</b>	Water Tight Bracket Fittings	<b>188</b>
<b>7.2</b>	Lighting Fitting for use with Mercury Electric Discharge Lamps	<b>188</b>
<b>7.3</b>	Lamp Holders	<b>188</b>
<b>7.4</b>	Ceiling Roses	<b>188</b>
<b>7.5</b>	Operating Theatre Lamp	<b>188</b>
<b>7.6</b>	Pendants	<b>189</b>
<b>7.6.1</b>	Plain	<b>189</b>
<b>7.6.2</b>	Tube	<b>189</b>
<b>7.6.3</b>	Fluorescent Fittings	<b>189</b>
<b>7.7</b>	Flexible Cord	<b>189</b>
<b>7.7.1</b>	Flexible Cords for use with Lighting Pendants and Electric Lighting Fittings	<b>189</b>
<b>7.8</b>	Flexible Steel Conduits and Adaptors	<b>190</b>
<b>7.9</b>	Flexible Non-Metallic Reinforced type Conduit	<b>190</b>
<b>7.10</b>	Ceiling Fittings	<b>190</b>
<b>7.11</b>	Installation of Apparatus and Light Fittings	<b>190</b>

## **Chapter 8 – Perforated Metal Cable Tray and Accessories**

<b>8.1</b>	Perforated Cable Tray	<b>191</b>
<b>8.2</b>	Bends and Tees	<b>191</b>
<b>8.3</b>	Installation	<b>191</b>

## **Chapter 9 – Bell and Audible Wiring System**

<b>9.1</b>	Wiring Systems	<b>192</b>
<b>9.2</b>	Conduits and Trunking	<b>192</b>
<b>9.3</b>	Cables	<b>192</b>
<b>9.4</b>	Transformers	<b>192</b>
<b>9.5</b>	Electrical Bell, Buzzer and Bell Indicator Board Accessories and Fittings	<b>192</b>
<b>9.6</b>	Electric Buzzer	<b>192</b>
<b>9.7</b>	Bell Indicator Boards	<b>192</b>
<b>9.8</b>	Bell Pushes	<b>192</b>
<b>9.8.1</b>	Ordinary type	<b>192</b>
<b>9.8.2</b>	Flush type	<b>192</b>
<b>9.8.3</b>	Surface Conduit	<b>192</b>

## **Chapter 10 – Flame Proof Installation**

<b>10.1</b>	General	<b>193</b>
<b>10.2</b>	Wiring System	<b>193</b>
<b>10.3</b>	PVC Insulated Cables	<b>193</b>
<b>10.4</b>	Multi-Core Cables	<b>193</b>
<b>10.5</b>	Mineral Insulated Cables	<b>193</b>
<b>10.6</b>	Conduits, Conduit Fittings and Terminal Boxes	<b>193</b>
<b>10.7</b>	Apparatus (Fixed)	<b>193</b>
<b>10.8</b>	Lighting Fittings	<b>193</b>
<b>10.9</b>	Installation	<b>193</b>
<b>10.9.1</b>	Conduit	<b>193</b>
<b>10.9.2</b>	Mineral Insulated Cables	<b>193</b>
<b>10.9.3</b>	Multi-Core Cables	<b>193</b>
<b>10.9.4</b>	Apparatus	<b>193</b>

## **Chapter 11 – The Protection of Structures against Lightning**

<b>11.1</b>	General	<b>194</b>
<b>11.2</b>	Accessories and Fittings	<b>194</b>
<b>11.2.1</b>	Air Terminals (Finials)	<b>194</b>
<b>11.2.2</b>	Roof Conductors	<b>194</b>
<b>11.2.3</b>	Down Conductors	<b>194</b>
<b>11.2.4</b>	Earth Terminals	<b>194</b>
<b>11.2.5</b>	Ridge Blocks and Wall Blocks	<b>194</b>
<b>11.3</b>	Installation	<b>194</b>
<b>11.3.1</b>	Air Terminals (Finials)	<b>194</b>
<b>11.3.2</b>	Roof Conductors	<b>194</b>
<b>11.3.3</b>	Down Conductors	<b>194</b>
<b>11.4</b>	Earth Terminations and Test Points	<b>195</b>

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## **Chapter 12 – Earthing**

<b>12.1</b>	General	<b>196</b>
<b>12.2</b>	Earth Leakage Circuit Breakers (Residual Current Operated Circuit Breakers)	<b>196</b>
<b>12.3</b>	Earth Electrode	<b>196</b>

## **Chapter 13 – Testing**

<b>13.1</b>	Testing by Contractor	<b>197</b>
<b>13.2</b>	Testing for the Supply Authority	<b>197</b>
<b>13.3</b>	Tests & Certificates to IEE Wiring Regulations	<b>197</b>

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## **PART I**

### **1.0 MATERIALS**

Material used shall be the best of its kind. It shall conform to the relevant British standards.

### **1.1 WATER**

All water used for mixing concrete, mortar or grout shall be obtained from a source approved by the officer-in-charge. The water shall be fresh, clean and free from acid, alkali, oil organic impurities, lime in solution or other material which is deleterious to concrete or steel. In general portable water shall be used.

As a guide, the following concentration may be taken to represent the maximum permissible limits of deleterious materials in water.

- (a) Suspended water – 2,000 mg/litre
- (b) Dissolved matter (max, concentration)
  - 1. Sodium & Potassium Bicarbonate 1,000 mg/litre
  - 2. Sodium Chloride 20,000 mg/litre
  - 3. Sodium Sulphate 10,000 mg/litre
  - 4. Ca + Mg Bicarbonate as HCO<sub>3</sub> 400 mg/litre
  - 5. Calcium Chloride 20,00 mg/litre
  - 6. Iron Salts 40,000 mg/litre
  - 7. Sodium Iodate, Phosphate, Arsonate & Borate 500 mg/litre
  - 8. HCL + H<sub>2</sub>SO<sub>4</sub> – 10,000 mg/litre
  - 9. NaOH – 5,00 mg/litre
- (c) pH value of water shall generally be not less than 6

Sea water shall not be permitted for mixing or curing of concrete.

Water found satisfactory for mixing is also suitable for curing concrete; however, water used for curing shall not produce any objectionable stain or unsightly deposit of the concrete surface. The presence of tannic acid or iron compounds is objectionable.

The concrete shall make arrangements for and provide all the water necessary for concrete, mortar, curing or any other purpose on the work.

## 1.2 CEMENT

### GENERAL

Cement shall be from an approved source and shall one of the following types of cement as specified.

Type	In accordance with
Ordinary Portland Cement	R.S 12
Rapid hardening Portland Cement	B.S 12
White Portland Cement	
Coloured Portland Cement	
Portland Blast furnace cement	B.S. 146
Low heat Portland Cement	B.S. 1370
Sulphate resisting Portland Cement	B.S. 4027
Low heat Portland blast (furnace cement)	B.S. 4246
Super Sulphated Cement	B.S. 4248
Ultra high early strength Portland Cement	] The requirements for physical ] properties for ordinary Portland ] Cement given in C.S. 107 or B.S. 12 ] B.S. 413 -1
Water Repellent Portland Cement	
Hydro-phobic Portland Cement	
Masonry Cement	

The initial setting time shall not be less than 45 minutes and the final setting time not more than 10 hours for ordinary Portland cement.

Note: Masonry cement conforming to B.S. 413 – 1 shall not be used for structural concrete. It may only be used for non-structural concrete, masonry mortars and for plastering flooring.

Special precaution shall be taken in storing and issuing of masonry cement to prevent confusing with cement to be used for structural concreting.

### 1.2.1 SUPPLY

The cement shall be packed in bags (multiply paper, or cloth). Alternatively it may be supplied at site in soils installed for the purpose.

### 1.2.2 TRANSPORT, STORAGE AND HANDLING

The cement needed for concrete mortar and grout shall be purchased by the contractor to suit the construction schedule. He shall make all necessary arrangements and be responsible for transporting, storing and handling it.

Cement shall be stored on the site in such manner as to facilitate identification or inspection of each consignment. The storage sheds shall be of weather proof construction and the floors shall be free from all possibilities of flooding. Chipping up or re-using of partially set cement shall not be allowed. The bags shall be stacked at least 100 to 200 mm clear above floor level over wooden planks and joints. A spacing of 600 mm should be kept between the exterior walls in the stack to reduce circulation or air to the minimum. To avoid lumping under pressure, cement bags shall not be stacked more than 10 bags high. Extra precaution shall be taken during monsoons or when cement is to be stored for usually long periods; the stack shall be enclosed completely in thick polythene sheet, canvas sheets or any other suitable water proof sheeting, with the flap closing on the top of the stack. Care shall be taken to see that the water proof sheeting, with the flap closing on the top of the stack. Care shall be taken to see that the water proof covering is not damaged at any time during use. When removing cement bags for use the “first in, first out” rule shall be applied.

In the case of large works, the storage capacity shall be adequate to ensure uninterrupted work in accordance with construction schedule.

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Storage of cement at the site of work shall be at the contractor's expense and risk.

### **1.2.3 TESTING OF CEMENT**

The officer-in-charge may extract samples of consignments of cement as and when he desires for the purpose of testing. Testing shall conform to B.S. 12 for Portland Cement and to the relevant British Standards for other cements. If the sample fails the test, the particular consignment shall be rejected and shall be removed from the site within 24 hours of notice in writing to the contractor to do so. Any consignment of cement stored at site for more than 3 months shall be re-tested if so required by the officer-in-charge.

If the contractor provides the cement, he shall arrange for the cement to be delivered at the site in sufficient time for standard tests to be made before the cement is required for use, or provide certificates of tests from the supplier that will be acceptable to the Officer-in-charge.

### **1.3 LIME**

Lime shall be obtained from an approved source; it shall be one of the following types, depending on the raw material from which it was manufactured,

- Type 1 Dolomitic Lime
- Type 2 Burnt Miocene lime stone

Lime which has perished, or which has been damaged by damp, rain or intermixture of dirt, or which has become partially airslaked shall on no account be used on the works and shall be removed from the site within 24 hours of notice to remove. Lime which gives a residue of more than 10 percent by weight when tested with hydrochloric acid shall be rejected.

The lime stored at the work site shall be protected from weather action, by being kept in a weather proof shed with impervious floor and sides.

#### **1.3.1 QUICK LIME**

This shall be freshly burnt from limestone broken to a uniform size not exceeding 40 mm and carefully freed from earth and other impurities.

The lime shall be delivered at the site of the mortar mill quite fresh, i.e. within 15 days of the date on which it was drawn fresh from the kiln. In cases where compliance herewith is not possible due to seasonal closure of kilns, written permission of the Officer-in-charge is necessary before stored slaked lime can be used.

#### **1.3.2 HYDRATED/SLAKED LIME**

All impurities, ashes, or pieces improperly or carelessly burnt shall be screened or picked out before slaking. Quick lime shall be slaked with sufficient water; slaking shall be done neither earlier than three weeks nor later than one week before being put into the mill.

The lime after slaking shall be screened through a sieve of such size as the Officer-in-charge may direct and all stuff that does not pass through the sieve shall be rejected. For plastering second and third coat or for any fine work, unless otherwise specified, the lime shall pass through a 1.18 mm B.S. Test sieve: for all other work, unless otherwise specified the lime shall pass a 2.36 mm BS Test sieve wire screen.

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### **1.3.3 LIME PUTTY**

Lime putty shall be obtained by treating either quicklime or hydrated lime with sufficient water so as to produce a plastic, sound product.

It shall be sieved to be entirely free from coarse particles and shall be thoroughly matured for not less than 16 hours before use.

### **1.4 FINE AGGREGATE FOR CONCRETE**

This shall conform to BS 882. See Chapter 4

### **1.5 COARSE AGGREGATE FOR CONCRETE**

Coarse aggregate for granolithic floor finishes shall be as specified in Chapter 4

### **1.6 BUILDING SANDS FROM NATURAL SOURCES**

The sand may be naturally occurring like river sand, pit sand or crushed stone sand. It shall generally conform to BS 1198 BS 1193 and BS 1200. It shall be hard, durable, clean free from adherent coatings such as clay. It shall not contain harmful materials like pyrites, salts, coal or other organic impurities mica, shale or similar laminated materials, or flaky or elongated particles in such a form or insufficient quantity to affect adversely the hardening, strength or durability of the mortar. In addition to the above, the sand when used for reinforced brick work shall not contain any material which may attack the reinforcement.

The quantity of clay, silt and dust shall not exceed the following unless there is satisfactory evidence to the contrary:

In natural sand – 3% by mass when determined by the decantation method given in B.S. 812.

In crushed stone sand – 15% by mass when determined by the sedimentation method given in B.S. 812.

#### **1.6.1 GRADING**

Sand for brickwork/stone work / block work and external plastering shall pass completely through a sieve of 2.36 mm sand for second and third coats of plastering, pointing and fine work shall completely pass through a 1.18 mm test sieve.

### **1.7 METHODS OF STACKING**

Material normally measured in stacks are rough stone of all kinds, broken stone and broken brick, gravel, sand and lime. However for purposes of mixing of mortar concrete etc. materials like sand, broken stone etc, shall be measured in properly constructed measuring boxes (or by weight as instructed by the Officer-in-charge) to suit the specified proportions of those materials.

Piles shall be formed of regular shape and uniform gross section.

Materials shall not be stacked on uneven ground or in any manner which does not permit correct and ready measurement from external inspection of the piles.

Rough stone which is to be measured in the stack shall be packed so closely as to give the minimum quantity of voids possible, without actual dressing of the stones to fit the interstices.

### **1.8 OTHER MATERIAL**

Materials not dealt with in this chapter will be specified in the relevant chapters.

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## **2.0 SITE PREPARATION, EXCAVATION & EARTHWORK**

### **2.1 SITE WORK**

#### **GENERAL**

The area described or shown on the relevant site plan or bill of quantities shall be cleared of all obstructions, roots and growth, vegetation of every description, trees and saplings. Unless otherwise specified, 150 mm top soil shall be removed from that part of the site to be occupied by the proposed buildings and for a distance of 3 metres around it and the area levelled. The top soil shall be preserved in stock piles if so directed by the Officer-in-charge.

#### **2.1.1 EXISTING SERVICES**

Particulars of over/under ground services shall be obtained from the Employer before commencing any work which may affect such services.

These services shall be maintained/diverted/plugged/dismantled as specified or directed. In case the drain ends required to be sealed off, contaminated earth shall be removed and disinfected as specified.

#### **2.1.2 DEMOLITION OF EXISTING STRUCTURES**

Where buildings are to be demolished this shall be done to ground level, or the bottom of the posts, stanchions, etc. as specified. Special care shall be taken to cause the minimum damage to the materials in the process of dismantling. The value of the materials which in the opinion of the Officer-in-charge have been broken or damaged through carelessness on the part of the contractor will be recovered from the contractor. All serviceable materials shall be removed and stacked or disposed or disposed as specified, and all debris shall be carted away by the contractor.

#### **2.1.3 FELLING AND REMOVAL OF TREES**

The trees shall be cut only after written permission of the Officer-in-charge is obtained.

The roots of trees shall be removed completely and the hollows filled up with suitable earth in layers of 150 mm levelled and rammed so that the surface at these points conforms to the surrounding areas.

Wood, branches of trees and other useful materials shall be handed over to the Officer-in-charge. The felled trees shall be cut to such lengths as directed by the Officer-in-charge, trunks and branches cleared of limbs and tops and stacked neatly, well away from the site of work. Other serviceable materials shall be stacked as directed and handed over to the Officer-in-charge.

#### **2.1.4 DISPOSAL OF WASTE MATERIALS**

At the conclusion of the site work, the contractor shall tidy up and leave the site of the work in a clean and sanitary condition. All unserviceable material shall be removed from the area and disposed of as directed. Care shall be taken to see that the unsuitable waste materials are disposed of in such a manner that there is likelihood of those getting mixed up with materials meant for construction.

#### **2.1.5 WATERWAYS**

All field drains and other water ways encountered during the excavations shall be temporarily diverted and reinstated or otherwise taken care of, as directed by the Officer-in-charge.

Filling of the location from which water courses have been diverted shall be commenced after clearing away all vegetable growths and soft deposits.



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## **2.2 EXCAVATIONS**

Note: The contractor shall visit the site, inspect the trial holes or bores where available, and decide for himself the nature of the ground, subsoil to be excavated and the ground water levels. The furnishing of particulars of trial holes or bores for the information of the contractor does not absolve the contractor from his responsibilities nor does it guarantee that similar conditions apply on other parts of the site.

### **2.2.1 ESTABLISHMENT OF LEVELS**

#### **2.2.1.1 BENCHMARKS**

A masonry pillar of a suitable design shall be erected at a prominent places in the site to serve as a benchmark for the execution of the work. The benchmark shall be so located that it remains undisputed till all the works are completed. This shall be connected to a Standard Bench Mark if so directed by the Officer-in-charge.

#### **2.2.1.2 LEVELS**

Before any excavations is commenced, the level of the surface after removal of top soil shall be agreed by the Officer-in-Charge and the Contractor. Such agreement shall be recorded on a drawing showing levels at a predetermined intervals, and shall be signed by the contractor and the Officer-in-charge. The contractor shall provide all labour and instruments to obtain and record these levels.

### **2.2.2 CLASSIFICATION OF SOILS**

Excavation in various types of material shall be classified under the following categories. No distinctions shall be made whether the material is dry or wet. The decision for the Officer-in-Charge with regard to the classification shall be final.

(a) Soft/loose soil

Generally and soil which yields to the ordinary application of pick and shovel, rake or other ordinary digging implements for example vegetable or organic soil, turf, gravel, sand, salt, silt, loam, clay, peat etc.

(b) Hard / dense Soil

Generally any soil which requires the close application of picks jumpers or scarifiers to loosen same for example, stiff clay, gravel and cobble stone.

Note: Cobble stone is the rock fragment usually rounded or semi rounded having maximum diameter in any direction between 80 mm and 300 mm.

(c) Mud – A mixture of soil and water in a fluid or weak state.

(d) Soft disintegrated rock (not requiring blasting)

This shall include rock or boulders which can be excavated by barring, wedging and splitting manually or using pneumatic tools. It shall also include embedded boulders measuring not more than one metre in any one direction.

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Note: The mere fact that the contractor resorts to blasting to loosen the material shall not mean that it will be classified as hard rock.

(e) Hard rock (requiring blasting)

This shall include all rock occurring in large masses which cannot be removed except by blasting. Hard varieties of rock such as granite with or without veins and secondary minerals which in the opinion of Officer-in-charge requires blasting shall be considered as hard rock. Boulders of hard rock larger than one metre in any one direction lying in the overburden and requiring to be blasted for easy and efficient removal shall also be classified as hard rock.

(f) Hard Rock (blasting prohibited)

For hard rock requiring blasting as described in (e) but where blasting is prohibited, the excavations has to carried out by chiselling, wedging or any other agreed method. Refer clause 2.2.3

(g) Common Excavations

This shall refer to excavation in all soils except rock requiring blasting with the use of excavating and earth moving machinery.

### **2.2.3 BLASTING**

Should rock be met with, in the course of excavations, it must be removed with wedges and levers. Blasting shall not be allowed without the written permission of the Officer-in-charge, who must be fully informed by the contractor as to the steps taken by his to safeguard the surrounding property: the contractor shall take all responsibility for any damage or annoyance caused by way of blasting.

In soft rock, if the contractor wishes to resort to blasting, he can do so only with the permission of the Officer-in-charge, but at no extra cost.

### **2.2.4 ANTIQUITIES AND USEFUL MATERIALS**

Any finds such as relics of antiquity, coins, fossils or other articles of value which may be discovered during the excavation work shall be the property of the Employer and shall be delivered to the Officer-in-charge.

All useful materials obtained from the excavation shall be the property of the employer and shall be stacked separately in regular stacks as directed by the Officer-in-charge.

### **2.2.5 PROTECTION**

Trenches and foundation pits shall be provided with proper caution signals and marked with red lights at night to avoid accidents.

The contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures, services etc.

### **2.2.6 REINSTATEMENT OF DAMAGE DURING EXCAVATIONS**

All materials, structures, foundations, surfaces, etc. affected or damaged during excavation shall be made good by the contractor at no extra cost to the Employer.

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### **2.2.7 ANTI-TERMITE TREATMENT**

The treatment may be pre-constructional or post constructional. Where specified, the work shall be carried out according to standard techniques and practices using chemical of approved make and concentrations, and as directed by the Officer-in-charge.

### **2.2.8 STABILITY OF EXCAVATION**

The methods of excavation shall in every case, be subject to the approval to the Officer-in-charge and the contractor shall ensure the stability and safety of the excavation, adjacent structures, services and the works.

The sides of the excavation shall be timbered and shored by a proper method previously approved by the Officer-in-charge.

The contractor shall have full responsibility for the stability of the excavations and safety of workmen. If any slip occurs, the Contractor shall remove all the slipped materials from the excavated pit without payment. If any damage to a built up structure occurs because of the slip, the Contractor shall make good without any payment.

### **2.2.9 EXCAVATION FOR FOUNDATIONS**

Excavation for foundations shall be taken to the natural firm ground and to the depths indicated in the drawings. Specific instructions shall be obtained from the Officer-in-charge.

- (1) the natural bearing stratum occurs at a depth less/more than that indicated.
- (2) The nature of the bearing stratum vastly differs in its bearing characteristics.

In the case of sloping site, all work including foundation excavation, construction and backfilling shall be completed at the lower locations before the excavations at the higher location in commenced.

The bed of the excavation shall generally be made horizontal and stepped in the case of sloping ground or when the bearing stratum requires such stepping.

Excavation for foundation in steeply sloping sites or sites on rock shall conform to drawings specially prepared for the purpose or approved by the Officer-in-charge. (some guidance notes are given in appendix 2.A)

Excavations shall be made to the correct profiles and levels shown on the drawings, trimmed to exact shape: and all disturbed material and other debris removed. Excavated material shall not be placed closer than one metre from the outer edge of the excavation.

The bed of the excavation shall be consolidated by watering and ramming. Soft/defective spots shall be dug out and filled with lean concrete or other materials as directed by the Officer-in-charge. In case any excavation has been made below level shown or required the contractor shall, at his own expense, fill up the excavation to proper level with lean concrete or other material as directed by the officer-in-charge.

Excavations are to be inspected by the Officer-in-charge and the work approved before any further work or concrete or backfill is laid on them. Concrete or back fill shall be laid as soon as possible after inspection to prevent deterioration due to water or weather. The contractor shall take sufficient precautions against deterioration of excavated surfaces. If surfaces become unsuitable due to water or other causes, deteriorated surfaces shall be removed and replaced with concrete as directed by the officer-in-charge. The above shall be at the contractor's expense if it is caused by negligence or for want of precautions on the part of the contractor.

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### **2.2.10 DISPOSAL OF SURPLUS MATERIAL**

All surplus material shall be carried away from the site and dumped at dumping sited selected by the officer-in-charge upto the lead specified in the bill of quantities. The officer-in-charge may instruct the contractor to dump the excavated materials in regular heaps, bunds, blankets, ripraps with regular slopes as directed and levelled so as to provide natural drainage. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and top.

### **2.2.11 DEWATERING**

The contractor shall provide, maintain and operate sufficient pumping equipment of the required capacity to keep the area of construction free of water from rain, drains, floods springs etc, during the construction period at no extra cost to the Employer.

#### **METHOD OF DEWATERING**

The contractor shall obtain the written permission of the officer-in-charge for the method he would use to keep the excavations free from water, the procedure adopted shall not result in the withdrawal of water/or soil from underneath the foundations of adjacent sites.

### **2.2.12 PLANKING AND STRUTTING**

Excavation with vertical sides shall be kept supported by planking and strutting which shall be 'close' or 'open' depending on the nature of the soil and the depth of the trench. The support required shall generally conform to section 10 of BS CP 2003.

Guideline to the type and extent of support required is given in Appendix 2B.

Support for trench excavation along of public road shall be adequate design and to the satisfaction of the Highway Authority.

#### **2.2.12.1 CLOSE PLANKING AND STRUTTING**

Close planking and strutting shall completely cover the sides of the trench, generally with short, upright members called 'poling boards'. These shall be 250 mm x 38 mm in section on or as directed by the officer-in-charge. The board shall generally be placed in position vertically in pairs, one board on each side of the cutting.

These shall be kept apart by horizontal walings or strong wood at a minimum spacing of 1200 mm cross struttred as approved by the officer-in-charge. The length and girth of the struts shall depend upon the width of the trench.

Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical 'walings' which shall be struttred to similar timber pieces on the opposite face of the trench.

The lowest boards supporting the sides, shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded with systematically to the other end. Concrete or masonry shall not be damaged while removing the planks. No claim from the contractor shall be entertained, for any timber which cannot be withdrawn or is lost or buried, unless such timber has been left permanently in position at the request of the officer-in-charge.

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### **2.2.12.2 OPEN PLANKING AND STRUTTING**

In case of open planking and strutting, the entire side surface of the trench is not required to be covered. The vertical boards of 250 mm x 38 mm shall be spaced sufficiently apart to leave unsupported strips of about 500 mm average width. The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of the officer-in-charge. In all other respects, open planking and strutting shall comply with the clause 2.2.12.1 for close planking and strutting.

### **2.3 FILLING AROUND FOUNDATIONS IN PITS, TRENCHES, PLINTHS ETC**

No filling in shall be done until the concrete foundations, brickfootings etc, have been inspected and approved by the officer-in-charge.

All clods of earth shall be broken or removed. Material for backfilling shall generally be obtained from the spoil of excavations but the officer-in-charge shall have the option in case of shortage of good selected earth obtainable from excavation, to direct the contractor to get suitable filling materials from other sources.

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick-bats mortar droppings etc, it shall then be filled with earth in layers not exceeding 150 mm in thickness, each layer being watered, rammed and properly consolidated before, the succeeding one is laid. The final surface shall be trimmed and levelled to proper profile.

When the area around the building is to be filled to a height more than 600 mm above the existing ground level, the filling inside and outside the building shall be carried out simultaneously in order to relieve the earth pressure on foundation walls. The contractor shall be responsible for making good at his own expense any damage occurring to any part of the building, which in the opinion of the officer-in-charge is due to the neglect of this precaution.

On no account will sea sand be allowed for any filling.

### **2.4 EXCAVATION AND BANKING (ON FILLING)**

#### **2.4.1 CUTTING**

The work shall be executed true to levels, slope shape and pattern indicated in the plan or as directed by the officer-in-charge. During excavation the natural drainage of the area shall maintain by the contractor.

Cutting shall be done from top to bottom. Under no circumstances shall undermining be allowed. All cutting shall be done to the required levels. In case it is taken deeper by the contractor, it shall be brought to the required levels by filling with earth only consolidated and at contractor's cost. However, in the case of hard rock, where blasting operations have been resorted to, cutting shall be measured to the actual levels, provided the officer-in-charge is satisfied that he contractor has not gone any deeper than was unavoidable.

#### **2.4.2 FILLING/BLANKING**

The earth from cutting shall, after approval by the officer-in-charge, be directly used for filling without claim for double handling. Filling shall be done in regular horizontal layers not exceeding 150 mm in depth. The surface of ground which is to receive filling, and having a gradient greater than 1 in 5 shall have horizontal benches cut to match the depths of compacted layers of filling. The earth shall be free from all roots, grass and rubbish and all lumps and clods exceeding 80 mm in any direction shall be broke. Each layer shall be consolidated after breaking all lumps and clods by ramming. Watering shall

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be done as directed by the officer-in-charge. Where specified, the top surface of the finally finished area shall be neatly dressed to lines and levels.

The finished formation levels of filling shall be kept higher than the required levels by making an allowance for future settlement; this may be 10% of the depth of filling in the case of ordinary consolidated fills, and 5% where the consolidation is done by heavy machinery. No allowance need be made where when the consolidation is done by heavy machinery under optimum moisture conditions.

## **2.5 EXCAVATION IN TRENCHES FOR PIPES CABLE ETC. AND REFILLING**

### **2.5.1 CUTTING**

Unless otherwise indicated on the drawings, trench excavation shall be open cut. Bottom of trenches for laying of pipes, cables, etc. shall be accurately graded so that the pipe or cable is uniformly supported along its length.

The excavation for underground services shall not cause instability to the foundations of the buildings. If the excavations encroach is to the stress dispersion zone bounded by the line drawn at an angle  $\theta^*$  to the horizontal from the nearest lower edge of the building foundations ( ) specific approval of the officer-in-charge shall be obtained before commencing work.

Note: Generally  $\theta = 45^\circ$  for stable soils  
 $\theta = 30^\circ$  for wet clays.

### **2.5.2 REFILLING TRENCHES FOR PIPES, CABLES ETC**

Normally the excavated earth shall be used for refilling unless such earth contains deleterious salts. All clods of earth shall be broken or removed. Where the excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm in any direction, mixed with fine material consisting of decomposed rock, lateritic soil or earth as available so as to fill up the voids as much as possible, and then the mixtures used for filling.

Filling in trenches for pipes and rains shall be commenced as soon as the joints of pipes and drains have been created and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of the pipes, in layers not exceeding 150 mm watered, rammed and consolidated, taking care that no damage is caused to the pipe below. In case of excavation of trenches in rock, the filling upto a depth of 300 mm above the crown of pipe or barrel shall be done with fine material such as earth lateritic soil or pulverised decomposed rock according to the availability at site. The remaining filling shall be done with boulders or rubble of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 300 mm. In the event of any of the excavated material being deemed unsuitable for filling by the officer-in-charge the contractor shall provide approved filling material at his own cost.

## **2.6 FILLING UNDER FLOORS**

### **2.6.1 EARTH FILLING**

The plinth shall be filled with earth placed in layers not exceeding 150 mm each layer watered and consolidated to the satisfaction of the officer-in-charge. The filling shall be to a height at least 75 mm above the final level, after through consolidating it shall be trimmed to the required levels and falls. Flooring work shall not be started until the filling has been inspected and approved by the officer-in-charge.

## 2.6.2 SAND FILLING

The sand shall be clean and free from dust, organic and foreign matter.

Sand filling shall be done in a manner similar to earth filling below floors. Consolidation shall be done by flooding the filling with water. The level of the consolidated sand shall be dressed to the required level or slope. Flooring work shall not be started until the filling work has been inspected and approved by the officer-in-charge.

### Appendix.

#### SUPPORT REQUIRED FOR EXCAVATIONS WITH VERTICAL SIDES IN UNIFORM GROUND

A indicates that no support is required

B indicates that open sheeting should be employed

C indicates that close sheeting or sheet piling should be employed

Type of soil	Upto 5 ft (shallow)	Depth of excavation 5 ft to 15 ft. (medium)	Depth of excavation Over 15 ft (deep)
Soft Peat	C	C	C
Firm Peat	A	C	C
Soft Clays and silts	C	C	C
Firm and stiff clays	A*	A*	C
Loose gravels and sands	C	C	C
Slightly cemented gravels and sand	A	B	C
Compact gravels and sands with or without clay binder	A	B	C
All gravels and sands below water table	C	C	C
Fissured or heavily jointed rocks (shales etc)	A*	A*	B
Sound rock	A	A	A

\* Open or close sheeting or sheet piling may be required if site conditions are unfavourable.

Note: This table does not apply to complex ground conditions for which reference should be made to the text of BSCP 2003: 1959

Note: Ref: Table 5 of BSCP 2003 : 1959

### **3.0 MORTAR**

#### **3.1 LIME MORTAR**

The mortar shall consist of slaked lime and sand, each complying with the respective standard and mixed in the proportions specified.

Lime and sand shall be mixed dry three times on an approved platform of masonry, stone, or wood, then sprinkled with the necessary quantity of water and ground in a mortar mill. The sand and lime shall be mixed only in sufficient quantities for a day's requirements. The mortar shall be raked up continuously during the grinding process, particularly in the angles of the mill. Water may be added as required during grinding, care being taken not to add more water than will bring the mixed material to the consistency of a stiff paste. The sides of the mill shall be maintained in good order. A satisfactory method of counting the revolutions shall be followed.

All mortar shall be used as soon as possible after grinding. As a rule it shall be used on the day on which it is made, but in no case shall mortar made 72 hours previously be permitted to be used or remain at the site of the work except mortar which is to be ground a second time for plastering work – see below. If hydraulic lime is used, the ground mortar shall be not be kept unused for more than 25 hours after grinding. In all cases, the mortar shall be kept damp and on no account to be allowed to dry. It shall always be protected from the sun and rain. All mortar more than 72 hours old or mortar hardened or set before being used shall be removed from the work site within 24 hours of order to do so, and no second mixing will be permitted.

Mortar for plastering shall be ground a second time after storing in a damp condition for an interval of two days in the case of stone lime, and one week in the case of fat lime so as to ensure thorough slaking. The mortar shall then be used at once.

#### **3.2 CEMENT MORTAR**

The mortar shall consist of Portland Cement and sand, each complying with the respective standard and mixed in the proportion specified.

<u>Item of Work</u>	<u>Cement</u>	<u>Sand</u>
Mortar for masonry	1	5 upto 8 as may be specified
Mortar for Plastering	1	3 upto 4 as may be specified
Mortar for pointing	1	3

The Portland cement shall be measured by weight, a bag weighing 50 kg being taken as 0.035 cu.m and the sand in suitable measuring boxes. Where gauge boxes are used for measurement of cement by volume the gauge box shall be 400 mm x 350 mm x 290 mm high while the gauge box for sand shall be 400 mm x 350 mm x 250 mm high. The sand shall be measured on the basis of its dry volume. In the case of damp sand, its quantity shall be increased suitably to allow for bulkage to be determined by the method given in the appendix.

The mixing of mortar shall be done in mechanical mixers unless the officer-in-charge permits hand mixing taking into account the nature magnitude and location of the work.



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### **3.2.1 MACHINE MIXING**

The cement and sand shall be fed into the mixer in the specified proportions and shall be mixed dry. Water shall then be added gradually and wet mixing. Mixing shall be restricted to such quantities as could be utilised on the work within 30 minutes of mixing.

### **3.2.2 HAND MIXING**

In the case of hand mixing, the measured quantity of sand shall be spread level on a clean dry platform and the cement spread over it. The cement and sand shall be mixed dry three times over. Water shall be added to the mixture only when the mortar is required to bring the mortar to the consistency of a stiff past.

Cement mortars shall be used up on the works within two hours after mixing. Mortar remaining unused for more than two hours shall be rejected and removed from the work site.

## **3.3 LIME – CEMENT – SAND MORTAR (i.e. Composite Mortar)**

### **3.3.1 PROPORTIONING**

Cement, lime putty/dry hydrated lime and sand shall be taken in the proportions specified.

### **3.3.2 MIXING**

Lime putty and sand shall be mixed and ground in the manner, described in 3.1. In case where factory made dry hydrated lime powder is used, prior grinding of lime and sand is not necessary, and mixing may be done in one operation in mechanical mixer. Only a quantity of this mixture which could be used within two hours of its mixing with cement shall be taken out and mixed thoroughly with the specified quantity of cement in mechanical mixer.

#### **3.3.2.1 HAND MIXING**

Hand mixing shall be permitted by the Officer-in-Charge after taking into account the nature, magnitude and location of the work, practicability of the use of mortar mill, mechanical mixer etc. or where items involving small quantities are to be done. Cement and sand shall be mixed dry on clean water tight masonry or wooden platforms or in troughs. Lime putty shall be mixed with water to the consistency of milk of lime, which shall be added to the mixture of cement and sand, and the mixture shall be kneaded back and forth for about 10 minutes with addition of milk of lime to obtain mortar or workable consistency.

### **3.3.3 PRECAUTIONS**

Mortar shall be used within 2 hours after mixing mortar unused for more than 2 hours shall be rejected and removed from the work site.

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#### 4.0 CONCRETE

The concrete shall possess the strength, durability; impermeability and resistance to abrasion required for the proposed structure. It shall be free of such defects as cracking, honey-combing, spalling of the surface, undue shrinkage etc. The concrete shall be of good quality and shall be produced with careful control over the batching of materials, water cement ratio etc. Necessary care and attention shall be given to the design and preparation of formwork.

Concrete shall be produced as specified and shall meet the following requirements of each class:

- (I) Non-structural concrete may be a Volume Batched Mix, satisfying the following:
  - (i) Proportion of the Constituents by Volumes:
  - (ii) Maximum size of aggregate for ex. 1:3:6 (50 mm)

Structural Concrete may be specified as one of the types

- (a) Volume Batched Mix satisfying the following
  - (i) Proportion of the Constituents by Volume
  - (ii) Nominal Maximum size of aggregate
  - (iii) Grade required for ex. 1:2:4 (20 mm) of Grade 20.

Testing and acceptance shall be as per clause 5.4.9.2

- (b) Prescribed Mix satisfying the following:
  - (i) The mix required from BSCP 110 Table 50
  - (ii) Grade required
  - (iii) Nominal Maximum size of aggregate.

The composition of the mix shall conform to BSCP 110 - Table 50 with the required field modifications.

Testing and acceptance shall be as per clause 5.4.9.2

- (c) Designed Mix satisfying the following:
  - (a) Grade specified
  - (b) Maximum size of aggregate
  - (c) Maximum Cement content in kg. of cement per cubic metre and other requirements if any to ensure durability.

Testing and acceptance shall be as per BSCP 110 CI 6.2.2. Where the contractor intends to use ready mixes concrete all relevant particulars detailed in BS 5328 shall be furnished for the approval of the officer-in-charge.

## **4.1 MATERIALS**

### **4.1.1 WATER**

Water shall conform to the specifications in Chapter 1

### **4.1.2 CEMENT**

All cement shall be from an approved source and shall comply with the latest revision of the standards noted below:

<u>Type</u>	<u>In accordance with</u>
Ordinary Portland cement	B.S.12
Rapid hardening Portland Cement ]	
White Portland cement ]	B.S. 12
Coloured Portland cement ]	
Portland Blast furnace cement	B.S. 146
Low heat Portland cement	B.S. 1370
Sulphate resisting Portland cement	B.S. 4027
Low heat Portland Blast furnace cement	B.S. 4246
Super Sulphated cement	B.S. 4248
Ultra high early strength ]	The requirements for Portland cement physical properties for ordinary Portland cement given in B.S. 12
Water repellent Portland Cement ]	
Hydro-phobic Portland Cement ]	

- Note: - (I) Where cements other than those complying with requirements of B.S. 12 are used, account shall be taken of their properties and any particular conditions of use.
- (II) Where Portland Blastfurnace cement complying with BS 146 is used, the slower rate of hardening shall be given due consideration and adequate curing shall be ensured.
- (III) Super sulphated cements shall not be mixed with any other cement.

For storage and other details see Clause 1.2

### **4.1.3 AGGREGATES**

Aggregate shall be hard and not contain materials such as coal, pyrites, lumps of clay etc, that are likely to decompose or change in volume when exposed to the weather, or affect the reinforcement (where provided). Aggregates with low absorption value shall be used for all concrete that is exposed to the weather or in contact with liquids.

The aggregates shall be free from soft, friable, thin, elongated or laminated pieces, coatings of dust, and from clay, alkali, organic or any foreign matter. The contractor shall wash thoroughly all aggregate or any portion of it delivered to the works if so directed by the Officer-in-charge.

#### **4.1.3.1 DENSE AGGREGATE**

These shall consist of one of the following:

COARSE & FINE AGGREGATE FROM NATURAL SOURCES (Complying with the requirements of B.S. 882: Part 2)

#### COARSE AGGREGATE

- (1) The coarse aggregate shall be crushed stone that is mainly retained on a 5 mm B.S. 410 test sieve or equivalent, and containing only so much finer material as is permitted. The stone shall be from an approved quarry and shall be clean, sharp, undecomposed gneiss or other approved igneous rock having clean, hard dense and durable fragments.

Note: As the quality of limestone available is variable, harder types may be used only if they conform to the tests prescribed in clause 4.1.3.4

#### FINE AGGREGATE

Fine aggregate i.e. that mainly passing a 5 mm B.S. 410 test sieve (or equivalent) and containing only so much coarse material as is permitted shall be.

- (a) Natural sand - obtained from the natural disintegration of rock, i.e. it shall be clean, sharp, river or pit sand free of earth, silt, clay, loam, carbon, alkali, mica, organic, matter and other deleterious substances.
- (b) Crushed stone sand - the use of this shall be permitted only for designed mixes. Crushed stone sand shall be manufactured from hard tough durable uncoated rock.

### 4.1.3.2 SPECIAL AGGREGATES

#### BROKEN BRICK OR TILE

Mass concrete with brick or tile aggregates may be specified when a high resistance to fire is required but not a high degree of impermeability not resistance to abrasion. Where specifically allowed in the plans, the brick or tile aggregate shall be of good quality and approved by the Officer-in-Charge. The brick shall be free from adhering mortar, plaster or dust and shall not contain soluble sulphates in excess of ½%.

#### HEAVY AGGREGATE

Steel shots, magnetite and heavy stones shall be used as specified in high density concrete required for screening radioactive sources where space is limited or for providing high sound insulation between rooms.

#### LIGHT WEIGHT AGGREGATE

Where light weight aggregate concrete is specified, natural aggregate such as pumice or artificial lightweight aggregate such as furnace clinker expanded clay, foamed slag etc of a quality approved by the Officer-in-Charge and complying with the requirements of B.S. 3797 shall be used.

### 4.1.3.3 STORING OF AGGREGATE

All aggregate shall be stored in scrupulously clean condition as the presence of soil, clay or organic material can seriously impair the strength concrete or inhibit setting. Aggregate storage piles shall be built on hard paved self draining surfaces in suitable hoppers or bins so as to avoid the inclusion of any foreign matter, soil, clay etc. The aggregate of different sizes shall be kept separate from each other. It is essential that the storage floors be sloped to facilitate drainage. Coarse aggregate shall be delivered to the mixers with the least amount of free moisture and the least amount of variation in free moisture as practicable.

Before commencing any run of concreting, it is essential that an adequate supply of aggregate is stored at the site. Reliance shall not be placed on promised delivery during mixing.

#### 4.1.3.4 TESTING OF AGGREGATES

Where necessary the suitability of the aggregate relevant to a particular structure shall be established well in advance by obtaining samples from sources and carrying out tests for determination of one or more of the following properties:

- (a) Particle size and shape
- (b) Clay, silt and fine dust
- (c) Specific gravity
- (d) Water absorption
- (e) Bulk density, voids & bulking
- (f) Moisture content
- (g) Organic impurities
- (h) Aggregate impact value (Note: this test is an alternative to test (j))
- (i) Aggregate Crushing value
- (j) 10% fines value
- (k) Crushing strength
- (l) Aggregate abrasion value

The tests shall conform to the relevant clauses of BS 812

The quantity of clay, silt and fine dust determined in accordance with the decantation method given in BS 812 shall be within the following limits.

In Coarse aggregate	1% by weight
In Natural sand	3%    ``
In Crushed stone sand	15%    ``

The aggregate impact value shall be as follows:

- (i) For normal structure shall be not more than 45%.
- (ii) Wearing surfaces shall be not more than 30%

The 10% fines value shall exceed the following limits:

- (i) for normal structures shall be not less than 50 KN
- (ii) for wearing surfaces shall be not less than 100 KN

#### 4.1.3.5 GRADING AND SIZES

##### COARSE AGGREGATE

The maximum size of the aggregate to be adopted shall be as specified and will depend on the dimensions of the member being cast and the spacing of the reinforcement. As a general guide the largest particle of aggregate shall not be larger than a quarter of the least dimension of the member in which it is used, and be at least 5 mm smaller than the least clear spacing between single bars. Generally it is an advantage to have the maximum size as large as possible.

The continuous grading limits for coarse aggregate shown in percentage by weight are given below:

## GRADING LIMITS FOR COARSE AGGREGATES

**TABLE 4.1**      **VIDE .S. 882: PART 2:1973**

BS 410      PERCENTAGE BY WEIGHT PASSING BS SIEVES								
TEST SIEVE	Nominal size of graded aggregate			Nominal size of single sized aggregate				
40 mm to 5 mm	20 mm to 4 mm	14 mm to 5 mm	63 mm	40 mm	20 mm	14 mm	10 mm	
75.0	100	-	-	100	-	-	-	-
63.0	-	-	-	85-100	100	-	-	-
37.5	95-100	100	-	0-30	85-100	100	-	-
20.0	35-70	95-100	100	0-5	0-25	85-100	100	-
14.0	-	-	90-100	-	-	-	85-100	100
10.0	10-40	30-60	50-85	-	0-5	0-25	0-50	85-100
5.0	0-5	0-10	0-10	-	-	0-5	0-10	0-25
2.36	-	-	-	-	-	-	-	0-5

### FINE AGGREGATE

The grading of fine aggregate, when determined by a test according to BS 882 shall be within the limits of one of the grading zones given in Table 4.2. However zone 4 aggregate shall not be used for prescribed mixes. A total tolerance of up to 5% maybe applied to the percentage underlined. This tolerance may be split up for example; it could be 1% on each of three sieves and 2% on another, or 4% one sieve and 1% on another.

The fine aggregate shall be described as fine aggregate of the grading zone into which it falls - e.g. BS 882, Grading Zone 1.

Note: - It is intended that individual zones should not be specified in contract documents relating to concrete the concrete mixes should be modified to make the best use of the materials readily available.

**TABLE 4.2**

### **FINE AGGREGATE (Ref. Table 2 of BS 882: Part 2: 1973**

BS 410      PERCENTAGE BY WEIGHT PASSING BS SIEVES				
TEST SIEVE	Grading Zone 1	Grading Zone 2	Grading Zone 3	Grading Zone 4
mm	mm			
10.0	100	100	100	100
5.0	90-100	90-100	90-100	95-100
2.56	60-95	75-100	85-100	95-100
1.18	30-70	55-90	75-100	90-100
(micron) $\mu^m$				
600	15-34	35-59	60-79	80-100
300	5-20	8-30	12-40	15-50
150	0-10*	0-10*	0-10*	0-15*

\* For crushed stone sands, the permissible limit is increased to 20%. The 5% tolerance permitted as above may in addition, be applied to the percentage underlined.

#### 4.1.3.6 MIXING OF SINGLE SIZES TO OBTAIN GRADED MATERIALS

When coarse aggregate brought to site is single sized (ungraded) it shall be mixed with single size aggregate of different size, in the proportion indicated in Table 4.3 to make it graded.

Table 4.3

S/No	Cement Concrete Mixture	Nominal size of graded aggregate	Part of single size aggregate (mm)				
			50	40	20	12.5	10
1	1:6:12	63	9	-	3	-	-
2	1:6:12	40	-	9	3	-	-
3	1:5:10	63	7 ½	-	2 ½	-	-
4	1:5:10	40	-	7 ½	2 ½	-	-
5	1:4:8	63	6	-	2	-	-
6	1:4:8	40	-	6	2	-	-
7	1:3:6	63	4 ½	-	1 ½	-	-
8	1:3:6	40	-	4 ½	1 ½	-	-
9	1:3:6	20	-	-	4 ½	-	1 ½
10	1:2:4	40	-	2 ½	1	-	-
11	1:2:4	20	-	-	3	-	1
12	1:2:4	12.5	-	-	-	3	1
13	1:1 ½ :3	20	-	-	2	-	1

The proportions indicated are by volume. These may be varied marginally by the Officer-in-Charge when considered necessary after making a sieve analysis aggregates brought to the site. No adjustment in rates shall be allowed for any variations in proportions so ordered by the Officer-in-Charge.

#### 4.1.4 ADMIXTURES

Additives, plasticisers or other workability agent shall not be used without the written approved of the Officer-in-Charge.

#### 4.2 LIME CONCRETE

Lime concrete shall be prepared by mixing graded stone or brick aggregate of nominal size as specified with wet ground lime mortar. Mortar for lime concrete generally consists of lime and sand in the proportion of 1:2 by volume.

##### 4.2.1 PROPORTIONING

The proportioning of wet mortar and aggregate shall be by volume. Generally the internal size of gauge boxes for measuring the materials shall be 400 x 350 x 250 mm (viz 0.035 m<sup>3</sup> approx.). While measuring the aggregate, shaking, ramming or heaping shall not be done.

##### 4.2.2 MIXING

The mixing shall be done by hand or in a mechanical mixer as specified. Brick aggregate shall be well soaked with water for a minimum period of 2 hours.

#### **4.2.2.1 MACHINE MIXING**

The mixing drum shall be free of hardened mortar adhering to its inner surface. Before commencing the mixing, the drum shall be flushed clean with water. A measured quantity of aggregate and wet ground mortar for one batch shall be poured in to the drum of the mixer, while it is revolving. The quantity of materials loaded in the drum shall not exceed the rated capacity of the mixer. The required quantity of water shall be added slowly and the wet mixing of a batch shall be continued for at least two minutes in the drum till a uniform mix of required consistency is obtained. The consistency of the concrete shall be such that the mortar does not tend to separate from the coarse aggregate. The entire concrete of a batch shall be discharged before the materials for the new batch are poured into the drum.

#### **4.2.2.2 HAND MIXING**

Hand mixing when allowed shall be done on a clean and water tight platform (of masonry, wood, or G.I. sheets) of sufficient size to provide ample mixing space. The specified wet lime mortar shall be laid on the top of the aggregate. The whole shall then be turned over and over, with addition of the necessary quantity of water by means of a sprinkler till a uniform mix of required consistency is obtained. The consistency of the concrete shall be such that the mortar shall not tend to separate from the coarse aggregate.

#### **4.2.3 LAYING**

Lime concrete shall be laid (and not thrown) in layers while it is quite fresh. Each layer shall be thoroughly rammed and consolidated before the succeeding layer is placed. Consolidated thickness of each layer shall not exceed 150 mm. Joints where necessary shall be staggered in different layers unless otherwise specified. Ramming shall be done by heavy iron rammers of 4.5 to 5.5 kg. The area of the rammer shall not be more than 0.03 m<sup>2</sup> each. Ramming shall be continued till a skin of mortar covers the surface completely. Compaction shall be done immediately on laying. Green work shall be protected from rain by suitable coverings.

#### **4.2.4 CURING**

After the concrete has begun to harden - i.e. about 24 hours after its laying, the curing shall be done by keeping the concrete damp with moist gunny bags, wet straw, sand or any method except water under pressure, approved by the officer-in-charge. Curing shall be done for a minimum of 7 days, after which period masonry and flooring work over the lime-concrete foundation or base concrete may be started.

#### **4.3 CEMENT CONCRETE**

This shall be prepared by mixing graded stone of specified nominal size with fine aggregate and cement in specified proportions and the required quantity of water to give the consistency needed for proper placement and compaction.

The grading and quality of the aggregate will be as given in clause 4.1.3.5.

Sampling, testing and acceptance criteria shall be as set forth in clause 5.4.9.

##### **4.3.1 PROPORTIONING**

###### **4.3.1.1 PROPORTIONING BY VOLUME**

Fine & Coarse Aggregate may be measured by volume unless otherwise specified. Boxes of suitable size shall be used for measuring the sand and aggregate. The internal dimensions of the boxes recommended are 400 x 350 x 250 mm (which is 0.035m<sup>3</sup> and corresponds to the volume of 1 bag of cement weighing 50 kg.). While measuring the aggregate, shaking, ramming or heaping shall not be



done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand, allowance for bulking shall be made as given in Appendix 4C.

Cement shall be gauged by weight. The unit of measurement for cement shall be a bag of 50 kg. and this shall be taken as 0.035 m<sup>3</sup>: but in case the volume of cement is permitted to be gauged in a measuring box the internal dimensions of the box for cement only shall be 400 mm x 250 mm x 290 mm to account for bulking.

The composition shall be as follows: -

**Table 4.4**

<b>Specified Mix</b>	<b>Equivalent Grade where specified</b>	<b>Quantities per 50kg bag of cement</b>		
		<b>Fine Aggregate</b>	<b>Coarse Aggregate</b>	<b>Approx. Water content in litres</b>
1:1:2	30	0.035m <sup>3</sup> 1 box	0.07m <sup>3</sup> 2 boxes	21
1:1 ½:3	25	0.053m <sup>3</sup> 1 ½ box	0.105m <sup>3</sup> 3 boxes	23
1:2:4	20	0.07m <sup>3</sup> 2 boxes	0.14m <sup>3</sup> 4 boxes	25
1:3:6	10	0.105m <sup>3</sup> 3 boxes	0.21m <sup>3</sup> 6 boxes	32
1:4:8	-	0.10m <sup>3</sup> 4 boxes	0.28m <sup>3</sup> 8 boxes	32

Note: 1. The international dimension of boxes for measuring aggregate shall be 400 mm x 350 mm x 250 mm height.

If gauging boxes are allowed to be used for cement the corresponding box shall be 400 mm x 350 mm x 290mm internal dimensions to account for bulking.

2. Quantities required per cubic metre of concrete are given in Appendix 4A.

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#### **4.3.1.2 PROPORTIONING BY WEIGHT**

##### **PRESCRIBED MIX**

The Officer-in-charge shall be informed of the nature and source of each material to be used and subsequently notified whenever a change is made. No admixtures shall be used unless specified.

The cement contents for these prescribed mixes are given in BSCP 110, Table 50 together with the total weights of dry aggregate to produce approximately one cubic metre of concrete,. Depending upon the specific gravity of the aggregates slight adjustments may be required to the quantity of aggregates to produce this volume of concrete having the required workability, strength and cement content. BSCP 110 Table 50 also gives the approximate proportions of fine aggregate to be used although small adjustments may be required on the site depending on the properties of the local materials. For grades 7, 10 and 15 a range of fine aggregate proportions is given, the lower percentage being applicable to finer material such as zone 3 sand and the higher percentage being applicable to coarser material such as zone 1 sand. Where single-sized coarse aggregates are used, the proportions shall be chosen to produce a combined grading within the limits of BS 882 or BS 1047 for graded coarse aggregate of the appropriate size.

Where weight-batchers are not available and if the necessary site control can be ensured, aggregates can be measured by volume after conducting the necessary field density tests. Cement shall be batched by weight (or in whole bags).

##### **DESIGNED MIX**

This shall be permitted if specifically allowed on the Bill of Materials, when the necessary weigh batchers are available and the required quality control assured.

The procedure indicated in BSCP 110 shall be followed.

#### **4.3.2 MIXING**

It shall be done in a mechanical mixer. Hand-mixing shall be done only with the prior permission of the Officer-in-Charge

##### **4.3.2.1 MACHINE MIXING**

The mixer drum shall be free of hardened mortar adhering to its inner surface. Before mixing commence the drum shall be primed by washing with rich cement grout. A measured quantity of dry coarse aggregate shall be first placed in the hopper. This shall be followed with the measured quantity of fine aggregate and then cement. /the skip shall be raised and the dry materials slipped into the drum. The dry materials shall be mixed for at least four turns of the drum after which the correct quantity of water shall be added gradually while the drum is in motion, to ensure even distribution of the materials. The total quantity of water for mixing shall be introduced before 25% of the mixing time has elapsed and shall be regulated to achieve the specified water cement ratio. The complete contents of the mixer shall be emptied before recharging.

When the mixer is closed down for the day or for any period exceeding 20 minutes, the drum shall be flushed clean.

##### **MIXING TIME**

The material shall be mixed for a period of not less than 2 minutes and until a uniform colour and consistency are obtained. The time shall be counted from moment all the materials have been put into the drum.

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#### **4.3.2.2 HAND MIXING**

When permitted for Volume Batched mixes, this shall be done on a smooth, clean and water-tight platform of suitable size and in the following manner.

The measured quantity of sand shall be spread evenly

- (b) The cement shall be dumped on the sand and then distributed evenly.
- (c) The sand and cement shall be mixed intimately with shovels, turning the mixture over and over again, until it is of even colour throughout and free from streaks.
- (d) The measured quantity of coarse aggregate shall be spread out and the sand cement mixture shall be on top
- (e) This shall be mixed at least three times dry, by shovelling and turning over from centre to side then back to the centre and again to the sides.
- (f) A depression shall be made in the middle of the mixed pile to receive the water.
- (g) Three quarters of the total quantity of water required shall be added while the material is turned in towards the centre with shovels. The remaining water shall be added by a water-can fitted with a rose-head, while slowly turning the whole mixture over and over again at least three times until a uniform colour and consistency is obtained throughout the pile.
- (h) The mixing platform shall be washed at the end of the day.

**TABLE 4.5- PRESCRIBED MIXES FOR ORDINARY STRUCTURAL CONCRETE**

Weights of cement and total dry aggregates in kg to produce approximately one cubic metre of fully compacted concrete together with the percentage together with the percentage by weight of fine aggregate in total dry aggregates. The restrictions in the types of cement and aggregate that maybe used are given in 6.1.2. Admixtures may not be used in ordinary structural concrete.

Nominal max. size of Concrete aggregate (mm)Grade

		40	20	14	10				
Workability		m	h	m	h	m	h	m	
Limits to slump that may be expected (mm)		50-100	100-150	25-75	75-125	10-50	50-100	10-25	25-50
7	Cement (Kg.)	180	200	210	230	-	-	-	-
	Total aggregate (Kg.)	1950	1850	1900	1800	-	-	-	-
	Fine aggregate (%)	30-45	30-45	35-50	35-50	-	-	-	-
10	Cement (Kg.)	210	230	240	260	-	-	-	-
	Total aggregate (Kg)	1900	1850	1850	1800	-	-	-	-
	Fine aggregate (%)	30-45	30-45	35-50	35-50	-	-	-	-
15	Cement (Kg.)	250	270	280	310	-	-	-	-
	Total aggregate (Kg.)	1850	1800	1800	1750	-	-	-	-
	Fine aggregate (%)	30-45	30-45	35-50	35-50	-	-	-	-
20	Cement (Kg.)	300	320	320	350	340	380	360	410
	Total aggregate (Kg.)	1850	1750	1800	1750	1750	1700	1750	
	1650								
	Sand*								
	Zone 1 (%)	35	40	40	45	45	50	50	55
	Zone 2 (%)	30	35	35	40	40	45	45	50
25	Cement (Kg.)	340	360	360	390	380	420	400	450
	Total aggregate (Kg.)	1800	1750	1750	1700	1700	1650	1700	1600
	1550								
	Sand*								
	Zone 1 (%)	35	40	40	45	45	50	50	55
	Zone 2 (%)	30	35	35	40	40	45	45	50
20	Cement (Kg.)	370	390	400	430	430	470	460	510
	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								
	Zone 1 (%)	35	40	40	45	45	50	50	55
	Zone 2 (%)	30	35	35	40	40	45	45	50
20	Cement (Kg.)	370	390	400	430	430	470	460	510
	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								
	Zone 1 (%)	35	40	40	45	45	50	50	55
	Zone 2 (%)	30	35	35	40	40	45	45	50
20	Cement (Kg.)	370	390	400	430	430	470	460	510
	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								
	Zone 1 (%)	35	40	40	45	45	50	50	55
	Zone 2 (%)	30	35	35	40	40	45	45	50
20	Cement (Kg.)	370	390	400	430	430	470	460	510
	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								
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	Zone 2 (%)	30	35	35	40	40	45	45	50
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	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								
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	Zone 2 (%)	30	35	35	40	40	45	45	50
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	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								
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	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								
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	Sand*								
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	Sand*								
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	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
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	Sand*								
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	Sand*								
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	1550								
	Sand*								
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	Sand*								
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	Sand*								
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	Sand*								
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	Zone 2 (%)	30	35	35	40	40	45	45	50
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	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
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	Sand*								
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	Sand*								
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	Zone 2 (%)	30	35	35	40	40	45	45	50
20	Cement (Kg.)	370	390	400	430	430	470	460	510
	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								
	Zone 1 (%)	35	40	40	45	45	50	50	55
	Zone 2 (%)	30	35	35	40	40	45	45	50
20	Cement (Kg.)	370	390	400	430	430	470	460	510
	Total aggregate (Kg.)	1750	1700	1700	1650	1700	1600	1650	
	1550								
	Sand*								

### 4.3.3 CONSISTENCY

The concrete shall be of such consistency as will suit the method of placement and compaction. The quantity of water shall be regulated by carrying out regular slump tests as prescribed in Appendix 4.B, for each mix using one bag of 50 kg cement it shall not exceed that indicated in Table 4.4.

In the case of vibrated concrete, the water content may be suitably reduced to avoid segregation.

The following slumps shall be adopted for different kinds of works:

TABLE 4.6

Work	Slump in mm	
	Vibrators used	Vibrators not used
Mass concrete in foundation, footings, retaining walls and pavement.	10-25	50-75
Thin section of flooring less than 75 mm thickness	25-40	75-100
Reinforced cement concrete work	-	refer chapter 5
Under water concreting -	100-180 (Actual Slump to be decided by Officer-in-charge)	

Concretes of the higher slump range of 75 mm and above shall be produced by using additional cement slurry and not merely water, so that the water cement ratio and compressive strength are kept reasonably constant. Generally about 10% more of cement will become necessary.

### 4.3.4 LAYING

Sufficient notice of not less than 24 hours shall be given to the officer-in-charge prior to commencing concreting so as to enable inspection of forms, reinforcement etc. the position of all construction joints and programme of concreting shall be decided in advance. Necessary stop-boards shall be provided at construction joints.

#### 4.3.4.1 COMPACTION

The entire concrete used in the work shall be laid gently (not thrown) in layers not exceeding 150 mm. It should be deposited as nearly as practicable in its final position and without segregation in one continuous operation upto the movement or construction joints.

It shall be adequately compacted by means of vibrators till air bubbles cease to appear on the upper surface and a dense concrete. The vibrator will be operated in a near vertical position, and the duration of vibration limited to that necessary to produce satisfactory consolidation without causing objectionable segregation.

The officer-in-charge may however at his discretion, permit hand compaction for certain items depending upon the thickness of the members and feasibility for vibrating the same. Hand compaction shall be done with the help of tamping rods so that the concrete is thoroughly compacted and completely worked into the corners of the formwork.

The layers of concrete shall be so placed that the bottom layer does not finally set before the top

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layer is placed. Compaction shall be completed before the initial setting starts i.e. within 30 minutes of addition of water to the dry mixture. Retempering of concrete shall not be permitted.

#### **4.3.4.2 TEMPERATURE**

During cold weather, concreting shall not be done when the temperature falls below 4.5°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and the work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38°C.

#### **4.3.4.3 UNDER WATER CONCRETING**

Concrete shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. Where found necessary to deposit any concrete under water, the method, equipment, materials and mix shall first be approved by the Officer-in-charge.

the concrete shall be deposited under water by one of the approved methods such as Tremie Method, Drop Bottom bucket, bags etc.

If it is necessary to raise the water after placing the concrete, the level shall be brought up slowly without creating any wave or commotion tending to wash away cement or to disturb the fresh concrete in anyway. Detailed procedures recommended in BSCP 2004 may be followed.

#### **4.3.4.4 CONTINUATION OF WORK**

When the placing of concrete is suspended, necessary removal of laitance and roughening the surface for jointing future work shall be done before the concrete sets. When the work is resumed the previous work must be thoroughly cleaned, roughened, watered and a grout of neat cement slurry of the proportion 1 kg of cement per 2 litres of water applied uniformly.

#### **4.3.5 CURING AND PROTECTION**

Green work shall be protected from rain by suitable covering. The work should also be suitably protected from damage during construction.

After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected with moist gunny bags, or any other material approved by the Officer-in-charge against quick drying. After 24 hours of laying of concrete, the surface shall be cured by flooding with water of minimum 25 mm depth, or by covering with wet absorbent materials. The curing shall be done for a minimum period of 14 days. In special cases, curing may have to be prolonged as required by the Officer-in-charge.

Over the foundation concrete, the masonry work may be started after 48 hours of its laying, but the curing of cement concrete shall be continued along with the masonry work for a minimum period of 14 days.

Where cement concrete is used as sub-grade for flooring, the flooring may be commenced before the curing period of sub-grade is over but the curing of sub-grade shall be continued along with the top layer of flooring for a minimum period of 14 days.

The water used for curing shall not produce any objectionable stains or unsightly deposit on the concrete surface. In special circumstances and locations, curing by other means such as sealing material, insulating blankets etc. may be adopted with the specific prior approval of the Officer-in-charge.

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#### **4.3.6 FORM WORK**

If centring and shuttering are required to be done for the work, it shall be done in accordance with the specifications for formwork under reinforced Cement Concrete work.

#### **4.3.7 TEST AND ACCEPTANCE**

See paragraph 5.4.9

#### **4.4 NO FINES CONCRETE**

Note: - no fines concrete consists of cement and coarse aggregate only. The absence of fine material results in a mass having uniformly distributed voids in it. The material is almost invariably cast in-situ and can be used for partitions and load bearing internal walls: if used for load bearing external walls it shall be rendered externally to prevent wind pressure forcing water through the voids.

The aggregate shall be crushed rock or approved light weight aggregate. Mixed proportions may be in the range of 1:6 to 1:10 or as specified. The water content shall be such as to produce a continuous film of cement grout of paste consistency over the aggregate.

Unless otherwise specified the following proportions of water, cement and aggregate shall be adopted.

For hard dense aggregates - 0.45:1:10 (10 mm to 20 mm)

For light weight aggregates - 0.60:1:6 (10 mm to 20 mm)

The material shall be poured as soon as possible after mixing and shall not be rammed or mechanically vibrated, though it can be lightly rodded. Pouring shall be as continuous as possible to an even height since diagonal joints are source of weakness.

#### **4.5 PLUM CONCRETE**

"Plum Concrete" shall be of hard dense rock of approved sizes used with concrete of specified mix.

A layer of concrete not less than 50 mm thick shall be placed, the first layer of plums placed upon this and the plums allowed to sink under their own weight. The concrete shall be of such consistency that the plums do not disappear completely from sight.

The thickness of each succeeding layer of concrete shall not be less than twice the maximum dimensions of plums permitted. The distance between any two plums and the face shall not be less than the maximum dimension of the plums nor less than 150 mm.

APPENDIX 4A. Quantities of Ingredients per cubic metre of concrete for Volume-Batched mixes.

Nominal mix	Equivalent Grade	Cement (Kg)	Fine Aggregate (dry sand) (m <sup>3</sup> )	Coarse Aggregate (m <sup>3</sup> )	Appropriate Aggregate (m <sup>3</sup> )	Water Cement ratio
1:1:2	30	552	0.38		0.76	0.35
1:1½:3	25	405	0.41		0.82	0.45
1:2:4	20	320	0.44		0.88	0.55
1:3:6	-	227	0.46		0.92	0.75
1:4:8	-	173	0.48		0.96	0.80

APPENDIX 4B - Slump test for concrete

Apparatus: The mould shall consist of a metal frustum of cone having the following internal dimensions: -

Bottom diameter	.....	20 cm
Top diameter	.....	10 cm
Height	.....	30 cm

The mould shall be of a metal other than brass and aluminium of at least 1.6 mm (or 16 BG) thickness. The top and bottom shall be open and at right angles to the axis of the cone. The mould shall have a smooth internal surface. It shall be provided with suitable foot pieces and handles to facilitate lifting it from the moulded concrete test specimen in a vertical direction as required by the test. A mould provided with a suitable guide by the test. A mould provided with a suitable guide attachment may be used.

The tamping rod shall be of steel or other suitable material, 16 mm in diameter, 600 mm long and rounded at one end.

Procedure: The internal surface of the mould shall be thoroughly cleaned and free from superfluous moisture and any set concrete before commencing the test. The mould shall be placed on a smooth, horizontal, rigid and non absorbent surface, such as a levelled metal plate. The operator shall hold the mould firmly in place while it is being filled with the test specimen of concrete. The mould shall be filled in four layers, each approximately one quarter of the height of the mould. Each layer shall be tamped with twenty five strokes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers shall penetrate into the under lying layer. The bottom layer shall be tamped through out its depth. After the top layer has been rodded the concrete shall be struck-off level with trowel or the tamping rod, so that the mould is exactly filled. Any mortar which shall leak out between the mould and the base plate shall be cleaned away. The mould shall be removed from the concrete immediately after filling or raising it slowly and carefully in a vertical direction. The moulded concrete shall then be allowed to subside and the slump shall be measured immediately by determining the differences between the height of the mould and that of the highest point of specimen.

The above operation shall be carried out at a place free from vibration or shock and within a period of two minutes after sampling.

Result: The slump shall be recorded in terms of millimetres of subsidence of the specimen during the test. Any slump specimen which collapses or shears off laterally, gives incorrect result. If this occurs, the test shall be repeated with another sample.

The slump test shall not be used for very dry mixes as the results obtained are not accurate.



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#### APPENDIX 4.C

##### **BULKING OF FINE AGGREGATE/SAND (FIELD METHODS)**

Two methods are suggested for determining the bulking of sand/fine aggregate. The procedure may be suitably varied, if necessary. Both depend on the fact that the volume of inundated sand/fine aggregate is the same if the sand/fine aggregate were dry. Method 1: Put sufficient quantity of sand loosely into a container until it is about two third full. Level off the top of the sand and pushing a steel rule vertically down through the sand at the middle to the bottom, measure the height. Suppose this is 'X' cm.

Empty the sand out of the container into another container without loss. Half fill the first container with water. Put back about half the sand and rod it with a steel rod, about 6 mm in diameter, so that its volume is reduced to a minimum. Then add the remainder and level the top surface of the inundated sand. Measure its depth at the middle with the steel rule. Suppose this is 'Y' cm.

The percentage of bulking of the sand due to moisture shall be calculated from the formula:

$$\text{Percentage bulking} = [X/Y - 1] \times 100$$

Method 2: - In a 250 ml measuring cylinder, pour the damp sand (consolidated by staking) until it reaches the 200 ml mark.

Then fill the cylinder with water and stir the sand well (the water shall be sufficient to submerge the sand completely). It will be seen that the sand surface is now below its original level. Suppose the surface is at the mark of 'Y' ml the percentage of bulking of sand due to moisture shall be calculated from the formula:

$$\text{Percentage bulking} = [200/Y - 1] \times 100$$

## **5.0 REINFORCED CEMENT CONCRETE**

Reinforced cement concrete work may be cast-in-site or present, and shall comprise the following which may be paid separately or collectively as per description of the item of work.

- (a) Form work
- (b) Reinforcement
- (c) Concreting

## **5.1 MATERIALS**

### **5.1.1 CONCRETE**

This shall be structural concrete conforming to the requirements of Chapter 4.

### **5.1.2 STEEL REINFORCEMENT**

The reinforcement shall be:

- i. Hot rolled mild steel round bars for concrete reinforcement B.S. 4 Part I  
B.S. 4360
- ii. Hot rolled high yield steel bars for concrete B.S. 4449
- iii. Cold work deformed steel bars for reinforcement of concrete
- iv. Hard drawn mild steel wire for the reinforcement of concrete B.S. 4482
- v. Steel fabric for reinforcement of concrete B.S. 4483

A certificate of origin and compliance with the requirements of related BSS shall be produced otherwise the steel shall be tested in an approved laboratory and results produced to the satisfaction of the officer-in-charge.

The cost of testing etc, shall be borne by the Contractor ribbed and/or deformed steel bars shall not be assumed to be high yield steel without testing.

#### **5.1.2.1 PROPERTIES OF REINFORCEMENT**

The chemical and properties of these steels are tabulated in Table 5.1

All requirements when placed shall be free from dirt, oil, mud, grease, rust, loose mill scale on any other foreign matter which can adversely affect the concrete or reinforcement chemically or reduce the bond.

#### **5.1.2.2 STACKING AND STORAGE**

Steel reinforcement shall be stored clear of the ground in a way as to prevent distortion and corrosion. Bar of different classifications shall be clearly marked/tagged and those of different sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths as to minimise wastage in cutting from standard lengths.

## **5.2 FORMWORK**

Framework shall include all temporary or permanent forms/moulds required for casting the concrete in-situ and all the temporary construction required for support.

The framework shall be designed and constructed with adequate waling, struts, braces, ties and clamps so as to produce finished concrete work to the required shape and dimensions within limits of specified tolerance if any and with the specified surface finishes vide clause 5.4.8. The framework

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shall be sufficiently rigid and tight to prevent loss of grout or mortar from the concrete and shall take due account of the method of placing and compacting.

The formwork shall withstand the worst combination of the following loads:

- i. Total weight of framework, reinforcement and concrete
- ii. Construction loads including dynamic effects of placing, compacting and construction traffic.
- iii. Wind loads

Frameworks shall be so constructed as to easily dismantle and removed in section in the desired sequence from the cast concrete, without shock, disturbance or damage. Where necessary the framework shall be so arranged that the soffit for properly supported op props only, can be retained in position for such period as may be required by the maturing conditions or specification. Screw jacks or hard board wedges shall be provided where required to make up for any settlement in the framework either before or during the placing of concrete.

Care shall be taken to see that no piece is keyed into the concrete.

Details of formwork shall be properly worked out, and approval obtained from the officer-in-charge well in time for important works. The completed framework shall be inspected and passed by the officer-in-charge before the reinforcement is placed in position, but the responsibility for the adequacy of the framework remains with the contractor.

Propping and centring shall be sufficiently rigid and stable. The permissible stresses in bending, the buckling load of props the permissible deflection of shuttering etc. should not be exceeded. Suitable to resist the lateral forces due to dumping of concrete movement of construction equipment and action of the wind and to provide lateral stability.

PROPERTIES OF CONCRETE REINFORCING STEELS (TABLE 5.1)

Properties Fabric	Hot-rolled mild Steel round bars B.S. 4360	Hot rolled high yield steel bars B.S. 4449/1978	Cold-worked deformed steel bars	Hard drawn mild steel wire B.S. 4482/1968	Steel B.S. 4483
General welded from  drawn  mild steel wires	Rounds	Deformed	Deformed  (deformations  designed to  increase bond with concrete by at least 80% as compared to plain bars)	May be plain, Fabric  indented or  otherwise  deformed	cold
Chemical composition as shown ladle analysis (a) S not 0.050 greater than (b) P not 0.050 greater than (c) P not greater than	0.060  0.060  0.280	0.050  0.050  0.040	0.060  0.060  0.250	0.060  0.060  0.250	
Tensile Properties (a) Specified 480N/ q.mm characteristics strength	All sizes 250N/mm <sup>2</sup>	6 upto & ] including ] 460N/mm <sup>2</sup> 16mm Over 16 mm 425N/mm <sup>2</sup>	6 upto & ] including ] 460N/mm <sup>2</sup> 16mm ] Over 16 mm 425N/mm <sup>2</sup>	All sizes 485N/mm	
(b) Tensile Strength	All sizes 440N/mm <sup>2</sup>	15% greater than actual yield Stress as shown In the tensile test	10% greater than actual 0.2% proof stress measured in the Tensile test	10% greater than 570N/mm <sup>2</sup> actual 0.2% proof stress measured in the tensile test	
(c) Min elongation on 5.65/So where So is the original are of specimen length	Under 10 10 upto ] and ] including ]22% 32 mm ]	19%   Over 16 mm]14%	6 upto ] and ] including]12% 16 mm ]	6 upto and ] including ] 12% 16mm ] 6.9% over a gauge over 16mm]14% of 11.3/So	

Note: Deformed steel bars shall not be assumed to be high yield steel without testing.

### 5.2.1 MATERIALS FOR FORMWORK

Temporary formwork shall be of timber, plywood, steel or any other material as specified.

Permanent formwork shall consist of filler blocks like clay/concrete hollow blocks, coffee units, trough units etc. as specified.

#### 5.2.1.1 TIMBER

The timber used for formwork shall be light weight and easily workable with nails without splitting. It shall be stiff and strong enough to avoid undue deflection loaded; be stable and not liable to warp when exposed to sun and rain, or wetted during concreting. It shall not be so soft as to get damaged easily on the contact faces under normal condition of erecting forms, fixing steel and pouring concrete. The timber shall be free from loose knots, projecting nails, splits or other defects that may mar the surface of the concrete. It shall not be so dry as to absorb water from concrete and swell and bulge, nor so green or wet as to shrink after erection. Species of timber which are not appreciably affected by contact with water shall be used. The sizes of timber generally used for formwork are given in Table 5.1.

The following timber sizes shall be used in general

Use	Size
Floor Boarding	25 mm or 32 mm thick
Wall boarding and sides of beams and columns	25 mm to 50 mm thick
Beam soffits	38 mm to 50 mm thick
Joists, ledges	100 x 50 to 250 x 75 mm generally 100 x 50
Use	Size
Raw Jungle Poles	Not less than 100 mm diameter at mid-length and 80 at thin end
Posts	75 x 100 to 100 x 100
Column yokes	50 x 50 to 75 x 75
Diagonal braces	150 x 32 tp 150 x 50

#### 5.2.1.2 PLYWOOD

Phenolic – resin bounded plywood shall be used as it is completely water proof and does not laminate as does ordinary plywood. Plywood panels shall be formed with 100 mm x 25 mm dressed timber and nailed with short, thin nails at 150 to 225 mm centres.

6 or 10 mm thick plywood shall be given a solid backing nailed at 100 to 150 mm spacing along the four edges and with at least one nail every 0.1 square metre throughout the surface. The edges of sheets shall be tacked to the same backing board to ensure the production of a smooth joint.

10 and 16 mm thick plywood shall be nailed to a skeleton backing of dressed timber before fixing to the studding.

19 mm thick plywood shall be nailed direct to studs at a maximum recommended spacing of 450 mm. For spacing greater than 450 mm skeleton backing of appropriate design shall be used.

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#### **5.2.1.3 STEEL**

The contractor shall use with the approval of the officer-in-charge any proprietor systems of steel formwork generally consisting of panels made up of steel sheet on light steel angle framing in sizes that can be easily handled. Special panels shall be used where curved formwork is necessary.

Special telescopic units which can be easily removed shall be provided as a simple type of joist for suspended slab formwork. Other proprietary fittings such as beam and column clamps and adjustable props designed to facilitate erection may also be used subject to the approval of the officer-in-charge in regard to their suitability for the particular work.

#### **5.2.2 FORMWORK TIES**

Wire shall generally not be recommended for fixing wall formwork as they are likely to cause rust stains or patches at the point where they are cut back. Such stains may be avoided by using bolts which should be either fitted with sleeves or well greased to enable them to be withdrawn easily from the concrete when formwork is removed. Any proprietary devices when used for supporting formwork shall have the approval of the officer-in-charge.

No metal part of any device for securing forms shall remain within the specified concrete cover.

All ties anchored against timber shall pass through a plate washer at least 50 mm x 50 mm of sufficient thickness to transfer the load without visible deflection or penetration into the timber.

#### **5.2.3 TOP FORMS**

Formwork shall be provided to the top surface of concrete where the slope or nature of the work requires it.

#### **5.2.4 PROPPING AND CENTRING**

Props used for centring shall be of steel, timber post round poles or any other material approved by Officer-in-charge, Bamboo props or supports shall be permitted for heights or lengths not exceeding 3 metres provided they are adequately braced. In no case shall round poles be of diameter less than 100 mm measured at mid length and 80 mm at this end. Maximum permissible spacing shall be 1.2 metres centre to centre. Poles shall rest squarely on wooden sole plates of 40 mm thickness and a minimum bearing areas of 0.1 sq metre laid on the ground. Double wedges shall be provided between the sole plates and the wooden props so as to facilitate tightening and easing of shutting without jarring the concrete.

The details of propping and centring stated above shall be applicable for spans of 4.50 metres and height up to 3.50 metres. In case any of these limits is exceeded the formwork shall be properly designed. In case the height of centring exceeds 3.50 metres, the props shall be provided in multistages and established with suitable diagonals and rakes.

Proprietary systems of props shall be erected as per manufacturer details.

##### **5.2.4.1 MULTISTOREYED STRUCTURES**

In the case of structures with two or more floors the normal props as per 5.2.4 shall be provided for supporting the floor to be cast on the topmost floor already cast. If necessary supports below this floor shall be provided preferably to come in line with the props of the upper floor. Planks shall be provided at the top ends of these props so as to give an even distribution of load. Formwork and concreting of the upper floor slab shall not generally be done until the concrete of the lower floor has set for at least 14 days.

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In case of balconies and cantilever beams coming one above the other, the members being cast shall be supported by props on two floors below the floor where initial supporting has been done. Poles shall rest squarely on wooden sole plates of 40 mm thickness and with minimum bearing area of 0.1 square metre.

#### **5.2.4.2 PRECAUTIONS**

Before the concreting is started, all the props and wedges shall be checked to see that they are intact, and suitable action taken in case they are loose. While the concreting is in progress, at least one carpenter/ fitter shall be readily available at the site. The carpenter shall keep a constant watch on the props and take remedial measures, if any of these get loosened. Care shall be taken that props and wedges do not get loose for this minimum period specified in table 5.2.

#### **5.2.5 SHUTTERING**

The shuttering shall have a smooth and even surface and be appropriate to the concrete finish required.

See Clause 5.4.8

For exposed concrete faces, timber for shuttering shall be wrote on all faces in contact with concrete. Wooden formwork with metal sheet plywood or other approved lining or steel plates stiffened by steel angles shall also win be permitted. Undressed timber may be used for formwork for hidden faces and external faces below ground.

When metal forms are used, all bolts and nuts shall be countersunk and well ground to provide a smooth plane surface.

The chamfers bevelled edged and mouldings shall be made in the formwork itself.

Provision for fan clamps and other fittings connected with services shall be made in the shuttering as directed by the Officer-in-charge.

As far as practicable, clamps shall be used to hold the forms together. Where the use of nails in unavoidable the minimum possible number of nails shall be used and these shall be left projecting sp that they can be easily withdrawn. Use of double headed nails shall be preferred.

Holes or openings shall be provided at suitable locations for cleaning up before placing concrete.

##### **5.2.5.1 SURFACE TREATMENT FOR SHUTTERING**

The surface of timber shuttering that would come in contact with concrete shall be thoroughly wetted and coated with raw linseed oil, mould oil approved manufacturers or any other approved material (such as ploythenes-polythylene sheets). To prevent adhesion of concrete to formwork. Inside surfaces of forms shall be thoroughly cleaned before application of any of the materials mentioned above. Approved released of agents shall be applied strictly in accordance with the manufacturers instructions and shall not be allowed to come in contact with any reinforcement.

Be-use of the shuttering shall be permitted only after the surface has been thoroughly cleaned and repaired if necessary.

#### **5.2.6 CAMBER**

Suitable camber shall provided for the horizontal members of structures especially those of long spans, to counteract the effect of deflection. The formwork shall be so assembled as to provide for such camber. The camber for beams and slabs shall generally be 0.1% and 0.2% of the span

depending upon the span and stiffness of the member in question. Cambers are not normally applied to short or very stiff cantilevers.

#### **5.2.7 SPECIAL FORMWORK**

Formwork locations like tall structures etc, use of special types of formwork like moving or sliding forms shall be permitted. The details of such formwork along with the sequence of working shall be approved by officer-in-charge before erection.

#### **5.2.8 APPROVAL OF FORMWORK**

The contractor shall give the officer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the formwork as to its strength, alignment and general fitness; however, such inspection shall not relieve the contractor of his responsibility for safety of men, machinery, materials and the results obtained.

#### **5.2.9 REMOVAL OF FORMWORK**

The formwork shall be removed as not to cause any damage to concrete due to shock or vibration.

Formwork shall normally be stripped in the following order:

- i. Shutters to vertical faces e.g side of columns, beams and walls.
- ii. Shutters forming soffits to roof and floor slabs, horizontal and inclined canopies etc.
- iii. Shutters forming soffits of beams and girders.

The removal of the formwork for larger structure shall be planned and a definite scheme of operation worked out to the satisfaction of the officer-in-charge.

Re-propping of beams shall not be permitted except with the approval of the officer-in-charge.

##### **5.2.9.1 TIME OF REMOVAL**

In no circumstances shall forms be struck until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected at the time of strike. Where possible, the formwork shall be left for as long possible, as it would assist curing. Forms should be eased out carefully in order to prevent the load being transferred suddenly to the partly hardened concrete has been laid, before easing and removal of centring and shuttering is undertaken shall be as given in Table 5.2. The officer-in-charge may however extend the periods noted where necessary by giving written instructions to the contractor.

**TABLE 5.2**

The minimum period for removing Formwork

Part of Structure	Period for Ordinary Portland Cement without admixtures
Sides of foundations, columns beams and walls	24 hours
Under sides of slabs of above 4.5 metres span	7 days
Under sides of slabs of above 4.5 metres span & under sides of beams and arches upto 6 metres span.	14 days
Cantilever slabs and beams	21 days
Domes shells and other structures of special nature	See note as below
	As per written instructions of Officer-in-charge



### **5.3 STEEL REINFORCEMENT**

The reinforcement shall be:

- i. Hot rolled mild steel round bars for concrete reinforcement.
- ii. Hot rolled high yield steel bars for concrete reinforcement BS 4449
- iii. Cold worked deformed steel bars for reinforcement of concrete.
- iv. Hard drawn mild steel wire for the reinforcement of concrete BS 4482
- v. Steel fabric reinforcement for reinforcement of concrete

Where Lanka Torsteel is not used a certificate of origin and compliance with the requirements of related SLS/BSS shall be produced. Else, the steel shall be tested in the Srilanka Steel Corporation Laboratory or other approved Laboratory and results produced to the satisfaction of the officer-in-charge.

The cost of testing etc, shall be borne by the Contractor.

#### **5.3.1 BENDING LAPPING AND WELDING**

##### **5.3.1.1 CUTTING AND BENDING**

Reinforcement shall be cut and/or bend in accordance with BS 4466. Bars shall be bend cold, correctly and accurately on an approved type of bending apparatus, to the size and shape shown of the detailed drawings or as directed by the officer-in-charge.

When hot bending in the opinion of the officer-in-charge is necessary, only hot rolled high yield or mild steel shall be allowed to be bent at a cherry red heat and allowed to cool gradually. In the case of cold worked bars, prolonged or excessive heating may reduce its properties and hot bending shall therefore be avoided.

##### **5.3.1.2 LAPS**

Preferably, bars of full length shall be used. Lapping of bars where necessary, shall be done as directed by the officer-in-charge. The lapping bars shall not touch each other and shall be kept apart by 25 mm or  $1 \frac{1}{4}$  times the maximum size of the coarse aggregate whichever is greater, (but not exceeding 4 x diameter of bar). But where this cannot be done, the lapping bars shall be bound together at intervals not exceeding twice the diameter of such bars, with two strands of annealed steel wire of 0.90 mm to 1.6 mm thickness twisted tight. The laps should be staggered for different bars and located at pints along the span where neither shear nor bending moment is a maximum. Laps in secondary reinforcement shall be 30 times the diameter of the bar unless otherwise shows. Length of laps shall be as given in Appendix 5.A unless otherwise specified.

##### **5.3.1.3 WELDING**

Welding may be used for (i) fixing in position between crossing or lapping reinforcement (ii) transfer load between reinforcement. Welding on site shall be avoided if possible, but where suitable safeguards and techniques are employed and provided that they types of steel (including high yield steels to SLS 375 & B.S. 4449 have the required welding properties, it may be undertaken with the approval of the officer-in-charge. Welding of reinforcement shall conform to standard codes of practices and to the approval of the officer-in-charge.

Generally however all welding shall be carried out under controlled conditions in the factory or workshop.

#### **5.3.1.4 RE-BENDING**

Where it is necessary to bend reinforcement projecting from already cast concrete, care shall be taken to ensure that the radius of bend is not less than that specified in B.S. 4466. Where it is necessary to re-shape steel previously bent, this should only be done with the officer-in-charge's approval and each bar should be inspected for signs of fracture.

#### **5.3.2 FIXING IN POSITION**

##### **5.3.2.1 TYING OF BARS**

Reinforcement bars shall be placed in position as shown in the drawings. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.90 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during the deposition of concrete. The ends of the binding wire shall be bent back, clear of forms and into the body of the concrete.

Note: If spacing of bars is less than 300 mm in each direction, alternate intersection may be tied. Crossing bars should not be tack welded for assembly of reinforcement unless permitted by the Officer-in-charge.

##### **5.3.2.2 SPACERS AND COVER BLOCKS**

The bars shall be kept in position by using spacers, chairs etc. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of reinforcement nor cause spalling of the concrete cover.

The following methods shall be followed.

- (a) In the case of beam and slab construction, pre-cast cover blocks in cement mortar 1 : 1 1/2 about 40 x 40 mm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcement.
- (b) In the case of cantilevered and doubly reinforced beams or slabs the vertical distance between the horizontal bars shall be maintained by introducing chair spacers or support bars of steel at 1.0 metre or at shorter spacing to avoid sagging.
- (c) In the case of other R.C.C. structure such as arches, domes etc. cover blocks, spacers, and templates shall be used as directed by the officer-in-charge. Projecting reinforcement shall be protected from the weather by grout washing, or special covers or wrapping, and/or subsequently cleaned until completely embedded in concrete.

Concreting shall not commence until the reinforcement has been inspected and approved by the Officer-in-charge. The position of reinforcement should be checked before and during concreting, particularly attention being paid to the position of top reinforcement especially in cantilever sections.

### 5.3.2.3 COVER

The cover of concrete to the reinforcement shall be as described in the drawings and shall be as described in the drawings and shall be provided and maintained within a tolerance of 3 mm under or over (except where specified as a minimum).

The following table shall be adopted for general guidance

**TABLE 5.3 COVER FOR REINFORCEMENT**

Conditions of exposure	Nominal cover Concrete grade							
	20		25		30		35	
	Gen- rally	Slabs & shells	Gen- rally	Slabs & shells	Gen- rally	slabs & shells	Gen- rally	slabs & shells
a) Mild e.g completely protected against whether, or aggressive conditions, accept for brief period of exposure to normal weather conditions during construction.	25	15	25	15	20	15	20	15
b) Moderate e.g. sheltered from severe rain and against freezing whilst saturated with water. Buried concrete and Concrete continuously Underwater.	40	25	40	25	30	25	30	25
c) Severe e.g exposed to driving rain, alternate wetting and drying and to freezing whilst wet subject to heavy condensation or corrosive fumes	-	-	50	30	35	30	35	30
d) Very sever e.g exposed to sea water or moor land water and with aggression subject to salt use for de-icing	-	-	-	-	60	-	60	-

Note: 1.The normal cover shall always be at least equal to (a) the size of the bar (b)max of the agg +5 mm when this dimension exceeds 32 mm.

2. In the case of reinforced concrete foundations, a 75 mm layer of blinding concrete, generally 1: 3: 6 (50 mm) mix shall generally be provided on the earth face.

3. The values given above may be modified to obtain a particular fire-resistance.

## 5.4 CONCRETING

The concrete shall be made as specified in chapter \$ and the proportions on ingredients shall be as specified. Concrete shall be mixed by a mechanical mixer except when the officer-in-charge permits otherwise.

### 5.4.1 CONSISTENCY

The concrete shall be of such consistency that it will flow sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar. The consistency shall depend on whether the concrete is vibrated or hand-tamped. It may be determined by slumps of concrete for the different types of works, and shall be as given in Table 5.4 below, unless otherwise specified.

**TABLE 5.4 SLUMP FOR CONCRETE**

Work	Slump In mm	
	Vibrators used	Vibrators not used
Mass concrete in R.C.C. foundation, Footings and retaining walls	10 – 25	80
Beams and slabs and columns	25 – 40	50 – 100
Thin R.C.C. Sections or sections With congested steel	40 – 50	125- 150

Note: Volume Batched Concretes of the higher slumps rang of 75 mm and above, shall be produced by using additional cement slurry (and not merely water) keeping the water-cement ration and the compressive strength of concrete reasonably constant.

The amount of water used in the concrete shall be regulated by volume or by weight as required to secure concrete of the proper consistency. Adjustment shall be made for any variation in the moisture content due to water absorbed by the aggregate and/or free water in aggregates. Addition of water to compensate for stiffening of the concrete shall not be permitted.

### 5.4.2 PLACING OF CONCRETE

The Officer-in-charge shall be kept advised sufficiently in advance as to when placement of concrete will commence. The concrete shall be transported from the mixer with the least possible delay in liquid tight containers or barrows band by methods which prevent the segregation or loss of ingredients. Slump loss in transit shall not exceed 25 mm. Compensation for excessive slump loss by allowing wetter consistency at the mixer resulting in higher water cement ratios, shall not be permitted. All concrete conveyors, barrows and chutes shall be primed by washing with rich cement grout before use. These shall be thoroughly washed and cleaned immediately after stopping concreting.

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A record shall be kept of the time and date of all concrete pours and the subsequent removal of formwork.

- 5.4.2.1** Concreting shall be commenced only after the Officer-in-charge has inspected the formwork and reinforcement as place, and passed the same.

Shuttering shall be cleaned of all shavings, saw dust, pieces of wood, or other foreign material by the use of air and water pressure hoses. All accumulation of water or debris shall be flushed out through the holes or opening provided for the purpose. These holes shall be neatly plugged before concreting.

- 5.4.2.2** In the case of concreting of slabs and beams, wooden plank or cat-walks supported directly on the centring by means of wooden blocks or lugs shall be provided to take the concrete to the place of deposition without disturbing the reinforcement in any way. Traffic shall not be allowed over the reinforcement or freshly placed concrete.

- 5.4.2.3** The concrete shall be deposited in its final position in such a manner as to preclude segregation of ingredients. In deep trenches and footings, concrete shall be placed through shutters as directed by the Officer-in-charge. In the case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 metres at a time. The progress of concreting in the vertical direction shall be restricted to one metre per hour.

The mix shall be such that there will be no excess water on the top surface on completion of compaction. In the case of deep lifts, the water content of batches at the top may have to be reduced to compensate for water gain from lower levels.

- 5.4.2.4** During cold weather, concreting shall not be done when the temperature falls below 4 – 5 ° C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.

- 5.4.2.5** The time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

### **5.4.3    COMPACTION**

Concrete shall be compacted into a dense mass immediately after placing by means of mechanical vibrators designed for continuous operation. The Officer-in-charge may however relax this condition at his discretion for certain items, depending on the scope of the work, on the thickness of the members and feasibility of vibrating the same, and permit hand compaction instead.

Hand compaction shall be done with the help of tamping rods. Concrete shall be thoroughly compacted and completely worked around the reinforcement, embedded fixtures, duct formers and into corners of the formwork.

Compaction shall be completed before the initial setting starts, i.e. within 30 minutes of addition of water to the dry mixture.

Concrete shall be deposited continuously in layers of such thickness that no concrete is deposited on concrete which had hardened sufficiently to cause the formation of seams and planes of weaknesses within section. If a section cannot be placed continuously, construction joints shall be located at points provided for in the plans or approved by the officer-in-charge. If a delay exceeding one hour occurs in placing, no fresh concrete shall be placed on that already deposited until the officer-in-charge's approval is obtained. The surface of the hard concrete is then to be prepared as specified in 5.4.4.

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#### **5.4.3.1 USE OF VIBRATORS**

The contractor shall inform the officer-in-charge of the number and types of vibrators to be used. Stand-by vibrators shall always be provided before commencement of work. External vibrators shall not be used without the approval of the officer-in-charge.

The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation, such that de-aeration and effective compaction are attained. The rate of the supply of concrete from the mixers shall be commensurate with this. The vibration shall continue throughout the whole duration of the placing of concrete, the vibrators being adjusted so that the centre of vibration approximates to the centre of the mass compacted at the time of placing.

The full depth of fresh concrete shall be compacted without damaging adjacent partly hardened concrete.

Concrete shall be considered as properly compacted when the air bubbles cease to appear on the upper surface and mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface.

When this condition has been attained, the vibrator shall be stopped if using vibrating tables or external vibrators, while needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets. In case both internal and external vibrators are being used, the internal vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instruction of the makers of the particular type of vibrator used shall be strictly complied with. Over vibration shall be avoided.

Shaking of reinforcement for the purpose of compaction should not be resorted to. Likewise, all precautions shall be taken to prevent displacement of the reinforcement during the placing and compaction of concrete.

#### **5.4.4 CONSTRUCTION JOINTS**

Concreting shall be carried out continuously up to construction joints, the position and details of which shall be decided in advance and approved by the Officer-in-charge. Such joints shall be kept to the minimum and shall not be located in valleys. The joints shall be located taking into account the shear and other stresses. They shall be straight and at right angles to the direction of main reinforcement. Immediately prior to re-commencement of concrete on a joint, the surface of the concrete against which new concrete will be cast shall be free from laitance and shall be roughened to the extent that the largest aggregate is exposed but not disturbed. Care shall be taken that the joint surface is cleaned immediately before the fresh concrete is placed against it. A coat of neat cement slurry at the rate of 2.75 kg of cement per sq metre shall then be applied on the roughened surface before fresh concrete is laid.

Particular care shall be taken in the placing of the new concrete close to the joint. The concrete shall be well compacted and if possible, a vibrator shall be used.

Where the officer-in-charge considers that special preparations are necessary, e.g. for an in situ-structural connection, preparation shall be carried out preferably when the concrete has set but not hardened, by spraying with a fine spray of water or brushing with a stiff brush to remove the outer mortar and expose the larger aggregate without its being disturbed.

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Where this treatment is impracticable and blasting or a needle gun shall be used to remove the surface skin and laitance. Hacking of hardened surfaces shall be avoided.

#### **5.4.4.1 COLUMNS**

In the case of columns, the joints shall be horizontal and located 100 to 150 mm below the bottom of the beam running into the column. The portion of the column above this joint shall be concrete with the beam. If a kicker (i.e a starter stub) is used, it should be at least 70 mm high and carefully constructed. It is preferable for the kicker to be incorporated with the previously place concrete. Where possible, the formwork should be designed to facilitate the preparation of the joint surface as the optimum time for treatment is usually two to four hours after placing.

#### **5.4.4.2 SLABS AND BEAMS**

When stopping the concrete on a vertical plane in slabs and beams, an approved stop-board (see Fig. 5/1) shall be placed with necessary slots for reinforcement bars. The construction joints shall be keyed by providing a train.

The curing shall be done for a minimum period of 10 days.

#### **5.4.5 MOVEMENT JOINT**

Movement joints shall generally be straight and conform to approved plans. The joints shall be formed with rigid formwork and stop ends suitably designed to cast the structurally separate component or part. Filling of these joints with resilient joint fillers and the provision of copper or bras plates shall be as specified or directed.

A note on movement joints given in Appendix 5B

#### **5.4.5.1 CONTRACTION JOINTS**

An interval of not less than 48 hours shall be allowed between casting of adjacent bays separated by formed contraction joints or construction joints.

#### **5.4.5.2 EXPANSION JOINTS**

Concrete shall not be place on both sides of the joints at the same time unless otherwise approved.

#### **5.4.6 CURING AND PROTECTION**

##### **5.4.6.1 CURING**

After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying with moist gunny bags, sand or other material approved by the Officer-in-charge. After 24 hours of laying concrete, the surface shall be cured by flooding with water of minimum 25 mm depth, or by covering with wet absorbant material, e.g. damp hessian or jute, coconut or straw matting, or a layer of sand about 50 mm thick taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give good bond between concrete and plaster.

The reinforced concrete work shall be done to such tolerance that the thickness of plaster required for finishing the surface does not exceed 10 mm.

Shallow patches shall first be treated with a coat of thin grout composed of one part of cement and one part of sand and then filled with mortar similar to that used in the concrete. The mortar shall be placed in layers not more than 10 mm thick and each layer shall be given a scratch finish to ..... with

the succeeding layer. The last layer shall be finished to match the surrounding concrete by floating, rubbing or tooling on formed surface by pressing the form material against the patch while the mortar is still plastic.

Holes left by bolts shall be filled with mortar carefully packed into place in small amount. The mortar shall be mixed as dry as possible, with just enough water so that it will be tightly compacted when forced into place.

Tiered holes extending right through concrete may be filled with mortar using a pressure gun (similar to the gun used for greasing motor cars)

Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. When uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of white Portland cement by the patching mortar, the exact quantity being determined by trial.

Care shall be taken to cure the material in the patches as taken with the whole structure. Curing shall be started as soon as possible after the is finished to prevent early drying. Damp hessian may be used but in some locations it may be difficult to hold it in place. A membrane curing compound will be most convenient in these cases.

#### **5.4.6.2 PROTECTION**

It shall be the responsibility of the contractor to prevent damage to the fresh concrete surfaces from rain indentation and physical damage. Immature concrete shall be protected from physical shock or movement and thermal shock particularly from cold weather. Exposed concrete surface shall be protected from rust marks and other disfigurement.

#### **5.4.7 FINISHING**

**5.4.7.1** Immediately on removal of forms, the reinforced concrete work shall be examined by the officer-in-charge, before any defects are made good.

- (a) Work that has sagged or contains honey-combing to an extent Detrimental to structural safety or architectural concept shall be rejected.
- (b) Surface defects of a minor nature accepted by the Officer-in charge shall be rectified as given below:  
surface defects which require repair forms are removed usually consists of bulges due to movement of forms, ridges at form joints, honey-combed area damage resulting from the stripping of forms, and bolt holes.
  - (i) Bulges and ridges shall be removed by careful chipping or Tooling and the surface shall then be rubbed with a grinding stone.
  - (ii) Honey-combed and other defective areas shall be chipped Out, the edges being cut as straight as possible and per-pendicularly to the surface, or preferably slightly undercut to provide a key at the edge of the patch, gular or trapezoidal fillet nailed on the stop-board. Inclined or feather joints shall not be permitted. Any concrete flowing through the joints of stop-board shall be removed soon after the initial set.



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#### **5.4.7.2 SURFACE PREPARATION FOR PLASTERING**

The surface which is to receive plaster or where it is to be joined with a brick masonry wall shall be properly roughened after the shuttering is removed.

#### **5.4.7.3 SURFACE PREPARATION FOR FLOOR FINISHES**

The surface of a reinforced concrete slab, on which a screed or other finish is to be laid shall be roughened with brushes while the concrete is green. This shall be done carefully without disturbing the concrete.

#### **5.4.7.4 PREPARATION FOR ROOF SLABS**

In case of roof slabs the top surface shall be finished even the smooth with a wooden trowel, before the concrete begins to set. When required, a brushed finish shall be obtained by brushing the surface with a stiff broom or wire brush while still green. This will provide a slightly coarse surface.

#### **5.4.8 SURFACE FINISHES**

This sub-clause on finishes to in-situ concrete covers formed finishes, worked finishes on plastic concrete and worked finishes on hardened concrete.

The contractor shall provide form work appropriate to the required formed finish and to the dimensional tolerance if any specified.

The general requirements for plain finish shall be as follows:

- (1) The surface shall have an even finish by use of a sheet material e.g. plywood.
- (2) Panels shall be arranged in a regular pattern as a feature of surface.
- (3) The concrete surface shall be free from voids, honey-combing and other large defects. Blow holes shall not be more than 10 mm diameter.
- (4) The concrete surface shall be free from discolouration due to contamination or grout leakage but variation in colour resulting from the use of an impermeable form lining may be permitted.

The tolerance for the concrete surfaces shall be as follows:

- (a) Abrupt irregularities not more than 5 mm.
- (b) Gradual irregularities expressed as maximum permissible deviation from a metre straight edge shall be not more than 5 mm.
- (c) The arrises to columns, walls etc shall be chamfered or rounded as specified in the drawings or as directed by the Officer-in-charge. Plain finish shall be left as struck unless otherwise specified. Making good or small defects will normally be permitted but only after inspection by the Officer-in-charge. Blowholes shall be filled with mortar to an approved sample.

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#### **5.4.8.1 FORMED FINISHES**

Formed finishes shall consist of one of the following:

- (1) Basic finish
- (2) Plain finish
- (3) Fine finish
- (4) Special finish

##### **5.4.8.1.1 BASIC FINISHES**

A basic finish shall be appropriate for areas which are not exposed in the finished work, e.g. foundations, backs of retaining walls, areas to be subsequently clad, plastered or rendered. There are no special requirements for this finish except those for dimensional tolerances. The concrete shall be fully compacted and shall be sound.

##### **5.4.8.1.2 PLAIN FINISH**

A plain finish shall be appropriate for plain concrete surfaces exposed in the finished work. E.g. Car parks subways, circulation areas and areas to be subsequently painted.

##### **5.4.8.1.3 FINE FINISH**

Fine finish shall be adopted for areas of high aesthetic importance and generally only for internal work. The contractor shall provide the control sample of fine finish in an approved location in advance of construction.

The general requirements for fine finish shall be as follows:

- i. A smooth even finish shall be produced with impervious sheet material e.g. plastic faced plywood.
- ii. Panels shall be made as large as practicable and arranged in an approved regular pattern as a feature of the surface.
- iii. Blow holes less than 5 mm will be permitted but otherwise the surface shall be free from voids, honey-combing and other defects.
- iv. Variation in colour resulting from the use of impermeable form lining will be permitted but the surface shall be free from discolouration due to contamination or grout leakage.
- v. Cover spaces shall not be used without the approval of the Officer-in-charge.

Tolerance for the fine finished surfaces shall be as follows:

- a. Abrupt irregularities in the surface shall not be more than 3 mm.
- b. Gradual irregularities expressed as maximum permissible deviation from a one metre straight edge shall not be more than 3 mm.
- c. Arises of columns, walls, etc, shall be chamfered/rounded as detailed in the drawing or as specified by the officer-in-charge.

Formwork ties shall not be used except with the permission of the officer-in-charge.

Making good of fine finished concrete will not be permitted and the surface shall be left as struck.

Blow holes shall be filled with mortar to an approved sample.

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#### **5.4.8.1.4 SPECIAL FINISH**

Special finishes to concrete surfaces like rough board finish, ribbed finish, coffered / Troughed etc. shall be provided by the Contractor to the specified requirements and tolerance indicated in the drawings.

#### **5.4.8.2 WORKED FINISHES: PLASTIC CONCRETE**

Worked finishes (normally to horizontal surfaces) shall be produced by working the concrete when still in the plastic condition.

The worked finishes on plastic concrete shall be one of the following:

- (a) Tamped finish
- (b) Scored finish
- (c) Floated finish
- (d) Trowelled finish

##### **5.4.8.2.1 TAMPED FINISH**

The surface of plastic concrete shall be tamped with the edge of a board or beam of adequate size and weight to give an even texture of parallel ribs. The concrete surface shall thus be given an overall ribbed effect. It shall be noted that the tamping shall be started with very little bleeding water present on the surface.

##### **5.4.8.2.2 SCORED FINISH**

This type of finish which gives an overall roughened surface to the concrete and shall be obtained by scoring (scratching) the concrete surface at the appropriate time with a stiff brush, metal comb, trowel or a length of mesh reinforcement.

##### **5.4.8.2.3 FLOATED FINISH**

The surface shall be floated with a wooden float to give an even, slightly coarse texture with no ridges or steps. Alternatively a skip float or power float may be used to give the required finish. Floating has to be timed properly to achieve the best results.

##### **5.4.8.2.4 TROWELLED FINISH**

After obtaining an initial finish using a wooden float/power float a fine smooth finish shall be given to concrete surfaces by hand trowelling or power trowelling. Power trowelling shall be adopted for large unbroken areas with few ducts, recesses etc. the timing of power trowelling in relation to the ambient condition of concrete shall be such that the concrete shall be sufficiently stiff to take the weight of the machine and the operator, yet sufficiently workable for the trowelling to be effective. Vacuum dewatering may be adopted to overcome this timing problem, if so directed.

#### **5.4.8.3 WORKED FINISHES : HARDENED CONCRETE**

Hardened concrete shall be given the following surface finishes as specified :

- (a) Abrasive blasted finish
- (b) Tooled finish
- (c) Power ground floor finish

Finishes on hardened concrete noted above shall be worked over a formed finish or worked finish on plastic concrete.

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#### **5.4.8.3.1 ABRASIVE BLASTED FINISH**

Abrasive blasted finish shall be carried out over a plain/fine/floated finish. These shall conform to approved samples and shall be carried out within 7 days of striking of formwork. The surface shall be blasted with an approved abrasive to even texture and to the depth of exposure specified. The minimum depth of exposure shall be 1mm, for light blasted finishes.

Abrasive blasting shall be stopped short of arrises with regular margin of 40mm or as otherwise directed.

#### **5.4.8.3.2 TOOLED FINISH**

Tooled finishes shall be obtained over an initial plain finish surface or a ribbed finish surface by using a snub-nose tool/disc head bush hammer/combed chisel or other approved tools. Tooling shall be carried out only on a concrete which is at least 21 days old and has a compressive strength of not less than 20 N mm<sup>2</sup> when tooling is carried out. Tooling shall be stopped short of arrisses with regular margin of 40 mm or as otherwise directed.

#### **5.4.8.3.3 POWER GROUND FLOOR FINISHES**

Power grinding shall be used to produce a hard wearing surface suitable for the direct application of thin sheet of tile covering. Grinding shall be used as a finishing technique and shall not be used to correct gross irregularities in the surface. The objective shall be to remove the thin, weak surface layer of concrete (about 1 mm thick) to produce a surface which is less prone to dusting and wear, more coarse and slip resistant.

A sample shall be provided by the contractor in an approved location. Power grinding shall be carried out of a floated finish obtained with specified tolerances. (The normal gradual irregularities of the surface shall be not more than 2 mm on a 1 meter strength edge). Power grinding shall normally be done dry and within 7 days of concreting. After grinding, all dust shall be swept away and the surface thoroughly washed down. To reduce dusting, a surface hardening solution may be applied to the specification of the manufacturer if so directed by the officer-in-charge.

### **5.4.9 (SAMPLING AND STRENGTHENING TEST OF CONCRETE FOR PRESCRIBED OR VOLUME BATCHED MIXES)**

#### **5.4.9.1 GENERAL**

Sampling and testing of concrete shall be as per B.S. 1881.

The characteristic strength of concrete on which the structural design is based is that 28 day cube strength below which not more than 5% of the test results may be expected to fall.

Compliance with the specified characteristics strength should generally be judged by tests made on cubes at an age of 28 days. In order to get an idea of the quality of the concrete sooner, compressive strength test at 7 days may be used to test compliance with the specified characteristic strength.

For this purpose the 7 days strength may be taken to be 2/3 of the 28 day cubic strength. The rate of sampling shall generally be as given below unless otherwise decided by the Officer-in-Charge.

One sample shall be taken from any one batch selected randomly to represent an average volume of not more than 20 cubic metres, 20 batches or ¼ of the total quantity of concrete under consideration for testing whichever is the lesser volume, but not at a rate less than 1 sample per day per Grade.

#### 5.4.9.2 TESTING PLAN

Each cube shall be made from a single sample taken from a randomly selected batch of concrete. The samples shall be taken at the point of discharge from the mixer or in the case of ready mixed concrete, at a point of discharge from the delivery vehicle.

#### ACCEPTANCE CRITERIA

Grade Designation	Specified Characteristic Strength N mm <sup>2</sup>	28 days compressive strength N mm <sup>2</sup> Average of any group of 4 consecutive test cubes shall be greater than	And individual test results greater than
Gr. 10	10	13	8.5
Gr 15	15	20	13
Gr. 20	20	27	17
Gr. 25	25	33	21
Gr. 30	30	40	26
Gr. 35	35	47	30
Gr. 40	40	53	34

Notes:

1. For relatively unimportant buildings and works in which the quantity of concrete is less than 15 cubic meters, the strength test may be waived by the officer-in-charge.
2. For works where a designed mix is adopted the detailed procedure for sampling and testing set out in BSCP 110 shall be followed.

APPENDIX 5A  
REINFORCED CEMENT CONCRETE

MAXIMUM ANCHORAGE LENGTH OF SINGLE BARS

Concrete Grade	Code	Tension		Compression	
		Used	Mild steel	Tor Steel	Mild steel Tor steel
20 (i.e 1:2:4 mix)	BSCP.110	45 Ø	40 Ø	30 Ø	27 Ø
25	BSCP 110	30 Ø	36 Ø	26 Ø	24 Ø

NOTES:

BSCP 110 VALUES ARE CALCULATED FOR SINGLE RODS, TAKING  
 $AREA OF ROD = \frac{\pi \phi^2}{4}$ , EFFECTIVE PERIMETER =  $\pi \phi$  ;  $\phi$

THE TENSILE STRESS	= 0.87 fy	LOCAL BENDERS	
THE COMPRESSIVE STRESS	= 0.72 fy	fy	
FOR TOR STEEL fy	= 410 N/M.M <sup>2</sup>	N/M.M <sup>2</sup> concrete stress	
FOR MILD STEEL fy	= 250 N/M.M <sup>2</sup>	20	25
	410	2.52	3.00
	250	1.7	2.0

fy AVERAGE ANCHORAGE STRESS

TENSION		COMPRESSION	
CON.Gr.20	CON.Gr. 25	CON.Gr.20	Con.Gr.25
410	2.21	2.47	2.73
			3.12

N/M.M<sup>2</sup>

250

N/M.M<sup>2</sup>

Note: Lapping (as per clause 3.11.6.5 BSCP 110) When bars are lapped, the length of the Lap should be at least equal the anchorage length required to develop the stress in the smaller of the two bars lapped, except that for deformed bars in tension the length of the lap should be 25% than the anchorage length required for the smaller bar.  
The length of lap provided bowen, should not be less than 25Ø + 150 mm in tension reinforcement and not less than 20 Ø + 150 mm in compression reinforcement.

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## APPENDIX 5B

Movement Joints – shall be as specified or directed

In general movement joints in the structure should pass through the whole structure one plane. Movement joints may be of the following types.

- a) Contraction Joint -        this has a deliberate discontinuity but no initial gap between concrete on both sides of the joints as it is intended to permit contraction of the concrete.

In a complete contraction joint – both concrete and reinforcement are interrupted.

In a partial contraction joint – both concrete and reinforcement are interrupted.

- b)        Expansion Joint        A joint with complete discontinuity in both reinforcement and concrete, intended to accommodate either expansion or contraction of the structure. Generally a wide gap between the adjoining parts of the structure is provided.
- c)        Sliding Joint                a joint with complete discontinuity in both reinforcement and concrete at which special provision is made to facilitate relative movement in the plane of the joint.
- d)        Hinged Joint                 a joint specially designed and constructed to permit relative rotation of the members at the joint.
- e)        Settlement Joint             a joint permitting adjacent members structures to settle or deflect relative to each other.

A joint may be designed to fulfill more than one of the above requirements.

**DEFINITION**

**Bat:** A Portion of a brick either especially manufactures or formed on the site by cutting a whole brick across its length (See fig. 6/1)

**Bond:** A disposition of the units in a wall usually designed to ensure that the cross joints in each course are not less than one quarter of the length of a unit from those in adjacent courses.

**Bricks**

A masonry unit not exceeding 337.5 mm (13 ½") in length, 225 mm (9") in thickness or 112.5 mm (4 ½") in height. (The height is taken to be the vertical dimension perpendicular to the base when the unit is used in its normal aspect. The height of a brick is not less than 38 mm (1 ½"). If less than this dimension, it shall be classified as a tile.

**Block**

A masonry unit which when used in its normal aspect exceeds the length or width or height specifies for bricks.

**Solid**

In which small holes passing through or nearly through the brick do not exceed 25% of its volume.

**Hollow**

In which holes passing through the unit exceed 25% of its volume.

**Co-ordinating size:** the size of a co-ordinating of space allocated to a masonry unit including allowance for joints and tolerances.

**Work size:** The size of a masonry unit specifies for its manufacture, to which its actual size conform within specifies permissible tolerances.

**Compressive Strength:** The average value of the crushing strength of ten masonry units tested.

**Common:** Suitable for general building work but having no special claim to give an attractive appearance.

**Facing:** Specially made or selected to give an attractive appearance when used without rendering or plastering or other surface treatment for the wall.

**Brick work & Block work**

As assemblage of units (brick or block) bonded together with mortar to form a wall including piers or column.

**Closer**

A portion of a unit used to maintain bond, either specially manufacture or formed on site by cutting a whole unit along its length (fig 6/1)

**Corbel**

A unit cantilevered from the face of a wall to from a bearing.

**Cornice**



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A projection, generally continuous, from the façade of a building or part of a building

Course

A layer (e.g. a course of brickwork or blockwork) which includes a layer of mortar as well as a layer of units.

Over sailing Course

Brick course projecting from a wall for the sake of appearance only as distinct from corbels which are load carrying.

Damp-poor course

A layer or layers of material laid or inserted in a structure to prevent the passage of water.

Efflorescence

An encrustment of salt left by evaporation

Flashing

A sheet of impervious material fixed to a structure and dressed to cover an intersection or joint where water would otherwise penetrate.

Footings

A projecting course or courses formed below the base of a wall to distribute the load

Frog

A purpose-made indentation in either or both of the two largest faces of a brick

Header

A unit with its end showing on the face of the wall

Indenting

The omission of units to form recesses in to which future work can be bonded

Jamb

That part of a wall at the side of an opening (see reveal)

Joint

A junction between walling Units

Bed joint – A mortar layer upon which walling units are set

Cross joint – A joint, other than a bed joint, normal to the face of a wall

Wall joint – A joint parallel to the face of the wall

Masonry Unit

A block, a brick or a fixing unit

Padstone (Template)

A strong block bedded on a wall to distribute a concentrate load, sometimes known as a template

Parapet

Top section of a wall where it conceals the gutter of the roof

Partition wall

Any internal wall primarily intended for sub-division of space

Pier

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A thickened section forming an integral part of the wall, placed at intervals along the wall primarily to increase the stiffness of the wall or to carry a vertical concentrated load (fig 6/3)

Pilaster

Attached pier

Pillar or column

A detached masonry support, rectangular, circular, or elliptical in shape (fig 6/2)

Plinth

A projection based of an external wall, which gives additional stability

Pointing

A refilling and finishing of joints from which mortar has been raked out

Quoin

An external corner

Reveal

The visible part of each side of a recess or opening in a wall (see 'jamb')

Scaffolding

A temporary erection of bamboo, timber, or steel work, used in the construction, alteration, demolition or repair of a building to support or to allow the hoisting or lowering of workmen, their tools and materials

Sill

Work forming the lower boundary of door or window opening

Stretcher

A unit laid with its length in the direction of the wall

String Course

A distinctive course or band in a wall, usually horizontal and sometimes projecting and moulded

Template

A pattern, usually of sheet material, used as a guide for setting out particular work

Toothing

Units left projecting to bond with the future work

Weathering

This term is used to describe both:-

- (i) the cover applied to, or the geometrical form of, a part of a structure to enable it to show rain water; (see also fig 6/2) or
- (ii) the effect of the climatic and atmospheric conditions on the external surface of material

## 6.1 MATERIALS

### 6.1.1 COMMON BURNT CLAY BRICKS

#### GENERAL

Bricks shall be hand or machine moulded. They shall be regular in shape with good clean surfaces, free from lumps of unslaked lime, stones, etc

Their surface shall be free from striations, laminations, pittings, cracks etc. They shall be uniform in colour and must be well burnt so as to give a clear ringing sound when struck. When broken, the fracture shall give a close grained uniform texture and colour and shall be free from black core or any sign of being imperfectly burnt

The dimension of bricks shall generally be 220 mm x 105 mm x 65 mm  
(8.7" x 4.1" x 2.6")

The general and specific requirements are tabulated below in the table 6.1

Description	Type I	Type II	
		Grade I	Grade II
Method of manufacture	Wire-cut, machine made	Hand-made	Hand-made
Average compressive strength not less than	10 N/mm <sup>2</sup> (1450 p. s. i.) storeyed	4.8 N/mm <sup>2</sup> (700 p. s. i.)	2.8 N/mm <sup>2</sup> (410 p. s. i.)
Use in locations unless otherwise specified	Load bearing multi storeyed	Two-storeyed construction	single-storeyed construction
Maximum water absorption	18%	28%	28%
Efflorescence	Slight	Moderate	Moderate
Normal dimension of individual bricks	220 mm x 105 mm x 65 (8.7" x 4.1" x 2.6")		
Overall dimension of	L 5280 mm 75 mm ( 207.93 mm 3.0 in ) B 2520 mm 40 ( 99.2 mm 1.6 in ) D 1560 mm 40 ( 61.4 mm 1.6 in )		
The bed faces shall be provided with grooves, frogs (deprecation) or holes to ensure adequate bonding			

#### 6.1.1.1 SAMPLING AND TESTING OF BRICKS

The bricks shall be sampled and tested for dimensions, general requirements, compressive strength water absorption and efflorescence  
Acceptance criteria shall be as set out in the same standard.

## 6.1.2 PRECAST BLOCKS/BRICKS

### GENERAL

These shall be composed of cement mortar/cement concrete in specifies proportions, or the proportions needed to achieve the specified compressive strength. These shall generally conform with B.S 6073 Part I and Part 2

### 6.1.2.1 MATERIALS

Cement – shall be ordinary Portland cement conforming to B.S. 12

Aggregates – Shall be natural aggregates conforming to B.S. 882 expect that the fine and/or coarse aggregates need not be graded

Admixtures – Use of admixtures shall be not permitted without the prior approval of officer-in-charge

### 6.1.1.1 SIZES AND SHAPES

The blocks/bricks shall be true to shape with good, clean arrises. The minimum thickness of the external shell of hollow and cellular bocks shall be not less than 15 mm or 1.75 times the nominal maximum size of the aggregate whichever is the greater

The maximum size of bricks shall be 337.5 x 225 x 112.5. The size of the bricks shall generally conform to the work size B.S. 6073 Part 2, Table 2 given below: -

Work sizes of bricks:-

290 x 90 x 90 mm

215 103 x 65 mm

190 x 90 x 90 mm

190 x 90 x 65 mm

The size of blocks shall generally conform to the work sizes in B.X. 6073 Part 2 Table 1 given below;-

TABLE 6.2 – work sizes of blocks (ref. TABLE NO.1 of B.S 6073: Part 2 1981)

Thickness m		60	75	90	100	115	125	140	150	175	190	200	215
		220	225	250									
Length	Height												
mm	mm												
390	190	x	x	x	x	x		x	x		x	x	
440	140	x	x	x	x			x	x		x	x	
440	190	x	x	x	x			x	x		x		x
440	215	x	x	x	x	x	x	x	x	x	x	x	x
440	290	x	x	x	x			x	x		x	x	x
590	140		x	x	x			x	x		x	x	x
590	190		x	x	x			x	x		x	x	x
590	215		x	x	x		x	x	x	x		x	x
		x	x										

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### 6.1.2.3 STRENGTH REQUIREMENTS

The blocks/bricks of thickness 75 mm or more when tested for compressive strength shall comply with the following: -

- (a) the average crushing strength of 10 bricks shall be not less than  $7.0\text{N/mm}^2$
- (b) the average crushing strength of 10 blocks shall be not less than  $2.8\text{N/mm}^2$
- (c) the coefficient of variation for the sample shall not be exceeded 20%

Blocks less than 75 shall be tested for transverse strength in accordance with the code and average transverse strength of 5 blocks shall be less  $0.65\text{N/mm}^2$

### 6.1.2.4 MANUFACTURE

Cement mortar used for manufacture of bricks shall be 1:6 or other proportions needed to achieve the specified compressive strength and the mortar shall be of stiff consistency

Cement concrete for blocks/bricks shall be 1:3:6 (14 mm) or other proportions needed to achieve the strengths specified. Concrete shall be of the required consistency to suit the moulds and the methods of compaction

The unit shall be manufactured by machines of approved mark. In the absence of machines, they shall be cast in properly designed rigid steel moulds or would moulds lined with galvanized steel sheets. The mould surfaces shall be cleaned and smeared with suitable oil after each casting. Hand tamping shall be with 16 mm diameter steel rods and shall be continuous after filling the first 25 mm. The units as cast shall be dense and solid as they come from the block making machines or mould. The units showing cavities of any kind must be broken up immediately; however, the concrete may be re-used if the officer in-charge considers that the time since mixing has not exceeded 30 minutes under no circumstances shall the unit be plastered at any stage to cover up defects.

Units which are too smooth to provide a key for the final plaster coating may be bristle brushed to provide a slightly rough surface after they have hardened for 6 hours.

Curing shall be carried on for 14 days. The units shall be cured for the first seven days by immersion in water commencing not earlier than 16 hours after casting; they shall thereafter be kept wet by stack curing for a further period of seven days, the units being stacked to a height of not more than 1.3 meters. In the case of hollow blocks the cavities shall be filled with sand and water throughout the day and night. On sunny and windy days, the top and side faces of stacks shall be protected with cadjans or hessian canvas which shall be removed at frequent intervals for watering

The units shall be built into the work not earlier than 4 weeks from casting.

The units which have been allowed to dry out earlier than prescribed or which found to be faulty in shape or finished, or show voids in their surface shall be rejected.

Each unit will have the date of casting marked it to ensure adequate curing.

### 6.1.2.5 SAMPLING AND TESTING OF BLOCKS

This shall be as per clause 13 of B.S. 6073 Part I

The units shall be made in batches, and from each batch of 1,000 not more than 15 units will be selected at random for testing the compressive strength and drying shrinkage.

In the case of blocks less than 75 mm thick, 10 blocks shall be selected for testing the transverse strength and drying shrinkage. The further preparation of the selected units for testing as describes in the British Standard is to be done at the site by the constructor who shall in the presence of the officer in-charge, pack the units in approved packing cases with suitable packing material to ensure the units remaining damp during transit and deliver them at the approved testing station at his own expense. The cost of the actual test shall be born by the owner. In the event of the units tested failing to meet the specified strength requirements, they shall be (at the discretion of the officer in- charge) relegated to some lesser category or condemned. In the former case they shall be suitable marked to avoid confusion and in the latter case they shall be removed from the site without delay

## 6.2 BRICKWORK (CLAY BRICK)

### 6.2.1 MORTARS FOR BRICKWORK

These shall conform to Chapter 3.

Mortar for brickwork shall be generally as given below in Table 6.3 unless otherwise specified:

Type of Mortar	nation	Mortar Desig- Cement	MasonryLime Cement	Sand	Mix by volume	Location
Cement-sand	iv	1	-	-	8	All walls above Ground level Except 4 1/2" Brickwork
Cement-lime sand		iv	1	-	2	9
Masonry cement - sand		iv	-	1	-5	-do-
Cement-sand *	iii	1	-	-	5	in 4 1/2 brick and in walls below ground level
Cement-lime sand		iii	1	-	1	5
Masonry cement	iii	-	1	-	4	-do- where specified
Cement-sand*	ii	1	-	-	3	-do-
Cement-lime sand		ii	1	-	1/2	4
Masonry cement	ii	-	1	-	2 1/2	-do-
Cement-sand*	I	1	-	-	3	-do-

Note: (1)\* Plasticizer of approve manufacture shall be used if directed by the Officer-in-charge.

- (2) The gauge box for cement shall be 400mm x 350mm x 290 mm or 300 x 300 x 350 mm. The corresponding gauge box for lime and sand shall be 400 mm x 350 mm x 250 mm or 300 x 300 x 300 mm respectively.

### 6.2.2 HANDLING OF BRICKS AND PREPARATION

Bricks shall not be handled in baskets, thrown from height or in other manner that would destroy the sharpness of the edges. In no case shall bricks of different dimensions be used in the same work except when specially permitted by the Officer in charge.

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In exposed brickwork, selected bricks of the specified class shall be used for the face work.

The bricks shall be wetted with water before use on works. Bricks required for masonry with mud or fat lime need not be wetted. The tops of walls left off shall be wetted before the work is recommended.

#### **6.2.3 LAYING AND JOINTING**

Bricks shall be laid in English bond unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete the bond; Closers in such cases shall be cut to the required size and used near the ends of walls. In all load bearing walls the bricks shall be laid with frogs upwards and the frogs shall be filled with mortar.

A layer of mortar shall be spread on full width over a suitable length of the lower course. Each brick shall be properly bedded and set home (in position) by gentle tapping with the handle of a trowel or wooden mallet. Inside faces of the set bricks shall be buttered with mortar and the next brick to be laid shall be pressed against it. All bricks in every course shall be grouted full with mortar using the trowel for chasing in for this purpose.

The thickness of mortar joint shall not exceed 10 mm.

#### **6.2.4 RAISING OF WALLS**

The quoins shall be set out and built up in advance of the main body of the brick walling.

The walls should be carried up uniformly in all cases where the nature of the work admits it. No part shall be left more than 1 metre below the rest of the work. The work shall not be built higher than 1.5 m in one day. The courses shall be kept perfectly horizontal and every fourth course shall be checked for level and plumb. Courses shall be break joints. At the end of the day's work and where it is not possible to raise the adjoining portion uniformly and in gable walls, the work shall be raked back according to the bond, at an angle not steeper than 45°. All perpendics, Quoins etc. shall be kept strictly true and square and the whole properly bonded together and brought to final levels at each floor. Over hand laying shall not be used without approval. Panel walls or Non-load bearing walls shall not be built against the concrete beams or slabs.

The lateral stability of walls, which are free standing during construction shall be ensured by adequate shoring and scaffolding until the roof or floor providing the necessary stability is constructed.

#### **6.2.5 CURING AND PROTECTION**

Brickwork shall be protected from rain by suitable covering when the mortar is green. Brickwork in cement/composite/lime mortar (except fat lime mortar) shall be kept constantly moist on all faces for minimum period of seven days. In the case of masonry with fat lime mortar, curing shall commence two days after laying and shall continue at least for seven days thereafter.

#### **6.2.6 FIXTURES, etc**

All iron fixtures like hold fasts, pipe, etc, which are required to be built into the wall shall be embedded in their correct positions in cement mortar or cement concrete as specified.

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#### **6.2.7 RAKING OF JOINTS FOR PLASTER**

When the face work is to be plastered or joints alone pointed upon, the joints shall be raked to a minimum depth of 12 mm by a raking tool during the progress of work or when the mortar is still green. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of lying. The face and top of courses of the work shall be cleaned thoroughly of all mortar droppings on the same day.

#### **6.2.8 BRICK ON EDGE COPING**

The top course of all plinths the top of walls below reinforced concrete parapets, steps etc, shall be brick on edge with extra fine vertical joints not exceeding 3mm in thickness. Bricks forming the corners of all such courses are to be properly radiated and keyed into position.

#### **6.2.9 TREATMENT AT ENDS OF BEAMS ETC**

The ends of steel beams and roof trusses shall rest in recesses having 15 mm space for free circulation of air and provided with perforated zinc sheeting.

#### **6.2.10 CORBELLING**

Corbelling shall be effected by a one fourth brick projection (in every course) for ordinary work and a one eighth brick projection where greater strength is required.

#### **6.2.11 DAMP-PROOF COURSE**

This shall conform to clause 17.1

#### **6.2.12 SCAFFOLDING**

For all exposed brick work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong and tied together with horizontal pieces over which scaffolding planks shall rest. Alternatively steel scaffolding may be resorted to, in which case the arrangement shall be approved by the officer-in-charge.

For all other brick work in building single scaffolding shall be provided. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for this purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall however, not be allowed in pillars/columns less than one metre in width, or immediately near the skew back of Arches. The holes left in masonry work for scaffolding purpose shall be completely packed and made good before plastering.

Note: - In the case of special type of brick work scaffolding shall be got approved by the Officer-in-charge in advance.

#### **6.2.13 HALF BRICK MASONRY**

The work shall be done in the same manner as specified in 3.4 except that all courses shall be laid as stretchers. The proportion of cement mortar shall generally be one part cement to 5 parts of sand.

#### **6.2.14 REINFORCED BRICKWORK**

In special cases such as long unsupported partition walls where reinforcement is considered necessary, 2 numbers of 6 mm dia. Rods shall be provided at every alternate course unless otherwise specified. The rods shall be straight and free from rust and loose flakes. They shall be placed over cement mortar beds of 1:3 composition. 10 mm thickness of mortar shall first



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be laid, the rods laid and then covered with a bed of 10 mm mortar immediately. The rods shall be fully embedded in the mortar. At the ends, the rods shall be bent up for half the thickness of the course.

#### **6.2.15 HONEY-COMB BRICKWORK**

Standard of specified bricks shall be used for this class of work and they shall be laid on cement mortar 1:3 or as otherwise specified.

The thickness of brick honey-comb shall be half brick or one brick as specified. Openings shall be equal and alternate in every course and the bearing width on each side shall be 20 mm minimum. The bond used shall be heading through out in one brick thick honey-comb work. The bricks shall be thoroughly bedded in mortar and jointed and the edges stuck flush and finished smooth as the work proceeds.

#### **6.2.16 BRICK WORK IN ARCHES**

Bricks for Arch work shall be specially selected and shall be free from defects of any sort.

The bricks shall be laid in concentric half brick rings with break joints (i.e. staggered joints). The arch work shall be carried out from both ends simultaneously and keyed in the centre. The bricks shall be buttered with mortar and well pressed in to their positions so as to squeeze out a part of the mortar and leave the joints thin and compact. All joints shall be full of mortar and the thickness of joints shall neither be less than 5 mm nor more than 15 mm in all arches; the voussoir joints shall be normal to the curve at these points.

Bricks forming skew back joints shall be specially moulded or cut so as to radiate thinly, and defects in this particular case shall not be remedied by the extravagant use of mortar nor shall any parting by chips be allowed.

Joints in any two consecutive rings shall not come in the same radial plane.

The arch work shall be quickly and evenly done and kept moist so that no portion of the arch hardens or sets before the whole arch is completed.

##### **6.2.16.1 CENTRING FOR ARCHES**

In all centres the upper bearing surface shall be very correctly formed to the curve of the intrados of the arch. The centring shall be strong enough to bear the dead load and live load coming upon it during construction without any appreciable deflections. For spans longer than 2 metres, timber centres shall be used shall be provided with hard wood wedge for slackening. For larger span arches special plans for centring shall be prepared and prior approval of the Officer-in-charge obtained.

In all centres the arrangement shall be such that the slackening can be effected without any vibration being transmitted to the arch, and in the case of a series of arches that the centres can all be slackened simultaneously.

The time after which this slackening has to be done shall be carefully decided.

When lime mortar is used, centres will ordinarily be slackened within 24 hours of the completion of the arch. Care however, shall be taken to see that the centring is not eased while the mortar is the last joint is so soft that it will be squeezed out, but at the same time centres will slackened while the mortar in the joints is still moist so as to allow the arch to compress itself and bring all the joints to fair bearing.

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In the case of a segmental arch, care shall be taken to see that the skew backs are secure, and they shall be given a week's time to set.

In the case of semicircular, elliptical or other arches springing from a horizontal joint, the adjacent wall shall be built up to two thirds of the height of the arch slackening centres.

#### **6.2.17 JOINING OLD WORK WITH NEW WORK**

New work shall be bonded carefully to existing work by cutting pockets into existing walls; the pocket shall not be less than 10 mm deep, with a width equal to the full thickness of the new work. The spacing and height of each pocket shall be as follows; for joining of,

Brick to Brick - 4 courses high and at 8 course centres.

Brick to Block]

Block to Brick] Every alternate block course.

Block to Block]

The new walling shall be bounded well into the pockets with all voids filled solid with mortar.

#### **6.3 MASONRY WITH CAST BLOCK/BRICK**

Unless otherwise specified, the blocks shall be built in cement mortar 1:5, with joints not exceeding 10 mm thickness. The blocks shall not be wetted before use.

Concrete Blockwork and brickwork shall be reinforced for construction in cyclone-prone areas.

Where concrete is to be laid over hollow block masonry, this shall be done over a specially cast hollow block course with the top of the cavities filled with concrete to a depth of at least 25 mm.

Where the space between the block course and reinforced or plain concrete above that course is less than the height of a block, the same shall be filled with cement concrete 1:3:6 (20 mm) or as specified.

The cavities between the reveal of any opening and the block work shall be filled up with cement concrete 1:3:6 (20 mm) for the length of a block.

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## **7.0 WOOD WORK**

### **DEFINITIONS**

#### **GENERAL**

The process of sawing timber from the log.

#### **HARDWOOD**

Conventionally, the timber of broad-leaved trees belonging to the botanical group-Angiosperms.

#### **SOFTWOOD**

Conventionally, timber of coniferous trees belonging to the botanical group Gymnosperms. Commercial timbers of this group are practically confined to the class Coniferae or conifers.

#### **STRUCTURAL TIMBER**

Timber used in framing and load-bearing structures where strength is the major factor in selection and use.

#### **veneer**

A thin sheet of wood produced by rotary-cutting or slicing.

#### **SEASONING AND CONDITIONING**

##### **OVEN DRY**

A state of timber when it does not lose moisture when placed in a ventilated oven at  $(103 \pm 2) ^\circ\text{C}$ .

##### **SEASONING/DRYING**

The process of drying timber to a moisture range appropriate to the conditions and purposes for which it is to be used.

##### **AIR SEASONING**

The process of drying timber in a kiln.

#### **DEFECTS, BLEMISHES AND IMPERFECTIONS**

##### **BLEMISH**

Any feature that mars the appearance of timber or other product without affecting its technical quality.

##### **BOW CAMBER**

A curvature of a piece of timber in the direction of its length.

##### **CUP (PING)**

A curvature occurring in the cross section of a piece.

##### **DECAY/ROT**

Decomposition by fungi and other micro-organisms resulting in softening, progressive loss of strength and weight and often a change of texture and colour

##### **DEFECT/FAULT**

Any feature that lowers the technical quality or commercial value of timber or other material and may therefore lead to its rejection or to its relegation to a lower grade.

##### **DRY ROT**

A type of decay of timber in buildings, caused by the true dry rot fungus, *Merutius lacrymans* (a brown rot).

##### **IMPERFECTION**

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Any feature that mars the appearance or lowers the technical quality of timber or other product, but does not make it unacceptable in relation to the relevant specification or grading rules or make it unacceptable for its immediate purpose where there is no specification or rule on which to base a decision.

**KNOT**

A portion of a branch enclosed in the wood by the natural growth of the tree.

**SHAKE**

A separation of the fibres along the grain due to stresses developing in the standing tree, or in felling or in seasoning.

**SPLIT**

A separation of the fibres along the grain forming a crack or fissure that extends through the piece from the surface to another.

**TERMITE DAMAGE**

Damage characterized by irregular honey combing or wide channels; bore-dust (frass) is usually present; that of the subterranean termite is cemented together with mud, whereas the bore-dust of drywood termites is granular and dry. The damage may affect, standing trees, logs or stored timber mostly when in contact with the ground; it occurs mainly in tropical climates.

**TWIST/WINDING**

Spiral distortion.

**WARPING**

Distortion in converted timber causing departure from its original plane, usually developed during seasoning.

**BALANCED CONSTRUCTION**

A construction such that the forces induced by changes in moisture content will not cause warping. In practice this means that corresponding veneers or layers on either side of the centre line are of the same species and thickness and are laid with the grain in the same direction.

**BLOCKBOARD**

A composite board having a core made up of strips of wood each not more than 30 mm wide, laid separately or glued or otherwise joined together to form a slab to each side of which is glued one or more outer veneers with the direction of the grain of the core strips running at right angles to that of the adjacent veneers.

**CORE**

The inner layer or layers of a piece of plywood, batten board blockboard or laminboard.

**FACE**

The surface of plywood, battenboard, blockboard or laminboard by which the grade or quality is chiefly judged.

Where both surfaces are of the same quality both are described as faces.

**FACED PLYWOOD**

Plywood faced with a material other than wood e.g. metal or plastics.

**GLUING/BONDING**

The process of uniting by means of an adhesive, two or more pieces of wood. When used without qualification the term implies a process characterized by continuity of the union over the whole area of contact.

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**LAMINATED WOOD**

As assembled product made up of layers of layers of wood and adhesives in which the grain of adjacent layers is parallel.

**PLY**

An individual layer in plywood. Usually a ply is a single veneer.

**PLYWOOD**

A product of balance construction made up of plies assembled by gluing; the chief characteristic is the crossing of alternate plies to improve the strength properties and minimize movement in the plane of the board.

**MULTI-PLY**

Plywood formed of more than three plies.

**VENEER**

A thin sheet of wood produced by rotary cutting or slicing.

**VENEERED PLYWOOD**

Plywood faced with a decorative wood veneer.

**FIBRE BUILDING BOARD**

Fibre building board sheet material usually exceeding 1.5 mm in thickness manufactured from fibres of lingo-cellulosic material with the primary bond derived from the felting of the fibres and their inherent adhesive properties. Bonding, impregnating or other agents may be added during or after manufacture to modify particular properties of the board.

**HARDBOARD**

See standard hardboard and tempered hardboard.

**WOOD CHIP BOARD AND OTHER PARTICLE BOARDS****PARTICLE BOARD**

Panel material manufactured under pressure essentially from particles of wood and/or other lingo-cellulosic fibrous material (for example, woodchips, sawdust, flax chivers etc) with or without the addition of an adhesive, hydraulic binders being excluded.

**WOOD CHIPBOARD**

Particle board made from particles of wood bonded with synthetic resin and/or other organic binder.

**CARPENTRY**

Permanent carpentry other than roofs.

**BOARDING**

Wooden covering to a floor, wall, roof etc. Carcassing timber/Framing timber. Timber used in the structural work of a building.

**CLEAT**

A block fixed to a main member to provide a bearing or to resist a thrust.

**LAMINATED MEMBER**

A solid member built up of comparatively thin boards connected together by nails, screws, bolts, connectors or adhesives.

**MATCHBOARDING**

Tongued and grooved boarding with a 'v' or beaded (see bead) edge.

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## **ROOFS**

### **LAMINATED ROOF TRUSS**

A roof truss in which the members are built-up from several thicknesses nailed or bolted together at their intersections.

### **SPROCKET**

An additional piece fixed to the top or side of rafter at the eaves to give an inclination less than the of the roof.

### **VERGE**

The overhanging edge of the roof covering at a gable.

## **JOINERY**

### **ARCHITRAVE**

Moulding or fillet round an opening fixed to the face to cover the joint between joinery and the adjoining work.

### **DOORS**

#### **FLUSH DOOR**

A door having two plane faces which entirely cover and conceal its structure.

**FRAMED AND LEDGED DOOR** – A door having rails and stiles framed together and filled in one face with vertical boarding of lesser thickness than the surrounding framing. The vertical boarding overruns the middle and bottom rails which are of less thickness than the top rail and stiles.

**FRAMED LEDGED AND BRACED DOOR** – A framed and ledged door fitted with diagonal brace or braces.

**LEDGED DOOR** – An unframed door composed of vertical boards fixed to horizontal ledges.

**LEDGED AND BRACED DOOR** – An unframed door composed of vertical boards fixed to horizontal ledges and diagonal brace or braces.

**PANELLED DOOR** – A door having stiles, rails and (some-time) muntins framed together with the spaces filled in with panels

**GROUNDS** – A sawn or wrot member on which another finishing for example, a skirting, is fixed.

### **LIPPING**

A strip of wood or other material applied to the edge of a flush door, table top, etc.

### **MORTICE**

A hole or slot to receive a lock

Note:- This term applies only when the lock is let in from the edge into the middle of the thickness of the member, not when it is recessed from one face of the member.

### **MOULDING**

1. A contour cut upon a member for ornament.
2. A moulded member

### **MULLION**

An intermediate vertical member of a window frame, door frame or similar structure.

### **MUNTIN**

An intermediate framed vertical member of a paneled door or other piece of framing.

**NOSING**

The projecting edge of a tread or board, often rounded.

**PANEL**

A filling to a space surrounded by framing.

**RAIL**

A framed horizontal member of a sash, door or other such piece of framing.

**REBATE**

A step-shaped reduction formed on the edge of a member.

**STILE**

A framed vertical outer member of a door or sash.

A closing stile	]	The stile of a door or sash which
Locking stile	]	closes against the jamb or mullion
Striking stile	]	of the surrounding frame and against which the opening appears when the door or sash is opened.
Hanging stile	-	A stile by which a door or sash, is hung
Meeting stile	-	The abutting stiles of a pair of doors or sashes.
TRANSOM	-	An intermediate horizontal member of a window frame door frame or similar structure.
WROT	-	Planned on one or more surfaces.

Joints used in carpentry and joinery (fig. 8.1)

BUTT JOINT - A plain square joint between two members.

COGGED JOINT - A joint where one member is supported upon another which it crosses, with part of its width housed into the other.

**COMBED JOINT OR CORNER LOCKED JOINT OR LAMINATED JOINT –**

An angle joint in which the parts of the meeting sections of the respective members are cut away so that the remaining projections on each fit into the slots formed in the other.

DOVETAIL - A splayed shape cut in the end of a member where it is joined to another, wider at the extreme end than at the shoulder, so that when fitted into a recess of corresponding shape it will resist withdrawal by tension in the direction of its length.

DOWEL - A cylindrical piece of wood used for positioning and fixing one member to another.

FINGER JOINT - A heading joint, joined by interlacing tapered projections on the ends of members.

KEY - 1. A wedge passing through a hole in a projecting tenon.  
2. A piece of wood inserted in a joint to prevent movement between adjacent surfaces.

KEYED JOINT - A joint that is located or secured by a key. Keys are used in various types of joints such as keyed tenons, keyed scarfed joints, keyed heading joints, keyed lapped joints etc.

LAPPED JOINT -A joint in which one member overlaps the other, and is secured by nails, bolts, adhesives, or other means.

MITRED JOINT -A butt joint between two members meeting at an angle with the respective ends cut to complementary angles.

MORTICE - A hole or slot to receive a tenon of corresponding size which may or may not penetrate the full width or thickness of the member in which it is formed.

MORTICE AND TENON JOINT – A joint in which a tenon on the end of one member is fitted into a mortice cut in the other member.

NOTCHED AND COGGED JOINT – A joint in which a notched member is supported by another member in which a cog has been formed.

TENON - A projection at the end of a framed member, of lesser cross section than the member, intended to fit into a corresponding mortice in the other member to which it is thereby joined.

## 7.1 MATERIALS

### 7.1.1 TIMBER GENERAL

Timber for constructional purposes shall be of the specified species and of the best quality, thoroughly well seasoned, sawn square, and free from sap, shakes, cracks and waney edges. It shall be free from decay and insect attack. It shall not contain loose or dead knots and other defects. Sound knots if they exist, shall be of such size and location as will be permissible for the relevant structural or joinery work.

Where a choice of more than one species is allowed, only one variety shall be used for any particular class of work.

The density of timber used for building purposes should not, in general, be less than 640 kg/m<sup>3</sup> (40 lb/ft<sup>3</sup>) at 12% moisture content.

The sizes of structural and non-structural timber components shall be as specified. The sizes recommended are given in 7B.

Any timber brought to the site, which in the opinion of the Officer-in-Charge does not conform to the required standard shall be rejected and shall then be removed from the site by the contractor at his own cost within 24 hours of notice to do so.

#### TOLERANCES

The tolerance for dimensions of timber both sawn (unplanned) and finished (planed) shall conform to guidelines which are reproduced below:-

a. Sawn (unplanned)

Maximum permissible		
Nominal dimension mm	variation mm	
Up to 25 - 0	+ 2	
Over 25 to 50	- 2	+ 3
Over 50 to 150	- 3	+ 6
Over 150	- 6	+ 6



b. Finished (planed)

Maximum permissible		
Nominal dimension mm	variation mm	
Up to 25 - 0	+ 1	
Over 25 to 50	- 1	+ 2
Over 50 to 150	- 2	+ 3
Over 150	- 3	+3

GRAIN SLOPE

In structural timber, the slope of the grain shall not exceed 1 in 8. Slope shall be measured over the worst face and over a distance of not less than 200 mm.

For timber to be used for door and window frames and shutter, the slopes shall not exceed 1 in 8. In paneling however, sloping grain may be permitted to any extent.

**7.1.1.1 MOISTURE CONTENT AND SEASONING OF TIMBER**

Timber seasoned under controlled conditions shall be used, as green timber is liable to shrinkage and warping and is easily affected by wood destroying and sap-staining fungi. The moisture content of the timber at the time of fabrication shall be within 3% of the moisture content likely to be attained by the timber in service.

Seasoning techniques shall be such that seasoning defects like end splits, surface cracks warping etc. are minimized. The moisture content of air seasoned timber shall be not more than 15% and that of kiln seasoned timber not more than 12%.

**7.1.1.2 PRESERVATIVE TREATMENT**

Special Preservative treatment such as Pressure Diffusion, vacuum or immersion treatment shall be carried out where necessary. Guidance may be obtained from BS 5628: Part 5 for structural timbers and BS 5589 for joinery work.

Unless otherwise specified, all parts of wood work resting on or set in masonry, shall be painted with two coats of hot tar which shall be applied without disfiguring exposed faces. 40 mm wide recesses shall be left for free circulation of air around the ends of all beams, and the recesses protected with perforated zinc sheet.

Timber buried in the ground shall be tarred. No timber shall be tarred, oiled or painted before inspection and approval by the Officer-in-Charge.

**7.1.2 ADHESIVES**

Adhesives used for joinery work shall conform to one of the following:

B.S. 745 Animal glues for wood.

B.S. 1444 cold setting casein glue for wood.

B.S 1203 synthetic resin adhesive (Phenolic and amino plastic) for plywood.

B.S. 1204 Synthetic resin adhesive (phenolic and aminoplastic) for wood.

For structural gluing one of the latter three glues shall be used as specified.

Regarding storage, mixing and use of adhesives, the instructions of the manufacturer shall be followed.

### 7.1.3

#### **FASTENERS**

##### **WIRE NAILS**

Wire nails (oval, chequered head, lost head, round or panel pins) shall conform to the following standards.

Steel nails –

Copper nails – BS 1202: Part II

Where not specified, the gauge of the nails shall be suited to the woods being used and their length shall give a sound and secure fixing. Nails or screws used with reactive timbers shall be of nonferrous metal.

Nails used in wood work likely to be subjected to, moist conditions (as in the case of external work) shall have the specified protective coating.

##### **WOOD SCREWS**

These shall be made of steel wire or brass wire and shall conform to BS 1210. The finish whether oxidized, anodized, galvanized etc., shall be as specified.

##### **COACH SCREWS**

These shall conform to BS 1494 Part 2. The finish shall be as specified.

##### **BLACK BOLTS, SCREWS AND NUTS**

These shall conform to BS EN 20898-1 with the specified finish.

##### **WASHERS**

These shall be made of steel or brass and shall conform to BS 4320.

##### **STEEL GUSSETS**

These shall be manufactured to the profiles shown on the drawings and made from steel plates conforming to BS 4360. Thickness of plates and the finish shall be as specified.

##### **MILD STEEL CONNECTORS**

These shall conform to BS 1579.

##### **OTHER FIXING DEVICES**

Expanding bolts and nuts, joist hangers, framing anchors, tie down straps, anchor bolts etc. shall be as specified in respect of materials, size, gauges and the finish.

##### **PLUGS**

These shall be of durable timber like teak of specified sizes.

##### **DOWELS**

These shall be Mild Steel rod of 16 mm diameter and of adequate length.

##### **HOLDFASTS**

These shall be of mild steel flats 25 mm x 6 mm x 250 mm long, turned up and with 2 Nos. 3 mm holes drilled at one end, and finish tailed at the other end.

### 7.1.4

#### **PLYWOOD, HARDBOARD, BLOCK BOARD, CHIP BOARD, ETC**

These shall conform to the relevant British standards as noted below.

1. Plywood for general purpose –
2. Plywood for exterior use – BS 1455 bonding
  - W.B.P. (Grade 1) – where varnished
  - Grade 2 – where painted
  - Grade 3 – where hidden
3. Block board – BS 3444

4. Wood chipboard – BS 5669
5. Hard board – BS1142

## **7.2 STRUCTURAL TIMBER AND TIMBER ROOF WORK**

### **GENERAL**

Structural timber and timber roof work shall be fabricated in accordance with detailed drawings and shall generally conform to BSCP 112: Part 2 in regard to workmanship.

The contractor shall provide details of the work as necessary to help ensure co-ordination with related building elements and services. He shall provide fabrication/installation drawings and obtain approval before starting fabrication. Where directed, he shall provide samples for intended connection before commencing actual fabrication.

Proprietary products shall be used to manufacturer's recommendations.

### **FABRICATION**

The sizes of timber sections unless otherwise stated are basic (nominal) sizes. Tolerance on sizes shall be as per Clause 8.1.

All timber shall be sawn, planed, drilled or otherwise machined to the correct size and shape in accordance with drawings and specifications. Dimensions and spacing shall not be scaled from the drawings. Pieces damaged by splitting or bruising shall be rejected.

Mating and bearing surfaces shall be finished to ensure close contact over the whole area. These surfaces shall have a good sawn or planed finish and treated with the specified preservative. Bearing surfaces of notches and other cuttings shall be true and smooth and in appropriate relation to the other surfaces of the piece.

### **7.2.1 JOINTS**

#### **7.2.1.1 NAILED JOINTS**

Wire nails shall be of the gauge shown in the drawings and at least 20 mm longer than the full thickness of the assembly to be secured; the projecting portion shall be clinched over at right angles to the grain to resist withdrawal.

All nails shall be soaked in hot boiled linseed oil and allowed to drain immediately before fitting. All nails shall be driven, unless the nails are of large gauge or the timbers are likely to be split in which case holes shall be drilled in one operation through all the members held in position. The holes shall be approximately 20 percent smaller in diameter than the nails.

#### **7.2.1.2 SCREWED JOINTS**

Lead holes shall be used in making screwed joints; the diameter of the hole for the shank shall be equal to the diameter of the shank; for the threaded portion, the diameter of the hole shall not exceed 0.9 of the diameter of the root of the screw thread adjacent to the shank. Care shall be taken to avoid placing screws in an end split.

#### **7.2.1.3 BOLTED JOINTS**

Bolt holes shall be drilled to diameters as close as possible to the nominal diameter of the bolt but not more than 1.6 mm larger than the bolt diameter. Care shall be taken to avoid placing a bolt in an end split. At least one complete thread shall protrude from the nut.

A washer shall be fitted under the head of each bolt and under each nut. The minimum sizes of washers are given in the table 7.1 below.

TABLE 7.1

Diameter of bolt	Minimum thickness of washer	Minimum side of square washed or dia of washer
mm	mm	mm
9.5		
12.7	3	51
15.9		
19.0	5	64
22.2		
25.4		
28.6		
31.8	6	76

Structural connections using steel plates, split rings etc. shall be as per BS CP 112: Part 2.

**Note-****LAMINATED ROOF TRUSSES**

Unless otherwise specified, all members of laminated roof trusses shall be connected with wire nails with a washer at each end of the nails.

**7.2.2 PRESERVATIVE TREATMENT OF CUT SURFACES**

Cutting of timber after preservative treatment shall be avoided. However when it is unavoidable, a liberal application of preservative shall be made to the cut surfaces.

**7.2.3 ASSEMBLY OF STRUCTURAL UNITS**

Assembly of structural units shall be done on a level bed and in such a way as to avoid damage to any of the members. The finished structural units shall conform to drawings and specifications. Twisted or damaged members shall be replaced before erection on the site.

Before proceeding with bulk production, a complete assembly of each type of framed truss or other structural unit shall be checked for accuracy. A similar check shall be carried out from time to time to control the wear and tear on templates and gauges.

Timber members of built up units shall be marked in accordance with a marking diagram.

**7.2.4 STORAGE**

Timber components shall not be exposed to high humidity and all materials and assemblies shall be protected against exposure to the weather, wetting, damage, decay and insect attack.

**7.2.5 PAINTING**

Where painting of the timber is specified, all parts of assemblies or individual pieces shall be protected with a priming paint complying with BS 2521 or BS 2522 and one undercoat before leaving the factory.

Steel components other than bolts, connectors and washers shall be thoroughly cleaned to remove all loose scale and rust and painted with one coat of genuine red lead paint before dispatch to site.

**7.2.6 TRANSPORT**

All materials and assemblies shall be protected from the weather, and suitable measures shall be taken to protect the surfaces during hoisting and fixing.

**7.2.7 HANDLING, HOISTING AND FIXING**

The over-stressing of members during handling shall be avoided. In the case of framed arches, portal frames, trusses etc., special care shall be taken to avoid distortion in hoisting from the horizontal to the vertical position. Where lifting points or methods of lifting are not indicated on the drawing guidance shall be sought from the Officer-in-Charge. On completion of erection, all joints

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shall be inspected and care taken to ensure that all bolts is tightened without crushing the wood under the washers.

**7.2.8 TESTING AND ACCEPTANCE**

When testing of a timber structure or component becomes necessary due to doubt about the adequacy in desing quality of material, etc., the test and acceptance criteria shall be as per clause 6 of BS CP 112 Part 2.

**7.3 JOINERY  
GENERAL**

Joinery work shall consist of the manufacture, delivery to the site and fixing in the building of all joinery described in the specification and shown on the drawings including the supply and fixing of:-

- (a) Metal straps, lugs and dowels
- (b) Priming and application of preservative
- (c) All iron mongery specified or shown in the drawings

The joinery work shall be of the best workmanship conforming generally to BS 1186: Part 2.

The joinery work shall be completed ready for the respective finishes.

**7.3.1 DIMENSIONS**

All wrot timber is to be sawn, planed, drilled or otherwise machined or worked to the correct sizes and shapes shown in the drawings or specified. Tolerance on timber sizes shall be as per Clause 8.1.1.

**7.3.2 EXPOSED FACES**

All timber that is to be exposed in the finished surfaces of joinery works shall be wrot on the appropriate faces unless otherwise specified.

**7.3.3 NATURAL FINISH**

When natural finish or finish for staining, clear polishing, or varnishing is specified, the timber in adjacent pieces shall be matched for colour and grain. The surface finish shall be as specified.

**7.3.4 SHRINKAGE**

The arrangement, jointing and fixing of joinery works shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work, and shall not cause damage to contiguous materials or structures.

**7.3.5 FABRICATION**

All necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating, and all other works necessary for correct jointing, shall be in conformity with BS 1186. All metal plates, screws, nails and other fixing that may be directed by the Officer-in-Charge or that may be necessary for the proper execution of the joinery works specified shall be the responsibility of the contractor. All works necessary for the proper construction of all framings, linings, etc. and for their support and fixing in the building shall be carried out to approval.

**7.3.6 JOINTS**

The joinery shall be constructed as shown in the detail drawings. Where joints are not specifically indicated they shall be the recognized forms of joints for each position. The joints shall be made so as to comply with BS 1186:

Part 2.

Glued joints shall be used where provision need not be made for shrinkage or other movements in the connections, and where sealed joints are required. All glued joints shall be cross-tongued or otherwise reinforced. All nails, springs, etc. shall be punched and puttied. Surfaces in contact shall have a good sawn or planed finish. All cutting edges of tools shall be sharp to avoid burnishing. The surface of plywood to be glued shall be lightly dressed with sand or glass paper. The sand or glass paper must not be allowed to clog and cause burnishing.

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Members to be joined by gluing are to be of similar conversion. All surfaces to be glued shall be kept clean, free from dirt, dust, sawdust, oil and any other contamination. Adequate pressure shall be applied and maintained whilst the glue is setting.

**7.3.7 MOULDINGS**

All moulded work shall be accurately worked to the full size details shown in drawings. All mouldings shall be worked on the solid timber except where otherwise stated.

**7.3.8 BENT WORK**

Where bending is specified, the work shall be performed by saw-kerfing, keying, backing-a-veneer, laminating or steaming, and shall be carried out to the satisfaction of the Officer-in-Charge.

**7.3.9 CIRCULAR WORK**

When circular work is specified, it shall be built up with an appropriate number of pieces out to the required shapes. The pieces shall be put together in two (or three) thicknesses so that they break joint, and shall be secured with hardwood keys and wedges or with hardwood pins (whichever is more appropriate).

**7.3.10 VENEERING**

This shall be carried out in an approved manner, and to the entire satisfaction of the architect.

**7.3.11 SCRIBING**

All skirtings, architraves, plates and other joinery works shall be accurately scribed to fit the contour of any irregular surface against which they may be required to form a close but connection.

**7.3.12 WEATHERING**

All weathering surfaces, throatings, grooves and joints, etc. and all open connections in external joinery works shall be properly executed so as to provide a reasonable degree of weather resistance.

All reasonable measures shall be taken to check or prevent capillary penetration of water in the joints and open connections of external joinery works, and in all other positions where joinery works may be exposed to water.

**7.4 DOOR AND WINDOW FRAMES**

**GENERAL**

The frames shall be wrot, framed and fixed in position as specified in drawings. The scantling of specified timber, shall be planed smooth and accurate to the dimensions shown in drawings. Rebates, rounding, and mouldings shall be made before assembly. Patching or plugging of any kind shall not be permitted except as specified. Tolerance on sectional dimensions of timber shall conform to clause 7.1.1.

In general joinery work shall conform to requirements of clause 7.3

**7.4.1 JOINTS**

These shall be of mortise and tenon type, simple neat and strong. Tenons shall be formed on the posts of frames. Mortise and tenon joints shall fit in fully and accurately without wedging or filling. The joints shall be glad and the frames put together and kept pressed in position by means of a press and pinned with hardwood pins of at least 10 mm dia.

**7.4.2 SURFACE TREATMENT**

Wood work shall not be painted, oiled or otherwise treated before it has been approved by the Officer-in-Charge. All portions of timber abutting against masonry or concrete or embedded in ground shall be painted with approved wood primer or preservative.

### **7.4.3 FIXING IN POSITION**

Before fixing, the backs and ends of frames shall be coated with 2 coats of boiling tar or solignum. When frames are to be built into masonry these shall be braced and protected as necessary to prevent distortion and damage during construction of the brick-work.

The frames shall be positioned accurately, plumbed, leveled and aligned as necessary. The timber frames unless otherwise specified shall be fixed at centers not exceeding 600 mm with at least one fixing located 150 mm from each end of jambs and one adjacent to each hanging point of doors/window shutters. Generally at least 3 fixings per side of each door frame and 2 fixings per side of each window frame shall be provided. The fixing device shall consist of a hold fast as described in clause 8.1.3 embedded in concrete, or stout steel screws driven into hard wood plugs embedded in the walls, or other approved cramps of a suitable design.

The feet of all door frames and posts shall not be buried into the concrete floor but shall be fitted to specially cast cement spur block projecting above the floor. 16 mm dia iron dowels shall be provided connecting the spur stone and the frame. The spur stone shall be such that the architraves if any and the coved floor finishes shall be accommodated producing a neat clean finish with no corners which can hold dust or vermin.

### **7.5 SASHES FOR DOORS, WINDOWS, FANLIGHTS ETC**

#### **GENERAL**

The specified timber shall be planed smooth and accurate to the full dimensions, rebates, roundings mouldings shall be made before assembly. Patching or plugging of any kind shall not be permitted except as specified.

The sashes shall be wrot, framed and fixed in position as per detailed drawing and as directed by the Officer-in-Charge.

Note:- Joinery work for doors and windows etc. shall be started immediately after commencement of the building work. The components shall be stored clear off the floor in a dry and covered area allowing for free circulation of air. Pressing and securing of joints shall be carried out at the time of fixing frames or shutters.

#### **(a) JOINERY WORK**

All members of the door sashes shall be straight without any warp or bow, and shall have smooth well planed faces at right angles to each other.

The corners and edges of panels shall be finished as shown in drawings, and these shall be feather-tongued into stiles and rails. Sash bars shall have mitred joints with the stiles. Stiles and rails shall be properly and accurately mortised and tenoned. Rails which are more than 180 mm in width shall have to tenons. The thickness of each tenon shall be approximately one third the finished thickness of the members and the width of each tenon shall not exceed five times its thickness. The tenons shall pass through stiles for at least  $\frac{3}{4}$ <sup>th</sup> of the width of the stile. Muntins and glazing bars shall be stubtenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less. When assembling a leaf, stiles shall be left projecting as a horn. The stiles and rails shall have 12 mm grooves in the paneled portion for the panel to fit in.

The depth of rebate in the frames for housing the sashes shall in all cases be 12.5 mm, the rebate in the sashes, for closing in double sash doors or windows shall be less than 20 mm. in the case of double leaved sashes the meeting of the stiles shall be rebated 20 mm and the rebate shall be splayed.

In general, the joinery work shall conform to the requirements of clause 7.3.

The joinery work shall be assembled and passed by the Officer-in-Charge before the joints are pressed and secured by hard wood or bamboo pins of about 6 – 10 mm diameter. The horns of stiles shall be sawn off.

(b) GLUEING OF JOINTS

- (b) The contact surfaces of tenon and mortise joints shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Officer-in-Charge. Sashes shall not be painted, oiled or otherwise treated before they are fixed in position and passed by the Officer-in-Charge.

(c) BEADING

Timber, plywood, hard board and particle board panels shall be fixed only with grooves but additional beading may be provided either on one side or on both sides.

For external doors and windows beading shall be fixed on the outside.

(d) FITTINGS

Fittings shall conform to the requirements of Chapter 10. Details of fittings shall be as specified.

(e) WOODEN CLEATS AND BLOCKS

Wooden cleats and blocks shall be fixed to doors and windows as specified or as directed by the Officer-in-Charge. The size and shape of cleats and blocks shall be as approved by the Officer-in-Charge.

(f) TOLERANCE

A tolerance of  $\pm 1.5$  mm shall be allowed on heights and widths of sashes.

**7.5.1 LEDGERS, BRACED AND BATTENED SASHES**

The thickness of the doors shall be the thickness of the battens only and not the combined thickness of battens and braces.

Planks for battens shall be 75 mm to 100 mm wide and 20 mm thick unless otherwise specified. These shall be planed smooth and provided with rebated joints rebated at least 12 mm. The tolerance on sizes of battens, ledgers and braces shall conform to clause 8.1.1.

**LEDGES AND BRACES**

The battens shall be fixed together by 25 mm thick ledges and braces fixed to the inside face of door shutters with screws. The ledge shall be 175 mm wide and brace 125 mm wide unless otherwise specified. The braces shall incline downwards towards the side on which the door is hung as shown in fig. 8/2. Edges and ends of ledges and braces shall be chamfered. Tee hinges shall be provided for these doors.

Wooden cleats, blocks and fittings shall be as specified.

**7.5.2 PANELLED, GLAZED OR PANELLED AND GLAZED SASHES**

**PANELLING**

The following types of paneling shall be used for door/window sashes as specified.

- (a) Plywood
- (b) Hardboard
- (c) Block board
- (d) Sheet glaze

These shall conform to the relevant SLS/BS.



The panels shall be framed into grooves to the full depth of the groove, leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove. Mouldings to the edges of panel openings shall be scribed at the joints.

#### **7.6 WOOD FLOORS**

Wood floors and landings shall be of specified timber. These shall be 30 mm thick unless otherwise specified, with grooved and tongued planks in equal widths not exceeding 150 mm, with well broken and splayed heading joints. They shall be fixed to the joints with 62 mm screws the heads shall be counter sunk and the holes filled with wax, two screws being used for each 150 mm plank wherever it crosses or ends be planed in both directions and made perfectly smooth and even. Where the underside of the floor is exposed the flooring is to be wrot on both sides.

#### **7.7 SKIRTINGS, PICTURE RAILS, MOULDINGS ETC.**

All skirting, picture rails, mouldings, and similar items shall include for all necessary grounds, backings or splayed fillets and for forming all mitres, scribings, fitted ends.

All such features shall be secured by screws driven in to holes fitted with rawl plugs or equivalent.

#### **7.8 WOOD STAIRS**

- (a) All wood stairs unless otherwise specified shall be framed up in the timber specified and to the design and sizes shown in the drawings.
- (b) All stringers shall be framed and pinned to newels and wall stringers plugged to walls. The feet of newels on a concrete ground floor shall have special cast concrete blocks as described in Clause 8.4.3. On upper floors, the newel feet shall be notched to wood joists and/or R.S.J. bearers in the concrete floor.
- (c) Where bull nose steps are shown, they shall be properly formed and the riser blocked, screwed, glued and wedged.
- (d) Handrails shall be framed and pinned to newels with all the bends, ramps and wreaths etc. required, and heading joints shall be formed with handrail screws.
- (e) Joinery work shall conform to the requirements of clause 8.3 and shall be as specified. Hand rails shall be French-polished. Other surfaces shall be stained/wax polished/decorated as specified or directed. All finished surfaces shall be protected with rough timber or boarding until completion.

#### **7.9 SHELVING**

All shelving shall be of the widths and thicknesses specified. Timber shelving shall normally consist of 25 mm thick boarding screwed to 100 x 55 mm timber brackets fixed to the wall at approximately 1.2 m centre.

Note: The contractor's rate shall provide for treating both the top and bottom with two coats of approved wood preservative.

#### **7.10 TRELLIS WORK**

##### **7.10.1 PLAIN TRELLIS**

This shall consist of wooden strips or laths 35 x 10 mm section unless otherwise specified, planed and nailed together at every alternate crossing. The stripe shall be spaced 35 mm apart so as to form 35 x 35 mm openings, or as shown in the drawing. These shall be fixed with nails to the frame. To cover the ends of strips, 50 x 12 mm beading shall be fixed to the frame with screws. Finished work with a tolerance of  $\pm 1$  mm may be accepted.

##### **7.10.2 TRELLIS DOOR AND WINDOW SASHES**

The sash frame shall consist of two styles and the top, lock and bottom rails, each of section 75 x 35 mm unless otherwise specified. The styles and rails shall be properly mortised and tenoned. The tenons shall pass through the styles for at least  $\frac{3}{4}$ <sup>th</sup> of the width of the style. The sash and frame shall be assembled and passed by the Officer-in-Charge before jointing. The joints shall be pressed and secured by hard wood pins of about 6 mm diameter. To this frame, plain trellis work as

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described in clause 8.10.1 shall be fixed as shown in the drawings or as directed by the Officer-in-Charge. The fittings, wooden cleats and blocks shall be provided as specified.

**7.11 PELMETS**

The sides, front and top of the pelmets shall be of 12 mm thick planks or boards of specified width unless otherwise stated.

These shall project from the wall face by 150 mm or as specified, and shall be securely fixed to walls with wood screws by means of wooden plugs and 100 mm long x 25 x 3 mm mild steel flats bent in the form of an angle or by any other device approved by the Officer-in-Charge. The pelmets shall be provided with curtain rods and brackets or curtain rails with rollers, stop ends and brackets as specified. Intermediate wooden brackets shall be provided if the front length of pelmets exceeds 1.5 metres.

**7.12 MILD STEEL BARS OR GRILLS IN WOODEN FRAMES**

These shall be of the pattern and details specified.

**7.12.1 FIXING OF MILD STEEL BARS IN WOODEN FRAMES**

Through holes shall be drilled in one frame, and 50 mm deep in the other frame. The bars shall be passed into the frame from one side and shall be of the correct length to fit in at one end and to end flush with outside of the frame at the other end.

Where there are mild steel flats provided along with the bars, these shall be fixed to the wooden frame with wood screws. Holes for passing M.S. bars shall be punched in the flats at proper positions.

**7.12.2 FIXING OF STEEL GRILLS**

The grills shall be fabricated as per design and fixed to the frame using round headed bolts and nuts in new work, and wood screws in the case of old work.

APPENDIX –7A

TABLE - A1

Imperial measure sizes most closely corresponding to the recommended Metric sizes of structural timber.

Component	Standard Metric Sizes (Imperial sizes in inches)		Standard Metric Sizes (Imperial sizes in inches)		(Imperial sizes in inches)
Ridge Plates	175	x	25	[7 x 1]	-
	175	x	50	[7 x 2]	-
Rafters	75	x	50	[3 x 2]	-
	100	x	50	[4 x 2]	-
Wall plates	100	x	75	[4 x 2]	-
	100	x	75	[4 x 3]	-
	50	x	50	[2 x 2]	-
	75	x	38	[4 x 2]	-
	125	x	50	[5 x 2]	-
	150	x	50	[6 x 2]	-
	175	x	50	[7 x 2]	-
Reepers	50	x	25	[2 x 1]	-
(Battens)	50	x	13	[2 x 1/2]	-
Eaves boards	200	x	25	[8 x 1]	200 x <sup>3</sup> 22 (8 x 7/8)
(valance boards)					200 x 19 (8 x 3/4)
Principal rafters	125	x	25, 32, 38		-
	(5 x 1, 1 ¼, 1 ½)				-
	150 x 25, 32, 38, 50				-
	(6 x 1, 1 ¼, 1 ½, 2)				-
	175 x 25, 32, 38, 50				-
	(7 x 1, 1 ¼, 1 ½, 2)				-
Tie beams	125, 25, 32, 38				-
	(5 x 1, 1 ¼, 1 ½)				-
	150 x 25, 32, 38				-
	(6 x 1, 1 ¼, 1 ½)				-
	175 x 25, 32, 38				-
	(7 x 1, 1 ¼, 1 ½)				-
Braces	75 x 50 (3 x 2)				-
	100 x 50 (4 x 2)				-
Ceiling bearers	100 x 50 (4 x 2)				-
	75 x 50 (3 x 2)				-
	50 x 50 (2 x 2)				-

TABLE - A2

Imperial Measure sizes most closely corresponding to the recommended Metric sizes of non-structural timber

Component	Standard Metric Sizes (Imperial sizes in inches)		Standard Metric Sizes (Imperial sizes in inches)		(Imperial sizes in inches)
Ceiling boards	115	x	22	[4 ½ x 7/8]	100 x 19 (4 x ¾)
	150	x	16	[6 x 5/8]	140 x 13 (5 ½ x ½)
Ceiling beadings	38	x	13	[1 ½ x ½]	-
	50	x	13	[1 ½ x ½]	-
Cornice mouldings	50	x	50	[2 x ½]	-
Window frames					
Jambs & Heads	100	x	50	[4 x 2]	95 x 44 (3 ¾ x 1 ¾)
	100	x	63	[4 x 2 ½]	95 x 57 (3 ¾ x 2 ¾)
Mullions	100	x	63	[4 x 2 ½]	95 x 60 (3 x 2 3/8)
Sills	125	x	50	[5 x 2]	120 x 44 (4 ¾ x 2 ¼)
Stops	40	x	16	[1 5/8 x 5/8]	38 x 13 (1 ½ x ½)
Window Sashes	36 [1 3/8] thick				32 (1 ¼) thick

	44 [1 ¾] thick				40 (1 5/8) thick	
Door frames						
Jambs & Heads	100	x	50	[4 x 2]	95 x 44 (3 ¾ x 1 ¾)	
	100	x	63	[4 x 2 ½]	95 x 57 (3 ¾ x 2 ¼)	
Stops	40	x	16	[1 5/8 x 5/8]	38 x 13 (1 ½ x ½)	
Door Sashes	36 [3/8] thick				32 (1 ¼) thick	

## 8.0 METAL WORKS

### DEFINITIONS

#### BEAD

A single run of weld metal deposited on a surface.

#### BUTT WELD

A weld in which the weld metal lies substantially within the extension of the planes of the surfaces of the parts joined or within the extension of the planes of the smaller of the two parts of differing size. the edges of the metal pieces shall be bevelled or chiselled to the required shape at the throat.

#### CRATER

A depression left in weld metal where the arc was broken or the flame was removed.

#### END CRATER

A CRATER AT THE END OF A WELD OR AT THE END OF A JOINT.

#### FILLET WELD

A weld of approximately triangular cross-section joining two surfaces approximately at right angles to each other in lap joint, tee joint or corner joint. It is of two types (1) Continuous, (2) Intermittent.

#### FUSION WELDING

Any welding process in which the weld is made between metals in a state of fusion without application of pressure.

- (a) In fusion welding – The depth to which the parent metal has been fused.

#### WELD METAL

All metal melted and or made plastic in making a weld and retained in the weld.

## 8.1 MATERIALS

Materials	Standards	Remarks
Hot rolled-Mild steel sections excluding angles and hollow sections	BS 4 Part – 1	To be hot rolled from weldable steel for structural purposes conforming to BS 4360
Hot-rolled MS hollow sections	BS 4848: Part 2	To be hot rolled from weldable steel for structural purposes conforming to BS 4360
Hot-rolled MS angles	BS 4848: Part 4	-do-
M.S. bars	BS 4360	
Steel tubes	BS 1775	
M.S. plates	BS 4360	
Galvanized steel sheet	BS 2989	
Steel plate & Sheet	BS 1449: Part 1	
Stainless Steel – Tubes	BS 3014	
Stainless Steel (Plate)	BS 1449: Part 2	
(Sheet)		
( & )		
(strip)		
Aluminium alloy		
Extruded section	BS 1161 or BS 1474	
Drawn tube	BS 1471	

Plate, Sheet & Strip	BS 1470
Copper alloy	
Sections	BS 2874
Tubes	BS 2871: Part 2
Sheet, Strip & foil	BS 2870
Plate	BS 2875
Fastenings	
Wood screws – Iron	BS EN 20898-1
Wood Screws – Brass	BS 1210
Bolts, Screws & Nuts	BS EN 20898-1
Rivets	BS 641 & VS 4620
	Or as specified
Expanding Bolts & Nuts	As specified
Plugs	-do-
Adhesives	-do-
Electrodes for manual are welding	BS 639

Note 1: Evidence to show that the steel supplied conforms to the relevant British Standards shall be furnished to the Officer-in-Charge to his satisfaction. For steel conforming to the specification for Structural Steel of any other country, the relevant specifications shall be forwarded to the Engineer for prior approval.

## **8.2 FABRICATION AND ERECTION – SHOPWORK**

### **8.2.1 PRELIMINARIES**

#### **8.2.1.1 QUALITY OF WORK**

Metal work shall be fabricated carefully and accurately to ensure compliance with design and performance requirements, using types and grades of metal as specified for the purpose. The finished work must be free from distortion and cracks. Proprietary products shall be used to the recommendations of the manufacturers.

Steel work shall be fabricated and erected by competent, experienced persons and shall generally conform to B.S 449: Part 2 – “specifications for the use of structural steel in Buildings.”

#### **8.2.1.2 CO-ORDINATION**

The work shall be carried out in co-ordination with the work on related building elements and services. The fabrication/installation drawings showing complete details of the work shall be furnished by the contractor well in advance for checking by the Officer-in-Charge; necessary modifications shall be made and sufficient number of corrected copies shall be furnished to the concerned parties.

#### **8.2.1.3 SAMPLES**

Where directed, the contractor shall furnish samples of the components and obtain approval for the same before proceeding with the fabrication.

#### **8.2.1.4 INSPECTION**

The Officer-in-Charge shall have access at all reasonable times to all places where the work is being carried out, and shall be provided by the contractor with all the necessary facilities for inspection during construction.

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## **8.2.2 SHOP PREPARATION**

### **8.2.2.1 STRAIGHTNESS**

All material before and after fabrication, shall be straight unless required to be of curvilinear form, and shall be free from twists.

### **8.2.2.2 CLEARANCES**

Care shall be taken to ensure that the clearances specified are adhered to. The erection clearance for cleated ends of members connecting steel to steel shall be not greater than 2 mm. at each end. The erection clearance ends of beams without web cleats shall be not more than 3 mm at each end, but where for practical reasons this clearance has to be increased, the seating shall be suitable designed.

Where black bolts are used the holes may be made not more than 2 mm greater than the diameter of the bolts unless otherwise specified.

### **8.2.2.3 CUTTING**

Cutting may be by shearing, cropping, sawing or machine flame cutting. Hand flame cutting may be adopted subject to the approval of the Officer-in-Charge if thermal cutting is permitted for plates which will be subjected to dynamic or fatigue loading, the edges shall be machined. In the case of highly stressed welded joints, thermal cutting shall be controlled to prevent excess hardening. Sheared or cropped edges shall be dressed to a neat workmanlike finish and be free from distortion where parts are to be in metal-to-metal contact.

### **8.2.2.4 HOLING**

Holes through more than one thickness of material for members such as compound stanchion and girder flanges shall where possible be drilled after the members are assembled and tightly clamped or bolted together. All matching holes for rivets and black bolts shall register with each other so that a gauge 2 mm less than the required diameter of hole will pass freely through the assembled members in a direction at right angles to such members.

Finished holes shall be not more than 2 mm larger in diameter than the diameter of the rivet or black bolt passing through them unless otherwise specified.

When holes are drilled in one operation through two or more separable parts, these parts when so specified by the Officer-in-Charge, shall be separated after drilling and the burrs removed.

Punching may be permitted before assemble when the thickness of material punched is less than 15 mm. The holes punched shall be 2 mm less in diameter than the required size and reamed after assemble to the full diameter.

Holes in connecting angles and plates other than splices, as also in roof members and light framing, may be punched full size through material not over 12 mm thick. This shall not be permitted for close tolerance or barrel bolts.

Where a connection is subject to impact or vibration or to reversal of stress (unless such reversal is solely due to wind) or, where for some special reason such as continuity in rigid framing or precision in alignment of machinery, slipping of bolts is not permissible, then rivets, close tolerance bolts, high strength friction grip bolts or welding shall be used. Holes for close tolerance and barrel bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance of +0.15 mm and – 0 mm. Parts to be connected with close tolerance bolts or barrel bolts shall preferably be firmly held together by tacking bolts or clamps, the holes drilled through all the thicknesses in one operation and subsequently reamed to size. All holes not drilled through all thicknesses in one operation shall be drilled to a smaller size and reamed out after assembly.

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Where this is not practicable the parts shall be drilled and reamed separately through hard bushed steel jigs.

Holes for rivets or bolts shall not be formed by a gas cutting process.

#### **8.2.2.5 FLATTENED ENDS OF TUBES**

For welded, riveted or bolted connections, the ends of tubes may be flattened or otherwise formed provided the methods adopted are such as not to injure or deface the material. The change of section shall be gradual.

#### **8.2.3 SHOP ASSEMBLE**

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers if any are provided.

All tubular members shall be sealed so as to prevent the access of moisture to the inside of the members (see also Clause 9.5.2)

#### **8.2.4 RIVETING**

Rivets shall be heated uniformly throughout their length, without burning or excessive scaling, and shall be of sufficient length to provide a head of standard dimensions. They shall when driven, completely fill the holes and if countersunk, the countersinking shall be fully filled by the rivet, and proudness of the countersunk head being dressed off flush if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting, and special care shall be taken in this respect for all single-riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

Wherever practicable machine riveting shall be carried out by using machines of the steady pressure type.

All loose, burned or otherwise defective rivets shall be cut out and replaced before the structure is loaded, and special care shall be taken to inspect all single-riveted connections.

Special care shall be taken in heating and driving long rivets.

#### **8.2.5 BOLTING**

Bolts shall be of sufficient length to have at least one complete thread projecting beyond the outer face of the nut when tightened up.

Washers shall be provided in all cases. Where necessary, washers shall be tapered or otherwise suitable shaped to give the heads and nuts of bolts a satisfactory bearing.

In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where a tubular member is drilled to take bolts or studs, provision shall be made to prevent the access of moisture to the interior of the tube. For example, a transverse sleeve can be inserted where a bolt passes through a tube, or grommets can be used under the heads and nuts.

#### **8.2.6 WELDING**

##### **GENERAL**

Steel shall normally be welded by the metal arc process conforming to B.S 5136. Other methods shall be subject to the approval of the Officer-in-Charge.

Welding of stainless steel, aluminium alloys, copper alloys, bronze etc. and brazing shall conform to the appropriate British Standard where specified, approval and testing of welders, and welding procedures shall be as per BS 4870, BS 4871 and BS 4872. Surfaces to be welded shall be dry. When



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rain is falling or during periods of high wind, necessary precautions shall be taken to protect outdoor welding areas.

Welding shall be so carried out as to ensure that:

- (1) Welds will be of good clean metal deposited by a procedure which will ensure uniformity and continuity of work.
- (2) The surfaces of the weld will have an even contour and regular finish and will indicate proper fusion with the parent metal.

All slag shall be removed after making each run by light hammering followed by wire brushing.

Weld metal shall not be allowed to spatter on surfaces which will be visible in the completed work.

But welds which will be visible in the completed work shall be dressed off smooth and flush with adjacent surfaces.

#### **8.2.6.1 EQUIPMENT FOR WELDING OF STEEL EQUIPMENT**

The contractor shall be responsible for ensuring that the capacity of welding plant, instruments, cables and accessories is adequate and suitable for the welding procedure to be used and for maintaining all welding plant and ancillary equipment in good working order. The contractor shall also take all necessary safety precautions in connection with the work. All electrical plant in connection with the work shall be adequately earthed. The welding return lead from the work shall be adequate in cross section and shall be correctly connected and earthed.

Adequate means of measuring the current shall be available with the welding plant or a portable ammeter shall be provided.

#### **ELECTRODES**

The electrodes used for manual metal arc welding shall comply with the requirements of BS 639 or other appropriate standard with the prior approval of the Officer-in-Charge. Electrodes shall be selected having regard to the application i.e. joint design, welding position and the properties required to meet service conditions.

All consumables shall be stored and handled with care and in accordance with the manufacturers' recommendations. Electrodes filler wires, rods and fluxes that show signs of damage or deterioration shall not be used.

Covered electrodes shall be stored in their original packets or cartons in a dry place adequately protected from the effects of the weather. When special protection or other treatment during storage or immediately prior to use is recommended by the manufacturer of the electrodes, they shall be treated accordingly.

### 8.2.6.2 BUTT WELDS

The details of the angle between fusion faces gap between parts etc. shall be as per BS 5135. The details for a single V-butt weld (without backing) are given below.

Weld details	Welding Position	Thickness T	Flat position		
			Gap G	Angle X R	Roof Face
			mm		mm
Weld from both sides or one side only	All Positions	5-12	2	60°	1
		Over 12	2	60°	2

The dimensions of the weld preparation may have to be modified for welding in positions other than flat, in which case they should be the subject of arrangement between the contracting parties.

In the as welded conditions the weld face shall be proud of the surface of the parent metal, the butt weld shall be built up so that the thickness of reinforcement at the centre of the weld shall be not less than 10% of the size of the butt weld nor more than 3 mm. See fig. 9/1. Where a flush surface is require, the butt weld shall be first built up as specified above and then dressed flush. When no dressing is to be carried out, the permissible weld profile shall either be as specified or as directed.

#### (a) FULL PENETRATION BUTT WELDS

Full penetration single V, U, J, bevel or square butt welds shall be completed by depositing a sealing run of weld metal on the back of the joint; else where these or other butt welds are to be welded from one side only, backing material may be used except where it is agreed between the Officer-in-Charge and the contractor that, by the adoption of an approved special method of welding, full penetration will be obtained without the use of backing material.

Note:- It should be noted that under fatigue conditions backing material may be undesirable.

Backing material shall consist of another steel part of the structure, or of material approved by the Officer-in-Charge. Where backing material is employed, the joint shall be arranged in such a way as to ensure that complete fusion of the parts to be joined is readily obtained.

In all complete penetration butt welds which are to be welded from both sides, the particular welding procedures which allow this to be done without back gouging shall be adopted; but where complete penetration cannot be achieved, the back of the first run shall be gouged out by suitable means to clean sound metal before welding is started on the gouged out side.

#### (b) PARTIAL PENETRATION BUTT WELDS

Partial penetration butt welds shall not be allowed unless specially designed in which case, the weld shall have a throat thickness not less than that specified.

### 8.2.6.3 FILLET WELDS

A fillet weld as deposited shall be not less than the specified dimensions clearly indicated as throat thickness and/or leg length as appropriate, taking into account the use of deep penetration processes or partial penetration. The effective length of a fillet weld designed to transmit loading shall be not less than 50 mm nor 6 times its leg length.

For concave fillet welds, the actual throat thickness shall be not less than 0.7 times the specified leg length. For convex fillet welds, the actual throat thickness shall be not more than 0.9 times the actual leg length.

Where the specified leg length of a fillet weld at the edge of a plate or section is such that the parent metal does not project beyond the weld, melting of the outer corner or corners which reduces the throat thickness, shall not be allowed.

#### **8.2.6.4 PREPARATION OF JOINT FACES**

If preparation or cutting of the material is necessary, this shall be done by shearing, chipping, grinding, machining, thermal cutting, thermal gouging or machine gas cutting. Edges shall be left free of slag. When shearing is used, the effect work hardening shall be taken into account and precautions shall be taken to ensure that there is no cracking of the edges.

##### **FUSION FACES**

The preparation of fusion faces, angle of bevel, root radius and root face shall be to the required accuracy.

Fusion faces and adjacent surfaces shall be free from cracks, notches or other irregularities which might be the cause of defects or would interfere with the deposition of the weld.

Fusion faces and the surrounding surfaces for a distance of at least 12 mm shall be free from heavy scale, moisture, oil, paint or any other substance which might affect the quality of the weld or impede the progress of welding. This is particularly important when a controlled hydrogen welding process is used.

#### **8.2.6.5 ASSEMBLY FOR WELDING**

Parts to be welded shall be assembled such that the joints to be welded are easily accessible and visible to the operator. Welding shall be done in the flat position whenever practicable.

Jigs and manipulators shall be used where practicable so that the welding can be carried out in the most suitable position.

##### **(a) ALIGNMENT OF BUTT JOINTS**

The root edges or root faces of butt joints shall not be out of alignment by more than 25% of the thickness of the thinner material for material up to and including 12 mm thick, or by more than 3 mm for thicker material. For certain applications and welding processes closer tolerances may be necessary.

##### **(b) FIT UP OF PARTS JOINED BY FILLET WELDS**

The edges and surfaces to be joined by fillet welds shall be in as close contact as possible since any gap increases the risk of cracking, but in no case shall the gap exceed 3 mm.

#### **8.2.6.6 TACK WELDS**

Tack welds shall be not less than the throat thickness or leg length of the root run to be used in the joint and shall be subject to the same welding conditions as those specified for the root run. The length of the tack weld shall not be less than four times the thickness of the thicker part or 50 mm whichever is the smaller.

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Where a tack weld is incorporated in a welded joint its shape shall be suitable for incorporation in the finished weld and it shall be cleaned and fused thoroughly with the final weld. Cracked, broken or otherwise defective tack welds shall be removed before final welding.

#### **8.2.6.7 IDENTIFICATION**

When specified by the Officer-in-Charge adequate means of identification, either by an identification mark or other record, shall be provided to enable each weld to be traced to the welder (s) by whom it was made.

#### **8.2.6.8 INSPECTION & TESTING**

The Officer-in-Charge shall have access to the contractor's work at all reasonable times, and the contractor shall provide him with all facilities necessary for inspection during manufacture and on completion.

Welds showing cavities or in which the weld metal tends to fall over the parent metal without proper fusion shall be cut out and re-welded to the satisfaction of the Officer-in-Charge. Care shall be taken to avoid undercutting of the base metal along the weld edges and where serious undercutting occurs the reduction shall be made good to the satisfaction of the Officer-in-Charge.

Where specified for important works, radiographic or ultrasonic testing procedures shall be carried out to the satisfaction of the Officer-in-Charge.

Finished welds and adjacent parts shall be protected with clean boiled linseed oil after all slag has been removed.

Welds shall not be painted or otherwise obscured until they have been accepted by the Officer-in-Charge.

##### **Quality of Welds**

Welds joints shall be free from defects that would impair the service performance of the construction.

#### **8.2.6.9 CORRECTION OF FAULTY WELDS**

Where welds do not comply with the requirements of the Clauses above, the defective portions shall be cut over they shall then be rewelded and reinspected in accordance with this standard. Where serious undercutting of the base metal along the weld edges is noticed, the education shall be made good to the satisfaction of the Officer-in-Charge.

#### **8.2.7 MACHINING OF BUTTS, CAPS, AND BASES**

Stanchion splices and butt joints of compression members dependent on contact for the transmission of compressive stresses, shall be accurately prepared to butt so that the permitted stress in bearing is not exceeded nor eccentricity of loading created which would induce secondary bending in the members. Stanchion caps and bases shall be prepared in a similar manner to the above, and where this is obtained by machining, care shall be taken that any attached gussets, connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by more than 2 mm.

#### **8.2.8 SLAB BASES AND CAPS**

Slab bases and slab caps, except when cut from material with true surfaces, shall be accurately machined over the bearing surfaces and shall be in effective contact with the end of the stanchion.

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A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided where necessary in stanchion bases for the escape of air.

**8.2.9 MARKING**

Each piece of steel work shall be distinctly marked before delivery in accordance with a marking diagram, and shall bear such other marks as will facilitate erection.

**8.2.9 PAINTING**

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust; all other steel worked shall be given one coat of red oxide of iron paint at the earliest possible opportunity. During the process of erection and subsequently until the work is completed the contractor shall maintain these protective coats.

Shop contact surfaces need not be painted unless specified. If so specified, they shall be brought together while the paint is still wet.

Surfaces not in contact, but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections.

All faces to be riveted or bolted together shall be painted before assembly.

In the case of surfaces to be welded, the steel shall not be painted or metal coated within a suitable distance of any edges to be welded if the paint specified or the metal coating would be harmful to welders or impair the quality of the welds.

Welds and adjacent parent metal shall not be painted prior to de-slugging, inspection and approval.

Parts to be encased in concrete shall not be painted or oiled. See also clause 15.1.

**8.3 ERECTION – SITE WORK**

**8.3.1 PLANT AND EQUIPMENT**

The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the Officer-in-Charge.

**8.3.2 STORING AND HANDLING**

All structural steel at the site shall be stored and handled so that members are not subjected to excessive stresses, damage deformation etc.

**8.3.3 PERMISSION**

The erection of steel work shall be started only after obtaining the permission of the Officer-in-Charge.

**8.3.4 SETTING OUT**

The positioning and leveling of all steel work, the plumbing of stanchions and the placing of every part of the structure with accuracy shall be in accordance with the approved drawings and to the satisfaction of the Officer-in-Charge.

**8.3.5 SECURITY DURING ERECTION**

The work may be erected in suitable units as may be directed by the Officer-in-Charge. Fabricated members shall be lifted at such points as will avoid the deformation or excessive stress in members.

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The structures or part of it placed in position shall be secured against overturning or collapse by suitable means.

During erection the work shall be securely bolted or otherwise fastened and if necessary temporarily braced, so as to make adequate provision for all erection, stresses and conditions, including those due to erection equipment and its operation. Neither riveting, permanent bolting nor welding shall be done until proper alignment has been obtained.

**8.3.6 MODIFICATION TO FABRICATION**

Modification to fabricated steel work which would involve cutting, welding etc. must not be made without the prior approval of the Officer-in-Charge.

**8.3.7 PAINTING AFTER ERECTION**

All surfaces to be painted shall be dry and thoroughly cleaned from all loose scale and rust.

The specified protective treatment shall be completed after erection. All rivet and bolt heads and site welds after deslagging shall be cleaned. Damaged or deteriorated paint surfaces shall first be made good with the same type of paint as the shop coat. Where specified, surfaces which will be in contact after site assembly shall receive a coat of paint (in addition to any shop priming) and shall be brought together while the paint is still wet.

Where the steel has received a metal coating in the shop, this coating shall be completed on site so as to be continuous over any welds and site rivets or bolts. Protection may be completed by painting on site in lieu of metal coating subject to the approval of the Officer-in-Charge. Bolts which have been galvanized or similarly treated are exempted from this requirement.

Site painting should not be done when humidity is such as to cause condensation on the surface to be painted. Please also see clause 15.8

**8.3.8 BEDDING OF STANCHION BASES AND BEARING OF BEAMS AND GIDERS ON STONE, BRICK OR CONCRETE (PLAIN OR REINFORCED)**

Bedding shall be carried out with Portland cement grout or mortar or fine concrete.

For multi-storied buildings this operation shall not be carried out until a sufficient number of bottom lengths of stanchions have been properly line, leveled and plumbed and sufficient floor beams are in position.

Whatever method is employed, the operation shall not be carried out until the steel work has been finally leveled and plumbed, the stanchion bases being supported meanwhile by steel wedges and immediately before grouting the space under the steel shall be thoroughly cleaned.

The belt holes and space beneath column base plates shall be filled with grout or mortar of specified below.

- a. Space not deeper than 25 mm neat cement slurry to as thick a consistency as possible and pured under a suitable pressure head.
- b. Spaces between 25 mm and 50 mm deep; A mortar of cement and fine aggregate in the proportion of 1.1, just fluid enough to pour, poured under a suitable head and tamped as filling proceeds.
- c. Spaces over 50 mm deep: A damp dry mortar of cement fine aggregate 1:2 well tamped against properly fixed forms as filling proceeds.

**8.3.9 ENCASING OF STEELWORK IN FOUNDATIONS AND FILLING BETWEEN GRILLAGE BEAMS**

Grillage beams and all steel in foundations shall be solidly encased in dense concrete of structural Gr. 20 (10 mm) with a minimum cover of 100 mm.

### **8.3.10 ERECTION OF TRUSSES**

Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be slinged at the apex, as this will develop compression stresses in the bottom tie member. They shall be lifted by slinging at two mid points of rafters, which shall be temporarily braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.

The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 10 m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots, so as to permit the free movement of the truss end. For larger spans, the truss shall be provided with bearing as per design.

## **8.4 ROLLING SHUTTERS**

### **GENERAL**

Rolling steel shutters shall be the product of an approved and recognized manufacturer regularly engaged in the production of the type of shutters required. Standard commercial products, which meet the general requirements of the specifications and vary only in non-essential details shall be accepted subject to the approval of the Officer-in-Charge. These shall include necessary locking arrangements and handles etc. These shall be suitable for fixing in the specified location and position i.e. outside or inside on or below lintel or between jambs of the opening. The doors shall be either push and pull type or operated manually or mechanically with a suitable gear mechanism.

### **8.4.1 SHUTTERS**

These shall consist of mild steel laths 12 mm thick (18 G) and 80 mm wide or as specified. The laths shall be machine rolled from a continuous strip into an easy curve free from crimps or sharp bends and with an effective bridge depth of 16 mm. These shall be interlocked together throughout their entire length and jointed at the ends with end locks designed in such a way as to maintain alignment and protect the slats against abrasion in the guides. All joints shall be completely air and weather tight.

The shutter shall be supported by means of spring barrels which in turn are supported by cast iron or steel brackets. The shutter slats shall coil on the spring barrel. A galvanized steel sheet hood not lighter than 1.5 mm G reinforced as for the end closures for the hood.

The spring shall be preferably of coiled type and shall be manufactured from high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions.

### **8.4.2 GUIDE CHANNELS**

The guide channel shall be a mild steel deep channel section of rolled, pressed or built up (fabricated) construction. The thickness of the sheet used shall not be less than 3 mm. The minimum depth for guide channels shall be as follows:

Clear width of Shutter	Depth of Guide Channel
Under 3.5 m	60 mm
3.5m and above	75 mm

The gap between the two legs of the guide channel shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent the rattling of the shutter due to wind.

Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to walls or columns by means of bolts or screws. The spacing of cleats shall not exceed 750 mm. Alternatively the guide channels may be provided with suitable dowels, hooks, or pins for embedding in the walls.

### **8.4.3 FIXING**

The installation shall be mounted plumb, square and true on the vertical surface of lintels and/or masonry. When completed, the door shall completely fill the opening for which it was designed and shall not obstruct the opening when in the open position. The shutters shall operate easily and smoothly under all conditions.

## **8.5 TUBULAR ROOFS AND COLUMNS**

### **8.5.1 STRUCTURAL STEEL TUBES**

These shall conform to B.S. 1775 and shall be one of the following types:

1. Hot finished welded (HFW) type.
2. Hot finished seamless (HFS) type
3. Electric resistance welded (ERW) type.

The steel shall contain:

Not more than 0.06 per cent Sulphur

Not more than 0.06 per cent Potassium

The steel shall have an yield strength of 209 n/mm<sup>2</sup> or as specified. The sizes of tubes and wall thickness shall be as specified.

#### **TOLERANCES**

These shall be in conformity with BS 1775 for each type of Tube. The tubes shall not deviate from straightness by more than 1/600 of any length.

Tubes shall be cleanly finished and reasonably free from scale. They shall be free from crack, surface flaws, lamination and other defects. The ends shall be cut clean and square with the axis of the tubes unless otherwise specified. Where Galvanized tubes are specified these shall be not dip galvanized and in conformity with the requirements of BS 1775.

#### **MINIMUM WALL THICKNESS OF TUBES**

Structural tubes shall have the minimum wall thickness indicated below depending upon the exposure.

Construction not exposed to weather 3.2 mm

Construction exposed to weather 4.0 mm

Structures not readily accessible for

Maintenance 5.0 mm

### **8.5.2 FABRICATION**

This shall conform to the requirements of clause 9.2.

#### **CAPS AND BASES FOR COLUMN**

The ends of all the tubes for columns, transmitting loads through the ends, shall be true and square to the axis of the tube and shall be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate shall be true and square to the axis of the column.

#### **SEALING OF TUBES**

When the end of a tube is not automatically sealed by virtue of its connection by welding to another member, the end shall be properly and completely sealed. Before sealing, the inside of the tube shall be dry and free from loose scale.



## FLATTENED ENDS

In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded, riveted or bolted connections provided that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

### 8.5.3 HOISTING AND FIXING

Shall conform to 8.3

## 8.6 STEEL DOORS, WINDOW, VENTILATORS AND COMPOSITE UNITS

### GENERAL

The type, overall sizes and location of steel door window and ventilators shall be either as shown on the drawings or as per details given by the Officer-in-Charge. For doors, the provision of the threshold or the tie-bar at the bottom of the door frame shall be as specified or as directed. (Usually external doors are provided with threshold and the internal doors with tie bars.)

The actual sizes of doors, windows and ventilators shall not vary by more than 1.5 mm from the dimensions given in the drawings. Where these are not built into the wall construction, the openings shall allow 12 mm clearance around to facilitate easy installation later on.

### 8.6.1 MATERIALS

Cold rolled steel sections made from steel sheet conforming to BS 1449: Part I.

### 8.6.2 PROTECTION

Rust proofing and protective finishes shall be as specified.

### 8.6.3 WORKMANSHIP

The fabrication, erection, glazing and finishing shall conform to the following standards.

BS 1245	-	Metal door frames (steel)
BS 990: Part 2	-	Steel windows generally for domestic and similar buildings
BS 1767	-	Steel windows for industrial buildings
BSCP 152	-	Glazing and fixing of glass for buildings

## 8.7 ALUMINIMUM FRAMED SLIDING GLASS DOORS

These shall be made of extruded Aluminium alloy sections anodized to Grade AA 25 as per BS 1615 or as specified mechanically jointed and erected and finished conforming in all respects to BS 5286.

## 8.8 ALUMINIUM WINDOWS

These shall be made of extruded aluminium alloy sections anodized to Grade AA 25 as per BS 1615 or as specified, mechanically jointed, erected and finished conforming in all respects to BS 4873.

**DEFINITIONS****LOCKS**

1. A device for securing a door, gate, lid, drawer of the like when closed, consisting of a bolt or a system of bolts propelled or withdrawn by a mechanism operated by a key or other means.
2. A mechanism combining of one case, a spring bolt and a dead bolt operated respectively by handles and a removable key.

**BOLT**

The part of the lock which provides the fastening by protruding from the lock case to engage in the staple, striking plate, link, shackle, or other member.

**CATCH**

A device to hold the spring bolt of a lock or latch in the 'in' and/or 'out' position respectively

**STAPLE**

A box like fitting fixed on a door jamb into which the bolt or bolts of a rim lock or rim latch door.

**MORTICE LOCK**

Any lock for fixing in a mortice out in the closing edge of a door.

**LATCH**

A device openable from both sides and generally self engaging for holding closed a door, gate or the like. It consists of a movable part falling by gravity or sliding or moving by means of a spring into a retaining member of some sort, the moving part of the device being operated by a handle and not by a removable key.

**MORTICE LATCH**

Any latch of fixing in a mortice cut in the closing edge of the door.

**RIM LATCH**

A latch for fixing to the face of the door, having a bevelled spring bolt and usually incorporating a jumbo bolt.

**HANDLE**

Any item or part of any item of door, drawer, cupboard, or gate furniture, intended to be held in the hand for opening, closing or moving to another position, the article to which it is fixed.

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#### **HASP AND STAPLE**

A device for securing a door, gate or lid in a closed position by the use of a padlock. The hasp consists of two members hinged together. One member is always a plate for fixing: the other member may be a slotted flap or wire loop arranged to pass over and around the staple. The staple consists of either a flat fixing plate from which a wire hoop projects or a flat bent plate pierced by a hole to receive the shackle of the padlock.

#### **DOOR BELL**

A device to enable callers to draw attention to their presence by means of ringing a bell.

#### **KICKING PLATE**

A plate fixed across the face of a door to protect the lower part of the door from disfigurement or wear.

#### **PUSH PLATE**

1. A plate larger than a finger plate to the face of a door to protect the door from disfigurement.
2. any plate lettered 'Push' which is fixed to a door as an instruction for opening.

#### **GENERAL**

This section deals with common items of iron mongery. These shall be of iron, brass, aluminium or as specified and shall be well made, reasonably smooth and free from flaws and other defects.

All hinges, locks, etc. shall generally be of blackened steel except near the coast or unless otherwise specified.

#### **FINISH**

The finish shall be as below or as specified.

- (a) Iron fittings – These shall be smooth finished and treated against rust formation.
- (b) Brass fittings – These shall be finished bright, chromium plated, oxidized or as specified.
- (c) Aluminium fittings – These shall be anodized. The surface shall be prepared to a satin finish and the grade of anodizing shall be as specified.

Note: Grades of anodizing shall conform to BS 1615 and depend on the location and frequency of cleaning. For example Grade AA 20 corresponds to 20 microns average coating thickness.

#### **FIXINGS**

Screws used for fittings shall be of the same metal and finished in the same way as fittings, except that chromium plated brass screws shall be used for fixing aluminium fittings. Fixings shall be of the size indicated in the drawings or as directed. Screw holes shall be countersunk to suit the head of specified wood screws.

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## **FITTINGS**

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Officer-in-Charge. These shall be truly vertical or horizontal as the case maybe. Screws shall be driven home with a screw driver and not hammered in. Recesses for counter sinking of hinges etc. shall be cut to the exact size and depth and shall be close fitting. Holes for through bolts shall be carefully sugared. Particular care shall be taken while fixings are made to flush doors made of plywood.

Samples of all iron mongery shall be produced well in advance and approval obtained from the Officer in Charge. Subsequent supplies shall conform in all respects to the sample produced. Sizes shall be specified. Some details of components are shown in the figures.

### **9.1 HINGES**

#### **9.1.1 KNUCKLE TYPE HINGES**

##### **GENERAL**

All hinges shall be free from flaws and defects that may adversely affect the appearance or service.

All edges shall be smooth and square without burrs or sharp projections. Movement of the hinges shall be free and easy and shall have no play or shake. The leaves shall be free to rotate one with the other through a minimum of 200°. The holes for the hinge pins shall be central and square to the knuckles. All hinge pins shall be riveted firm with well formed countersunk or domed heads. All screw holes shall be counter sunk with no sharp edges.

##### **9.1.1.1 STEEL HINGES**

Steel hinges shall be one of the following types confirming to BS 1227. all steel hinges shall be smooth finished and tested against rust formation.

Broad steel butt hinges.  
Steel butt hinges (heavy gauge)  
Steel butt hinges (light gauge)  
Steel cabinet hinges  
Steel parliament hinges  
Steel tee hinges  
Steel strap hinges

Steel hinges of the following types shall conform to BS 1227 part IA

Rising butt hinges  
Falling butt hinges  
Lift off butt hinges

Hinges shall be manufactured from mild steel sheets, plates, or stripes and hinge pins from mild steel wires all confirming to the requirements of BS 1227. Dimension of hinges and knuckles, diameter of hinge pins, size, number and location of screw holes etc. shall be as given in the figures.

Tee hinges shall be fixed with 6 mm diameter bolts with the nuts on the inside.

### 9.1.1.2

#### **SOLID DRAWN (EXTRUDED) BRASS KNUCKLE TYPE HINGES**

These shall confirm to BS 1227 part IA. Section 4 and shall be one of the following types.

Brass broad butt hinges  
Brass strong butt hinges  
Brass washered butt hinges  
Brass projection butt hinges  
Brass rising butt hinges  
Brass falling butt hinges  
Brass backflap butt hinges  
Brass counterflap butt hinges  
Brass lift off butt hinges

Brass hinges shall be made of extruded brass sections (brass conforming to BS 249)

Pins shall be made of steel or brass wire as specified. Hinges with washers shall be fitted with washers made of steel, phosphor bronze or nylon as directed.

The helix and lining of knuckles of rising hinges or falling hinges shall be anodized. The finish shall be polished brass, polished chromium plate, satin chromium plate, bronze metal antique or as specified

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### 9.1.1.3

#### **EXTRUDED ALUMINIUM KNUCKLE TYPE HINGES**

These shall confirm to section 6 of BS 1227 Part IA. The hinges shall be anodized to Grade AA. 15 of BS 1615. Hinge pins shall be of Aluminium or stainless steel. Hinges shall be fitted with washers at least 1.27mm thick between knuckles. These washers shall be of nylon or stainless steel.

### 9.1.2

#### **SPRING HINGES**

These shall be single acting when the shutter is to open on one side only or double acting when the shutter is to open on both sides. The hinges shall be made of mild steel or brass as specified. They shall work smoothly and shall hold the door truly vertical in the closed position.

The size of the spring hinge shall be taken as the length of the plate.

### 9.1.2.1

#### **MILD STEEL**

The cylindrical casing shall be made either from mild steel of 1.60 mm thickness, lap jointed and brazed, welded and riveted, or from solid drawn tube of wall thickness 1.60 mm pressed to form the two casings. It shall be stove enameled black or as specified.

### 9.1.2.2

#### **CAST BRASS**

The cylindrical casing shall be made either from brass steel of 1.60 mm thickness, lap jointed and brazed, or from solid drawn tube of not less than 1.60 mm wall thickness. It shall be stove satin/bright nickel plated, copper oxidized, or as specified.

### 9.2

#### **DOOR CLOSER**

Hydraulic door closers (exposed type) shall be made of cast iron/aluminium alloy/zinc alloy and of shape and pattern approved by the Officer-in Charge.

The door closers may be polished or painted and finished with lacquer to the desired colour.

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- 9.2.1 MILD STEEL CLOSERS**  
All dents, burrs, and sharp edges shall be removed from various components and they shall be pickled scrubbed and rinsed to remove grease, rust, scale or any other foreign elements. After pickling, all the mild steel parts shall be given phosphating treatment, in accordance with standard practices.
- 9.2.2 ALUMINIUM CLOSERS**  
Aluminium alloy door closers shall be anodized and the anodic coating shall not be less than grade AA 15 of BS 1615
- 9.3 DOOR BOLTS**
- 9.3.1 SLIDING BOLTS**  
**GENERAL**  
The fixing and staple bolts shall be cast with 6 mm studs.
- Bolts shall be finished to shape and have threaded ends and provided with round worms and nuts of square or hexagon type. All screw holes shall be counter sunk to suit the counter sunk head of woods screws of specified size. All edges and corners shall be finished smooth. In the case of a single leaf door, a hole of suitable size shall be drilled in the door frame and an iron or brass shield plate cut to shape be fixed at the face of the hole.
- 9.3.1.1 MILD STEEL SLIDING DOOR BOLT**  
These shall be made of mild steel sheets and rods and treated against rust.
- 9.3.1.2 CAST BRASS SLIDING DOOR BOLTS**  
These shall be made from rolled brass. The hasp shall be of cast brass and secured to the bolt. Alternatively, the hasp and the bolt may be cast in one piece. All components shall be finished smooth and polished before assembly. Cast brass sliding bolts shall be finished bright, chromium plated, oxidized or as specified.
- 9.3.1.3 ALUMINIUM SLIDING DOOR BOLT**  
These shall be made of aluminium alloy. Aluminium sliding door bolts shall be anodized to Gr AA 15 of BS 1615.
- 9.3.2 BARREL BOLTS/TOWER BOLTS (fig 10/22)**  
Tower bolts vary in length from 75 mm to 380 mm. These shall be well made and free from defects. The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts shall be made of sheet of thickness 12 mm or more, and shall have counter sunk screw holes to suit the counter sunk head of the wood screws. All sharp edges and corners shall be removed and finished smooth. The plate shall be screwed to the inside of the door so that the bolt engages or shoots in a metal socket or staple fixed on the door frame, or metal socket let into the floor.
- 9.3.2.1 MILD STEEL BOLTS**  
Mild steel tower bolts shall have barrel made in mild steel plate. The bolt shall be mild steel or cast iron rod of suitable diameter. The plates and straps after assembly shall be firmly riveted or spot welded.
- The rivet head shall be properly formed and the rivet back shall be finished flush with the plate.

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The bolts shall be bright finished or plated as specified and the barrel and socket, stove enameled black.

**9.3.2.2 BRASS BOLTS**

Brass tower bolts with cast brass barrel and rolled or cast brass bolt.

or

Brass tower bolts with barrel of extruded sections of brass rolled or drawn brass bolt.

The knobs of brass tower bolts shall be cast and the bolt fixed with a knob.

**BRASS TOWER BOLTS**

Bolts and barrel polished or plated as specified.

**9.3.2.3 ALUMINIUM BOLTS**

Aluminium barrel tower bolts with barrel and bolt of extruded sections of aluminium alloy. The knob shall be properly screwed to the bolt and riveted at the back.

Aluminium alloy tower bolts shall have anodized bolt and barrel unless otherwise specified. The anodic film may be either transparent or dyed as specified. The quality of the anodized finish shall not be less than grade AA 10 of BS 1615.

**9.3.3 FLUSH BOLTS**

These shall be of cast brass, cast Aluminium alloy or extruded Aluminium alloy as specified. Only one material shall be used in the manufacture of all the components of flush bolts except the spring which shall be of flush bolts of phosphor bronze or steel strip. When the rod is completely in its maximum bolting position by the spring. The length of the bolt shall be of such that, when the bolt is pulled down, the top of the bolt shall be flush with the top of the lip face. The top of the bolt shall be given a taper of 45° to enable easy pull or push.

**9.3.3.1** brass flush bolts shall be satin or bright polished alternatively, they may be nickel or chromium plated as specified in BS 1224, or copper oxidized.

**9.3.3.2** Aluminium flush bolts shall be anodized and the quality of the anodized finish shall not be less than grade AA 15 of BS 1615.

**9.4 MORTICE LATCH/MORTICE LOCK/MORTICE LATCH AND LOCK RIM LATCH/RIM LOCK/RIM LATCH AND LOCK**

These shall conform to B.S 5872 in regard to design and dimensions.

**9.5 DOOR HANDLE**

The door handles shall be well made and free from defects. These shall be finished correct to shape and size dimensions.. All edges and corners shall be removed and finished smooth so as to facilitate easy handling. Cast handles shall be free from casting defects. Where the grip portion of the handle is joined with the piece by mechanical means, the arrangement shall

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be such that, the assembled handle shall have adequate strength comparable to that of integrally cast handles.

The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size, and window handles of 75 mm size, unless otherwise specified. These shall be fixed with 25 mm long no. 6 wood screws.

Door handles shall be of the following types according to the material used.

**9.5.1 MILD STEEL HANDLES**

These shall be of mild steel sheet, pressed into oval section. Iron handles shall be treated against rust formation.

**9.5.2 CAST BRASS HANDLES**

These shall be of cast brass of specified size and of the shape and pattern specified. Brass handles shall be finished bright, chromium plated, oxidized, or as specified.

**9.5.3 CAST ALUMINIUM HANDLES**

These shall be of aluminium of specified size, and of shape and pattern specified.

Aluminium handles, shall be anodized and the anodic coating shall not be less than grade AA 15 of BS 1615 as specified.

**9.6 CASEMENT FASTENER**

Where specified casement fasteners for windows shall be of brass and of a study and suitable design with a cross tongue and a mortice plate fixed to the mullion of the windows. The fasteners shall be oxidized black.

**9.7 CASEMENT STAYS**

These shall be of brass, straight or curved. The hinge pin shall be mild steel or phosphor bronze. There shall be of no blow holes in any part of the window stay and the movement of the window stay shall be free and easy. The screw holes shall be countersunk to suit Countersunk 19 mm X no 6 wood screws. The window stays shall be bright finished oxidized or chromium plated.

**9.8 HOOKS AND EYES**

These shall be mild steel, hard drawn brass, or as specified. These shall be well made and free from defects. They shall be finished to the correct shape and dimensions so as to function properly when they are in use. Cast hooks eyes and plates shall be free casting and other defects. All sizes of hooks and eyes shall be determined by the length of the hooks measured 'out to out'. Unless otherwise specified the articles shall be finished bright. Mild steel hooks and eyes shall be treated against rust formation. Cast brass hooks and eyes shall be finished bright or chromium plated.

**9.9 HASP AND STAPLE**

Hasp and staple shall be of Mild Steel, Brass, Aluminium. The hinge pin which in all cases shall be of mild steel (or phosphor bronze in the case of brass hasp and staples) shall be firm and its riveted heads well formed. The movement of the hasp shall be free, easy and square and shall not have any play or shake. The hasp shall fit the staple correctly. The size shall be determined by the length of the bigger leaf of the hasp.

The staple except in the case of a cast one, shall be riveted properly to its plate. The safety type hasp shall be secured to the door by two small bolts where as the staple is generally screwed on the door/frame. A padlock is a necessary adjunct to the hasp and staple. The



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padlock maybe galvanized steel, brass or bronze. All screw holes shall be clean and counter sunk to suit counter sunk wood screws. All edges and corners shall be rounded.

**9.9.1 MILD STEEL HASP AND STAPLE**

These shall be manufactured from mild steel sheets and shall be finished with/without protective coating, stove enameled or plated.

**9.9.2 BRASS HASP AND STAPLE**

These shall be manufactured by casting and finished polished, oxidized or as specified.

**9.9.3 ALUMINIUM HASP AND STAPLE**

These shall be made from dye sections and shall be anodized. The anodic coating shall not be less than grade AA 15 of BS 1615.

## **10.0 FLOOR FINISHES**

**10.1** Floor finishes with cement concrete tiles/clay tiles including ceramic floor tiles/pre cast concrete slabs/natural stone slabs/artificial stone/slabs wire cut bricks

### **10.1.1 MATERIALS**

#### **10.1.1.1 CALY FLOORING TILES**

Clay flooring tiles shall generally conform to BS 1286 and shall be Ceramic tiles or clay floor tiles (quarries) as described below

##### **(a) CERAMIC TILES**

These shall be produced by compacting blended ceramic powders and firing to temperatures above red heat. They shall be either vitreous with water absorption not exceeding 4% or fully vitrified with water absorption not exceeding 0.3%.

The sizes of these tiles may be one of the following or as specified.

100mm x 100mm x 9.5mm  
200mm x 100mm x 9.5mm  
150mm x 150mm x 12.5mm  
150mm x 150mm x 9.5mm  
150mm x 75mm x 12.5mm  
150mm x 75mm x 9.5mm

The colour of the tiles shall be as specified. Deviation on length and breadth shall not be exceeded  $\pm 1.5$ mm for 100 mm tiles and  $\pm 3.0$  mm on the 200 mm tiles. Deviation on thickness shall not be more than  $\pm 5\%$ .

Tile specials like round edges, coves, angle beads, steps treads etc. shall conform to BS 1285 or as specified.

##### **(b) CLAY FLOOR QUARRY TILES**

These shall be produced by extrusion or other plastic forming of a suitable clay or combination of clays and other minerals; the process includes firing above red heat. (Note: these tiles are thicker than ceramic tiles and the surface less even and fine)

The sizes of these tiles shall be one of the following or as specified.

150 x 150 x 16mm  
150 x 150 x 18mm  
150 x 150 x 22mm  
230 x 230 x 32mm  
150 x 75 x 16mm  
150 x 75 x 19mm  
150 x 75 x 22mm

Deviation on length and breadth shall not be exceed  $\pm 2.0$  mm for 150 mm length and  $\pm 4.0$  mm for the 230 mm lengths. Deviation on thickness shall not be more than 10%.

Water absorption of the tiles shall not exceed 10% when tested in accordance with BS 1286.

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The colour of the tiles shall be specified. Suitable tile fittings shall be supplied as specified or directed.

#### **10.1.1.2 CEMENT CONCRETE TILES**

These shall be manufactured with ordinary Portland Cement conforming to CS 107 and hard dense aggregates from natural sources conforming to BS 882.

These shall comply with the requirements of BS 1197. the tiles shall be of the following sizes or as specified.

150 x 150 x 15mm  
200 x 200 x 20mm  
225 x 225 x 20mm  
300 x 300 x 30mm  
400 x 400 x 35mm  
500 x 500 x 40mm

Deviation on sides shall be  $\pm 1.0\text{mm}$  and on thickness  $\pm 3\text{ mm}$   
Length of the skirting shall be from 150 to 900 mm  
Height of the skirting shall be 100 mm or 150 mm  
Thickness of skirting shall be 12mm  
Coves were specified shall have a radius of 25mm

When coloured tiles are specified or when any special aggregate is specified for the wearing surface, the thickness of the facing layer shall be as follows.

For tiles under 400 mm in size – the minimum thickness  
shall be 6 mm

For tiles equal to 400 mm - the minimum thickness  
shall be 8 mm

For tiles over 500 mm - the minimum thickness  
shall be 10 mm

The colour of the tiles shall be as specified. Pigments used in the manufacture shall comply with the requirements of BS 1014. For homogeneity of colour, the pigments shall be milled in with dry cement before being added to the mix, or alternatively, coloured cement shall be used. The colour of the tiles shall be uniform through out the wearing surface. There shall be no trace of efflorescence on the tiles so that the colour of the tiles is neither obscured nor reduced in intensity. A suitable water repellent like metallic soap shall be added while making the tiles to reduce efflorescence. The surface of the tiles shall be smooth and plane, free from projections, depressions and crazing. All arrises shall be sharp and true.

Skirting and fittings shall have both smooth surfaces free from crazing.

#### **10.1.1.3 CHEQUERED TILES**

Where chequered tiles are specified thickness of the tiles shall not be less than 22mm. Chequers shall 25 to 50mm in size with a groove depth of 3 mm. The minimum thickness of the wearing layer shall be 6 mm measured from the top of the chequers.

#### **10.1.1.4 CHEQUERED TILES FOR STAIR TRADES**

Tiles for stir treads shall be chequered as above and shall comply with the following.

The lengths of the tiles including the nosing shall be as specified.

The nosing edge of the tile shall be rounded and have the same wearing layer as the top.

The minimum thickness of the tile shall be 30 mm

The front portion of the tile for a minimum breadth of 75 mm from and including the nosing shall have grooves running parallel to the nosing and spaced at centers not exceeding 25mm. The rest of the tile shall have the normal chequer pattern.

#### **10.1.1.5 BRICKS**

Clay bricks for floor finishes shall be wire cut.

#### **10.1.1.6 NATURAL STONE SLABS**

Paving slabs of natural stone shall be of granite or marble.

Granite slabs shall be of thickness depending on sizes specified, but not less than 50 mm nor more than 150 mm

Marble slabs shall not be less than 20 mm nor more than 40 mm thick and be as specified.

The thickness of the slate shall vary from 6 to 12 mm for interior use and 32 to 38 mm for exterior use.

#### **10.1.1.7 ARTIFICIAL STONE (CAST STONE OR RECONSTITUTED STONES)**

These shall confirm to BS 1217.

#### **10.1.1.8 BEDDING MOTAR**

Unless otherwise specified, motors for bedding shall be lime cement motor 1:1:5 or cement mortar 1:3 conforming to requirements of Chapter 3. the mortar shall contain the least amount of water necessary for workability.

Dry beddings specified for brick paving shall be a bed of clean sand 50 mm thick well rolled and laid to falls.

#### **10.1.1.9 SEPARATING LAYERS**

Where a separating layer between the base concrete and finish is specified, this shall be one of the following.

- (a) Sand conforming to BS 1199.
- (b) Bituminous felt selected from those classified in BS 747.
- (c) Waterproofing building papers selected from those described in BS 1521.
- (d) Polythene film of specified thickness.

#### **10.1.2 LAYING**

##### **10.1.2.1 LAYING THE SEPARATING LAYER**

- (a) Sand: Where sand is used as a separating layer, this shall be soft building sand, slightly damp, laid on the base in a uniform layer not exceeding 20 mm in thickness and consolidated by tamping. If a fall is required, the thickness of the separating layer shall be varied from 12 mm to 25 mm. Additional falls needed shall be obtained by laying a screed beneath the sand layer to the required falls

- (b) Felt or building paper or polythene film: where felt, building paper or polythene film is used, it shall be laid on an accurately formed base having a true and smooth surface to enable the bedding material to be constant in thickness throughout its area. The separation material shall be laid flat and lap jointed.

#### **10.1.2.1.1 BEDDING IN CEMENT MORTAR DIRECT TO THE BASON A SEAPRATING LAYER.**

The flooring units shall be soaked in clean water and allowed to surface dry before use.

If a separating layer is not used and the base has become thoroughly dry, it shall be well wetted before laying the bedding mortar. Bedding mortar shall be freshly mixed and spread upon the base to the specified thickness, the thickness may vary from 10 to 12 mm for units up to 12 mm thick and 20 to 25 mm thick for thicker units. The bedding mortar shall be tempted down true to levels.

Over this bedding, neat cement slurry of honey like consistency shall be spread out at the rate of 4.4kg of cement per square meter of the floor over such an area as will accommodate about twenty tiles or slabs.

The tiles or slabs shall be then placed in position and tamped down to the requirement finished level.

Special care shall be taken in finishing to falls and cross falls in the case of baths and toilets.

Any cement brought to the surface shall be wiped off with a damp cloth.

Joints for tiles or slabs shall vary from 2 to 5 mm depending upon the size and type of tiles.

As the laying proceeds, wide joints shall be pointed in cement mortar 1:3 with pigments added to match the colour of the flooring. The joints shall be finished flush with the surface.

Bricks shall be laid to specified patterns with 10 mm joints and pointed in cement mortar 1:3.

#### **10.1.2.2 EXPANSIONS JOINTS.**

The position of expansion joints in the sub floor base, bedding and finish shall coincide.

#### **10.1.2.3 CURING**

The floor finishing shall be cured for a period of at least seven days by wetting it with water.

### **10.2 GRANOLITHIC FLOOR FINISHES**

#### **10.2.2 MATERIALS**

- (a) Cement – Portland cement conforming to BS 12
- (b) Sand – Sand conforming to BS 1198, 1199, 1200.
- (c) Coarse Aggregate – Coarse aggregate for granolithic shall confirm to BS 882. the aggregate shall be free from dust. The size of aggregate shall be from 5 mm to 10 mm.

#### **10.2.3 THICKNESS OF FINISH AND JOINTS**

Construction joints between bays of the floor finish need only be plain untreated vertical butt joints. Granolithic shall be laid in bays of sizes given in the table below. The length of bays shall not be exceed 1 ½ times the width. Vertical butt joints shall be located over construction joints in the base and movement joints must be provided to correspond with any in the base.

Construction	Thickness of finish	Maximum pay size
Monolithic	10 - 25mm	30 m <sup>2</sup> on concrete base 5mm thick
Bonded floors	40 mm min	15 m <sup>2</sup> and length not exceeding 1 ½ x width
Bonded stairs	15 – 20mm min	
Unbonded	Up to 75mm	2 m <sup>2</sup>

#### 10.2.4 PREPARATION OF THE BASE

##### MONOLITHIC CONSTRUCTION

Where the floor finish is laid monolithically no special preparation of the base concrete is usually necessary. The finish shall be applied within 3 hours of laying the base concrete. The thickness shall be between 10 and 25 mm.

If the topping is to be laid while the base concrete is still green it would be sufficient if the laitance on the base concrete is removed by a light or mist spraying with water and by brushing.

##### BONDED CONSTRUCTION

Where the floor finish is laid on matured concrete, the surface of the base shall be thoroughly and carefully prepared to ensure adequate bond between the base concrete and floor finish. This preparation shall include the following:-

The laitance on the base concrete shall be entirely removed by complete hacking with a metal tool to expose as large a proportion of clean coarse aggregate as possible. All loose concrete and dirt shall be removed by thorough washing or hosing. These operations shall be delayed until shortly before the floor finish is to be laid to reduce the risk of further accumulation of dirt.

Several hours before the floor finish is to be laid, the base concrete shall be wetted and any excess water brushed off before grouting. The purpose of this operation is to produce as nearly as practicable a saturated but surface dry condition in the base concrete.

- c) Not more than ½ hour before the floor finish is to be laid, a neat cement grout shall be brushed into the base. The grout shall consist of water and the same cement as is used in the floor finish, mixed to the consistency of a thick fluid. About 2 kg of cement per sq m of the surface will generally be found suitable for the purpose.

A proprietary bonding agent may be used as an alternative to the grout; but it should be noted that the paragraphs (a) and (b) of this clause still apply.

- (d) Excess of grout shall be removed by thorough sweeping just prior to placing the topping material.

##### UNBONDED CONSTRUCTIONS

These screeds generally 50mm – 75mm thick, are laid on a damp proof membrane or concrete which is weak, contaminated or includes water-repellant admixture. The surface of the base shall be cleaned before laying the unbonded screed.

#### **10.2.4 MIX FOR GRANOLITHIC CONCRETE**

Mix proportions – The mix proportions shall be 1 part cement, 1 part fine aggregate 2 parts coarse aggregate, by weight. The aggregate and cement shall be accurately batched by weight. In circumstances where batching by weight is impracticable, cement shall be batched by the whole bag, and accurate gauge boxes shall be used for aggregates, due allowance being made for bulking of deep fine aggregate.

Method of mixing – the materials shall be thoroughly mixed by mechanical means whenever possible. The amount of water added shall be minimum necessary to give sufficient workability for laying and compacting.

#### **10.2.5 PLACING AND COMPACTING.**

The concrete shall be placed between forms of steel sections or battens which are fixed rigidly to a firm foundation and supported throughout their length. The forms shall be true to line and level.

The concrete shall be fully compacted by means of a tamping beam or other suitable compacting equipment taking care that an excess of laitance is not brought to the surface.

#### **10.2.6 FINISHING THE SURFACE**

After the granolithic concrete has been fully compacted, the surface shall be trowelled at least three times at intervals during the next 6 to 10 hours, so as to produce a uniform and hard surface with a high resistance to abrasion. (The resistance to abrasion of the floor finish depends very largely upon the care with which the trowelling is carried out).

About two hours after the first trowelling, the surface shall be re-trowelled to close any pores in the surface. During this operation any laitance shall be removed and not trowelled back into the topping. A third, and possibly fourth trowelling will be necessary, and the final trowelling shall be at such a stage when considerable pressure is required to make any impression on the surface.

Under no circumstances shall cement be sprinkled on to the surface to absorb surplus water. Coloured granolithic finish shall be laid with coloured cement or with an approved pigment to the satisfaction of the Officer – in – Charge.

#### **10.2.7 LAYING STAIR FINISHES**

The finish to the risers and treads may be applied in either of the following.

##### **1. MONOLITHIC CONSTRUCTION**

The framework shall be erected to the finished profile. As concreting of the stairs proceeds, the finishing mix shall be placed against each riser board to the thickness specified and up to the level of the underside of the tread or landing. The structural concrete shall be placed to the same level and both mixes thoroughly compacted. The finish to the stairs treads and the landings shall be applied as for the floor finish within 3 hours of completing the base concrete.

##### **3. BONDED CONSTRUCTION**

The structural concrete shall be laid to the profile of the stairs less the thickness of finish. Before commencing application to the finish, any laitance on the surface of the concrete shall be removed, the risers and treads hacked to provide a key for the finish and the surface cleaned with air hose. Formwork shall then be set to the finished profile and the finishing mix shall be well tamped into the

cavity between the riser board and the existing concrete face. Finally the finish shall be laid over the tread as for the floor to the specified thickness.

The forms shall be removed after 24 hours of laying or as directed by the Officer – in Charge. On removal of the framework any small cavities or pinholes in the surface shall be filled with cement mortar by means of a wood float and the surface rubbed later with a stone to remove laitance or the finish to the risers may be applied by rendering. Where so directed, treads, landings etc. shall be given a non-stop finish with corborundum sprinkled in the proportion of 1.35kg /sq m of paving and well trowelled in before the granolithic has set.

#### **10.2.8 CURING**

As soon as the surface has hardened sufficiently to prevent damage, the concrete shall be cured continuously for at least 7 days in one of the following.

Wet canvas or straw mats, or a 50 mm layer of damp sand spread on the surface and kept continuously damp and position for the full curing period.

(b) Water proof sheeting kept in close contact with the surface of the concrete for the full curing period. The sheeting shall overlap the sides and ends of the slab and be securely held in position. Adjacent sheets shall overlap by at least 75 mm.

For coloured concrete, method (b) above shall be used.

##### **10.2.9.1 SURFACE TREATMENT**

Where specified for purpose of reducing dusting, surface hardening solutions like sodium silicate, silico fluoride, drying oil and surface sealants shall be applied in accordance with clause 220 – BS 204 or as instructed by the Officer – in Charge.

##### **10.2.10 TOLERANCE OF LEVEL**

This will depend on the area of floor, but a maximum tolerance of  $\pm 15$  mm, shall be acceptable unless otherwise indicated in drawings.

Local variations in level shall be  $\pm 3$  mm under a 3 metre straight edge.

There should be no appreciable difference in level across joints especially where heavy moving loads are in service.

##### **10.2.11 ADHESION TO THE BASE**

When the floor is tapped with a rod or mallet, it shall not be sound hollow. Edges and corners of bays shall be particularly tested for adhesion. In addition if there are visible and measurable lifting of edges or cracks in the topping, the affected bays shall be wholly cut out and freshly laid.

##### **10.2.12 GRANOLITHIC SPRINKLED FINISHES**

Note: the general qualities and characteristics of the sprinkled finish are similar to those for granolithic concrete topping except that the wearing layer is thinner.

The concrete floor slabs are brought to the finished floor level and while still plastic ie. Within three hours of laying, they are sprinkled with a mixture of 1 part cement and 2 part granite or other hard aggregate graded 5 mm down, mixed dry and supplied at the rate of 7.5 kg/sq.m. this mixture shall be tamped in with a wood float and trowelled as necessary to a smooth fine finish. The surface shall be coated with a single application of 10% solution of silicate of soda except where the floor is to be covered with linoleum in which case silicate of soda is not to be applied.



### **10.3 CEMENT MORTAR/CEMENT CONCRETE FLOOR FINISHES**

#### **10.4 BASE CONCRETE**

Where concrete is specified for the ground floor it shall be cement concrete 1:3:5 (25mm) or as specified and not be less than 75 mm thick. For heavier loads this thickness shall be designed.

##### **10.4.1 TOPPING**

The topping shall be one of the following.

The floor finish of cement mortar 1:2, 12 mm thick shall be laid within 30 minutes of laying the concrete and finished rough with wood floats, or trowelled to a smooth finish as directed by the Officer – in – Charge. If the finish cannot be applied monolithically, the surface of the base concrete shall be prepared as per clause 11.2.3 and the finishing mortar bonded with a proprietary bonding agent applied to the base concrete to the instructions of the manufacturer. Panel sizes shall be limited to 15msq . if a coloured floor is specified, a setting coat 3 mm thick shall be laid over the surface layer; this coat shall consist of neat cement and sufficient quantity of colouring pigment of approved make missed dry until homogeneous. The surface shall be finished smooth with steel floats to the satisfaction of the officer –in – charge. Borders shall be formed and finished as shown in the drawings or as directed.

All colored cement finishes shall be polished with floor polish of approved colour before handing over the building.

Where the topping is specified to be cement concrete, the mix shall be 1:2:4 (10mm) This shall be of 25mm thickness or as specified.

The topping shall be finished by trowelling or floating shortly after the compactions of the concrete has been completed. Care shall be taken to avoid bringing an excess of laitance to the surface. If required, the finish shall be as for granolithic concrete. See clause 10.2.6

All other clauses of 10.2 shall apply to cement concrete, floor finishes.

### **10.5 CAST –IN – SITU TERRAZZO FLOOR FINISHES**

#### **DEFINITIONS**

Terrazzo – A cement based polished exposed aggregate floor or wall surface, whether pre-cast or laid – in – situ over an under layer. Please see (b) below;

Underlayer – the layer of the concrete in the terrazzo finish which lies immediately below the terrazzo topping.

##### **10.5.1 MATERIALS**

Cement – ordinary cement conforming to CS 107

White/coloured portland cement conforming to BS 12

Facing aggregates – the aggregates shall consist of good quality marble or other natural stone of similar characteristics such as Calcirtes, Dolomites, Serpentine, Calcitic, and Dolomitic marbles and granites etc. Serpentine, Calcitic and Dolomitic marbles and granites etc. they shall be of adequate harness, angular in shape but not elongated and flaky. The aggregates shall not contain clay, iron oxide, pyrites or other harmful foreign matter in such a form or in sufficient quantity to affect adversely the bond or strength, or cause surface failures. The facing aggregate may be of the required colour or may be a mix of aggregates of different colours in the required proportions.

Aggregate should preferably be graded and it is important to avoid a high fines or dust content. The approximate sizes of aggregates corresponding to commercial grades are given in table 10.1

Table 10.1

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**Sizes of Facing Aggregate Corresponding to Commercial Grades**


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<b>No</b>	<b>mm</b>
0	Less than 3
1	3 to 5
2	5 to 7
3	7 to 10
4	10 to 13
5	13 to 19
6	19 to 25
7	25 to 32
8	greater than 32

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(d) Aggregated (both fine and coarse) for the terrazzo under layer: These shall conform to BS 882. The maximum size of coarse aggregate shall not exceed 10mm.

(e) Pigments used shall normally comply with the requirements BS 1014.

(f) Dividing strips - the dividing strips may be of copper, brass, aluminium, plastic or similar material. Metallic dividing strips may have a protective coating of bitumen. The thickness of strip shall not be less than 1.5 mm and width not less than 25 mm. Portions of the bottom edges of the dividing strips may also be cut to a height not exceeding 12 mm and twisted so as to provide anchorage into the terrazzo finish. The spacing of such cut portion shall be not closer than 300 mm.

### 10.5.1 GENERAL REQUIREMENTS

10.5.2.1 The terrazzo finish normally consists of the terrazzo topping and a cement concrete under layer with a combined thickness of at least 40 mm. The thickness of terrazzo topping shall not be less than the following depending upon the grades of chips used.

Table 10.2

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Grade	Size of Chips		Minimum Thickness
No.	Retained on sieve Size mm	Passing Sieve Size mm	mm
0	-	3	5
1	3	5	5
2	5	7	5
3	7	10	8
4	10	13	8
5	13	19	8
6	19	25	10
7	25	32	10
8	32	-	10

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Note: it is not necessary that any one chip should be wholly within the top terrazzo layer.

The under layer shall be of cement concrete mix 1:2:4, and the maximum size aggregates used not exceed 10mm.

The mix for the terrazzo topping shall consist of cement with or without pigments, facing aggregates and water. A mix richer than one part of cement to two parts of facing aggregate by volume shall be provided.

The proportions of cement shall be exclusive of any pigments added to the cement.

#### **10.5.2.3 PREVENTION OF CRACKS IN IN-SITU TERRAZZO FLOOR**

While laying the floor, the joints in flooring shall always coincide with the expansion joints if any, in the structural slab. The floor finish shall be divided into panels not exceeding one square metre in area and separated by dividing strips.

The length of panels shall not exceed twice the width.

The water-cement ratio shall be kept as low as possible in order to reduce the drying shrinkage. Aggregates smaller than 3 mm shall not be used.

#### **10.5.3 MIXING OF MATERIALS**

Mixing of materials shall be done carefully and thoroughly in order to ensure uniform finish. If done manually the mixing shall preferably be done in a trough or tub. The complete quantities of cement and pigment required for any particular area shall be mixed and stored properly in order to avoid variation in colour or appearance.

Where different coloured chips are used they shall first be well mixed in the required proportions of the various colours and sizes. Coloured cement may be procured as ready mixed material or mixed at site; in the latter case the pigment and cement in the required proportions shall be mixed thoroughly and sieved before mixing with aggregate.

The coloured cement and the chips shall be mixed together dry. While mixing the aggregates, care shall be taken not to get the materials into a heap, as this would result in the larger chips failing to the edge of the heap and the cement working to the centre at the bottom.

After the materials have been thoroughly mixed in the dry state, water shall be added in small quantities in a fine spray while the materials are being mixed until proper consistency is obtained. The mixture shall be plastic but not so wet that it will flow a rough indication for the addition of the proper quantity of water in the mix that it shall be capable of being moulded by hand without any water flowing out.

Machines mixing may be used, but the common type of concrete mixer will not be as suitable as the mixer specially made for terrazzo work in which segregation is prevented by blades with a lifting as well as rotating movement.

The mix shall be used in the work within half an hour of the addition of water.

#### **10.5.4 SPREADING THE UNDERLAYER**

Dividing strips including the strips required for decorative design shall be fixed on the base to the exact surface level of the floor and panel sizes limited as recommended in clause 11.5.2.3. Anchorage arrangements for dividing strips shall be provided as specified. Where dividing strips are not used, screed strips properly levelled to the correct

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Before spreading the under layer, the base shall be cleaned of all dirt, laitance, or loose material and then well wetted with height to suit the thickness of the floor shall be fixed on the base Water without forming any water pool on the surface. It shall than be smeared with cement slurry just before the spreading of the under layer.

After application of the cement slurry, the under layer shall be spread and levelled with a screeding board. The slightly rough surface left by the screeding board will form a satisfactory key for the terrazzo.

#### **10.5.5 LAYING THE TERRAZZO TOPPING**

Terrazzo topping shall be laid while the under layer is still gree, but has hardened sufficiently, this is normally achieved 18 to 24 hours after the under layer has been laid. A cement slurry preferably of the same colour as the topping shall be brushed on the surface immediately before laying its commenced. If possible the entire work of laying the topping shall be completed at one stretch.

The terrazzo mix shall be placed on the screed bed and compacted thoroughly by tamping or rolling and trowelled smooth. The time interval allowed between each successive trowelling is important as only that much trowelling which is sufficient to give a level surface is needed immediately after laying. Further compacting shall be carried out at intervals, the amount depending upon the temperature and the rate of setting of the cement.

Excessive trowelling or rolling in early stages shall be avoided as this will tend to work the cement up to the surface and this will produce a finish liable to cracking and will also necessitate more grinding of the surface in order to expose the chips.

Boarders and decorative designs shall be laid before the main body of the flooring. They shall be laid and finished in the same manner as the flooring preferably using dividing strips. Where however, stencils or framework of wood or metal are used instead of dividing strips, they shall be removed before the topping mix commences to harden. The removal shall be effected as little disturbance to the materials as possible, and any ragged edges left after removal of all stencils or framework shall be rectified with a trowel, care being taken to consolidate the terrazzo to avoid damage to the edges of the design.

#### **10.5.6 CURING**

The surface shall be left dry for air-curing for a duration of 12 to 18 hours. It shall then be cured by ponding water over it for a period of not less than four days

#### **10.5.7 SURFACE GRINDING, CURING, AND FINISHING**

Polishing shall be done by machine. About 4 days after laying the top layer, the surface shall be watered and ground evenly with a machine fitted with special rapid cutting grit blocks (carborundum stone) or coarse grade (No 60) till the marble chips are evenly exposed and the floor is smooth. After the first grinding, the surface shall be thoroughly washe dto remove all ground mud and covered with a grout of cement and/or colouring matter in the same mix and proportion as the topping in order to fill any pin holes that appear. The surface shall be allowed to cure for 5 to 7 days and then ground with a machine fitted with fine grit blocks. (No 120) The surface then shall be cleaned and repaired as before and allowed to cure again for 3 to 5 days. Finally the third grinding shall be done with a machine fitted with fine grade grit blocks. (No 320) to get an even and smooth surface without pin holes. The finished surface shall show the marble chips evenly exposed. Where use of a machine for polishing is not feasible or possible rubbing and polishing shall be done by hand if approved by the Office – in – Charge. This shall be done in the same manner as specified for machine polishing except that carborundum stone of coarse grade (NO 60) shall be used for the

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rubbing stone of medium grade (No 80) for the second rubbing and stone fine grade (No 120) for the final rubbing and polishing.

After the final polish either by machine or by hand, oxalic acid shall be dusted over the surface at 33 gm per square metre; the surface shall then be sprinkled with water and rubbed hard with a pad of woolen rags. On the following day, the floor shall be wiped with a moist rag and dried with soft cloth and finished clean.

In case a wax-polished surface is desired for floors the wax polish shall be sparingly applied with soft linen on the clean and dry surface. The polishing machine fitted with pads shall then be run over it.

#### **10.5.8 PRECAUTIONS**

Flooring in lavatories and bathrooms shall be laid after the fixing of the water closet, squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned.

After the final polishing, the floor shall be protected against misuse or damage by subsequent operations. Due precautions shall be taken in the disposal of the washed off ground material and the Oxalic Acid used for cleaning. It is important to ensure that the ground material does not enter sewer pipes and the Oxalic Acid is not washed out into the surrounding area of the building as it will have a harmful effect on vegetation.

### **10.6 CAST –IN- TERRAZZO SKIRTINGS AND WALL LININGS**

#### **10.6.1 UNDERLAYER**

For a terrazzo finish on vertical surfaces like skirting and wall linings, the under layer shall consist of stiff cement mortar 1:3, finished rough so as to provide an adequate key for the topping.

#### **10.6.2 THICKNESS**

The combined thickness of the under layer and terrazzo topping shall be not less than 20 mm

The minimum thickness of terrazzo topping shall not be less than 6 mm

#### **10.6.3 LAYING, CURING AND GRINDING**

These shall be similar to those described for in- situ terrazzo flooring except that the grinding may have to be done manually.

## 10.7 TERRAZZO TILE FLOORING

### 10.7.1 MATERIALS

#### 10.7.1.1 TERRAZZO TILES

The size of tiles are given below in table 10.3

TABLE 10.3

Length of each side Work size in mm	Minimum thickness in mm
150 ± 1	15
200 ± 1	20
300 ± 1	30

The tiles shall be manufactured under a hydraulic pressure of not less than 14N/mm sq (approx 200 psi)

The proportion of cement to aggregate in the base layer of tiles shall neither be leaner than 1:3 1/2 nor richer than 1:3 by weight. The proportion of cement to marble chips in the facing layer shall not be richer than 1:1 1/2. The proportion of pigment to be used shall not exceed 10% of the weight of the cement. The facing layer shall be such as to provide a minimum wearing thickness of 6 mm after grinding.

The tiles shall be supplied.

- (a) ground and grouted
- or
- (b) ground, grouted and reground to a fine grit finish for floors, skirting and walls.
- or
- (c) ground, grouted and high polish finished for skirting and walling.

The tiles shall be free from defects of flows. The chips shall be evenly distributed. The face shall be free from projections, depressions, flakes and crazes. The edges of tiles shall be perpendicular to the surface. The plans of the upper and lower surfaces of the tile shall be parallel and adjacent vertical edges of square tiles shall be at right angles to each other.

All edges shall be sharp and true.

The tiles delivered shall be practically uniform in colour except as otherwise ordered. The age of tiles at the delivery shall not be less than 7 days after pressing. When tested by the method described in Appendix A of SLS 419, water absorption of tiles shall be as below:

- (a) water absorbed by tile face: No single result shall be more than 4 kg/msq
- (b) Total absorption: No single result shall be more than 8%

Transverse strength of tiles when tested in accordance with Appendix B of SLS 419 shall not be less than 3 MPa

The tiles shall be stored in such a way as not to cause damage or discolouration during storage.

#### **10.7.1.2 CHEQUERED TILES**

These shall be of the same size as plain tiles; the dimension of chequers and thickness shall conform to the requirements of clause 11.1.1.3

#### **10.7.1.3 TILES FOR SKIRTING**

Skirting tiles shall be 150 mm to 600 mm long, 12 mm thick and 100 or 150 mm high or as specified. Radius of covers shall be 25 mm and base width 40 mm or as specified.

#### **10.7.1.4 TILES FOR RISES OF STEPS**

These shall be at least 12 mm thick and of sizes specified or directed.

#### **10.7.1.5 TILES FOR TREADS OF STEPS**

These shall be chequered pattern and shall conform to clause 11.1.1.3 chequered cement concrete tiles.

### **10.7.2 LAYING**

#### **10.7.2.1 LAYING OF FLOOR TILES PLAIN OR CHEQUERED**

The sub-grade concrete or the reinforced concrete slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be in cement mortar. 1:3 with only the minimum volume of water required to achieve workability. The average thickness of bedding mortar shall be 20 mm or as specified.

Cement mortar bedding shall be spread, tamped and screed to proper levels. Over this bedding neat cement slurry of honey like consistency shall be spread at the rate 4.4kg of cement per sq m, over such an area as would accommodate about twenty tiles. The tiles shall be washed clean and fixed over the bedding one after another, each tile being gently tapped with a wooden mallet till it is properly bedded, and in line with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1.5 mm and in straight lines or to suit the required pattern. The surface of the flooring during laying shall be frequently checked with a straight edge at least 2 metre long, so as to obtain a true surface with the required slope.

Where full size tiles cannot be fixed, these shall be cut (sawn) to the required size and the edges rubbed smooth to ensure a straight and true joint.

Tiles which are fixed in the floor adjoining the wall shall butt in at least 12 mm under the plaster, skirting, or wall tiling with the junction finished neatly and without waviness.

As the tiles are being laid, surplus cement grout that may come out of the joint shall be wiped off with a damp cloth.

#### **10.7.2.2 LAYING OF SKIRTING AND RISES OF STEPS AND WALLING**

##### **PREPARATION OF SURFACE**

This shall conform to 13.1.2. in the case of brickwork/blockwork and stone masonry and 13.5.2 in the case of formed concrete surface.

##### **LAYING**

A 12 mm thick plaster of cement mortar 1:3 or as specified, shall be applied and allowed to harden. The plaster shall be roughened while green, with wire brushes, or by scratching diagonal lines 2 mm deep at approximately 75 mm centers both ways. The back of tiles shall

be buttered with a coat of grey cement slurry, the edges with grey or white cement slurry with, if so specified pigment to match the shade of tiles, and set in the bedding mortar. These shall be tamped and corrected to proper planes and lines the tiles shall be set in the required pattern and butt joint. The joints shall be as fine as possible. The top of the skirting shall be truly horizontal and joints truly vertical except where otherwise indicated.

The rises of steps or skirting shall rest on the top of the tread or flooring. Where full size tiles cannot be fixed, the tiles shall be cut (sewn) to the required size and their edges rubbed and finished smooth.

### 10.7.3

#### **CURING, POLISHING AND FINISHING**

The day after the tiles are laid all joints shall be cleaned of cement mixed if specified with pigment to match the shade of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

The floor shall then be kept wet for a minimum period of 7 days.

The surface shall thereafter be ground evenly with a machine fitted with coarse grade grit blocks (No 60). Water shall be used profusely during grinding. After grinding, the surface shall be thoroughly washed to remove all ground mud and cleaned and mopped. In order to fill any pin holes that appear, it shall then be covered with a thin coat of grey or white cement, mixed if so specified with pigment to match the colour of the topping of the wearing surface. The surface shall be again cured. The second grinding shall then be carried out with a machine fitted with fine grade grit blocks (No 120)

The final grinding with a machine fitted with a finest grade grit blocks (No 320) shall be carried out the day after the second grinding.

For smaller areas or where circumstances so require, hand polishing may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:-

1 <sup>st</sup> grinding	-	coarse grade stone (No. 60)
2 <sup>nd</sup> grinding	-	medium grade (No. 80)
3 <sup>rd</sup> grinding	-	fine grade (No 120)

in all other respects, the process shall be similar to machine polishing. The preceding description is for unground tiles. If ground in the factory, only final grinding shall be done at the site. Chequered tiles shall be polished by hand or as directed. Care shall be taken to polish the chequer grooves and noses of stair treads to match adjacent work.

After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre. The surface shall be sprinkled with water and rubbed hard with a pad of woolen rags. The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished .

The finished floor shall not sound hollow when tamped with a wooden mallet.



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## **10.8 GLAZED TILE FLOORING AND SKIRTING**

### **10.8.1 MATERIALS**

#### **10.8.1.1 WHITE GLAZED TILES**

The tiles shall be of approved make and shall generally conform to BS 1281. they shall be flat, and true to shape and free from cracks, crazing spots, chipped edges and corners. The glazing shall be of uniform shade.

The tiles shall be normal sizes such as 150 x 150 mm, 100 x 100mm or as specified. The thickness of the tiles shall be 5 mm or 6 mm as specified. The tolerance on facial dimension shall be  $\pm 1.0$  mm and on thickness  $\pm 0.5$  mm.

The top surface of the tiles shall be glazed. The glaze shall be either glossy or matt as specified. The underside of the tiles shall be completely free from the glaze.

The edges of the tiles shall be preferably free from glaze; however, any glaze if unavoidable, shall be permissible on any edge of the tile.

#### **10.8.1.2 COLOURED GLAZED TILES**

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

#### **10.8.1.3 DECORATIVE TILES**

The type and size of the decorative tiles shall be as follows:

- (i) Decorated on white black ground  
152 x 152 x 6 mm or 108 x 108 x 6 mm
- (ii) Decorated and having coloured black ground:  
152 x 152 x 6 mm or 108 x 108 x 6mm
- (iii) Fantasy glazed tiles: 108 x 108 x 6mm

#### **10.8.1.4 GLAZED TILE SPECIALS**

The specials consists of coves, internal and external angles, beads, cornices, and their corner places.

Coves, beads and angles shall be of thickness not less than the tiles with which they are used. The size of coves, beads, angles and cornices shall be as specified. The stipulated size of coves, beads and angles refer to the greater width of the special measured in a straight line. The stipulated size of cornices is their height. The lengths of specials shall be 150 mm 100 mm or other standard size conforming to the size of tiles used.

### **10.8.2 PREPARATION OF SURFACE AND LAYING**

The sub-grade concrete or the reinforced concrete slab on which the tiles are to be bedded shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:3 or as specified. The average thickness of the bedding shall be 10mm.

Mortar shall be spread, tamped, corrected to proper levels, float finish with a wooden float and allowed to stiffen sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the tiler to place wooden plank across and squat on it.

Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over such an area as would accommodate about twenty tiles. The tiles shall be soaked in water, washed clean and shall be fixed in this

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grout, each tile being gently tapped with a wooden mallet till it is properly bedded and level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long so as to obtain a true surface with the required slope.

Where full size tiles cannot be fixed these shall be cut (sewn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed on the floor adjoining the wall shall butt at least 10 mm under the wall finish.

As tiles are being laid, surplus cement grout shall be wiped off with a damp cloth.

Skirting work shall conform to the relevant requirements of 11.7.2.2

### **10.8.3 POINTING AND FINISHING**

The joints shall be clean of grey cement grout to a depth of 2 to 3 mm using a brush or trowel, and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of the tiles. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

### **10.9 PARQUET FLOORING**

Parquet flooring shall consist, unless otherwise specified or specified timber blocks 150 x 75 x 25mm thick. The top surface of the blocks shall be planned smooth and the edges shall be square and plane for the top 12mm and 'V' grooved along the bottom 12 mm.

In the case of the ground floors, the parquet flooring shall be laid on 75 mm thick cement concrete 1:3:5 (25 mm) rendered with an additional 25 mm thick cement and sand rendering 1:2 mixed with suitable waterproof additive and finished with a medium rough surface. The concrete and rendering shall be cured with water for at least 14 days and shall be allowed to dry up and harden for at least another 7 days before the flooring is laid.

The prepared surface shall be treated with a mastic compound obtained by boiling together pitch and coral tar in the proportion of one cwt of pitch to 7 1/2 gallons of coal tar or a suitable asphaltic bitumen.

The bottom surface and the 'V' grooves of the parquet blocks shall be treated with the same compound, and the blocks set on the concrete floor to an approved pattern with tight fitting joints. The surface shall be perfectly smooth and level and shall be protected with saw dust or other approved cove until completion when the whole surface shall be again cleaned, sand prepared and wax polished.

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## **10.10 SKIRTING FOR CEMENT RENDERED FLOORS**

### **10.10.1 SKIRTING WORK SHALL BE IN CEMENT SAND MORTAR 1:2**

**10.10.2** Cement mortar skirting shall be provided at the floor of the wall immediately above the floor finish. Unless otherwise specified the skirting shall be 100 x 15 mm thick with a sunk V groove 12 x 12 mm provided at the junction of the skirting and the plaster above. The junction of the floor finish and skirting shall be rounded with a radius of 25 mm or in the manner directed by the Officer – in- Charge. The finishing of the skirting shall match the floor finish. Skirting finished with coloured cement shall be polished with floor polish of appropriate colour before handing over the building.

## **11.0 ROOF COVERING AND ROOF DRAINAGE**

### **GENERAL**

The following specifications stipulate the fixing details of roof coverings in buildings subject to moderate winds. For buildings subject to high winds, fixing and bracing details shall be as specified in the drawings and the continuity and anchorage of the fixing through the structure to the ground shall be ensured for water proofing of concrete flat/sloped roofs see relevant clause of Chapter 15.

## **11.1 GALVANISED CORRUGATED STEEL SHEET ROOFING**

### **11.1.1 MATERIALS**

#### **11.1.1.1 GALVANISED CORRUGATED STEEL SHEETS**

Galvanised corrugated steel sheets shall comply with the requirements of BS 2989. The corrugations shall normally have a pitch of 75 mm and a depth of 18 mm. The zinc coating shall be bright, clean and even, and shall have been provided at the rate of 305 g/m<sup>2</sup>. The coating adherence shall be such that no flaking of the zinc coating shall have taken place after corrugating the sheets or curving after corrugating.

Unless otherwise specified, the sheets shall be 0.56 thick (24 BWG), with 8, 10 or 12 corrugations per sheet. Lengths shall be 1.80, 2.10m, 2.40, 2.70m or 3.0 m.

Other Profiled Sheets

Other troughed units or profiled sheets shall be of approved manufacture.

#### **11.1.1.2 FIXING ACCESSORIES**

Fixing accessories like hook bolts, drive screws, bolts, nuts, rivets and washer shall comply with the requirements of BS 1494: Part I – See Clause 12.2.1.2.

#### **11.1.1.3 ACCESSORIES**

Ridges and hips shall be of plain galvanised steel sheets 600 mm wide 0.6 mm (84 gauge) or 0.8 (22 gauge) thick as specified.

#### **11.1.1.4 STORAGE, TRANSPORT AND HANDLING**

The sheets shall be stored at the site over timber battens in a dry and clean shed.

Sheets and fittings shall be carefully handled so that they are not damaged during handling or transport. Where slings or grabs are used they shall be suitably arranged to avoid damage to sheet edges.

### **11.1.2 WORKMANSHIP**

#### **11.1.2.1 SLOPE OF ROOF, LAPS AND PURLIN SPACINGS**

Roof shall not be pitched at a slope flatter than 10° (i.e. 1 vertical to 5.67 horizontal)

End laps – the laps shall be a minimum of 150mm for slopes of 10° or more, with a minimum of 100 mm for vertical falls.

Side laps – side laps shall be formed on the side of the sheet away from the prevailing wind.

Side laps shall be one and a half or two corrugations, depending upon the conditions of exposure.

## PURLIN SPACINGS

Unless otherwise specified in the drawings purline shall not be spaced at more than the following distances:-

<u>Thickness of Sheets</u>	<u>Maximum Spacing of sheets</u>
1.6 mm	2.8mm
1.2 mm	2.4 mm
1.0 mm	2.0 mm
0.8 mm	1.8 mm
0.6 mm	1.6 mm

The overhang at the eaves shall generally not exceed  $\frac{1}{4}$  of the spacing of purline and the overhang at gable ends shall not exceed 150 mm beyond the purlins.

### 11.1.2.2 LAYING

Before laying it shall be checked that the roof framing is true to lines and levels. The final protective coats of paint to the roof framing shall be completed before fixing of sheets is commenced.

The sheets shall be laid on the purlins to a true plane with the lines of corrugations parallel or normal to the sides of the area to be covered, unless otherwise required in a specifically shaped roof.

The laps in the sheets shall be painted with a coat of approved steel primer and two coats of approved steel paint before laying.

### 11.1.2.3

The holes for the fixing bolts shall be through the crown of the corrugation and shall be either punched or drilled. They shall be 1.5 mm larger in diameter than the bolts or fixing screws used.

Holes for fixing the sheets shall be in the exact positions required to suit the purlins.

No hole, for a fixing, the sheets shall be cut to clean, true lines without any distortion.

Where necessary, the sheets shall be cut to clean, true lines without any distortion.

Openings in sheets for outlets, vent pipes, flues etc, shall be cut to the minimum size necessary and edges of openings reinforced as specified or as directed. All burrs, lubricant, dust, drilling swarf and any other foreign matter shall be removed before finally fixing the sheets in position.

### 11.1.2.4 FIXING

The sheets shall be fixed commencing from the leeward end so that the side laps will have the better protection from rain driven by the prevailing wind. The eaves course shall be laid first with the top edges extending at least 39 mm beyond the back of steel angle purlins or 75 mm beyond the centre line of timber purlins.

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At side laps (where the edge corrugations of the sheets are to opposite hand) the underlapping sides shall finish with an upturned edge and the over lapping sides with a downward edge.

Where sheets abut a wall the sheets shall finish with an upturned edge.

Sheets shall be fixed with hook bolts and drive screws of 8 mm nominal diameter spaced at intervals of not more than 375 mm. Sheets shall be secured to every purlin by at least two bolts.

Fixing to tubular purlins shall be "U" bolts at lap joints and eaves, and "J" bolts at intermediate purlins.

Each hook bolt or screw shall have a metal washer shaped to the profile of the sheet. A sealing washer of bituminous felt shall be provided between the metal washer and the sheet so that the bolt hole is sealed when the nut is tightened.

The sheets shall be adequately supported when holes are punched in position. Sheets with wrongly drilled holes shall be rejected.

#### **11.1.2.5      FIXING OF RIDGES AND HIPS**

The ridges and hips of plain galvanised steel sheets shall lap at least 200 mm on each side over the corrugated galvanised steel sheets. The end laps of the ridges and hips, as well as between ridges and hips shall also be not less than 200 mm.

Ridges and hips shall be fixed to the roof members below, such as the purlins, hip and valley rafters, with the same 8 mm diameter hook bolts or drive screws as fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on each side. If this is not possible extra fixings shall be provided.

The end laps of ridges and hips shall be joined together by galvanised steel seam bolts 25 x 6 mm size, each provided with one bitumen and one galvanised steel washer. There shall be at least two such bolts in each end lap. The ridges and hips shall be straight from end to end and plane and parallel to the general plane of the roof.

#### **11.1.2.6      FINISH**

On completion, the fastenings shall be checked and adjusted as necessary to ensure that they are watertight and the sheeting is secure but not buckled or distorted. The roof, when completed, shall be true to lines and slopes and shall be leakproof.

### **11.2            RIGID PVC PROFILED SHEETS AND GLASS FIBRE REINFORCED PLASTIC (GRP) PROFILED SHEETS.**

#### **11.2.1        MATERIALS**

Rigid PVC profiled sheets whether reinforced or otherwise shall be of approved manufacture conforming to BS 4203. The profile and colour shall be as specified.

GRP profiled sheets shall be of approved manufacturer conforming to BS 4154. The profile, finish and light diffusion class shall be as specified.

Fastening and Accessories shall be of approved manufacture.

### **11.2.2 WORKMANSHIP**

Workmanship shall conform to specifications of the manufacturer. Selection and spacing of fixing shall be as given in Appendix B of BS 5427.

### **11.3 VALLEY GUTTERS OF PLAIN GALVANISED STEEL SHEETS**

Valley shall be of plain galvanised steel sheet 900 mm overall width and 1.6 mm (16 gauge) thick or other thickness as specified and bent to shape.

They shall lap with the corrugated galvanised steel sheets for not less than 250 mm width on each side the end laps of valleys shall be not less than 230 mm.

Valley sheets shall be laid over 20 mm thick wooden boarding laid to shape. The valley sheet shall be fixed to the roof members below, such as purlin and valley rafters, with the same 8 mm diameter hook bolts or drive screws as fix the sheets to those roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces, on each side. If this is not possible extra filling shall be provided.

The edges of valleys shall be straight from end to end. The surfaces shall be true and without bulges and depressions. The valley sheets shall be turned up. At the top end and down to the gutter head at the lower end to suitable profile as directed by the officer-in-charge. The edges shall be dressed over a reeper.

### **11.4 FLASHING**

#### **a) GALVANISED STEEL SHEET**

The juncture of all sloping roofs and walls are to be flashed with 12 mm (18 gauge) thick galvanised steel sheet flashing unless otherwise specified. One edge shall be dressed over the roof to a width of not less than 300 mm to the other edge turned up to a height of not less than 150 mm, tucked into a chase cut in the wall and pointed in cement mortar 1:2.

#### **b) LEAD SHEET**

Lead flashing, where specified, shall be of milled lead sheets at least 14 Gauge (2 mm) thick weighing 24.4 kg. per Sq. m. One edge shall be dressed over the roof to a width of not less than 300 mm and the other edge turned up to a height of not less than 150 mm and nailed to wooden plugs with copper nails. The upper edge shall be vocered by an apron of the same material overlapping the flashing by 100 mm. The top edge of the apron shall be tucked into a chase cut in the wall for a depth of at least 50 mm, fixing with lead wedges, and the joint finally filled with cement mortar 1:2.

### **11.5 GUTTERS**

Gutters shall be of the specified material and design. Details of fixing shall conform to the relevant clauses below or as otherwise specified. The gutters shall be true to lines and slopes and shall be leak proof.

#### **11.5.1 GUTTERS OF PLAIN GALVANISED STEEL SHEETS**

##### **11.5.1.1 EAVES GUTTERS**

Eaves gutters shall be formed of 0.8 mm thick (22 gauge) sheets to the shape and section specified. Longitudinal edges shall be turned back to the extent of 12 mm and beaten to form a rounded edge.

At joints sheets shall be hooked into each other and beaten flush to avoid leakage; alternatively the joints shall be soldered.

The inside surfaces of eaves gutters shall be treated with two coats of hot tar and the outside with galvanised iron prime and two additional coats of anti-corrosive paint.

The gutters shall be supported on and fixed to mild steel brackets 20 mm x 3 spaced at centres not exceeding 1.2m. Details of gutter fixing to rafters or purlins shall be as shown in fig 12/1 unless otherwise specified or directed by the officer-in-charge.

The minimum slope of the gutter shall be 1 in 120. For connection to down pipes, a proper drop and or funnel shaped connecting piece shall be made out of galvanised steel sheet of the same thickness as the gutter and riveted to the gutter. Unless otherwise specified, this shall be either 12" x 12" at top when square or 12" diameter when circular and the lower end shall be tapered suit the size and shape of the down pipe, and provided with an outlet and spigot for joining to the down pipe.

The outlet shall have a strong grating of galvanised wire mesh fixed thereto.

#### **11.5.1.2 BOX GUTTERS**

Unless otherwise specified box gutters shall be of 1.2 mm (18 gauge) thick galvanised steel. The sections shall be well riveted together and bedded in red lead with a pad of Hessian Canvas soaked in red lead between the metal surfaces to ensure water tight joints and laid to a fall of at least 1 in 120.

Gutters having free sides (i.e. not adjacent to brickwork or timber framing) shall have 40 mm x 7 flat bar stiffeners at 1.5 m intervals across the top of the gutter and bolted to sides. The inside and outside surfaces shall have a thick coating of bitumen and sand.

The sides of box gutters next to walls shall have 0.8 mm (22 gauge) thick galvanised steel flashing; one edge shall be dressed over the edge of the gutter and secured with clips, and the other edge tucked and wedged into the brick joint and pointed in cement sand 1:2 Stopped ends, nozzles, short lengths shall be provided as required. For gutter heads see Clause 12.7.1.1

#### **11.5.2 ASBESTOS CEMENT GUTTERS**

These shall be half round or ornamental as specified. Lapping shall be in the direction of flow of water. Joints shall be fixed tight with either a mastic jointing compound or special synthetic rubber joint pads supplied by the makers of the gutter and finally caulked with 6 mm asbestos cord.

The gutters shall be fixed to mild steel brackets (fig 12/1) screwed to fascia board, or to the ends of rafters. The centres of supports shall not exceed 900 mm from the socket end of each length. All specials shall be provided as required.

#### **11.5.3 UPVC GUTTERS**

Half round eaves gutters shall conform to BS 4576.

Rectangular gutters of approved local manufacture shall be used where specified.

The internal and external surfaces of the gutters pipes and fittings shall be clean, smooth and reasonably free from grooving and other defects that would impair their performance. The end of the gutters, pipes and fittings shall be clearly cut and square with the axis of the component. The gutters and pipes shall be straight.



The fixing used shall have the following minimum requirements:-

- a) The wall thickness of the fixing manufactured from PVC shall not be less than that of the gutter with which they are used.
- b) When fixed, the gutter and bracket shall provide a secure component.
- c) Every length of gutter shall be supported at intervals of not greater than 500 mm.

## **11.6 RAIN WATER PIPES**

### **GENERAL**

Rain water pipes shall be galvanised steel sheets, asbestos cement pipes, or unplasticised P.V.C. pipes or cast iron as specified.

### **11.6.1 GALVANISED STEEL RAIN WATER PIPES**

Unless otherwise specified rain water pipes shall be formed of galvanised steel sheets 0.8 mm thick (22 gauge) they shall be fixed 40 mm clear from the face of the wall with mild steel straps 20 x 1.5 mm, screwed to wooden blocks of durable timber embedded in the wall at a spacing of not more than 1.8 m. The outer surfaces of the pipe and the mild steel straps shall be made for all bends, offsets, swan necks, shoes, short lengths etc.

### **11.6.2 ABESTOS CEMENT RAINWATER DOWN PIPES**

These shall be the best quality, well compressed complying with BS 569. The down pipes shall be fixed with mild steel straps as per Clause 12.8.2

Joints in down pipes shall be treated by inserting a ring of tarred hemp and caulking with cement mortar 1:2.

The following fittings shall be provided as required.

Stop-ends with socket or spigot

Loose sockets

Stop-ends outlets (drop ends) with sockets

Nozzle outlets (for use in the centre of a run)

Angles 20°, 60° and 45°.

### **11.6.3 CAST, IRON RAIN WATER DOWN PIPES**

External cast iron rain water down pipes shall be of approved manufacture, neatly finished, free from sand marks and complying with BS 460. The pipes shall be 1.80 metre in length including socket ends.

Internal cast iron rain water pipes and fittings shall conform to BS 416. The pipes shall be factory painted (with a tar base composition) both inside and outside.

Pipes shall be fixed 10 mm clear from the face of the wall by means of straps and screwed to tapered wooden blocks embedded in the wall to a depth of 100 mm.

Internal rain water pipes shall be jointed with yarn and molten lead or a caulking compound well caulked.

External rain water pipes shall be unjointed; where specified they shall be jointed with red and white lead putty or approved mastic.

#### **11.6.4 U.P.V.C. (UNPLASTICISED POLYVINYL CHLORID) PIPES**

11.6.4.1 U.P.V.C. Circular pipes shall conform to BS 4576. For pipes of diameter large than 65 mm BS 4514 may be referred to.

The dimensions of pipes shall be as follows:

<u>Nominal Diameter</u>	<u>Minimum wall thickness</u>
63 mm	1.8 mm
82 mm	3.2 mm
110 mm	3.2 mm
160 mm	3.2 mm

Standard lengths of pipes shall be from 1.8 m to 3.6 m. Specials like bend, Shoes off set bend, branch, half rounds, stop ends etc. shall be supplied as required along with the pipes.

##### **11.6.4.2 HANDLING AND STORAGE**

Pipes shall be stored under shade and on level ground. Pipes shall not be rested on their socket. They shall not be stacked in large piles.

##### **11.6.4.3 JOINTING**

Only pipes free from damage shall be used. Dust, oil, water, grease etc. shall be wiped off the surface with a dry cloth. The grease shall be thoroughly removed with a suitable solvent such as Methylene Chloride. The mating surfaces shall be glass papered to the full depth of the socket and cleaned.

Solvent cement, not more than 12 months old, shall be applied on to the pipe and socket. The joint shall be made immediately, excess solvent wiped out and left undisturbed for one hour.

##### **11.6.4.4 FIXING**

The fixing used shall comply with the following minimum requirements:

- i. The wall thickness of fixings manufactured from P.V.C. shall in no case be less than that of the pipe with which they are to be used.
- ii. In the case of eared fixings the centre to centre dimension of the fixing holes shall be such as to avoid damage to the pipe when installing the system with the pipe in position.
- iii. When assembled, the pipe and fixing shall form a sturdy unit.
- iv. Every length of pipe shall be independently supported. Intermediate supports shall be provided for long lengths of pipe where necessary.
- v. Any metal fixings shall be suitably protected against corrosion.
- vi. Screws for use in brick work, concrete or masonry shall be not less than 50 mm and of minimum size No. 10

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## **12.0 PLASTERING**

### **12.1 LIME PLASTERS – 15 MM THICK**

The plaster shall not exceed 15 mm total thickness. This shall consist of a single coat of lime mortar including where necessary the setting coat of pure white lime putty.

#### **12.1.1 MATERIALS**

Lime mortar 1:2 or other specified proportion conforming to the requirements of Clause 3.1.

#### **12.1.2 SURFACE PREPARATION**

New brickwork or stone masonry shall have been finished with recessed joints to receive plastering see clauses 6.2.7 and 7.2.3 respectively. In the case of stone masonry, the bushings on the wall to be plastered, shall be removed to within 12 mm projection.

Where so specified for dense and smooth surfaces a suitable bonding treatment shall be applied to manufacturers instructions before plastering.

All soft joints in old stone masonry or brick work shall be ranked out to a depth of not less than 12 mm.

The walls shall be brushed clean of all dust, thoroughly wetted and surface dried before plaster is applied.

#### **12.1.3 APPLICATION**

Plastering of walls shall commence after completion of ceiling plastering if any. The plastering shall be started from the top and worked down towards the floor. All put-log-holes (i.e. holes left for scaffolding) shall be properly filled in advance of the plastering.

To ensure an even thickness and a true surface, gauges of plaster 15 mm x 15 mm, or broken clay tiles set in mortar shall be first established on the entire surface at about 2 metre intervals both vertically and horizontally.

The thickness of the plaster specified excludes the key i.e. the grooves or open joints in the brick work.

The minimum thickness of the plaster over any portion of the surface shall not vary from the specified thickness by more than 3 mm.

Mortar shall be applied between the gauges to slightly more than the required thickness i.e. slightly proud of the gauges. The plaster shall be well pressed into the joints, levelled and brought to a true surface by working on a wooden straight edge reaching across gauges, with small upward and sideways movement. Finally the surface shall be finished true with a wood float or trowel according to the type of finish required.

If a sandy granular texture is needed, the surface shall be wood floated. If a smooth finish is needed, trowelling shall be done to the extent required; during this process the setting coat of pure white lime putty shall be applied on the surface to facilitate finishing.

All moulded work, apart from the cover shall be formed and run in lime cement mortar 1:1:15 all ornaments, mitres etc. neatly formed. These shall be finished with lime putty as described above.

All arrises shall be plastered in lime cement mortar 1:1:15 and finished with lime putty for wedges of not less than 25 mm along each face of the arris.

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All necessary dubbing behind, rounding of corners at the junctions of the walls plastering of cornices etc. shall be done.

In suspending work at the end of the day, the plaster shall be left cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scraped, cleaned and wetted with lime putty before plaster is applied to the adjacent areas, to enable the two to be properly jointed together. Plastering work shall be closed at the end of the day on the body of the wall not nearer than 150 mm to any corners or arrises. It shall not be closed on the body of features such as plaster band and cornices, nor at corners or arrises.

Horizontal joints in plaster work shall not be formed on parapet tops and copings, as these invariably lead to leakages.

No portion of the surface shall be left out initially to be patched up later on.

Any cracks which appear on the surface and all portions which sound hollow when tapped, or are found to be soft or otherwise defective shall be cut out in rectangular shape and redone as directed by the officer-in-charge.

#### **12.1.4 FINISH**

The plaster shall be finished to a true and plumb surface and to the degree of smoothness required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5m long and with plumb bobs. The gap between the straight edge and any point on the plastered surface shall not exceed 3 mm. All horizontal lines and surface shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

#### **12.1.5 CURING**

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of seven days. During this period it shall be suitably protected for all damages, at the contractor's expense by such means as the officer-in-charge may approve.

### **12.2 LIME CEMENT PLASTER 15 mm THICK**

The plaster shall not exceed 15 mm in total thickness it shall consist of a single coat of lime cement mortar including where necessary the setting coat of pure white lime putty.

#### **12.2.1 MATERIAL**

Lime cement mortar 1:1: 15 or other specified proportions conforming to the requirements of clause 3.3

#### **12.2.2 SURFACE PREPARATION AND APPLICATION**

Preparation of surface of the masonry/brickwork, and the application and curing shall be as specified in clause 13.1

#### **12.2.3 SURFACE FINISH**

Unless otherwise specified all surfaces of lime cement plaster for external rendering shall be wood floated; internal plastering shall be trowelled and finished with a setting coat of lime putty.

### **12.3 15mm THICK CEMENT PLASTER ON MASONRY/BRICK WORK**

The plaster shall not exceed 15 mm total thickness comprising a single coat of cement mortar and the setting coat of neat cement slurry.

#### **12.3.1 MATERIALS**

The cement mortar 1:3 or other specified proportion conforming to the requirements of clause 3:2

### **12.3.2 SURFACE PREPARATION AND APPLICATION**

The surface preparation, application and curing shall be similar to the procedure specified in clause 13.1 taking account of the following details:

The setting coat of neat cement slurry shall be applied within an hour of the completion of plastering.

It shall be trowelled smooth without showing signs of trowel marks or waviness or folds. Where a smooth finish is not specified, the surface shall be finished off with a rough wood float to the texture approved by the officer-in-charge.

### **12.4 18mm THICK COLOURED CEMENT PLASTER – 2 COAT WORK**

This shall consist of 2 coats. The base coat shall be cement mortar 12 mm thick with a surface coat of coloured cement mortar 6 mm thick.

#### **12.4.1 MATERIALS**

Cement mortar 1:3 or other specified proportion conforming to the requirements of Clause 3:2.

An approved water proofing additive shall be used where specified.

#### **12.4.2 SURFACE PREPARATION AND APPLICATION**

Surface preparation, application and curing shall be similar to the procedure in clause 13.1 taking account of the following details:

The base coat of cement mortar shall where specified include 3% by weight of an approved water proof additive. The base coat shall be left roughened with a wire brush to provide a key for the surface coat. The surface coat shall consist of a mortar of coloured cement and sand mix as specified applied to thickness of 6 mm. It shall be applied not earlier than 24 hours of applying the base coat. It shall finished with a rough texture to accord with the approved sample are or as directed by the officer-in-charge.

### **12.5 CEMENT PLASTER OF CONCRETE SURFACES**

Cement plaster for concrete surfaces shall be of cement mortar of maximum thickness 6 mm in the case of single coat work and of maximum thickness 10 mm in the case of 2 coat work.

The thickness of the plaster on the soffit of suspended floors shall be the minimum possible.

#### **12.5.1 MATERIALS**

Cement mortar 1:3 or other specified proportion conforming to the requirements of clause 3:2

#### **12.5.2 SURFACE PREPARATION**

Projecting burrs of formed surfaces shall be removed and the surface scrubbed with wire branches. The surface shall than be prepared as follows:

- i. A first coat of spatter dash shall be applied over smooth clean concrete surface if so directed by the officer-in-charge. The dashing shall consist of 1 part of cement and 2 parts of clean fairly coarse and mixed to a thick slurry and kept well stirred. It shall be applied using a strong whipping motion normal to the face of wall. On setting and hardening the spatter dash shall give a good key for the subsequent coat to be applied.

- ii. Where directed by the officer-in-charge the surface shall be hacked with a pointed tool at spacings of not more than 50 mm the hacks being not less than 3 mm deep. The surface shall then be cleaned of all mould oil, grease etc, by scrubbing with water containing detergent and washing off with plenty of clean water. The surface shall be allowed to dry before application of plaster.

### **12.5.3 APPLICATION**

#### **(a) Soft Plaster**

Floor rendering and finishes of a suspended floor shall have been completed before commencing plaster its soffit. In the case of flat roofs, the weather proofing and other work shall have been completed so that the soffit plaster is not disturbed by subsequent operations on the floor or the roof. The concrete surface shall be wetted in advance and allowed to dry before application of plaster.

To ensure an even thickness and a true surface, suitable gauges shall be established at about 1.5 metre intervals in both directions as described in Clause 13.1.3 and the plaster applied and finished smooth as described therein with a floating coat of lime putty. The finished soffit shall not show trowel mark, waves or folds and shall be true and plane. The mortar shall be used within an hour of adding water to the dry mix.

- #### **(b)**
- In the case of concrete surface other than soffits of suspended Floors, the plaster shall be finished to a true and plumb surface and to the proper degree of smoothness required. All horizontal surfaces shall be tested with a levelling instruments and all jambs and corners with a plumb bob as the work proceeds. All internal surfaces shall be finished smooth with a floating coat of lime putty and external surfaces wood floated rough to the texture desired, all to the satisfaction of the officer-in-charge.

### **12.5.4 CURING**

Shall be as in 12.1

### **12.6 20 MM THICK 2 COAT WORK**

2 coat work 20 mm thick shall comprise a first coat of 12 mm thickness, and a second coat of 8 mm thickness including the final lime putty.

#### **12.6.1 MATERIALS**

The cement mortar, of specified proportions conforming to the relevant clauses of Chapter 3.

#### **12.6.2 SURFACE PREPARATION**

Surface preparation shall be as for 15 mm thick lime plaster clause 131.2

#### **12.6.3 APPLICATION**

The first coat (Scratch coat) 12 mm thick. This shall be as per clause 13.1.3 except that the thickness of plaster is 12 mm as measured from the face of the brick work or stonework to the plastered surface. It shall be carried to the full length of the wall or to natural breaking points like doors and windows. The scratch coat shall be cross scratched to provide a mechanical key for the subsequent

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coat. The surface shall be kept continuously damp for at least 2 days following its application. It shall then be allowed to dry before application of the second coat.

The second coat 8 mm thick

Before starting to apply the second coat the surface of the scratch coat shall be campened evenly by using fog spray to get uniform suction. The second coat shall be 8 mm thick and pressed well into the first coat. It shall be brought to a true even surface, with a trowel and the surface finished smooth with a setting of pure white lime putty.

#### **12.6.4 FINISHING AND CURING**

Finishing and curing shall be s per clause 13.1.4 and 13.1.5

All plaster work shall be kept damp continuously for a minimum period of 7 days after the application of the finishing coat.

Should the plaster crack through neglect of curing or because of any other fault, the work shall be removed and redone at the contractor's expense.

#### **12.7 20 MM THICK ROUGH CAST PLASTER**

(Note: This is a good water proof covering generally for external work)

It shall consist of 2 coats: the first coat shall be 12 mm thick of either lime cement mortar 1:1:5 or cement mortar 1:3. The second coat which is the finishing coat shall be at least 8 mm thick and made up of a mixture of cement and stone chips in specified proportions dashed over the freshly plastered first coat.

Where directed, a sample panel of rough cost work shall be done first and approval of the officer-in-charge obtained.

##### **12.7.1 MATERIALS**

Cement mortar 1:3 or lime cement mortar 1:1: 5 conforming to the relevant clauses of Chapter 3.

##### **12.7.2 PREPARATION OF THE SURFACE**

This shall conform to the requirements of clause 13.1.2

##### **12.7.3 APPLICATION**

The first coat of plaster 12 mm thick shall be applied and left rough to receive the finishing coat. The finishing coat or rough cast shall consist of a mixture of one part of cement and three parts of stone chips 6 to 10 mm size. It shall be mixed well to a paste of proper consistency and flung on the first coat with large sized trowels to form an even rough coat. The second coat shall be applied while the first coat is still soft and unset.

The plastering shall be cured for at least 7 days.

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## **12.8 LATH AND PLASTER**

### **12.8.1 MATERIALS**

#### **Metal Lath**

Metal lathing for plasters' work shall be expanded metal lathing of the gauge specified and conforming to BS 1369: or other approved reinforcement, nailed and fixed to studs, brackets etc.

The material shall be protected by one coat of bituminous paint or by galvanising.

#### **Cement Mortar**

Cement mortar 1:3 shall conform to requirements of clause 3:2

### **12.8.2 PROCEDURE**

The expanded metal shall be fixed with the 'long way' of the mesh across the supports. Sheets shall be lapped not less than 25 mm at the sides and ends. Sides shall be wired together with galvanised wire of not less than 18 S.W.G every 75 mm between supports.

Before plastering operations are commenced the metal lathing shall be thickly coated with cement slurry.

The cement mortar shall be applied in not less than three coats and finished smooth with pure white lime putty. No lime plaster shall be in direct contact with any metal work.



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## **13.0 GLAZING**

### DEFINITIONS

#### GLAZING

Fixing of glass or a similar material in a framework opening to admit light.

#### CLEARANCE

Edge clearance - the clearance between the bottom edge of the glass and the rebate.

Back clearance – the clearance between the inside face of the glass and the rebate

#### SPRIG

A small headless nail used for securing glass in wood surrounds while the putty hardens.

#### SURROUND

Any frame, sash, casement or other building component into which glass is glazed.

## **13.1 MATERIALS**

### GENERAL

All glass used for glazing work shall be cut accurately to size with clean, undamaged edges and shall be free from flaws, specks or bubbles and surface disfigurement of any sort.

Toughened glass and laminated glass, where specified shall be manufactured to precise glazing sizes and with a permanent identification mark in a position which is visible but not prominent after fixing. If so directed, samples of glass to be used shall be submitted to the officer-in-charge and his approval obtained before purchase of the glass.

#### **13.1.1 The following types of glass shall all conform to BS 952**

Transparent sheet glass	- Clean sheet glass flashed colour sheet glass Pot colour sheet glass.
Transparent glass	Flat & polished plate glass
Translucent glass	Rough cast glass patterned glass opal glass
Wired glass	
Laminated and toughened glass	

#### **13.1.2 LINSEED OIL PUTTY**

This shall conform to BS 544

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Note: As initial setting is controlled by absorption of some of the oils into the frame it may be used for soft woods. Linseed oil putty shall not be used on non absorbent hardwoods like teak.

#### **13.1.3 METAL CASEMENT PUTTY**

This shall be of an approved type suitable for bedding and fronting into metal surrounds, sealed timber or sealed concrete surface.

#### **13.1.4 SELF ADHESIVE GLAZING TPES/VELVET AND WASH LEATHER SHALL BE OF APPROVED MAKE**

#### **13.2 WORKMANSHIP**

Glazing and fixing of glass for buildings shall generally comply with BS CP 152. In respect of all materials and products, the instructions of the manufacturer shall be followed.

External glazing shall be completely wind and water tight.

Note:

Thickness of glass to be used for windows, doors and other low level glazing shall be as specified and conform to clause 3.8 and 3.9 of BSCP 152 and Clause 7.4.2 of the Manual for Design and Buildings for High Winds issued by the Ministry of Local Government, Housing and Construction.

#### **13.2.1 PREPARATION**

All rebates and grooves shall be clean, dry and unobstructed. All heads and rebates in woodwork made of soft wood shall be given a coat of wood primer before glazing. In the case of hard wood which is non-absorbent, a metal casement putty shall be used.

Rebates shall be sealed with primer and at least one undercoat before applying metal casement putty.

In the case of metal surrounds a specified primer shall be applied to the surround and heads. The metal surrounds shall be free from dirt, dust, grease burs weld spatter and other projections. They shall be smooth and undistorted and shall be painted before glazing is commenced.

Stone/brick./concrete surrounds, rebates or grooves shall be sealed with at least two coats of alkali-resistant sealer before application of compound.

#### **13.2.2 FIXING**

##### **GENERAL**

Glass panes shall be cut to fit the rebates of the frames leaving an edge clearance of 3 mm all around in which to bed the putty so that the glass does not touch the surround at any point. For panes exceeding 0.2 m<sup>2</sup> in area, the glass shall be set on small blocks of resilient material spaced at not more than 75mm from the corners, to locate the pane properly within the surround.

In timber or metal frames, the thickness of back putty shall not be less than 2 mm. A rebate of 10 mm shall generally be available for fixing glass externally. Patterned/wired glass shall be fixed with patterns or wires parallel to the surround or as directed. Adjacent panels shall be aligned as directed.

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#### **13.2.2.1 GLAZING WITH PUTTY**

The bedding putty shall be applied uniformly over the rebate and the glass pressed into position and secured with glaziers sprigs. These fixings shall be spaced at 450 mm around the frame. On pressing in the glass a certain amount of bedding putty is pressed out and the remaining putty which is called the back putty shall be at least 2 mm thick between the glass and rebate. The glass is then 'front puttied' and the putty shall be stopped about 2 mm from the sight line of the rebate so that when paint is applied it is carried over the glass up to the sight line and so seals the edge of the putty to the glass.

The front putty shall be sloped at an angle to prevent accumulation of water. The back putty shall also be stopped at an angle to prevent shrinkage causing a groove in which dirt can accumulate.

The putty shall be left for 14 days to harden before painting.

#### **13.2.2.2 GLAZING WITH BEADS**

The beads shall be of approved hard wood secured by rust proofed panel pin or preferably by brass counter sunk screws and cups. Pins shall not be more than 75 mm from the corners or more than 200 mm apart. For double glazed units, cups and screws shall be used.

Rebate and beads shall first be sealed with proprietary sealing compound applied by brush. The glass shall then be bedded in glazing compound and set in position using setting blocks and distance pieces to restrain movement. The bead shall then be bedded with the glaziers putty and screwed or pinned in position. For internal bead glazing, the bedding for the bead can be omitted.

Plate glasses shall be bedded on a strip of asbestos tape or felt to act as a cushion between the glass edge and the bead.

Dry bead glazing where specified in internal situations shall be of self adhesive glazing tapes or self adhesive black velvet or wash leather, passed round the edge of the glass and trimmed off flush on both sides in accordance with the instructions of the manufacturers. The beads shall be sealed as specified and fixed to the surround by springs of screws.

#### **13.2.3 PROTECTION AND CLEANING OF FINISHED WORK**

White wash indicators shall be restricted to small central areas of panes. All smears and excess putty and sealant shall be cleaned off.

Putty shall be sealed and protected as soon as sufficiently hard by paint or varnish as specified or as directed.

Broken panes shall be replaced and redecorated as directed by the Officer-in-Charge.

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## **14.0 PAINTING AND DECORATION**

### **DEFINITIONS**

#### **ALUMINIUM PRIMER**

A primer containing a proportion of aluminium pigment. It should be distinguished from an aluminium paint in which the aluminium is designed to float to the top of the film giving metallic brilliance, a feature undesirable in a primer. Aluminium primers are especially valuable on resinous timber or timber which has been treated with oil soluble wood preservative. This term must not be confused with a primer for aluminium.

#### **ANTI-CORROSIVE PAINT OR COMPOSITION**

A paint used for preventing the corrosion of metal and more particularly, a paint especially formulated to prevent the rusting of iron or steel.

#### **BITUMINOUS PAINT**

Originally a paint from the class of paints consisting essentially of natural bitumens dissolved in organic solvents; they may contain softening agents, pigments and inorganic fillers. It is usually black or dark in colour. By extension the term is applied also to dried films. Within recent years the term 'bituminous' has by common usage come to include bitumen-like products such as petroleum asphalt; it is not recommended that the term should be used for paints based on coal tar or coal tar pitch. These are more generally known as black varnish (q.v) or 'black paint (coal tar or base)

#### **CEMENT PAINT**

A paint based essentially on Portland Cement, supplied as a dry powder, for mixing with water immediately before use.

#### **COPAL**

Natural resins formed from the exudation of various tropical trees. The hard fossil types are the basis of copal varnishes, the softer types frequently obtained by the tapping of live trees being mostly used for spirit varnishes. Congo copal is the main surviving member of the fossil class, Manila copal that of the spirit soluble class.

#### **DISTEMPER**

Although there is a tendency to apply this term to all interior water paints used for house decoration, it should preferably be used solely to describe the earlier types of such product, namely those in which the binding medium consists essentially of either glue or casein or similar sizing material. (see also 'water paint')

#### **DRIERS**

Substances which, when incorporated in relatively small proportions in drying oils, or in paint or varnishes based on drying oils, bring about an appreciable reduction of their drying times at ordinary temperatures. These substances are usually compounds of lead, manganese or cobalt.

#### **DRYING**

The process of change of a coat of paint or varnish from the liquid to the solid state, due to evaporation of solvent, physicochemical reactions of the binding medium or a combination of these causes.

#### **TOUCH DRY**

When a very slight pressure with the fingers does not leave a mark or reveal thickness.

#### **HAND DRY**

When the drying has reached such a stage that if desired a further coat can be satisfactorily applied by brushing, necessary after flattening. The term is also used to describe certain degrees of film hardness when tested by specified methods.

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**DRYING OIL**

A oil usually of vegetable origin of which linseed (q.v) and tung oil (q.v) are the commonest examples, having the property of hardening by oxidation to a tough film when exposed in the form of a thin layer to air.

**EFFLORESCENCE**

The development of a crystalline deposit on the surface of brick, cement, etc, due to water containing soluble salts, coming to the surface and evaporating so that the salts are deposited. In some cases, the deposit may be formed on the top of any paint film present, but usually the paint film is pushed up and broken by the efflorescence under the coat.

**EMULSION PAINT**

organic binder in water. Industrially the name is mainly restricted to these paint in which the medium is an emulsion of a synthetic resin. The medium may also be called a jatex by analogy with natural rubber latex; polyvinyl acetate emulsion paint is typical example.

**ENAMEL**

One of a class of finishes obtained by melting siliceous materials. The term is also used in the paint industry to describe pigmented varnishes which simulate in appearance the flow smoothness and gloss of vitreous enamel. The same broad definition applies to 'enamel paint' and 'hard gloss paint', although all three may differ in degree in respect of one or more properties, such as flow, smoothness, gloss, capacity and in the retention of these properties on ageing.

**EPOXY PAINT**

A paint based on an epoxy resin: the designation is frequently qualified to indicate the nature of the cross linking agent used, 'epoxy /amine', 'epoxy / polyamide' or 'epoxy / isocyanate' where the cross linking agents are polyamines, polyamides and isocyanates respectively.

**FILLER**

1. A composition used for filling fine cracks and indentations to obtain a smooth, even surface preparatory to painting. It may vary in consistency from a paint to a paste, and may be applied in successive coats by brush or in one application by means of a broad knife.
2. Synonymous with 'extender' (q.v)

**FLAME-CLEANING**

The application of an intensely hot flame to structural steel resulting in the removal of mill scale and the dehydration of any remaining rust, leaving the surface in a condition suitable for wire brushing followed by the immediate application of paint.

**FLAT (MATT)**

The description of a painted surface which scatters or absorbs the light falling on it, so as to be substantially free from gloss or sheen (see also 'gloss')

**FLATTING DOWN**

Cutting or rubbing down the surface of a paint varnish with fine abrasive to produce a smooth dull surface.

**FRENCH POLISH**

A lacquer made essentially from shellac and methylated spirit. Other spirit – soluble gums, such as sandarach and benzoin, are sometimes added to impart some special property. It is supplied with a cambric covered 'rubber' cotton wool, lubricated with oil. The oil is afterwards removed by 'spiriting off' (z.v)

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## **GLOSS**

The degree to which a painted surface possesses the property of reflecting light in a mirror-like manner (specular reflection) the extent to which this property developed depends mainly on the composition of the paint, and the surface ranging from dead flat to full gloss being obtainable. The following stages in increasing order of gloss are normally recognised.

## **FLATT OR MATT**

Practically free from sheen even when viewed from oblique angles.

Eggshell felt

Eggshell gloss

Semi-gloss

Full-gloss – smooth and almost mirror like surface when viewed from all angles.

## **GOLD SIZE**

1. An oleo-resinous varnish which dries rapidly to a tack condition, but which hardens off slowly. It is used chiefly as an adhesive for fixing gold leaf to a surface.
2. An oleo-resinous containing a high proportion dries, which rapidly dries hard after application. It is frequently used for preparations of stopping and filling composition.

## **HARD STOPPING**

A material in stiff paste form, which is usually applied by means of a knife to fill deep indentation in a surface and which dries hard throughout. It should not be confused with glazing putty which is of a different consistency and which hardens more slowly.

## **INHIBITIVE PIGMENT**

A pigment which retards or prevents the corrosion of metals by chemical and or electrochemical means, as opposed to a purely barrier action. Red lead and zinc chromate are examples of inhibitive pigments as opposed to red iron oxide which has little or no inhibitive action.

## **KNOTTING**

A quick-drying composition used in the preparation of joinery for painting to form a local impervious covering knots and other resinous areas liable to stain or soften a superimposed coat of paint.

The most usual composition consists of a solution of shellac in industrial methylated spirit.

## **LACQUER**

1. A coating composition dries solely by evaporation of the solvents e.g. cellulose and spirit lacquers.
2. A gold stoving finish for tinplate which is not formulated on a spirit or cellulosic basis and does not dry solely by solvent evaporation.

## **LAYING OFF**

The final light strokes of the brush during a painting operation.

## **LEAD PAINT**

A paint, the dry pigment content of which contains more than 5 per cent of soluble lead compounds (expressed as PbO) of the dried pigment.

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**MASTIC**

An adhesive composition. The term is loosely used to describe a plastic filler, stopper, putty or adhesive. Not to be confused with 'gum mastic' which is natural resin used for picture varnish.

**RESIN, NATURAL**

A glassy amorphous organic substance produced either in the metabolism of tree growth, e.g. copal (q.v) or by insects, e.g. shellac. The former may be obtained from growing trees or dug up from the ground. (fossil resin) where it has lain since the trees from which it was formed decayed in prehistoric times. These resins, as distinct from gums, are not soluble in water but may be dissolved in organic solvents or vegetable oils. If necessary after heat treatment to form varnishes.

**RESIN, SYNTHETIC**

Originally, a member of a group of synthetic substances which resemble and share some of the properties of natural resins, but now used for material which bear little resemblance to natural resins. The term is generally used to understand to mean a member of the heterogeneous group of compounds by condensation and/or polymerization. Chemically modified natural polymers, such as cellulose acetate and hardened casein, are not considered to be synthetic resins.

**RESINOUS TIMBER**

Wood from certain trees which contain resinous material in the cells. The resins have high solvent power for many paint media, even where these have partially dried. This resin frequently exudes through paint films applied on such wood, especially in sunny locations.

**SEALER**

A clear or pigmented liquid used on absorbent surfaces prior to painting, which when dried reduces the absorptive capacity of surface, often known as 'suction'. Also used where necessary to prevent any soluble or diffusible matter from 'bleeding' (q.v) into and disfiguring new paint, or to protect the existing paint system from the softening action of solvents in a top coat. (See also 'sanding sealer')

**SHORT OIL**

A low ratio of oil to resin in a medium (See also 'long oil')

**PINK PRIMER**

Traditionally, a wood primer based essentially on white and red lead pigments. Now sometimes loosely applied to wood primer, pink in colour, but based on pigment other than lead. The use of the term is therefore to be deprecated and where priming paints based on a mixture of white and red lead are required they should be referred to as such.

**PLASTER PRIMER**

Primers with a degree of resistance to alkali which are used for priming plasters and cements of varying degrees of alkalinity. The primers must not only resist saponification but must insulate succeeding coats of paint from attack. Plaster primers based on tung oil/phenolic resin varnishes or tung oil/coumarone varnishes usually are sufficiently alkali-resistant for use on more plaster.

**PLASTIC EMULSION PAINT**

These are paints which are bound with emulsion of vinyl acrylic and polyurethane polymers. They harden within 2 – 3 hours and provide matt, sheen, lustre or gloss surfaces. Emulsion paint are tougher, more elastic and through permeable are more resistant to weather than oil bound distempers.

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## **PUTTY**

A stiff plastic material of high mineral filler content which is applied by a knife and which normally hardens as exposure.

### **GLAZING PUTTY**

A type of putty used for fixing glass panes in frames, based on whiting and linseed oil

### **HARD PUTTY**

See 'hard stopping'

- a. Short oil alkyd. An alkyd resin containing not more than 40 per cent of oil as modifying agent.
- b. Short oil varnish. An ole-resinous varnish other than an alkyd, containing not more than 1 ½ parts by weight of oil to 1 part by weight resin, in the finished varnish.

## **SOLVENT**

A liquid usually volatile, which is used in the manufacture of paint to dissolve or disperse the film forming constituents and which evaporates during drying and therefore does not become a part of the dried film. Solvents are used to control the consistency and character of the finish and to regulate application properties.

## **SPIRIT**

In the paint industry, this term is used somewhat loosely but generally refers to commercial ethyl alcohol normally sold as industrial methylated spirit.

The term mineral spirits is used particularly in America, for what is known in the U.K as 'white spirit' (q.v). This consists mainly of a mixture of aliphatic hydrocarbons with a proportion of aromatic hydrocarbons.

## **SPIRIT VARNISH**

A lacquer based on a solution of resin or resins in industrial methylated spirit.

The more correct term would be spirit lacquer (See lacquer)

## **STAIN**

Solution or suspension of colouring matter in a vehicle designed to colour a surface by penetration without hiding it. True stains are classified as water stains, oil stains spirit stains, according to the nature of the colouring material. These have not the same powder penetration as the true stains and leave a coloured coating on the surface.

## **STAINERS**

Coloured pigments ground in a paint vehicle, which can be added in relatively small proportions to already prepared paints to modify their colour. (see also 'tinters')

## **STOPPER**

A stiff paste used for filling holes and cracks and similar defects in surfaces, normally applied after priming. (see 'hard stopping')

Slight stickiness of the surface of a film of paint, varnish or lacquer apparent when the film is pressed with the finger.



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**THINNERS**

Volatile liquids added to paints and varnishes to facilitate application and to aid penetration by lowering the viscosity. They should be completely miscible with the paint or varnish at ordinary temperature and should not cause precipitation of the non-volatile portion either in the container or in the film during drying. For some purposes, thinners containing a small proportion of non-volatile material may be used.

**TENTING**

The final adjustment of the colour, of a paint to the exact colour required.

**TURPENTINE**

A colourless volatile liquid distilled from the products of certain pine trees and consists of a complex mixture terpene hydrocarbon.

Turpentine was formerly extensively used in paints and varnishes but has now been largely replaced by 'white spirit' (q.v)

**UNDERCOAT**

The coat or coats applied to a surface after priming, filling etc. or after the preparation of a previously painted surface, and before the application of a finishing coat. An undercoat should possess good hiding power, build up a film which can be rubbed down to a very smooth surface and a colour leading up to that of the finishing coat, and should otherwise be suitable for use with the other paints in the system.

**VARNISH**

A transparent coating composition based essentially on drying oils, resins and solvents. (See also 'spirit varnish' and of 'lacquer') it provides a clear finish to timber enhancing its natural beauty.

**VINYL RESIN**

A synthetic resin of the thermoplastic type obtain by the polymerization of monomers containing the vinyl group. In strict chemical terminology the description covers not only the polymerized vinyl ester, e.g. polyvinyl acetate but also polystyrene and the polycrylates. Vinyl resins may be applied as solution in organic solvent as plastisols (q.v), as organosols (q.v) or in aqueous dispersion or latex form (see 'emulsion paint')

**WHITE SPIRITS**

The most commonly used thinner for paints and varnishes.

**ZINC-RICH PRIMER**

An anticorrosive primer for iron and steel incorporating zinc dust in a concentration sufficient to give electrical conductivity in the dried film, thus enabling the zinc metal to corrode preferentially to the substrate, i.e. to give cathodic protection.

## **14.1 WHITE WASHING AND COLOUR WASHING OF NEW WALLS**

### **GENERAL**

Unless otherwise specified new wall surfaces shall receive three coats of white/colour wash.

### **14.1.1 PREPARATION OF THE SURFACE**

New surfaces shall be thoroughly cleaned of mortar or other splashes. Any damage to the plaster shall be made good to match the adjacent surfaces and the surface brushed clean of dust and dirt.

### **14.1.2 PREPARATION**

Lime used for white or colour washing shall be fresh burnt shell like. The lime shall be screened through a sieve of 850 microns and dissolved in a tub of sufficient water to give a thin creamy consistency.

When thoroughly mixed, it shall be strained through a clean coarse cloth. Gum Arabic or glue in the proportion of 4 gm per litre of the cream shall be added.

#### **Colour Wash**

Where colour wash is specified colouring matter of the colour specified shall be added. In the case of yellow was, finely powdered yellow clay commonly known as "Samara" may be used.

The contractor shall paint sample areas for approval of the tint by the officer-in-charge.

Note: Only sufficient wash for the day's work shall be prepared each morning. The wash shall be stirred continuously during use.

### **14.1.3 APPLICATION**

Each coat shall be laid on with a brush and allowed to dry before the next coat is applied. One coat comprises a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke and similarly one stroke from the right and another from the left over the first brush before it dries. The number of coats to be applied shall be as specified. At the end of the work, the whole surface shall present a uniform appearance and colour shall be of even tint without exhibiting any patches, streaks or hair cracks.

The contractor shall take every precaution to prevent the white/colour wash being splashed on the wall, floor, doors, windows, furniture and other surfaces and articles not to be white/colour washed. The contractor shall clean up at his own cost, all such items to the satisfaction of the officer-in-charge. Ladders, poles, scaffolding etc. shall be shod with gunny bags to prevent damage or scratching of the walls and floor.

## **14.2 WHITE WASHING AND COLOUR WASHING OF OLD WALLS**

### **GENERAL**

Unless otherwise specified old walls shall receive one coat if there is no change of colour. The white or colour wash shall be prepared as specified in clause 14.1.2

### **14.2.1 PREPARATION OF SURFACE**

All loose scales and flakes of the old white wash/ colour wash shall be removed thoroughly. Minor repairs to plaster and making good shall be carried out to the satisfaction of the officer-in-charge. Where so specified the entire surface of old whitewash colourwash shall be thoroughly removed by scraping the surface cleaned.

#### **14.2.2 APPLICATION**

For old work, after the surface has been prepared as in clause 14.2.1 a coat of white or colour wash shall be applied over the patches and repaired areas. One or more coats as specified shall be then applied over the entire surface.

One or more coats as specified shall be then applied over the entire surface.

#### **14.3 DISTEMPERING 'NEW SURFACES' WITH OIL BOUND DISTEMPERS**

##### **14.3.1 MATERIALS**

Oil bound distempers shall be of approved quality primer for new surfaces shall be an alkali resistant such as cement primer or distemper primer as specified and shall be of the same manufacture as the distemper.

##### **14.3.2 SURFACE PREPARATION**

The plastered 'surface' shall be well cleaned down of efflorescence dust etc by scrubbing and washing. It shall then be allowed to dry for at least 48 hours and sand papered to give a smooth and even surface. Unevenness and pittings and small holes shall be filled with gypsum and allowed to set.

##### **14.3.3 APPLICATION**

###### **14.3.3.1 PRIMING COAT**

The priming coat shall be with distemper primer or cement primer as specified.

Note:

The priming coat shall be with distemper primer or cement primer as specified.

1. The cement primer is composed of a medium a pigment which are resistant to the alkalies present in the cement, lime or lime cement the wall finish; it provides a barrier for protection of subsequent coats of oil emulsion distemper paints.
2. If the plaster has not dried completely, cement primer shall be applied before distempering the wall. But if the distempering is done after the wall surface is dried completely, distemper primer shall be applied.
3. Oil bound distemper is not recommended to be applied within six month of the completion of wall plaster.
4. For old work no primer coat is necessary.

###### **14.3.3.2 DISTEMPER COATS**

Note: 50 mm double bristled distemper brushes shall be used. Old brushes which are dirty and caked with distemper shall not be used on the work. After each days work, brushes shall be thoroughly washed in hot water with soap solution and up to dry.

After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes; a horizontal stroke followed immediately by a vertical one together constitute one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between consecutive coat to permit the proper drying of the preceding coat.

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#### **14.4 DISTEMPERING OLD WALLS WITH OIL BOUND SURFACES**

##### **14.4.1 MATERIALS**

This shall be as per clause 14.3.1

##### **14.4.2 SURFACE PREPARATION**

All loose pieces and scales shall be thoroughly removed by sand papering. The surface shall be cleaned of all grease, dirt etc. Pitting in plaster shall be made good with plaster or paris mixed with the colour to be used. The surface shall be rubbed down again with a fine grained sand paper and made smooth. A coat of distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

##### **14.4.3 APPLICATION**

No primer coat is necessary. For old work the distemper shall be applied over the prepared surface in the same manner as for new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade

At the end of work the surface shall be uniform in colour without patches, overlap and brush marks.

#### **14.5 CEMENT PAINTING NEW SURFACES**

##### **14.5.1 MATERIALS**

Cement paint shall be of approved quality.

##### **14.5.2 PREPARATION OF SURFACE**

The surface shall be thoroughly cleaned of all mortar dropping dirt, grease and other foreign matter by brushing and washing.

All holes shall be filled with cement mortar or gypsum and allowed to harden:

##### **14.5.3 MIXING AND APPLICATION**

The cement paint shall be thoroughly mixed with water to the proper consistency as specified by the manufacturer and applied uniformly with broad hairbrushes. The paint shall be used within an hour of being mixed.

After the first coat has set, it shall be cured with water spray at least for the next 24 hours. The surface shall then be watered again before the application of the next coat. A primer shall be used instead of the first coat if so specified by the paint manufacturer. The number of coats shall be as specified. Unless otherwise specified, new wall surfaces shall be given one cement primer coat and two finishing coats of cement paint.

#### **14.6 CEMENT PAINTING OLD SURFACES**

##### **14.6.1 MATERIALS**

The cement paint shall be of approved quality.

##### **14.6.2 PREPARATION OF SURFACE**

All loose particles shall be removed and dirt and foreign matter brushed off from the surface. Pitted surfaces shall be made good and patches wetted and primed with a coat of cement paint. The surface shall be sprayed with water several times with a few minutes interval between each spraying, to allow the moisture to soak into the surface.

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#### **14.6.3 MIXING AND APPLICATION**

This shall be as per clause 14.5.3

#### **14.7 PAINTING NEW SURFACES WITH PLASTIC EMULSION PAINT**

##### **GENERAL**

Manufacturers instructions shall be followed, in the choice of paints for external work.

##### **14.7.1 MATERIALS**

Emulsion paints shall be of approved manufacture. The instructions of the manufacturer shall be followed in all respects, and in the choice of paints for external work.

##### **14.7.2 SURFACE PREPARATION**

Surface preparation shall be as per clause 14.3.2

New surfaces shall be painted until they are perfectly dry.

##### **14.7.3 APPLICATION**

A coat of alkali resistant primer shall be applied to the prepared wall surface. If the paint itself is of alkali resistant composition, one coat of the paint itself could be used as primer. Unless otherwise specified, emulsion painting of new walls shall consist of a coat of alkali resistant primer and two coats of emulsion paint to match approved samples.

Splashes of paint on floors shall be cleaned out without any delay as they will be difficult to remove after hardening.

#### **14.8 PAINTING OF OLD SURFACES WITH PLASTIC EMULSION PAINT**

##### **14.8.1 MATERIALS**

These shall be as per clause 14.7.1

##### **14.8.2 SURFACE PREPARATION**

This shall be as per clause 14.4.2

##### **14.8.3 APPLICATION**

This shall be as per clause 14.7.3

#### **14.9 PAINTING**

##### **GENERAL**

##### **a) Materials**

Paints, oils, varnishes etc, of approved manufacturer shall be used. Ready mixed paint as received from the manufacturer shall be used without any admixture. If for any reason, thinning of ready mixed paint is necessary the brand of thinner recommended by the manufacturer or as instructed by the officer-in-charge shall be used.

Approved paints, oils, or varnishes shall be brought to the site in their original containers in the sealed condition.

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Where directed, sample areas shall be provided of each type of coating including preparation of surfaces, and not approved by the officer-in-charge before proceeding with the painting.

b) Preparation

Painting shall not be started until the preparations have been inspected by the officer-in-charge and approval given by him to commence the painting work. Painting shall not be carried out in adverse weather conditions as condensation may occur on surface being painted.

Painting except the priming coat, shall generally be commenced after practically finishing all other building work. The rooms shall be thoroughly swept out and the entire building cleaned at least one day in advance of starting the paint work.

b) Preparation of surface

Preparation of wood, steel and other surfaces, both new and painted shall conform to the relevant sub clauses on this specification – See Clause 15.9.1 to 15.9.6

Priming coat shall be applied by brush unless otherwise approved.

c) Application

Application of finishing coats shall be by brush spray or roller as specified and approved by the officer-in-charge. Paints used shall be brought to the requisite consistency by adding a suitable thinner recommended by the paint manufacturer. Each coat shall be allowed to dry thoroughly this should be facilitated by thorough ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and dust cleaned off before the next coat is laid. The paint shall be stirred thoroughly in its containers before pouring into smaller containers. Whilst applying also, the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. No left over paint shall be put back into the stock tins. When not in use, the containers shall be kept properly.

Brushing

The paint shall be laid on evenly and smoothly by means of crossing and laying off.

The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternatively into the opposite direction two or three times and then finally laying off in the direction two or three times and then finally laying off in the direction of the grain in the case of wood work. In this process, no brush marks shall be left after the laying-off is finished. The full process of crossing and laying off will constitute one coat.

Spraying

Where stipulated, the painting shall be done by spraying. The spray machine used may be a high pressure (small air aperture) type, or a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced work men shall be employed for this class of work. Spray painting shall be done only when dry conditions prevail.

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No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moulding etc. shall be left on the work.

In painting doors and windows, the putty round the glass must also be painted; but care must be taken to see that no paint stains etc, are left on the glass. Tops of shutters and surfaces in hidden locations shall not be left out in painting.

In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

The additional specifications for primer and other coats of paints shall be as per the detailed specifications under the headings.

#### **14.9.1 PAINTING NEW WOODWORK**

##### **14.9.1.1 Preparation of Surface**

At the time of painting, the moisture content of timber shall not exceed that appropriate to its use.

Large, loose knots and other gross defects shall be cut and the holes plugged with sound wood.

All heads of screws and nails shall have been set at least 3 mm below the surface and filled with hard stopping.

The surface shall be sand papered to a smooth and even finish and all projections, tool marks and other irregularities smoothened off. Resinous knots shall be treated with an approved quality shellac knotting conforming to B.S 1366. Where resinous or oil exuding woods are to be painted, the entire areas shall be treated with shellac knotting and allowed to set hard.

##### **14.9.1.2 Priming coat for wood**

The priming coat for new wood surfaces shall be as follows:

Non-resinous woods

Pink primer consisting of white lead in linseed oil, with not more than 10% red lead, or aluminium wood primer or acrylic emulsion primers.

Resinous or oily woods

Aluminium wood primer

Hardwoods like teak containing excess of natural oil shall be degreased by washing down with white spirit. The priming coats shall be applied by brush, worked into the surface, joints and angles, and particular care shall be of adequate thickness and suit the surface porosity.

Any primed surfaces which have deteriorated on site or in transit shall be touched up or reprimed as directed by the officer-in-charge. Immediately after joinery work is approved and before fixing, joinery surfaces shall like bottom edges of door shutters shall be primed and painted before fixing. Backs of members which will be in contact with external wall shall receive at least two coats, preferably of Aluminium wood primer.

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Note: Aluminium wood primers have an alkali or oleoresinous medium which adheres well even on dense and non absorbent wood. They seal against bleeding of resins in soft woods dispensing with the need for shellac knotting.

#### **14.9.1.3**

After priming is over nails and screw holes and similar depressions shall be stopped with a propriety hard stopping or putty (BS 544) pressed in well and finished off flush with the surface.

#### **14.9.1.4**

To obtain a fine smooth surface free from even minor irregularities a filler shall be applied with a broad knife after priming or sealing and stopping. The filler shall be gypsum plaster or a water soluble cellulose based filler for interior work, and water proof proprietary paste filler for outdoor work.

#### **14.9.1.5 UNDERCOATS**

All exposed surfaces shall be painted with an even film of the undercoat specified avoiding uneven thickness at edges and angles. The undercoat shall be rubbed down to a smooth surface with abrasive paper and the dust removed before applying the finishing coat.

#### **14.9.1.6 FINISHING COATS**

The finishing coat shall be applied evenly over all exposed surfaces, avoiding brush marks, sags, runs and other defects. Where two hard gloss finishing coats are specified, the second coat shall be applied within 48 hours of the first coat.

The specified coats of paints shall be applied to rebates and beads before glazing and the putty shall be primed and patented in the same manner after glazing.

### **14.9.2 REPAINTING OLD WOOD WORK**

#### **14.9.2.1 PREPARATION OF SURFACE**

In the old paint is sound and firm and its removal is considered unnecessary, the surface shall be rubbed down with pumice stone after it has been cleaned of all grease by washing with lime solution; it shall then be rinsed with water and dried. All dust and loose paint shall be completely removed and edges or surrounding paint work feathered off. The surface shall then be washed with soap and water, wiped and allowed to dry.

Prescribed treated decayed timber shall be cut out and replaced by compatible wood, except small areas where an approved hard stopper may be used. If decay of old wood work is considered likely, a pintable preservative shall be applied liberally and allowed at least 48 hours to dry before priming.

All cracks, splies and defects shall be spot primed, made good with an approved hard stopping, rubbed down to a smooth level surface and brought forward with an undercoat.

If the old painted surface is blistered or flaked badly, the old paint shall be completely removed as described in Clause 15.16

#### **14.9.2.2 APPLICATION**

Painting including priming shall be as per new work. See clauses 15.9 and 15.9.1

#### **14.9.3 PAINTING NEW IRON/STEEL SURFACES**

Painting of iron/steel surfaces shall afford protection from corrosion.



#### **14.9.3.1 PREPARATION OF SURFACE**

The surfaces of iron/steel shall be cleaned before application of the paint by chipping, scraping and wire brushing of the surfaces to remove rust, loose scale, welding slag and spatter. All dust and dirt shall be thoroughly wiped off the surface.

Where specified other methods of cleaning like flame cleaning with oxy-acetylene or butane gas, blast cleaning and chemical cleaning followed by brushing shall be carried out to the instructions of the officer-in-charge.

In the case of surfaces which have already been primed, defects in the primer, rust and loose scales shall be removed to expose the bare metal and the patches primed to match the existing primed surface. If the primed surface is satisfactory, dirt and grease shall be removed and the surface given a light rubbing.

#### **14.9.3.2 APPLICATION**

##### **a) Application of primer**

The prepared steel work shall be approved by the officer-in-charge, before commencing painting.

To the bright, clean, rust free surfaces a coat of rust inhibitive primer like approved zinc/phosphate oil base or red lead to B.S. 2523 or red oxide /zinc chromate shall be applied immediately after the preparation is completed. A second priming coats shall be applied to the arrises as paint tends to run away from the arrises. In corrosive conditions and external situations a second priming coat shall be given.

Primers shall be applied manually using brushes unless otherwise specified. In the case of flame cleaned surfaces, primers shall be applied while the metal is warm if the formulations permit such a procedure.

##### **b) Finishing coats**

Unless otherwise specified, two coats of ready mixed paint (the base of which shall consist of not less than 60% carbonate of lead and 40% of zinc pigmented to approved tints) shall be used. The material shall be touch dry in not less than 4 hours and hard dry in not more than 12 hours. The finish coats shall be glossy; the first coat shall be of a lighter shade than the final coat.

#### **14.9.4 REPAINTING OLD IRON/STEEL WORK**

##### **14.9.4.1 PREPARATION OF SURFACE**

In the old paint is sound and firm and its removal is considered unnecessary, it shall be rubbed with wire brushes to remove any loose paint. All dust shall then be thoroughly wiped away. This surface shall be wiped finally with mineral turpentine to remove grease and then allowed to dry.

Corroded areas shall be cleaned to bare metal by wire brushing and or abrasion and wiped clean with white spirit, followed as quickly as feasible by spot-priming. The primer shall be an approved zinc phosphate /oil based red or lead to BS 2523 or red oxide/zinc chromate. The first protective coat shall be applied as soon as the primer is hard dry.

##### **14.9.4.2 APPLICATION**

Painting including priming shall be as for new work. See clause 14.9 and 14.9.3

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#### **14.9.5 PAINTING OF NEW PLASTERED SURFACES**

Plastered surfaces shall not be painted until completely dry. Trial patches of primer shall be laid on and checked for drying before commencing painting.

##### **14.9.5.1 PREPARATION OF SURFACE**

Plaster and mortar splashes shall be carefully scraped off. If it is necessary to rub down irregularities, care shall be taken to avoid causing variation in porosity leading to variations in the sheen of the paint.

Dust and efflorescence shall be cleaned off; efflorescence shall not be washed off. Defective areas shall be made good and stopped using the same plaster as used for the surface as a whole. Holes and undulations shall be filled up with plaster of Paris and rubbed down.

##### **14.9.5.2 APPLICATION**

###### **a) Primer**

For all plastered surfaces one or two coats of an alkali resisting primer like cement primer shall be used before applying paints containing oil.

###### **b) Finishing coats**

Finishing coats as specified shall be applied to match with sample areas.

All other clauses of 14.9 – General shall be applicable in so far as they relate to this work.

#### **14.9.6 REPAINTING OF OLD PLASTERED SURFACES**

##### **14.9.6.1 PREPARATION OF SURFACES**

If surfaces are damp, the cause of dampness shall be removed. Mould or mildew causing discolouration shall be stripped and mould inhibitor shall be applied. Unsound plaster shall be removed and made good.

Cracks and holes shall be filled with new plaster of the same type and finish as the old plaster and spot primed with suitable paint or alkali resisting primer as directed and shall be brought forward with suitable paint.

Old paint shall be washed off if water soluble and the surface allowed to dry. Other paints shall be rubbed scraped dry and the surface treated with a primer.

##### **14.9.6.2 APPLICATION**

Shall be as per 14.9 & 14.9.5

#### **14.10 VARNISHING OF NEW SURFACES**

##### **14.10.1 MATERIALS**

The varnish shall be of an approved make with sufficient drying oils incorporated in the manufacture shall be touch dry in eight hours and hard dry in twelve hours.

##### **14.10.2 PREPARATION OF SURFACES**

Surface preparation shall conform to clause 14.9.1.1 the surface shall be perfectly dry, smooth and free from dust. If knots are present in the wood, these shall be treated with Shellac knotting as

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specified under painting. Where so directed, knots shall be cut to a slight depth and filled in with wood putty. Cracks and holes shall be cleaned of dust and shall be filled in with wood putty made as follows:-

On a piece of wood say 200 x 150 mm face and on the side where cross grains appear, a small quantity of glue size shall be poured and the surface scraped with the edge of a fine carpenter's shisel. The very fine wood powder scraped off shall be mixed with the glue and the stiff paste thus formed shall be used for the filling.

The fillings when dry shall be rubbed down with a carpenter's file; the entire surface shall then be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with a dry clean cloth so that it presents a uniform presence.

Sand papering across the grains shall be avoided.

a) Undercoat of flatting varnish when varnishing without straining.

Where so specified, the surface shall be treated with an undercoat of flatting varnish thinned down with white spirit before applying the finishing coats of varnish. This undercoat shall be dry, hard and brittle, so that when cut and rubbed down it shall produce a smooth surface which shall enhance the gloss of the finishing varnish.

b) Staining

Where staining is specified the stain shall be composed of suitable dyes in oil free from varnish. Two coats shall be brushed on with bristle brushes to approved depth of colour, the second coat applied after an interval of not less than six hours, and these shall dry free from gloss.

#### **14.10.3 APPLICATION**

The number of coats to be applied shall be as specified. The top coat shall be given with an approved brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light streaks to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, the latter being finished on the upstroke so that the varnish as it sets, flows down and obscures the brush marks. The above process will constitute one coat. If the surface is horizontal, the varnish shall be worked in every direction with light quick strokes, and finished in one definite direction so that it will set without showing brush marks. In handling and applying varnish, care shall be taken to avoid forming froth or air bubbles. Rubbing down and flatting the surface with fine sand paper shall be done after each coat except the final coat.

While drying, the work shall not be exposed to draughts and damp air.

The finished surface shall then present a uniform appearance with a fine glossy surface free from streaks, blisters etc.

Note: Any varnish left over in the small container shall not be poured back into the stock tin, it will render the latter unfit for use.

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## **14.11 VARNISHING OLD SURFACES**

### **14.11.1 PREPARATION OF SURFACES**

If the old varnished surface is firm and sound it shall be cleaned of grease and dirt with turpentine and then clean rubbed with water and sand paper until the surface is clean and smooth. It shall dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in 14.10.2 The entire surface shall then be rubbed smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish. See Clause 14.16. Varnishing shall be then applied as for new work.

## **14.12 FRENCH POLISHING OF NEW SURFACES**

### **14.12.1 MATERIALS**

Pure shellac varying from pale orange to lemon yellow colour, shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade.

### **14.12.2 PREPARATION OF SURFACES**

The surface shall be cleaned. All unevenness shall be rubbed smooth with sand paper and the surface well dusted. Knots if visible shall be covered with preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 kg of whiting per litre of spirit and coloured to match colour of the wood. The surface shall again be rubbed perfectly smooth with glass paper and wiped clean.

### **14.12.3 APPLICATION**

Unless otherwise specified, three coats of polish shall be applied.

A pad of woollen cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moisten with the polish and rubbed hard on the wood in a series of overlapping circles, applying the mixture sparingly but uniformly over the entire area to give an even level surface.

A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly damped with methylated spirit and rubbed lightly and quickly with circular motion. The finished surface shall have a high gloss and clear finish showing off the natural grains.

## **14.13 FRENCH POLISHING OLD SURFACES**

### **14.13.1 PREPARATION OF SURFACE**

The old polished surface shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper.

If the old polished surface is much soiled then it will be necessary to remove the entire polish; this shall be done as described in 14.16. French polish shall then be applied as for new work

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## **14.14 WAX POLISHING OF NEW SURFACES**

### **14.14.1 MATERIALS**

Proprietary wax polish or wax polish prepared as follows:

Pure bees wax free from paraffin or stearine adulterants shall be used. Its specific gravity shall be 0.965 and melting point shall be 63°C. The polish shall be prepared from a mixture of bees wax, linseed oil, turpentine and varnish in the ratio of 2: 1 ½ : 1: ½ by weight.

The bees wax and boiled linseed oil shall be heated over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and turpentine and varnish added to it in the required proportions and the mixture shall be well stirred.

### **14.14.2 PREPARATION OF SURFACES**

Preparation of surfaces shall be as described in clause 14.12.3 with the exception that knotting, holes and cracks shall be stopped with a mixture of fine saw dust formed of the wood being treated, beaten with sufficient bees wax to give it cohesion.

### **14.14.3 APPLICATION**

The polish shall be applied evenly with a clean soft pad of cotton cloth in such a way that the surface is completely and fully covered. The wax shall be allowed to remain overnight so as to soak into the pores of the wood. The next day the superfluous wax shall be wiped off and the surface rubbed with soft flannel to a fine polish.

## **14.15 WAXING OLD SURFACES**

The wood work shall be cleaned of all grease by washing with lime water. The surfaces shall then be washed with soap and completely dried. Then it shall be prepared smooth as specified in clause 14.14.2.

The polish shall be applied in the manner specified in clause 14.14.3

## **14.16 REMOVING OLD PAINT**

### **14.16.1 WITH PATENT PAINT REMOVER**

Solvent paint and varnish remove- this shall be applied by brush, to soften the paint or varnish film, to facilitate its removal by scraper. Several applications of the remover may be made, allowing sufficient time for the paint or varnish to soften right through. The surface shall then be cleaned with white spirit.

### **14.16.2 BURNING OFF**

This may be allowed for painted wood work where the heat of the flame will not affect the supporting surface and where the paint coating is not itself highly inflammable. Fire extinguishing equipment shall be at hand when using this method. Suitable precautions shall be taken when burning off lead paint.

### **14.16.3 FLAME CLEANING**

Flame cleaning with oxyacetylene (flame may be used on steel which is thick enough not to distort)

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**14.16.4 SCRAPING, ABRASION OR GRIT BLASTING MAY BE ADOPTED AS DIRECTED**

**14.17 PAINTING CAST IRON RAIN WATER AND SOIL PIPE**

**14.17.1 MATERIALS**

Short oil varnish, Red oxide paint, anti-corrosive paint (aluminium or bitumastic paint)

**14.17.2 APPLICATION**

Areas treated with Dr. Angen Smiths Solution shall be given a priming coat of short oil varnish. Over this priming coat shall be applied one coat of red oxide paint and two coats of anti-corrosive bitumastic or Aluminium paint as specified.

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## **15.0 MISCELANEOUS BUILDING WORKS**

### **15.1 DAMP PROOF COURSES**

#### **GENERAL**

Damp proof courses shall be laid for all walls. The damp proof course shall extend for the full thickness and shall be located or as shown in drawings or as directed by the officer-in-charge.

Note: Consideration shall be given to flooding and site drainage in deciding on the height.

#### **15.1.1 CEMENT CONCRETE LAYER**

This shall consist of cement concrete of specified proportions and thickness, where so specified, water proofing material of approved manufacture shall be added to the concrete mix in accordance with the manufacturer's specifications. The surface of brick work or stone work masonry shall be leveled and prepared before laying the cement concrete. Edges of the damp roof course shall be straight, even vertical. Side shuttering shall consist of wooden forms and shall be strong and properly fixed so that it does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the side formwork is removed, the surface revealed shall be smooth without any honey-combing.

#### **Curing**

The concrete shall be adequately cured after which it shall be allowed to dry.

#### **Application of Hot Tar**

The surface shall be properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil. Two coats of hot tar shall be applied at the rate of 0.25 litres per sq.m per coat.

#### **15.1.2 CEMENT MORTAR LAYER**

This shall consist of a 20 mm thick layer of cement mortar 1:2 finished with an application of two cents of hot tar applied at the rate of 0.25 litres per sq metre for each coat.

#### **15.1.3 VERIFIED BRICK DAMP COURSES**

These shall consist of at least two courses of vitrified bricks set and joined in cement mortar 1:3 and pointed to match surrounding work. The bricks shall conform to BS 3921 and shall not absorb more water than 3% of their weight when tested in accordance with BS 743.

#### **15.1.4 DAMP PROOF COURSES IN SHEETS OF BIUTMEN, POLYTHENE, LEAD OR CHOPPER**

These shall conform to BS 743 as regards materials and workmanship.

### **15.2 DAMP PROOFING OF WALLS/TANKING**

This shall conform to BSCP 102.\

### **15.3 FLOOR SCREEDS/ROOF SCREEDS**

Note: Screeds shall be provided over structural bases

- a) To provide a degree of level and smoothness to suit a particular floor finish where this is not provided by the structural base.
- b) To raise levels
- c) To provide slopes for drainage or
- d) To accommodate services

Unless otherwise stated the thickness and bay sizes of screeds shall be as per Table 17.1 below

Type	Base	Thickness	Bay Size
Monolithic	Concrete less than 3 hours old (No preparation for base)	12 – 25 mm	15m <sup>2</sup> max and length not
Bonded	Sound, clean concrete more than 3 hours old but not including water-repellent admixture. Base preparation conforming to clauses 11.2.3	40 mm (min)	Exceeding 1 ½ times the width
Unbonded	Damp-proof membrane or concrete which is weak, contaminated or includes water repellent admixtures	50 mm (min)	

### 15.3.1 MATERIALS FOR SCREEDS

Portland cement conforming to CS 107

Aggregates BS 882 and Max normal size 10

Building sands BS 1199

Workability additives shall be of approved manufacture.

### 15.3.2 MIXES

Unless otherwise specified, mix proportions (by weight) shall be as per table 17.2 below or as specified.

TABLE 17.2

Thickness of Screed mm	Cement	Fine aggregate (dry sand or crushed stone graded 5 mm down)	Coarse aggregates graded 10 mm down)
Upto 40	1	3 – 4 ½	
40 to 75			
Over 75	1	1 ½	3

Note: The cement aggregate ratio by weight shall not exceed 3. hatching by volume shall conform to clause 4.3.2.1

A mechanical mixer shall be used. Hand mixing shall be adopted with the permission of the officer-in-charge. The driest mix which can be thoroughly compacted with the means available shall be used. A sample squeezed in the hand shall ball together without water being forced out. Workability aide to attain low water cement ratios shall be used to the manufacture's instructions, if approved by the officer-in-charge.

### 15.3.3 The base shall be prepared as described in clause 10.2.3



#### **15.3.4 LAYING**

Screed concrete shall be laid in bays and thoroughly compacted preferably by means of screed vibrator. Excess of laitance shall not be drawn to the surface while vibrating. The surface shall be leveled with wooden screed boards and wood floated or trowelled to suit the flooring/roof finish as directed by the Officer-in-charge.

#### **15.3.5 TOLERANCE FOR LEVEL**

This shall conform to the tolerance for granolithic or other finishes. Please see clause 10.2.10

#### **15.3.6 CURING**

This shall be the same as for granolithic floor finishes.

### **15.4 WALL TILING AND MOSAIC WORK**

#### **GENERAL**

Internal wall tiling and mosaic work shall generally conform to BS 5385: Part 1 and external wall.

Tiling and mosaic work to BS 5385 Part 2

Where dedicated, sample areas shall be furnished and approval of the officer-in-charge obtained as regards materials and workmanship. The work on completion shall conform to the sample areas.

#### **15.4.1 MATERIALS**

##### **14.1.1.1 Glazed ceramic tiles and specials**

These shall be of approved manufacture and for internal work, shall generally conform to BS 1281. For external work and for heavy duty work those recommended by the manufacturers shall be used. The tiles for external use shall highly be vitrified and thicker than the internal tiles, and shall be glazed or unglazed as specified. Wall tile sizes shall generally conform to BS 1281. The following tile sizes are manufactured by the Wall Tiles Corporation.

4 ½	x 4 ¼
6"	x 6"
6"	x 3"
8"	x 4"

The tiles shall be flat or round edged, glazed or matt white or other approved colour as specified. The tiles shall be sound, hard well and evenly glazed, free from twist and crazing and true to shape. Tile fittings shall not be less in thickness than the tiles with which they are used. The tiles shall not be damaged or soiled during storage and handling.

##### **15.4.1.2 Mosaics**

Mosaics Tessere shall be glazed or unglazed ceramics of sizes supplied by the Ceylon Ceramics Corporation or as specified.

Note: -

These are assembled in the form of sheets to approved pattern and colour with Nylon nets glued to the back of surface or with paper glued to the face of the mosaic.

#### **15.4.1.3 Cement and mortar**

Adhesive where specified, as bedding material for ceramic tiles and misscis shall conform to BS 5980.

#### **15.4.1.4 Adhesives**

Adhesives where specified, as bedding material for ceramic tiles and mosaics shall conform to BS 5980.

### **15.4.2 FIXING**

#### **15.4.2.1 Fixing tiles**

A rendering of cement mortar 1:3 as specified shall be applied over the prepared surface of the wall. The rendering shall be finished with wood floats to give an even texture. The surface shall neither be trowelled nor overworked. No water shall be applied while working and excessive laitance shall not be drawn to the surface. The surface shall be left scratched with wire nail or other pointed tool to provide adequate key for the bedding mortar. The rendering shall be cured for a week and allowed to dry.

The rendering shall be at least two weeks old (or as specified by the manufacturer of the tiles) before the tiles are fixed. External tiling shall be started as the top and worked downwards. Before fixing tiles, the rendering shall be wetted and allowed to dry. Tiles shall be soaked in water for at least half an hour, then drained and stacked. One of the two methods of fixing tiles shall be adopted as approved by the officer-in-charge.

- a) The buttering method: the back of each tile shall be buttered with cement mortar 1:3 fill all frogs and other indentations filled and bedded solidly over the rendering. The thickness of bedding shall generally be 6 mm and shall in no case exceed 12 mm. The joint widths shall be uniform and normally about 2 mm.
- b) Floating method: The bedding mortar shall be applied to the rendered surface to a thickness of between 6 and 10 mm and allowed to stiffen for a short period. A plastic and rich cement mortar 1:2 using fine sand shall be applied to the bedding mortar and evened up. The tiles shall then be pressed on to this surface. Alternatively the tiles could be buttered with the rich fatty mortar and pressed into the stiffened bedding mortar.

A straight edge shall be used to ensure that the surface of the tiling is flat and true. Any adjustment of the tiles shall be made within 10 minute of fixing.

As the work proceeds, the joints shall be finished off with white (or coloured Portland cement to match the colour of the tiles) and very fine sand mixed in the proportion of 1:1 to paste like consistency; the entire surface shall be cleaned down using a damp cloth before any cement smears and surplus mortar begins to harden on the surface or in the joint spaces, care being taken to avoid any disturbances to the tiles.

If adhesives are used for bedding, specifications of the manufacturers shall be followed.

#### **15.4.2.2 Fixing Mosaics**

The background (of rendering) shall be prepared in a similar manner to tiles as per clause 15.4.2

Before bedding face-papered sheets, the joint cavities on the fixing side of the sheets shall be pregrouted with a grout of white (or coloured) Portland cement and very fine sand in the proportion of 1:1 mixed to a paste like consistency. The backs of mosaics shall be cleaned free of grouting material.

The bedding mix of cement mortar 1:3 shall be floated on to the back ground by trowelling to a thickness not exceeding 10 mm and finishing with a wooden float. A coat of neat cement paste shall be applied and the surface evened up. The bedding shall be allowed to stiffen slightly before mosaic is

applied. The mosaic sheets shall then be hung in position and firmly pressed back at their top edges and the pressure continued downwards until the sheets are firmly bedded.

After a few sheets have been so positioned, this area shall be beaten with a suitable flat implement to ensure good adhesion and a true flat surface. The paper shall be soaked with water, removed, and adjustment of the mosaic done within 10 minutes of fixing. When the work is firm, a grout shall be rubbed over the surfaces to fill any voids remaining in the joints and the work cleaned off with moist cloth. After the grout has hardened sufficiently the surface shall be washed down with water and left clean.

In the case of sheets with nylon backing pregrouting of joints between mosaics is not necessary. Post grouting of joints shall be done with a grout of cement and fine sand mixed in the proportion of 1:1 to paste like consistency as described before and the work finished off true and flat.

#### **15.5 FIBRE BOARD CEILINGS**

These shall be fixed as described above. Painting shall be as specified in Chapter 14.

#### **15.6 PROPRIETARY CEILING SYSTEM**

These shall be of approved manufacture and shall be fixed to the manufacturer's specification.

#### **15.7 PLASTERING FOR SLAB BEARING**

Particularly in exposed locations or where specified cement plaster 6 mm thick finished with a floating coat of neat cement and a thick coat of lime wash shall be applied on the top of the walls.

#### **15.8 WATER PROOFING OF REINFORCED CONCRETE ROOFS GENERAL**

Water proofing of flat roofs shall be of the best workmanship executed with utmost care and attention to detail so as to avoid failure. The slope specified shall be accurately provided.

##### **15.8.1 REINFORCED CONCRETE SLABS LAID FLAT**

Note: The roof shall be cured for at least 7 days by ponding water to a depth of about 50 mm. (Clause 5.4.6.1) after the curing period is over, the roof shall be allowed to dry for another three weeks and attain sufficient strength before laying the water proofing.

##### **15.8.1.1 The screed concrete**

A screed of a suitable design shall be laid over the flat slabs and finished to specified slopes. The screed shall be one of the following.

Note: On completion of beating, there shall be no voids and the surface shall be smooth and even. The surface shall be kept moist for a period of 7 days.

##### **15.8.1.2 Water proof cover**

The surface shall be finished in one of the following ways:-

##### **a) Tiling**

Two courses of flat tiles of sound manufacture and 150 x 100 mm or such other size as specified shall be laid in cement mortar 1:3 with non-volatile crude oil at the rate of 10% by weight of cement or water-proofing admixtures to the specifications of the manufacturers. The tiles shall be laid over a 10 mm thick bed of cement mortar with joints exceeding 6 mm,

and the joints of the 2 courses shall be staggered. Before the work dries up, the joints shall be raked up to about 6 mm pointed with the same mortar and pressed and rubbed over with thin bar trowels ( the excess mortar being scraped off) until the surface of the pointing attains a black polish. The edges of the tile layers shall be finished flush with the finishes for the edges of reinforced concrete slab with a 20 mm thick band of cement mortar 1:3.

b) Mastic Asphalt

The mastic asphalt shall be of the following composition by weight:

Sand	..	70 – 74%
Bitumen	..	15 – 13%
Filler (cement etc)	..	15 – 13%

The sand and bitumen shall be heated separately to about 200° C and bitumen added to the sand and stirred well. The filter shall be added when mixing

- a) Cement concrete 1:3:6 (20 mm) with a minimum thickness of 25 mm conforming to clause 4.
- b) Lime concrete (25 mm) with a minimum thickness of 50 mm composed of one part by volume of slaked lime to 2.5 part by volume of well burnt broken brick aggregate of maximum size 25 mm. No sand shall be incorporated. The brick aggregate shall be wetted thoroughly and mixed with lime adding just enough water to make it into a stiff paste.

This concrete is laid to a minimum of 50 mm in thickness and well beaten with wooden rammers 40 mm diameter and 1.2 metre long.

The surface of the roof shall be given a priming coat of bitumen, and while still cacky, the hot mastic should be poured on the surface, spread and tamped gently, smoothed out and worked with wooden float or trowels with sufficient pressure until it is free from voids and blow holes and a smooth homogeneous layer 12 mm thick is obtained.

The surface shall be sprinkled with a mixture of fine dry sharp sand containing about 10% of cement and rubbed with floats until a perfectly smooth surface is obtained.

The mastic shall be carried 75 mm up the walls or parapete previously painted with hot bitumen the angle between the wall and roof shall be rounded off and the part carried up the wall beveled.

c) Bitumastic Emulsion

This treatment shall consist of a priming coat applied to the roof and 230 mm up the parapet walls of Flintkote, Type 1 or equivalent emulsion diluted with about 5% of water at the rate of 0.75 litre/sq.m.s second coat shall be applied when the priming coat is dry, of the same but undiluted emulsion at he rate of 0.75 litre/ aq.m. On this layer. When still wet, a woven fabric shall be embedded, overlapping all joints by 100 mm. When this is dry, a priming coat of the same emulsion at the rate of 0.5 litre sq/m shall be applied over the membrane. A final water proofing coat of Flinknote, Type 7 or equivalent emulsion shall be applied by trowel at the rate of 2.5 liter/sq.m. A thick coat of lime wash shall be applied over the Flinknote to avoid excessive heat absorption.

d) Plastic Asphalt

The surface shall be cleaned thoroughly and a coat of Bituminous solution. PF.4 applied as primer. Care shall be taken that the surface is perfectly dry

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Plastic Asphalt shall then be applied in two thin layers each 1.5 mm thick, the second coat being applied after leaving the first coat to dry for four to six days.

- e) Bitumen felt roof covering

This shall conform to BS 747 for roofing felts and BSCP 144 for workmanship.

- f) Proprietary roof covering shall conform to the manufactures' instructions in all respects.

Note: For b,c & d one coat of clay tiles set in cement mortar 1:3 shall be provided where specified or directed.

## **15.8.2 REINFORCED CONCRETE SLABS LAID TO SLOPES**

15.8.2.1 The screeds shall be uniform in thickness and one of the following:

- a) A 12 mm thick layer of cement mortar 1:2 mixed with water proofing admixture to the instructions of the manufacture.
- b) A layer of cement mortars 1:3 treated with 2 coats of hot tar 3 mm thick and blinded with sand.
- c) Cement Concrete 1:3:6 (20 mm) 25 mm thick conforming to requirements of clause 4:1
- d) Lime concrete – 50 mm thick conforming to the requirements of clause 15:8.1

### **15.8.2.2 The water proofing cover**

This shall conform to 15.8.1.2

## **16.0 SANITARY INSTALLATIONS**

### **16.1 General**

Sanitary installation shall be carried out as per approved drawings and in accordance with the regulations of local authority. Pipes, appliances and fittings shall be approved manufacture conforming to the BS EN British Standards. Associated appliances appliances and fittings for e.g flushing devices and pans shall be compatible. The work shall be carried out by licensed/registered plumbers and shall be tested as such time and in such manner as the Engineer shall direct and to his satisfaction.

### **16.2 Appliances**

#### **16.2.1 General**

Selection, installation and requirements of appliances shall conform to BS 6465: Part I or be as specified.

a) Vitreous China

The quality of all vitreous china appliances shall conform to BS 6465.

The appliances shall be stored in the manufacturers packing or covered with polythene sheets and kept dry in covered sheds. Contact with lime and cement shall be prevented.

b) Cast Iron

Appliances made of Cast Iron like baths, sinks etc. shall be of remelted soft, tough, grey iron of a suitable mixture and a quality not less than grade 10 as specified in BS 1452. The minimum thickness of the finished casting shall be 4.76

c) Stainless Steel

Appliances of stainless shall conform with either of the following:-

- i. An 58 A of BS 1449 for steel plate, sheet and strip

Or

- ii. Stainless steel of composition 5% Nickel, 18% chromium and 8% Manganese with a minimum thickness of 0.91 mm (20 G)

d) Finish

- i. Vitreous Enamelling of Cast Iron or pressed steel sheet conform to BS 1344.
- ii. Chromium plating to appliances and fitting shall conform to BS 1224, service condition 3 finished bright or specified.

#### **16.2.2 Bath**

Baths shall be one of the following:

- a) Porcelain enamelled cast iron baths conforming to BS 1189. The cast iron baths shall be one piece construction.
- b) Cast Acrylic baths conforming to BS 4305.

The cast acrylic baths shall be of one piece made from

- i) Cast acrylic sheet of minimum thickness 8 mm or
- ii) Cast acrylic sheet of minimum thickness 3 mm. reinforced over its entire underside by a laminate of glass fibre and polyester resin.

#### **16.2.3 Overflows for Baths**

These shall be of approved manufacture and conform to BS 3380 Part I. They shall be straight, oblique angled or square angled, and shall be made of brass, stainless steel or plastic.

External surfaces of metal components shall be either of self colour, polished or Polished and plated as specified. Where applicable, plating shall comply with the Requirements of the service condition 2 of BS 1224.

#### **16.2.4 Wash Down Type Water Closets**

These shall be of vitreous china of approved manufacture, conforming to BS 5503. The closets shall be of one piece construction with an integral 100 'P' or 'S' trap with at least a 75 mm water seal. Where required, the closet shall have a 50 mm diameter vent horn on the outlet side of the trap. The flushing rim and inlet shall be self draining and so constructed as to permit ready access of air to the flush pipe at the end of the flush. There shall be provision for at least two holes less than 6.5 mm diameter for fixing to the floor.

Closets conforming to BS 5503 may also be used with the approval of the Engineer.

#### **16.2.5 W.C. Seats and Cover**

These should be of approved manufacture conforming to BS 1254. These shall be one of the types.

- a) Type 1 of Phenol plastics or amino plastics or (b) Type 2 of any suitable plastic material.
- b) The minimum thickness of the seat at its thickest point shall be 19 mm and the minimum thickness of the seat at its thinnest point shall be 4.7 mm excluding the rounded edges.

The cover shall be of 6 mm minimum thickness to within 25 of the edge. There shall be no sharp edges.

Buffers shall be made of synthetic or natural rubber-resilient and non-absorbent, or suitable plastic material.

Hinges and bolts shall be of chromium plated brass or other non-corrodible material.

#### **16.2.6 WV Flushing and Flush Pipes**

##### **16.2.6.1 Cisterns**

These shall conform to BS 1125. The cisterns shall be of cast iron, vitreous china, pressed steel or plastic as specified.

These cisterns shall be manually operated or automatic and high level or level as specified.

The cisterns shall be capable of discharging 9 litres in not more than 5 seconds when fitted with a high level type flush pipe and in not more than 6 seconds when fitted with a low level type flush pipe.

Note: Where specified, flushing cisterns for urinals, shall have a capacity of 5 litres be automatic and conform to BS 1876.

Cisterns shall be provided with a ball valve of 15 mm diameter (horizontal plunger type) conforming to BS 1212 and a polythene float of 150 mm diameter conforming to BS 2456. Flushing mechanisms shall be easy to operate but shall not self siphon or leak. When the operating mechanism incorporates a china pull, the chain and fixing links shall be of galvanised steel and strong enough to sustain a dead load of 50 kg. without causing apparent or permanent distortion to the cistern. The 'pull' shall be of galvanised steel, non-ferrous metal or suitable plastic. The finish shall be free from burrs. In the case of low level cisterns, the handle shall be chromium plated brass.

Cisterns shall have a removable cover of the same material as the cistern. Screws, bolts or other fixing shall be of non-corrodible material or protected against corrosion.

#### **16.2.6.2 Flush Pipes**

The flush pipe shall be medium quality galvanised steel tube not less than 1 mm thick, or of uPVC or a suitable co-polymer pipe (BS 3506) with a wall thickness of at least 1.5 mm. In the case of a high level cistern, the pipe shall have a nominal internal diameter of 32 mm and in the case of low level cistern, the internal diameter shall be 35 mm. After assembly of the flush pipe for low level cisterns, the seat and cover shall be capable of remaining in the raised position.

The over flow pipe shall be a 20 mm diameter galvanised steel uPVC pipe and shall have a noncorrodible mosquito proof brass cover having 1.25 mm diameter perforations.

#### **16.2.7 Bidets**

Bidets shall be of approved manufacture conforming to BS 5505. These shall be provided with a minimum of two floor-fixing holes. An overflow, if provided, shall have an aperture of not less than 600 sq.mm.

#### **16.2.8 Wash Basins**

Wash basins shall be of vitreous china of approved manufacture conforming to BS 6465 or acrylic sheet, or stainless steel of approved manufacture. Vitreous china wash basins shall be flat back/ angle back or other pattern and shall be white or of other specified colour.

The size of the wash basin shall be large / medium / small as specified. The basin shall have provision for two tap holes, a circular waste hole to suit 32 mm diameter waste and stud slots of adequate design to receive the brackets on the underside of the wash basin. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. A slot type of overflow having an area not less than 500 sq mm shall be provided.

Pedestals for wash basins, where specified shall be of the same manufacture. The quality of glazing of the pedestal shall be exactly the same as that of the basin with which it is to be installed. It shall be completely recessed at the back to accommodate the supply and waste pipes and fittings, and shall be capable of supporting the basin rigidly and adequately.

Pedestals for wash basins, where specified, shall be of the same manufacture. The quality of glazing of the pedestal shall be exactly the same as that of the basin with which it is to be installed. It shall be completely recessed at the back to accommodate the supply and waste pipes and fittings, and shall be capable of supporting the basin rigidly and adequately.



### 16.2.9 Sinks

- a) Fire Clay Sinks
- b) Stainless Steel Sinks
- a) Fire Clay Steels

Fire clay sinks shall conform to BS 1206 and shall be of one piece construction made out of white glazed fire clay. These shall be provided with an overflow. The flow of the sink shall gently slope towards the outlet which shall be suitable for a waste pipe of 50 mm conforming to BS 3380 Part 2. The overflow invert shall be 30 mm below the top edge of the sink.

- b) Stainless Steel Sinks

Stainless steel sinks shall be of approved manufacture conforming to BS 1244.

These shall be

Type A – single bowl, single drainer, right or left hand

Type B – single bowl, double drainer

Type C- double bowl, single drainer, right or left hand

The surface shall be free from pitting, ripples and undulations, cracks and dents. the stainless steel shall be asutentitio stainless steel complying with grades 302517, 302525. 304512, 304515, 604516 of BS 1449 Part 2. The thickness of the sheet before forming shall be a minimum of 0.83 mm.

The upper surfaces of the draining boards shall be back ledge, interior of the sink bowl and all fascia surfaces shall have any one or combination of the following finishes:

- a) Matt
- b) Stain
- c) Bright

Draining boards shall be ribbed or grooved and shall be inclined towards the sink bowl.

### 16.2.10 Waste Fittings for Wash Basins and Sinks

Waste fittings shall be of approved manufacture conforming to BS 3380: Part I, shall be of copper alloy of stainless steel, with integrally formed gratings and with or without overflow slots. Backnuts, chain and chain stay, tail pipe and coupling nuts shall of copper alloys or stainless steel. Waste plugs shall be of hard rubber, valcanised rubber or plastic and shall of watertight fit. Chains shall be fixed with a shackle to the overflow front grid or a bolt type stay to a hole in the appliance, or a screw type stay to the wall. Brass fittings shall be chromium plated to the requirements of service condition 2 BS 1224. Otherwise they shall be of self colour or polished.

### 16.2.11 Traps

#### General

Traps shall be of such design that do not allow accumulation of deposits. If the trap is not an integral part of the appliance, it shall be attached to and be immediately beneath its outlet and be self-cleansing. The internal surface of the trap shall be smooth throughout. Traps shall be accessible and shall be provided with facility for cleaning.

#### Depth of Seals

Traps with outlets for pipes upto and including 50 mm size shall have a minimum water seal of 75 mm.

Traps with outlets for pipes over 50 mm size shall have a minimum water seal of 50 mm.

Traps discharging to an external gulley may have a reduced water seal of not less than 40 mm.

#### Diameter of Tubular Traps

The size of tubular traps shall be not less than those given in Table 2.2

Table 2.2 Minimum Sizes of Tubular Traps

Type of Appliance	Size of Trap mm	Type of Appliance	Size of Trap mm
Wash Basin	32	Drinking Fountain	32
Bidet	32	Bar Well	32
Sink	40	Hotel or Restaurant	40
Bath	40	Kitchen Sink	
Shower Bath Tray	40	Bowl Urinal	40
Wash Tub	50	Urinal shall 1 to 6*	65
Food Waste Disposal Unit (Domestic)	40	Food-waste disposal Unit Industrial type)	50
		Sanitary Towel Macerator	50

Note: Where there are more than six stalls in one range, additional outlets shall be provided.

Traps shall be one of the following:

- Cast iron trap conforming to BS 437
- Copper alloy traps – upto 50 mm diameter conforming to BS 1184
- Plastic traps conforming to BS 3943

#### 16.2.12 Pillar taps

Pillar taps shall be of chromium plated brass and shall conform to BS 5412. The nominal size of pillar taps shall be the nominal bore of the pipe outlet to which it is attached. It shall be 15 mm or 20 mm as specified.

#### 16.2.313 Bib taps

These shall be of specified nominal size and shall conform to BS 1010 Part 2. Bib taps shall be of brass, smooth finished or chromium plated.

### 16.3 Pipe Work

#### General

Sanitary pipe work shall generally conform to BS 5572.

### 16.3.1 Materials

#### 16.3.1.1 Sand Cast Pipes and Fittings Conforming to BS 416

The metal used for the manufacture of cast iron soil, waste and ventilating pipes and fittings shall be of a quality not less than Grade 10 specified in BS 1452. The casting shall be sound and free from defects which render them unsuitable for their purpose. Every pipe and fitting shall ring clearly when tested for soundness by being stuck with a light hammer. The dimensions of straight pipes shall be as given in Table 1 of BS 416.

Fittings and their sockets and spigots shall conform to Table 1 to 30 of BS 416.

Pipes and fittings shall be supplied with or without ears as specified.

Pipes and fittings shall be capable of withstanding a hydrostatic pressure of 0.16 N/mm<sup>2</sup> without showing any sign of leakage.

#### Casting of Pipes

Pipes and fittings shall be thoroughly cleaned and then hot or cold coated.

The coating by either method shall be smooth and tenacious, sufficiently hard not to flow when exposed to a temperature of 63° and not so brittle at a temperature of 0°C that it chips off when scrubbed lightly with the point of a penknife.

Any pipe or fitting which is imperfectly coated by either method, or the coating of which does not set or conform to the quality specified, shall be re-coated.

Note: If coated pipes or fittings are to be painted after installation, a suitable barrier coat should be applied by the purchaser.

#### 16.3.1.2 uPVC Soil and Ventilating Pipes, Fittings and Accessories

These shall be of approved manufacture conforming to BS 4514. Dimensions of pipes and fittings shall be as follows:-

Nominal Size mm	Mean Outside Dia. mm	Minimum Wall Thickness mm	
		Pipe	Fitting
82	82.6	3.2	3.2
110	110.2	3.2	3.2
160	160.3	3.3	3.5

Pipes shall be 1.8, 2.4, 3.0 & 3.6 meters long as specified.

#### 16.3.1.3 Plastic Waste Pipes

These shall be of one of the diameters are to be indicated below or any other as specified in the drawings and conform to BS 5255.

#### 16.3.1.4 Wire Ballons

These shall conform to BS 416 Table 22. These shall be made of copper wire with 4 Nos. 2.337 mm (13 G) legs and wrapping 1.6 mm (16 G) to give a maximum mesh of 19 mm.

#### 16.3.2 Jointing

All joints made in pipe work and joints of pipe work to appliances shall be airtight and watertight and shall remain so during use. Care shall be taken to ensure that no jointing material projects inside the bore of the pipe, is present. Thermal or other movements in pipe lines or between pipe work and appliances shall be taken care of by making the pipe work flexible and capable of accommodating such movements.

The jointing shall be suitable for the material of the pipe or fitting. Cast iron pipes with spigot and sockets shall be jointed by caulking with molten lead, fibrous lead yarn, cold caulking compounds or by using rubber gaskets as specified.

Plastic pipes (uPVC) shall be jointed by solvent weld or joint rings. Where jointing is with cement mortar, this shall be of 1:3 composition.

Jointing and caulking compounds, cement, gaskets, washers and other jointing material shall be of the type recommended by the pipe manufacture. Manufacturer's recommendations on installation of pipe work shall be strictly followed.

Where pipes pass through walls or slabs, these shall be wrapped with a layer of inert material. Alternatively, sleeve pieces shall be used for the full thickness of slabs or walls through which the pipe passes.

#### 16.3.3 Supporting and Fixing of Pipes

External pipe work shall be fixed clear of the face of masonry by at least 30 mm so as to give free access all round the pipes for the application of paint or other protective coating. Fixing shall be carefully aligned.

The distance between pipe supports shall not exceed the following:

Type of Pipe	Vertical Metre	Horizontal or Low Gradient Metre
Cast Iron	3.0	1.8
uPVC		
32 mm – 40 mm	1.2	0.5
50 mm	1.2	0.6
75 – 100 mm	1.8	0.9
150 mm	1.8	1.2
Galvanised steel		
25 mm	3.0	2.4
32 mm	3.0	2.7
40 – 50 mm	3.7	3.0
65 – 75 mm	4.6	3.7
100 mm	4.6	4.0

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At least one fixing shall be provided for each length of pipe or fitting:

The type of fixing shall be as follows:-

a) Cast Iron Pipe

- i. Cast Iron pipes shall be fixed by using the ears on the pipe sockets. The pipes shall be screwed on to plugs of hard wood with stout iron pipe nails.
- ii. They may also be fixed by means of cast iron, malleable iron or steel holder bats, for building in or screwing to the wall.
- iii. Purpose made straps or hangers may also be used for fixing in which case these shall be made from 16 G. galvanised mild steel flats.

b) uPVC Pipes

Holdersbats of metal, plastic coated metal or suitable plastic materials shall be used but care shall be taken to ensure that the pipe clip does not bite into the external surface of the pipe when tightened.

**16.3.4 Installation**

Care shall be taken to protect the work and prevent the entry of foreign matter into any part of the system during construction. Openings shall be kept sealed with purpose made fittings. Special care shall be taken with pipe systems having real seal joints to prevent deflections of the joint after the pipe work is assembled. Pipe work shall not be allowed to carry any external load either during or after construction.

Pre-fabricated units shall be tested at the works or place of fabrication and inspected on delivery at the site.

Testing of pipe work shall conform to clause 12.3 of BS 5572 given below.

**16.3.5 Inspection and Testing**

Inspection and testing shall be carried out during the installation of the discharge system (ie. As the work proceeds) to ensure that the pipe work is properly secured and clear of obstructions from debris and superfluous matter and that all work which is to be concealed is free from defects before it is finally enclosed. A similar check shall be made on completion of the work.

Pre-fabricated units shall be tested at the works or place of fabrication and inspected on delivery at the site.

Testing of pipe work shall conform to Clause 12.3 of BS 5572 given below.

**16.3.5.1 Testing**

Soundness Test (Air test)

Normally this test to detect if all pipes and fittings are air-tight, shall be completed in one operation, but for large multi-stored systems testing in sections will be permitted.

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## Preparation

The water seals of all sanitary appliances shall be fully charged and test plugs or bags inserted into the open ends of the pipe work to be tested. In order to ensure that there is a satisfactory air seal at the base of the stack, or at the lowest plug or bag in the stack if only a section of the pipe work is to be tested, a small quantity of water sufficient to cover the plug or bag can be allowed to enter the system.

One of the remaining testing plugs shall be fixed with a tee piece, with a cock on each branch, one branch being connected by means of a flexible tube to a manometer. Alternatively a flexible tube from a tee piece fitted with cocks on its other two branches, can be passed through the water seal of a sanitary appliance. Any water trapped in this tube should be removed and then a manometer can be connected to one of the branches as described above.

## Application

Air is pumped into the system through the other branch of the tee piece until required pressure is obtained. The air inlet cock is then closed and pressure in the system should remain constant for a period of not less than three minutes.

### **16.3.5.2 Leak Detection**

Defects revealed by an air test may be located by the methods given in 2.3.5.2.1 to 2.3.5.2.3.

#### **16.3.5.2.1 Smoke**

A smoke producing machine may be used which will introduce smoke under pressure into the defective pipe work. Leakage may be observed as the smoke escapes. Smoke cartridges containing special chemicals shall be used with caution, taking care that the ignited cartridge is not in direct contact with the pipe work and that the products of combustion do not have a harmful effect upon the materials used for the discharge pipe system.

Smoke testing of plastic pipe work shall be avoided due to naphtha having a detrimental effect, particularly on Abs, uPVC, MUPVC. Rubber jointing components can also be adversely affected.

#### **16.3.5.2.2 Soap Solution**

With the pipe work subjected to an internal pressure using the smoke machine or the method described in 2.3.5.1 a soap solution can be applied to the pipes and joints. Leakage can be detected by the formation of bubbles.

#### **16.3.5.2.3 Water Test**

There is no justification for a water test to be applied to the whole of the plumbing system. The part of the system mainly at risk is that below the lowest sanitary appliance and this may be tested by inserting a test plug in the lower end of the pipe and filling the pipe with water up to the flood level of the lowest sanitary appliance, provided that the static head does not exceed 6 meters.

### **16.4 Installation of Sanitary Appliances**

Appliances shall be so sited that there is adequate light for the user and also for proper cleaning.

All exposed appliances, pipe work and controls shall be so arranged as to facilitate cleaning, maintenance and repair. Pipe work shall be fixed clear of walls for easy cleaning and painting. The

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distance between the level of the tap outlet and the spillover level of a bath, wash basin, sink or similar sanitary appliance shall not be less than 13 mm.

There shall be space around taps for cleaning.

Fastening like screws, bolts, nuts washers shall be of anti corrosive material like bars.

#### **16.4.1 Supports for Appliances**

Supports shall be adequate to support the dead weight of the appliance and the load which may be placed in it or on it.

Unless the appliance is designed to be fixed clear of walls and/ or floor, the supports shall be such as to permit the appliance to be sealed into or against the wall or floor with a permanently impermeable joint.

The general type of supports shall be classified as follows:-

- a) Wall supports, including brackets of various types and wall hung supports in which a part of the appliance is built into the wall.
- b) Floor supports, where the appliance rests directly on the floor or is supported by a pedestal, feet or leg resting on the floor.
- c) Cradles, charis and similar frames
- d) Combination of the above types.

In no circumstances shall any pipe work or other plumbing be relied upon, for support or fixing.

All fixing screws shall be of non ferrous metal or stainless steel. Brackets or other supports shall be cast iron or galvanised steel whether subsequently painted or not.

Brackets shall be of adequate and securely fixed, having regard to the cantilever effect of the weight of the appliance fully loaded. Brackets shall be provided with lugs for building into the structure or may be screwed to proper plugs inserted into carefully prepared holes. Plug, if of wood, shall be of durable hard timber.

Appliances supported on floors shall be bedded solidly on a level and even base.

Sanitary fittings of large size e.g baths, which are designed for floor support, shall be provide with adjustable feet to correct irregularities in levels.

Sanitary appliances made of acrylic and other plastics shall be provided with continuous supports such as cradles.

#### **16.4.2 Workmanship**

Chases and ducts: A check shall be made to ensure that all holes, chases and ducts required for pipework have been properly provided.

Delivery and storage: Before delivery, arrangements shall be made for storage of appliances under cover to prevent damage. Upon delivery, these shall be checked carefully to ensure that they are in accordance with requirements and free from defects or damage.

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Before fixing the appliances a check shall be made to ensure that the required brackets etc. for fixing have been properly embedded and the wall finishes completed.

Water supply and discharge pipe lines shall be installed before the appliances are fixed. Before installing appliance, it is necessary to make sure that the discharge pipe is clear of obstruction. Joints between appliances and traps and/or pipes shall be of the union or detachable type.

All offices shall be temporarily plugged during progress of the works to prevent obstruction.

All offices shall be temporarily plugged during progress of the works to prevent obstruction.

Attention should be given to the possibility of movement and settlement from other causes. Where pedestal WC pans are set on solid floors in cement mortar, the mixture shall not be richer than 1:3. Only a thin layer must be used under that part of the pedestal which is in contact with the floor, otherwise there is danger of the appliance cracking as the mortar sets. Where WC installations are set on solid floors, proper provision shall be made in the floor to receive the fixing screws.

Sinks and baths shall be so fitted that they drain to the outlet. Cistern overflow pipes shall be so arranged as to give visible warning of discharge and the flow led into the outlet directly.

#### **16.4.3 Inspection and Testing**

Inspection upon completing of the work, all appliances shall be carefully examined for faults in installation which shall be corrected before the appliances are handed over for use.



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## **PART II**

### **1.0 GENERAL REQUIREMENTS**

#### **1.1 Introduction to the Specifications**

This part (Part II) of the specifications relates principally to the design, selection, erection, inspection and testing of electrical installations in and around the buildings and is intended to provide safety, especially from fire, shock and burns and to ensure satisfactory operation with a minimum of maintenance over a long period of time.

This part of the specification should be read in conjunction with part I (General Requirements) of the specification the conditions of contract published by ICTAD and the particular specification of the respective services installation and constructed as a whole for the complete specification.

#### **1.2 Scope of work**

This part of the specifications covers the design, manufacture, inspection and testing, erection, connection, site testing, setting to work, commissioning and energizing the electrical installations and maintenance during the defects liability period of the contract. It is intended to provide safety, especially from fire, shock and burns and to ensure satisfactory operation with a minimum of maintenance over a long period of time.

Co-ordination with the electricity supply authority for obtaining the required power supply at the premises and payment of all inspection and testing fees shall fall within the scope of work.

#### **1.3 Drawings**

Shall be generally as in Clause 3 of Part I of this specification. Only specific requirements relevant for the electrical installations are indicated below.

##### **1.3.1 Tender Drawings**

The Tender drawings shall serve to indicate the general layout of various items and equipment of the electrical system and cable routes. These shall be diagrammatic unless specifically identified and dimensioned.

The Tender drawings shall not necessarily indicate every required fitting, elbow, transition box, junction box; pull box or similar items required for the complete installation.

Other than in are as of particular importance where branch circuits and associated cables and conduit routing are shown, the Contractor shall provide all required branch circuit conduit and cables as required to serve equipment and accessories in order to make the system functional.

##### **1.3.2 Working Drawings or Shop Drawings**

Prior to commencement of any work the Contractor shall prepare and submit three copies of working drawings or shop drawings for approval by the Engineer. The drawings shall provide all relevant details and layout arrangements of conduit, cables wiring and equipment.

The drawings shall be prepared to recognized drawing office standards, be properly labeled and dated, with references for easy identification. The drawings and documents shall show conduit and wire ways, joints pull boxes and all features and positions of other switch gear that are to be installed.

#### **1.4 Standards and Regulations**

All materials and work shall comply with the appropriate latest British Standard Specification, the recommendations, of the International Electro-technical Commission, BS Codes of Practice for electrical installations.

Alternative specifications may be recognized where such represents a standard not less rigid than that specified above subject to the approval of Engineer..

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The electrical installation shall comply with the latest requirements of the Electricity Supply Authority, standard specifications of the British Standards Institution or the Regulations for Electrical Installation issued by the Institution of Electrical Engineers, London (IEE Wiring Regulation), the current edition being the 16<sup>th</sup>.

**1.5 Electricity Supply**

Electricity supply to the premises will be 400 V, three phases, four wires or 230V, two wires at 50 Hz. The neutral of the incoming supply is solidly earthed at the source and connection of the neutral to earth at any other point is not allowed. The distribution system together with the consumer's installation shall from a TT system.

**1.6 Materials and Samples**

All materials and equipment supplied shall be new and in accordance with Clause 7 of Part 1 of this specification.

Whenever called for by the Engineer, sufficient number of samples of the material to be supplied and the materials used in the installation shall be the same and/or identical to the samples submitted and accepted by the Engineer.

**1.7 Manufacturer's Data**

Manufacturer's data sheets giving type reference, performance characteristics, dimensions, weights, installation instructions, wiring diagrams etc. shall be supplied for all equipment supplied.

**1.8 Accessibility**

Wherever possible all equipment and switchgear which must be serviced, operated and maintained shall be located in fully accessible position

**1.9 Setting out of Work**

The Contractor shall be responsible for the accurate setting out of the works, in relation to original points, lines and levels of reference given by the Engineer.

The dimensions given in the drawings shall be checked against actual site measurements and exact relationship of the adjacent existing structures, services, or works to the proposed work shall be established. If any errors are found in positions, levels, dimensions, alignments etc., such errors shall be notified to the Engineer.

Where the work of the contract involve installation in close proximity to the work of others and where there is evidence that the work of the contract will interfere with the work of others, the Contractor in consultation with the Engineer shall plan out a co-ordinating procedure to make satisfactory adjustments if necessary with respect to working space, point of connection etc. In which case necessary drawings shall be prepared and submitted to the Engineer for approval.

If the installation within the contract is undertaken before co-ordinating with others and as specified above or so as to cause interference with the work of others, necessary changes in the work to correct conditions shall remain the sole responsibility of the Contractor.

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## **2.0 WIRING SYSTEM USING PVC INSULATED OR SHEATHED CABLES**

### **2.1 PVC – Insulated and Sheathed Cables**

Cables shall comply with BS 6004 or BS 6346 (SLS 733): Cables can be either copper or aluminium conductors as per the particular specification.

### **2.2 Boxes for the Enclosure of Electrical Accessories**

Boxes shall be insulating material or suitable metal and shall comply generally with BS 4662.

### **2.3 Electrical Accessories**

Electrical Accessories, eg: switches and socket outlets, shall comply with appropriate Sri Lanka Standards, British Standards or IEC regulations and Chapter 7 of this specification.

### **2.4 Electrical Accessories**

Joint boxes shall be made from non metallic material to comply with BS 4662. They may be provided with or without brass terminals.

### **2.5 Installation**

Cabling shall run in conduits or cable traces, or on surfaces or structures. Routes shall be approved by the Engineer.

#### **2.5.1 Plastic Casings**

All down and horizontal runs of cables shall be enclosed in casing fixed to walls and secured with brass screws driven not more than 450 mm apart to dovetailed wooden plugs or PVC rawl plugs buried in the walls.

Wiring above a horizontal ceiling shall be secured to the roof timbers with wiring clips and pins spaced not more than 225 mm apart. In semi-permanent buildings or covered ways, where no ceiling is provided, the wiring shall be the same as for wiring above the horizontal ceiling.

Rigid PVC conduit shall be used to protect cables through walls.

#### **2.5.2 Segregation of Services**

Cables shall run at least 160 mm clear of non-electrical services.

#### **2.5.3 Protection of Cables**

Cables buried in wall finishes shall be protected throughout their entire length by one of the following means, as indicated on drawings:

- close joint light gauge steel oval conduit having protection against corrosion in accordance with class 2.
- light gauge steel conduit (Class A) complying with BS 31 (plain) or complying with BS 4568 having protection against corrosion in accordance with Class 2.
- rigid PVC conduit complying with Clause 3.3
- non-circular conduct of channeling manufactured from rigid PVC.

Ends of conduits shall be so finished as to prevent abrasion of the cable insulation when cables are being drawn in or out of conduits or connected to apparatus. Bushes for use with metallic conduits may be of rubber or PVC.

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Where conduit buried crosses an expansion joint in the concrete, it shall be wrapped with water-proof building paper for a distance of 300 mm on either side of the joint. Any alternative method of protecting the conduit against stresses due to expansion shall be approved by the Engineer.

Cables buried in concrete floors shall be protected throughout their entire buried length by means of heavy gauge welded conduit (Class B) complying with Clause 3.2 or rigid PVC conduit complying with Clause 3.3.

Conduit buried in concrete shall have at least 35 mm. depth of cover over its entire length. Conduit buried in plaster shall have at least 5 mm depth of cover over its entire length.

Where conduit is buried in the carcass of a building or in the ground, all open ends shall be temporarily plugged to prevent ingress of foreign matter, moisture or water during and after construction.

Where conduit buried crosses an expansion joint in the concrete, it shall be wrapped with water-proof building paper for a distance of 300 mm on either side of the joint. Any alternative method of protecting the conduit against stress due to expansion shall be approved by the Engineer.

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### **3.0 WIRING SYSTEM USING PVC CABLES ENCLOSED IN CONDUIT OR TRUNKING**

#### **3.1 Wiring System**

The wiring system shall use PVC insulated cables of 300/500 V rating complying with BS 6004 or BS 6364 enclosed in,

- Screwed metallic conduit
- PVC conduit

Where other conduit systems are to be used they shall be to the approval of the Engineer. PVC and metal conduits shall not be used together in the same installation. The wiring system shall be such that the cables are fully protected. The conduits used shall be of adequate sections to allow easy drawing 'in' and 'out' anyone of the cables or all cables in the conduit.

#### **3.2 Steel Conduits and Conduit Fittings**

Steel conduits and conduit fittings shall comply with BS 31, BS731 or BS4568 and shall be of approved manufacture. No conduit smaller than 20 mm in diameter shall be used other than in instances where only two wires are run in a conduit. The inside surface of conduits and all fittings shall be smooth and free from burrs and all other defects. The conduits used for surface wiring shall be heavy gauge screwed seamless steel.

##### **3.2.1 Protection against Corrosion**

The steel conduits and fittings installed shall be protected against corrosion to the class of protection given in the particular specification.

##### **3.2.2 Adaptable and Junction Boxes of Metal**

Substantial boxes of ample capacity shall be provided at every junction involving a cable connection in a conduit system and at suitable points to allow easy drawing 'in' or 'out' of any or anyone of the cables or all the cables in a conduit.

Conduit boxes shall be properly looped.

If runs of conduits must run from a danger area to a safe area, a sealing device or a stopper box shall be provided at the point where conduit enter the safe area. These boxes shall conform to BS 4662.

##### **3.2.3 Termination of Conduits**

Where the conduit terminate at a junction box, looping box, inspection box or other metal case, a screwed socket shall be employed and so arranged as to be in good mechanical and electrical contact with the metal case with an internal hexagonal brass bush screwed into the socket from inside the case and the two locked together. Plain slip or pingrip sockets shall not be used.

##### **3.2.4 Spacer Bar Saddles and Distance Saddles**

The surface conduits and fittings shall be fixed to the walls, roofs, ceiling etc., by means of heavy gauge spacer bar saddles in such a manner that all the cables can be drawn in at any time after the installations of the conduit pipes.

The spacing of supports shall be as given in Table 11C of the IEE Wiring Regulations.

In addition, at bends, sets or boxes the conduit shall be fixed on either side.

On girders, the conduit and fittings shall be fixed by means of adjustable girder clips.

### **3.2.5 Conduit Couplers and Bends**

Conduit couplers shall be of the screwed type. Running joints shall be provided with backnuts. Stock bends shall be formed at site to suit the local conditions.

Radius of every conduit bend other than a bend complying with BS 4568 (Steel) or BS 4607 (PVC) shall be such as to allow compliance with Table 52C of 15<sup>th</sup> Edition of IEE Regulation and in any event, the radius of the bend shall be not less than 2.5 times the outside diameter of the conduit.

### **3.3 Rigid PVC conduits and Conduit Fittings**

PVC conduits and fittings shall conform to BS 4607: Part 1 and shall surface mounted or buried in the walls or in floor slabs. Conduits shall be mechanically continuous and water tight so that the cables are fully protected. No conduit smaller than 20 mm in diameter shall be used.

#### **3.3.1 Boxes (Adaptable for Accessories) of Plastic Material**

Boxes of plastic material shall be of moulded construction and shall conform to BS 4662. The boxes shall be provided with spouts for outlets and provision shall be made for a brass terminal for earth continuity conductor. Other types of boxes shall be to the approval of the Engineer.

### **3.4 Adhesive Tape**

Black adhesive tape is used to insulate soldered joints in elastomer cables. In the case of PVC insulated cables, PVC insulating tape and PVC adhesive tapes shall be used to insulate the soldered points.

### **3.5 Installation**

#### **3.5.1 General**

The conduits shall be erected and completed before any cables are drawn in. the corners of conduit pipes shall be turned by easy bends without altering the section. The use of manufactured bends are not permitted. All metal or PVC boxes for mounting fittings shall be secured to wall or ceiling at least by two brass screws by an approved method.

Conduit systems not designed to be sealed shall be provided with suitable outlets to drain – off the moisture condensate within the system.

Electrical conduit shall be distinguished from pipelines of other services by a basic identification colour in compliance with BS 1710.

All pipe work shall be adequately supported by means of standard or purpose made clips so that no movement or distortion of pipe takes place except that necessary to take up the expansion or contraction of pipe work with the changes in temperature.

Flexible or pliable conduit shall not be used as protective conductor.

Conduits being installed in reinforced concrete floor slabs or columns shall be placed and securely tied to the reinforcing steel prior to concrete being poured. All conduit ends shall be completely sealed against the ingress of concrete and immediately following the pouring of concrete shall be swabbed out and a pull wire installed prior to the ends being plugged.

The metal conduit shall be bonded to earth to keep the electrical resistance of the conduit with the earthing lead measured from the connection with the electrode to any other position in the completed installation not to exceed 1 ohm. The ends of every earth continuity conductor whether stranded or solid shall be connected to the conduit pipe by screwed or grip joints to enable it to give ample and permanent electrical conductivity and mechanical rigidity.

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### **3.5.2 Trunking**

Trunking shall be to BS 4678 and be securely fixed and adequately protected against possible mechanical damages.

Every entry to finished trunking shall be so placed as to prevent the ingress of water or be protected against such ingress.

Spacing of supports for fixing trunking shall be in accordance with Table 11D of Appendix 11. The cable capacities of trunking shall be as given in Table 12E and 12F of Appendix 12 of IEE Regulations.

In every vertical trunking containing cables or conductors internal barriers shall be provided so as to prevent the air at the top of the trunking from attaining an excessively high temperature. The distance between barriers shall be distance between floors or 5m which ever is lesser.

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#### **4.0 WIRING SYSTEM USING ELASTOMER OR PVC INSULATED MULTI-CORE CABLES**

##### **4.1 General**

The details of installations given in the Appendix 9 of the IEE Regulations are to be observed. PVC insulated cables shall be used in all wiring systems unless otherwise specified.

##### **4.2 Elastomer – Insulated Cables-Unarmoured**

These shall be used for voltage of 600/1000 range and shall conform to BS 6899, BS 116 or BS 6007.

Butyl rubber and ethylene propylene rubber materials shall be used as insulation where temperature does not exceed 80°C.

##### **4.3 Elastomer – Insulated Cables-Wire Braided**

These shall be used where additional strength is required for the cable (to avoid breaking of the cable)

##### **4.4 PVC Insulated Cables-Unarmoured**

These shall conform to BS 6004, BS 6346. These shall be used where the conductor temperature does not exceed 65°C.

##### **4.5 PVC Insulated Cables-Armoured**

These shall generally conform to BS 6346 where armoured cables are laid in ground. Wire armouring shall be used if the ground is liable to subsidence, to prevent cables from breaking. If physical damage from stones or workmen's tools is expected steel tape armouring shall be used.

Whenever XLPE cables are used BS 5467 shall apply.

##### **4.6 Cable Supports**

Every cable and conductor used as fixed wiring shall be supported in such a way that it is not exposed to undue mechanical strain. The method of supports shall conform to Appendix II of the IEE Regulation.

##### **4.7 Cable Glands**

These shall conform to BS 4121 or BS 6121:1973 where appropriate. These shall be installed such that the sheath or armour of the cables shall be securely retained without damage.

##### **4.8 Installation**

Cables shall be supported by means of insulators, cleats or saddles and clips when used indoors.

Unarmoured cables in ground shall be enclosed in metal or rigid PVC conduit.

Joints of cables to BS 6004 shall in general be made in a joint box or in an accessory. Joints will not be permitted in BS 6346 cables. Where joints are unavoidable all U.G. joints shall be made in a resin type joint box. Joints above ground shall be to the approval of the Engineer.

All terminations for BS 6346 cables shall be provided with a cable gland. In BS 6004 cables, the sheath should enter the fitting or the accessory.



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## **5.0 SWITCHGEAR, DISTRIBUTION BOARDS, CIRCUIT BREAKERS, CONTACTORS AND BUSBAR CHAMBERS**

### **5.1 Rated Voltage and Frequency**

The rated voltage shall be 400/230 V, AC and the frequency shall be 50 Hz.

### **5.2 Enclosures**

Enclosures shall be provided to protect all equipment against external influences and to have a protection against contact with live parts.

For factory built equipment this requirement is considered to be satisfied if the equipment conforms to the relevant British Standard Specification.

Enclosures provided during erection shall comply with Regulations 412 – 3 to 412 – 6 of the Wiring Regulations. Further they shall provide a degree of protection appropriate to the environment where they are used.

Enclosure for outdoor use shall provide a degree of protection not less than IP 54 conforming to BS 5490.

### **5.3 Fuses**

Semi-enclosed rewirable fuses shall comply with BS 3036:1958. Cartridge type fuses shall comply with BS 88:Part II: 1975 or BS 1361:1971 or the latest.

### **5.4 Switchgear**

Circuit breakers shall be of the air-break type and comply with BS 3871, BS 4572 – Part 1 and IEC 157-1.

Air break switches, disconnectors, fuse switches, switch fuses etc., shall comply with BS 5419. all equipment shall be designed to carry the rated currents continuously and the utilization category shall be AC 22 unless otherwise specified.

All switchgear shall be fitted with a reliable indicating device, indicating the position of the moving contacts if the contact separation is not externally visible.

### **5.5 Distribution Boards**

Distribution boards shall be S.P. & N.T.P. or T.P. & N as specified in the design.

Fuse distribution boards shall generally comply with the requirements of BS 5486: Part II.

Wooden fuse boards shall be to the approval of the Engineer.

M.C.B. boards shall comply with B.S. 5486: Part III.

Every distribution shall be provided with a multi-terminal earthing conductor.

### **5.6 Consumers Control Units**

Consumer units shall comply with BS 5486: Part 13 and shall be fitted with an incoming switch or a MCCB as specified.

### **5.7 Moulded Case Circuit Breakers and Enclosures**

MCCBs shall comply with BS 4752 Part I or BS 3871: Part II or IEC 157-1 and the enclosures shall meet the requirements of clause 5.2. MCCB's shall be fitted with magnetic over load and thermal circuit protection.

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### **5.8 Miniature Circuit Breakers**

MCBs shall comply with BS 3871: Part I and be provided with thermal overload and magnetic short circuit protection with time lag features.

### **5.9 Busbar Chambers and Busbars**

Busbar chambers shall be fabricated from sheet steel stiffened and braced as necessary and shall generally comply with the requirements of BS 5486: Part I.

These shall be rust protected and provided with removable end, top and bottom plates.

The busbars shall be of copper or aluminium of adequate cross section and the design shall be such that connection can be made by clamping without the necessity for drilling.

The busbars shall be of tinned copper or aluminium alloy coloured in their respective phase colour or encapsulated in insulation.

Busbars shall, in addition to being spaced at such intervals to give the necessary air clearance for the voltage rating, be completely insulated in an approved manner. Primary busbars, connections and their supports shall be capable of carrying the short time current associated with their short circuit ratings for a period of 3 seconds.

The connections from busbars in individual units shall have a continuous current rating of not less than that of the equipment comprising the unit.

Primary busbars shall be clearly marked and shall be displaced for standard phase sequence and shall be readily extensible. Busbars where installed shall be rated to withstand at any position the full fault level related to the largest protective fuse that could be used with the main isolator.

### **5.10 Iron Work for Switch Frames**

Mounting structures and frames shall be of steel. These shall be of sufficient size and strength to ensure rigidity and freedom from vibration and rust protected. All switchgear shall generally be fixed to the steel frames.

### **5.11 Installation of Main Switchgear and Associated Equipment**

Factory built assemblies shall be installed in accordance with manufacturer's installation instructions.

All cables that terminate on the switchgear assembly shall be provided with cable glands, clamps, cable end boxes etc., as required by the wiring.

All conduits, trunking, ducts etc., shall be terminated on the switchgear structure without impairing the degree of protection provided by the enclosure.

All switchgear shall be rigidly fixed or mounted on DIN rails and should be able to withstand the normal thermal & mechanical stresses and dynamic stresses due to switchgear operation.

All switchgear shall be installed so as to ensure easy of operation and maintenance.

Site built assemblies of main switchgear shall generally comply with the above requirements and shall be to the approval of the Engineer.

### **5.12 Identification of Switchgear and Distribution Boards**

Labels shall be provided for all instruments and components mounted on the front of each control panel. Where a group of pilot lights and control switches are associated with one item of the plant a common label will be used which will surround the components of the group.

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Within panels adequate labeling shall be provided using white letterset "Helvetica Medium 24 PT" labeling shall be capital letters on the trunking lids coated with hard varnish for all fuses, relays, control equipment etc. such labeling shall correspond in detail with item numbers for additional identification of equipment.

Where the operation of switch gear and control gear cannot be obtained by the operator and where this might cause a danger, a suitable indicator, complying with BS 4099 where applicable shall be fixed in a position visible to the operator.

Protective devices shall be arranged and identified so that the circuit protected may be easily recognized; for this purpose it may be convenient to group them in distribution boards.

Diagrams, charts or tables shall be provided indicating in particular symbols conforming to BS 3939. (Please see Annexure B)

- the type of composition of circuits (Points of utilization served), number and size of conductors typing of wiring, and
- the information necessary for the identification of devices performing the function of protection, isolation and switching and their locations, and
- a description of earth protection afforded.

Every item of equipment or enclosure within which a voltage exceeding 250 volts exists and where the pressure of such a voltage would not normally be expected, shall be so arranged that before access is gained to live parts a warning of the maximum voltage present is clearly visible.

Access should be restricted by an appropriate transparent material on which the voltage underneath is clearly marked.

#### **5.13 Surge Protectors and Arrestors**

Current Transformers provided for monitoring and controlling and protection should be in accordance with IEC 44.

#### **5.14 Current Transformers**

Current Transformers provided for monitoring and controlling and protection should be in accordance with IEC 44.

#### **5.15 Low Voltage Main Switch Board (110 – 1000V)**

Main switch boards shall conform to IEC 439, 1-3. The enclosure and switch gear inside assembly should be designed to withstand mechanical stress in case of a severe fault condition. The degree of protection of enclosures shall conform to the IEC 529 and meet the specified requirements.

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## **6.0 APPARATUS INCLUDING WIRING ACCESSORIES**

### **6.1 Accessories**

All accessories if not made in accordance with the requirements of other British Standards shall comply with the requirements of other British Standards shall comply with the requirements of BS 5733.

### **6.2 Switch Boxes, Socket Outlet Boxes**

Boxes shall conform to the requirements of BS 4662. In PVC insulated, PVC sheathed wiring systems boxes may be of wood.

The wooden boxes shall be of Halmilla or Teak or other approved hard wood, square or rectangular in shape, with a fully covered back having a wall thickness of 10 mm all round and be suitable to accommodate flush type switches, bell pushes, socket outlets etc.,

For steel conduit wiring systems the boxes shall be of cast iron or steel.

For PVC conduit wiring system the boxes shall be of moulded plastic, steel or cast iron.

### **6.3 Switch Plates and Socket Outlet Plates**

Switch plates and socket outlet plates if of insulating material shall have a thickness of not less than 2 mm and if metal shall have a thickness of not less than 1 mm. The plates shall completely overlap the box.

### **6.4 Switches**

Switches shall comply with BS 3676 or SLS 1000 and of the quick-break, quick make type. Switches shall generally be of the all insulated pattern unless associated with a metallic conduit system.

### **6.5 Cord Operated Switches**

Cord operated switches for ceiling mounting shall comply with BS 3676 and the cord shall be of insulating material. The cord switch shall have a strong mechanical action and operate with single pulls on the cord.

### **6.6 Switches with Pilot Lamp**

These shall be similar to items described in Clause 6.4 and provided with the pilot lamp to indicate when the switch is on.

### **6.7 Light Dimmer and Fan Speed Control Switch**

These shall be to BS 4743 and BS 5518 and shall be suitable for use with incandescent or fluorescent lamps with circuit modification or for fan speed control.

### **6.8 Socket Outlets and Plugs**

These shall conform to BS 1778, BS 4343 Parts 2, 5 and 15. Socket outlets and plugs of the shuttered type shall conform to BS 546.

13A socket outlets and plugs shall conform to BS 1363.

### **6.9 Switch – Socket Outlets and Plugs**

Switch socket outlets shall be of the all insulated pattern and shall incorporate a single pole switch in the live conductor. Socket outlets and plugs shall conform to the requirements of BS 546, BS 1363, BS 3676 or BS 5733.

### **6.10 Fused Connection Units for Electric Clocks**

This shall be of moulded plate type suitable for mounting on an insulated or wooden box with a cord outlet on the front of the plate. The fuse link shall conform to BS 1362 or BS 646 and of 2A rating.

### **6.11 Ceiling Fans**

These shall conform to BS 367.

The ceiling fans shall be three bladed type 1400 mm sweep if not otherwise specified. The motor shall be single phase 220/230 V, 50 Hz, totally enclosed capacitor type, with grease packed ball bearing. The fan to be supplied with an insulated shackle, canopy, specified length of down rod and a choke type speed regulator. The terminal block on the fan as well as the capacitor and the fan hook shall be provided with removable covers. The speed regulator shall be provided with on and off position and five running positions and should be capable of regulating down to 35% full speed.

The fan hook should be rust protected and subject to the approval of the Engineer. The down rod shall be of adequate mechanical strength and the internal diameter shall not be less than 16 mm.

Ceiling fans shall be suspended at a minimum height of 2750 mm from the floor unless otherwise specified in the design/bill of quantities.

### **6.12 Exhaust Fans**

The motor shall be of the totally enclosed shaded pole induction or capacitor type suitable for use in 230V, 50 Hz, AC supply with grease packed ball bearing having an easily accessible lubricator. It shall be controlled by a regulator designed for regulation of speed down to 60 to 70 percent of full speed and the regulator shall be of the series choke type having four speeds and off positions or shall be controlled off a switch socket outlet. The regulator unless fully insulated shall be earthed, complete with all necessary connections and fixtures.

The air displacement and sweep shall conform to BS 848: 1949.

#### **6.12.1 Light Proof Cowls**

These shall have louvers of robust material, fitted by means of fixing rings and nuts, so as to restrict entry of light fully but to allow easy flow of exhaust air and fitted to the body of the exhaust fan by screws.

#### **6.12.2 Weather Proof Cowls**

These shall have louvers of robust weather resisting material fitted by means of fixing nuts so as make the exhaust fan 100 percent weather proof, yet permitting of air extraction.

### **6.13 Shaver Sockets**

Shaver sockets complying with BS 3052 shall be used in a room containing a fixed bath or a shower. In rooms other than bathrooms socket outlets complying with BS 4573 shall be used.

### **6.14 Cooker Control Unit**

These shall comprise of a double pole switch of not less than 30A rating complying with BS 3676 and a 15A switch socket-outlet having fuse protection or 13A socket-outlets and a pilot lamp or a mechanical indicator to show whether the supply is 'on' or 'off' and shall be of the all insulated pattern.

### **6.15 Operating Theatre Power Column**

The whole unit shall be strongly constructed, rigidly installed and wired to one phase of the supply. The number of 5A and 15A socket outlets shall be as specified in the bill of quantities/design. The complete fittings shall be smoothly finished without rough or sharp edges for easy cleaning with pinum and two coats of enamel paint.

### **6.16 Time Delay Switches**

These shall be fully variable type, self starting motor driven, delay action time switches arranged so that when momentarily energized by a remote push button the contact closes for an adjustable period of 2 to 10 minutes and shall be complete with moulded bakelite case.

### 6.17 Insulated Terminal Blocks

To avoid wastage of cables and to provide looping facilities for wiring bakelite joint blocks with four or six terminals enclosed in suitable enclosures shall be provided where appropriate. These shall be approved manufacture confirming to relevant British Standards.

### 6.18 Installation of Accessories

All switches, bell pushes and fan regulators shall be installed on the live side of the circuit at a minimum height of 1350 mm from the finished floor level unless otherwise specified in the design.

In toilet area where a fixed bath or a shower is used the switch shall be installed outside and immediately adjacent to the normal access door of the room, or to be operated by an insulated cord.

All socket-outlets except in a toilet, kitchen or operating theatre etc., shall be mounted at a minimum height of 150 mm from the finished floor level or 150 mm above a working surface (e.g. in a kitchen, laboratory etc., unless otherwise specified).

In a room where a shower or a fixed bath is installed only shaver sockets is permissible to be installed.

No two socket-outlets fed from two different phases shall be installed within 2m from each other. Continuity conductor used shall be 4.0 mm<sup>2</sup> of 250 V grade if it is wired of one way of a distribution board protected by a rewirable fuse.

All switches and socket-outlets shall be installed on suitable wooden or conduit boxes depending on the type of wiring.

All ceiling fans shall be suspended with a minimum clearance of 2750 mm from the floor level unless otherwise specified in the design. The exhaust fans are fitted in a hole in the wall. Their direction of rotation should be such as to extract air from the room. Their positioning is important to get maximum efficiency. Cooker control units shall be of approved manufacture and be installed by an approved method at position shown in the layout drawing. The rate for the installation shall include the necessary length of earth wire and the necessary length of wire required for installation in accordance with type of wiring specified in the bill of quantities.

### 6.19 Emergency Generators/UPS Systems

Emergency Generator and UPS systems shall be utilized according to the requirements as a back-up power source and shall comply with following IEC/BS specifications.

Generator	-	IEC 341, BS 4999
Engine & Governor	-	BS 5514 and BS 6514 respectively

The sound level of the generator should be within the specified limits of environmental requirements.

### 6.20 Power Factor Correction/Harmonic Filters

Power Factor Correction should be done to compensate reactive power in LV/HV installation. Capacitor banks and switchgear shall be in compliance with IEC 70, IEC 947 : Part I. Harmonic filters provided, if any, shall comply with IEC 146 or IEC 1000/4.

### 6.21 Distribution Transformers

These shall be in compliance with following specifications.

Oil Filled Transformers	:	IEC 76
Dry Type (Cast Resin) Transformers	:	IEC 720

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## **7.0 LIGHTING FITTINGS AND ANCILLARY EQUIPMENT AND LAMPS**

### **7.1 Lighting Fittings for use with Tungsten Filament Lamps**

#### **7.1.1 General**

Lighting fittings for use with tungsten filament lamps unless otherwise specified in the particular specification shall be as follows. The lamp holders shall comply with BS 5042 and be to customer's choice. Provisions for earthing should be made available appropriately.

#### **7.1.2 Bracket Fittings**

These shall be in accordance with the relevant British Standard, and be to customer's choice or as in design/bill of quantities.

A plastic or glass bell shaped shade having a depth not less than 200 mm and bottom diameter not less than 160 mm shall be used complete with all necessary accessories and fixtures and be provided with lamps of 75 watts, maximum.

#### **7.1.3 Water Tight Bracket Fittings**

These shall comply with the relevant British Standards and be to customer's choice or as in design/bill of quantities. These shall have reflectors of non-corrodible non-tarnishing material finished with aluminium colour outside and white store enamel inside, and shall have clear well glass covers with rubber gaskets. Fittings shall be perfectly water tight.

These shall be mounted on a suitable size mounting block or on a conduit box depending on the type of wiring complete with all necessary wiring connections, accessories and fixtures.

### **7.2 Lighting Fittings for Use with Mercury Electric Discharge Lamps**

Each fitting shall consist of an outdoor type mercury vapour lamp with choke and capacitor housed in a steel box. The lamp shall be complete with a gallery and shade mounted on a suitable bracket which shall be fixed to the wall or to a pole by means of suitable clamps as specified in design/bill of quantities as per client's choice. Earthing and power factor correction should be provided.

### **7.3 Lamp Holders**

Bayonet lamp holders shall comply with the requirements of BS 5042 (.....) These shall be all insulated and of the Type B 15, unless otherwise specified, provided with solid plungers and a shade ring. If installed inside bath rooms these shall be provided with insulating shrouds.

For lamps of wattage above 200W, approved Edison Screw type lamp holders complying with BS 5042. Part II shall be used.

### **7.4 Ceiling Roses**

Ceiling roses shall comply with BS 67 and shall be of the two plate or three plate type. Multiple pendant type should be subject to the approval of the Engineer.

### **7.5 Operating Theatre Lamp**

These shall be made of heavy gauge spun aluminum with its outside stove enameled white. Each unit shall have two sets of lamps one suitable for use on 230V, 50 Hz. AC and the other suitable for use on 24V DC.

All bright metal parts shall be chromium plated or the reflector of glass silver mirrored and rigidly mounted to the frame. The lamps for both sets shall be of such a wattage as to give 450 to 600 foot candles on the operating table at a distance of 1250 mm from table.

## **7.6 Pendants**

### **7.6.1 Plain**

A plain pendant shall comprise a ceiling rose, a length of flexible wire, a suspension type bayonet lamp holder, a translucent plastic shade of diameter not less than 200 mm and depth of 125 mm together with associated wiring and fixtures. It shall be controlled by a 5A switch and wired with copper conductor of cross sectional area 1 mm<sup>2</sup> unless otherwise specified.

### **7.6.2 Tube**

A tube pendant shall be generally as described above except that the lamp is a suspension type fluorescent fitting suspended by chains to suit the specified mounting height.

### **7.6.3 Fluorescent Fittings**

These shall comply generally with BS 4533. Fittings may be batten or suspension type, 20 or 40 watts, single or twin type and shall comprise of current limiting choke or chokes to assist starting. Starter or starters used shall be normal or glow type having a radio interference suppressor and a power correcting capacitor incorporated in the system. Each fitting shall be complete with reflector, fluorescent tubes having bi-pin lamp caps and bi-pin lamp holders all wired internally. The fitting shall be suitable for the use with 230V, 50Hz normal supply. Suspensions of tubes shall be by rigid tubes or chains fixed to hooks screwed into plugs buried in the ceiling or any other approved method. Thickness of the sheet metal of the reflector shall be not less than SWG24.

Battern type fitting shall be fixed direct on to the support by the end of plugs or any other approved method. The colour of the tube shall be warm white or day light unless specified in the bill of quantities.

All accessories shall conform to the following British Standards:

Choke	BS 2818
Tubes	BS 1853
Starters	BS 3772
Condenser	BS 4017
Holder	BS 5042

## **7.7 Flexible Cord**

Every flexible cable or cord used shall comply with BS 6500 or BS 6007 or BS 6004 where appropriate. The colour coding of these cables shall conform to Table 52B of IEE Regulations. The applications shall be as given in Table 10 B of the same regulations.

### **7.7.1 Flexible Cords for use with Lighting Pendants and Electric Lighting Fittings**

Flexible cords for pendants and fluorescent fittings shall be of minimum size of 0.5 mm<sup>2</sup>, PVC insulated and sheathed unless otherwise specified.

Where a flexible cord supports or partly supports a luminaire the maximum mass supported by the cord shall not exceed the appropriate value indicated below.

<b>Nominal cross sectional area of conductor (mm<sup>2</sup>)</b>	<b>Maximum Mass (kg)</b>
0.5	2
0.75	3
1.00	5



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### **7.8 Flexible Steel Conduits and Adaptors**

These shall be of galvanized steel conforming to BS 731: Part I and shall be kept water-tight and be used in special situations such as,

- (i) an awkward short run under floor from main conduit line to a light fitting or
- (ii) in the connections between motor starter and motor.

Brass adaptors connecting water tight flexible conduit pipes threaded internally to the pitch of the flexible tube screwed onto the two ends of the flexible pipe shall be used.

### **7.9 Flexible Non-Metallic Reinforced Type Conduit**

These shall be used for final connections to motors, thermostats etc.

### **7.10 Ceiling Fittings**

These shall consist of suitable shaped ceiling fittings of an approved non-corrodable non-transishing material and shall have provision to fit one or more bayonet cap lamps to accommodate a total capacity of not less than 75 watts and shall comprise of necessary fixtures accessories and wiring.

Fittings shall be not less than 300 mm in diameter and 100 mm in depth and shall be so designed to prevent ingress of water when mounted in exposed position.

### **7.11 Installation of Apparatus and Lighting Fittings**

Batten and bracket fittings shall be installed on the wall mounted on suitable mounting blocks or conduit boxes with necessary brass screws at a height of 2500 mm from the finished floor level unless otherwise specified in the design/bill of quantities. Connectors shall be used to connect the wiring to the ceiling batten or bracket fittings.

Pendant lamps and fluorescent fittings shall be suspended at a height of 2500 mm from finished floor level and shall be wired off a ceiling rose with appropriate flexible cords.

The installation shall be complete with all wiring inclusive of switches etc., depending on type of wiring.

The operating theatre lamps shall be wired off a separate way of the distribution board and controlled off a 5A switch installed as specified in the design of light fittings. Specially if flush mounted and totally enclosed or required to be provided with heat-resisting insulation suitable for the temperatures likely to be encountered, heat resisting sleeves shall be fitted over the individual cores to prevent a short circuit between conductors or an earth fault. Similar method should be used for accessories and appliances which are subject to such conditions.

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## **8.0 PERFORATED METAL CABLE TRAYS AND ACCESSORIES**

### **8.1 Perforated Cable Trays**

Cable trays shall be fabricated from galvanized sheet steel of thickness not less than 2.5 mm and shall be subject to the approval of the Engineer.

### **8.2 Bends and Tees**

All bends shall be formed at site to suit the local conditions. Factory made tees shall be subject to the approval of the Engineer.

### **8.3 Installation**

Cable trays may be suspended from the ceiling, roof girders or fixed to the walls by means of brackets. At the point of support the bracket or the support shall extend the full width of the cable tray.

Each bracket shall be fixed to the tray by at least two screws. Connections between lengths of cable tray shall be subject to the approval of the Engineer. At joints the earth continuity shall be secured by means of adequate bonds.

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## **9.0 BELL AND AUDIBLE WIRING SYSTEMS**

### **9.1 Wiring Systems**

Wiring systems shall be separated from other wiring, if it is not supplied directly from the main supply system. The wiring of the bell circuit shall be similar to other wiring systems. Unless otherwise specified these shall be concealed, semi-concealed or surface types as specified in the bill of quantities.

### **9.2 Conduits and Trunking**

The same type of conduit and trunking wiring as for lighting installation shall be used unless otherwise specified. These wires may run in the same conduit or trunking. If the bell wiring is fed off from a different source of supply the wiring shall run in separate conduits or trunking or the bell wiring shall be separated by a continuous partition.

### **9.3 Cables**

Cables used for wiring shall be 1.0 mm<sup>2</sup> PVC insulated and sheathed cables of 250 V grade along with an earth wire, unless otherwise specified.

### **9.4 Transformers**

Transformers shall comply with BS 3535 and have the primary and secondary coils wound separate with earth protection. One terminal of the secondary shall be arranged for earthing. Two fused tapping shall be arranged on the secondary giving a voltage of 12. The transformer shall be mounted on a bakelite case and cover fastened by screws. The primary coil shall be wound for 230V, 50 Hz, single phase AC supply and the secondary for 12V giving an output of 10VA for a single bell and 60 to 100 VA when used with indicator boards.

### **9.5 Electrical Bell, Buzzer And Bell Indicator Board Accessories and Fittings**

These can be either electronic or electro-mechanical type. In case of an electro-mechanical device metal bell and the gong should be electroplated.

These shall be suitable for use on 12V, AC 50 Hz., single phase supply or 230V, 50 Hz, single phase AC, supply or as specified in the bill of quantities.

### **9.6 Electric Buzzer**

Electric buzzer shall have cover and base of bakelite with screw pressed iron movement, brass contact pillar, steel springs and coils wound with enameled copper suitable for use on 230V, single phase, 50 Hz, AC supply or as specified in the bill of quantities.

### **9.7 Bell Indicator Boards**

Shall be electronic type with LCD indicators.

### **9.8 Bell Pushers**

#### **9.8.1 Ordinary Type**

Ordinary type shall be of the low voltage type having base covers and plungers of moulded bakelite.

#### **9.8.2 Flush type**

Flush type shall be of the low-voltage type having the base plunger and flush plate of moulded bakelite mounted inside a teak flush box or conduit box of suitable size, with the flush plate overlapping the box.

#### **9.8.3 Surface Conduit**

Surface conduit shall be of low voltage type having the base and plunger of moulded bakelite, with contact springs silver plated, iron cased and threaded for conduit entry. The bell buzzer of bell indicator shall be mounted at an easily visible place on a suitable mounting block or base and wired to bell pushes at different locations including the earth wire. Re-setting of the buzzer should be provided at the location.

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## **10.0 FLAME PROOF INSTALLATION**

### **10.1 General**

The flame proof installations shall comply with CP 1003. All circuits within the danger area shall be adequately protected against over current, internal short circuit and earth leakage current.

### **10.2 Wiring System**

Wiring shall be any of the following.

- cables drawn into screwed solid drawn seamless or seam-welded steel conduit
- lead sheathed steel wire armored cable with PVC overall sheath
- mineral insulated, metal sheathed cable
- PVC insulated, wire armored cable with PVC over sheath

### **10.3 PVC Insulated Cables**

PVC insulated cables for use in conduit system shall comply with BS 6004.

### **10.4 Multi-Core Cables**

Multi-core cables shall be PVC insulated, steel wire armored with a flame retardant, oil resistant PVC outer sheath. The fillers and the bedding shall be of PVC and the cables shall comply with BS 6346.

### **10.5 Mineral Insulated Cables**

MICL Cables shall comply with BS 6207 and be provided with a PVC over sheath.

### **10.6 Conduits, Conduit Fittings and Terminal Boxes**

Conduits & conduit fittings shall comply with BS 31 or 38 and shall be solid drawn or seamless, screwed and galvanized. Additionally, terminal boxes shall comply with the requirements of BS 4683 or BS 229.

### **10.7 Apparatus (Fixed)**

Apparatus shall conform to the requirements of Clause 217 of CP 1003 as regards construction. All apparatus shall be intrinsically safe or provided with enclosures conforming to BS 4683.

All intrinsically safe apparatus shall be to the approval of the Engineer.

### **10.8 Lighting Fittings**

Lighting fittings shall comply with BS 4533 – Part II and Clause 7.1 of this specification and shall be to the approval of the Engineer.

### **10.9 Installation**

#### **10.9.1 Conduit**

Conduit wiring shall comply with the requirements of Clause 405 of CP 1003.

#### **10.9.2 Mineral Insulated Cables**

MICL cables shall be installed in accordance with the manufacturer's instructions, and Clause 407 of the CP 1003. The fittings shall be to the approval of the Engineer.

#### **10.9.3 Multi-core Cables**

Installation of multi-core cables shall be in accordance with the specification and additionally shall meet the requirements of Clause 406 of CP 1003.

#### **10.9.4 Apparatus**

Apparatus shall be installed generally in accordance with manufacturer's instructions and in positions exposed as little as possible to the substance giving rise to the risk.

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## **11.0 THE PROTECTION OF STRUCTURES AGAINST LIGHTNING**

### **11.1 General**

The lightning protection installation shall comply with C.P. 326. Radioactive type of lightning protection is not acceptable.

### **11.2 Accessories and Fittings**

#### **11.2.1 Air Terminals (Finials)**

Air terminals (Finials) Shall be of phosphor bronze having four sharp points, three of which are equally around one vertical point, total height not less than 100 cm and diameter of rod not less than 10 mm.

All vertical conductors forming part of an air terminal network shall be of phosphor bronze of not less than 10 mm diameter.

#### **11.2.2 Roof Conductors**

Roof conductors shall be soft annealed copper tape of size not less than 20 mm in width and 3 mm in thickness to the required length.

#### **11.2.3 Down Conductors**

Shall be soft annealed copper tape of size not less 20 mm, in width and 3.00 mm in thickness to the required length.

#### **11.2.4 Earth Terminals**

Earth terminal networks shall be of hard drawn copper rods of diameter not less than 12 mm or copper strips of dimensions not less than 20 x 3 mm buried as close as practicable to the structure to be protected. The earth resistance of the lightning protection system shall not exceed 10 ohms.

#### **11.2.5 Ridge Block and Wall Blocks**

Ridge blocks and wall blocks shall be of nonmetallic material to the approval of the Engineer.

### **11.3 Installation**

All sharp bends and up turns shall be avoided. Any bend shall have a radius as great as possible. The number of joints shall be minimum and, if a joint is made it shall be brazed.

#### **11.3.1 Air Terminals (Finials)**

Finials shall be fixed by steel saddles and brass screws to the nonmetallic support, the fixtures of which shall be perfectly watertight.

The roof and down conduction shall be clamped to the lower end of the finials by means of a ridge saddle. Finials shall project to a height not less than 100 cm above the roof. The scope of work shall be inclusive of supplying of a final nonmetallic support, water tight seal and all accessories, lead sheet, bitumen, compound cement, plaster etc. and installation of same complete with all necessary connections and fixtures.

#### **11.3.2 Roof Conductors**

Roof conductors shall be run along the roof of the building secured to ridge blocks which shall be spaced not more than 60cm apart by brass screws and copper saddles and the ridge blocks secured to the ridge cement plaster. A sufficient length of roof conductor shall be supplied and installed complete with necessary ridge blocks, saddles, accessories, fixtures and connections.

#### **11.3.3 Down Conductors**

Down conductors shall be run along walls fixed by wall plugs which shall be spaced not more than 100 cm apart, buried in the plaster fastened by means of copper saddles and brass screws. A sufficient length of down conductor shall be supplied and installed complete with necessary wall blocks, saddles, accessories, fixtures and connections for the layout of lightning conductor system.

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A combination of strip and rod conductors, reinforcing bars, structural steel stanchions etc, can be used as all or part of down conductor system provided proper electrical bonding is assured from air terminal to earthing point.

#### **11.4 Earth Terminations and Test Points**

Each down conductor shall be provided with a testing joint while not accessible for unauthorized interference shall be convenient for testing. No connections other than one direct connection to an earth electrode shall be made below the test joint. An earth termination should be connected to earth down conductor. Earth termination network should be bonded to metal in or around the structure and services below ground.

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## **12.0 EARTHING**

### **12.1 General**

All conductors and extraneous metal parts of the installation covered by this specification shall be connected back to the main earthing terminal.

All earthing installations, size of earth wires and bonding shall be in accordance with Chapter 54 of the IEE Wiring Regulations, 16<sup>th</sup> Edition or latest.

### **12.2 Earth Leakage Circuit Breakers (Residual Current Operated Circuit Breakers)**

Unless otherwise specified all Earth Leakage Circuit Breakers (ELCBs) shall be residual current devices. (Current operated ELCBs) and shall comply with BS 4293.

RCD's for computer systems should be of adequate operating current for this purpose. The socket outlets feeding UPS systems which generate harmonics should have RCD's having a sensitivity of 300 MA if the UPS system is not provided with necessary harmonic filter designed in accordance with IEC 146, IEC 1000/4.

### **12.3 Earth Electrode**

Earth electrode shall consist of an earth pipe, earth rod, earth tapes or earth plate buried to a depth of 2 metres or more in the ground and the earth resistance which shall be less than 10 ohms tested on a dry day. If this value is not possible to be achieved, devices for earth leakage protection should be provided.

Minimum cross section of protective conductor in relation to the cross section area of associated phase conductor should conform to Table 54G of the 16<sup>th</sup> Edition of IEE Wiring Regulation.

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## **13.0 TESTING**

### **13.1 Testing by Contractor**

The Contractor shall be responsible for testing and commissioning of each installation, in stages if required, to ensure that it is in proper working order and capable of performing all its functions in accordance with Clause 16 of Part 1 of this specification to the satisfaction of the Engineer.

### **13.2 Testing for the Supply authority**

The power supplying authority will carry out tests prior to the provision of supply. It is the responsibility of the contractor to arrange the test, provide all necessary assistance and obtain the approval of the authority.

### **13.3 Tests and Certificates to IEE Wiring Regulations**

The Contractor shall also carry out tests as prescribed in Part 7 of BS 7671 : 1992, with Amendment 2; 1997 (AMD 9781) or the current edition of the IEE Wiring Regulations and provide Completion and Inspection Certificates.