TAMIL NADU POLICE HOUSING CORPORATION LTD.,

MATERIALS

Circular No.1

Testing of Materials – Cement

I CEMENT

The cement used shall be any of the following and type selected should be appropriate for the intended use.

a. 43 grade ordinary port land cement conforming to IS 269
b. 43 grade ordinary port land cement conforming to IS 8112.
c. 53 grade ordinary port land cement conforming to IS 12269.
d. Rapid hardening port land cement conforming to IS 8041.
e. Port land slag cement conforming to IS 455
f. Port land Pozzolana cement (Fly ash based conforming to IS 1489 (Part-2)
g. Port Pozzolana cement (calcined clay based) conforming to IS 1489 (part –2)

h. Hydrophobic cement conforming to IS 8043
i. Low heat Port land cement conforming to IS 12600
j. Sulphate resisting Port land cement conforming to IS 12330.

In the above normally ordinary Port land cement 33 grade and 43 grade were used. The Chemical requirements, Physical requirements, setting time, compressive strength of mortar cube is as follows.

A)1. Chemical Requirements:

For Ordinary Port land Cement Grade 43

SI	**Characteristic**	**Requirement**
1	Ratio of percentage of lime to percentages of Silica, alumina and iron oxide	Not greater than 1.02 and not less than 0.66
2	Ratio of percentage of alumina to that of iron oxide	Not less than 0.66
3	Insoluble residue, percent	Not more than 2 percent
4	Magnesia, percent by mass	Not more than 6 percent

5	Total sulphur content calculated as sulphuric anhydride (SO3) percent by mass	Not more than 2.75 and 3.0 when tricalcium aluminate percent by mass is 7 or less and greater than 7 respectively
6	Total loss on ignition	Not more than 5 percent

Physical Requirements:

1 Fineness

a. Specific surface for ordinary cement not less than 2250 cm^2/gm.

II Setting Time

Initial not less than 30 minutes and final not more than 10 hours

III Compressive Strength of mortar cubes

1:3 one of cement and three of standard sand by mass shall not be less than.

Curing Time(Hour)		**Compressive strength**
a.	72_+1	160
b	168_+2	220

B. 43 Grade Ordinary Port land Cement Conforming to IS 8112

High strength ordinary Port land cement meets the need of certain specialized work such as pre-stressed concrete and certain item of pre cast concrete where cement having compressive strength much higher.

Chemical Requirement

Sl	Characteristic	Requirement
1	Ratio of percentage of lime to percentages of silica, alumina and iron oxide, when calculated by the formula $\frac{CaO - 0.7\ SO_3}{2.8\ SiO_2 + 1.2\ Al_2O_3 + 0.65\ Fe_2O_3}$	Not greater than 1.02 and not less than 0.66
2	Ratio of percentage of alumina to that of iron oxide.	Not less than 0.66
3	Insoluble residue, percent by mass	Not more than 2
4	Magnesia, percent by mass	Not more than 6
5	Total sulphur content calculated as sulphuric anhydride (SO_3) percent by mass	Not more than 2.75 and 3.0 when tricalcium aluminate (percent by mass) is 7 or less, and greater than 7 respectively
6	Total loss on ignition	Not more than 4 percent

Physical Requirement

1. Fineness : Specific surface not less than 3500 Cm^2/g

2. Setting Time : Initial not less than 30 minutes and final not more than 10 hours

3. Compressive Strength of cement mortar Cubes 1:3 (One cement three standard sand by mass.

Curing time	**Compressive strength**
a. 72+/- hours	Not less than 230kg/cm^2
b.168+/-hours	Not less than 330kg/cm^2
c.672+/-hours	Not less than 430kg/cm^2

d. Cement shall show progressive increase in strength at 72 hours.

Standard sand for testing of cement Requirements:

i. The sand shall be of quartz, light grey or whitish variety.
ii. The sand shall be free from silt
iii. Sand grains shall be angular, the shape of grains approximating to spherical form, and elongated and

flattened grains being present only in negligible quantities.

Grading

Passing through 2mm IS sieve	100 Percent
Retained on 90 micron IS sieve	100 Percent
Particle size greater than 1mm	33.33 Percent
Particle size smaller than 1mm and And greater than 500 micron	33.33 Percent
Particle size below500 micron	33.33 Percent

The above micron shall be free from organic impurities.

The attention of the Engineers in charge and users of cement is drawn to the fact that the quality of various cements mentioned is to be determined on the basis of its conforming to the performance characteristics given in the respective Indian standard specification for that cement. Any trade-mark or any trade name indicating any special features not covered in the standard or any qualification or other special performance characteristics some times claimed/ indicated on the bags or in advertisements alongside the statutory quality marking or otherwise have no relation what

so ever with the characteristics guaranteed by the quality marking as relevant to that cement.

Field Test

It is possible to identify the adulteration in cement.

1. A sample of cement is taken and it is roasted, if there is no change in colour it is free from adulteration.

2. Colour of the cement should be uniform and grey (for O.P.C)

3. Cement should feel smooth when touched (or) rubbed in between fingers like flour. If it is felt rough , it indicates adulteration with sand / earth. If hand is inserted in a bag or heap of cement, it should be feel Cool. If a small Quantity of cement is thrown in a bucket of water, it should sink and should not float on the surface ...

4. Cement should be free from any hard lumps. Such lumps are formed by the absorption of moisture from the atmosphere. Any bag containing such lumps should be rejected.

WATER

Circular No.2

WATER : TNPHC using good suitable water for Construction instruction-Reg.

The Engineer in charge of the project should take more care for using suitable water for the construction. Many projects were lost its life because of proper care has not been taken to use proper water. It is very much essential to safe guard the interest of an individual and the nation. The Engineer in charge should take more care for using suitable water for construction.

Generally potable water is considered satisfactory for mixing concrete.

The water used for mixing mortar concrete and curing should be clean and free from injurious amount of oils, acids, alkali, salts, sugar, organic materials and other substance that may be deleterious to concrete or steel

As a guide the following concentrations represent the maximum permissible values.

a. To neutralize 100ml sample of water, using phenolphthalein as an indicator it should not require more than 5 ml of 0.02 normal Na.oH

b. To neutralize 100ml sample of water using mixed indicator it should not require more than 25ml of 0.02 normal H_2 SO_4.

The permissible limits for solids shall be as given below.
(clause 4.3)

	Permissible limit ,Max
Organic	200mg /l
In organic	3000mg/l
Sulphates(as SO_3)	400mg/l
Chlorides (as Cl)	2000mg/l for plain concrete work and 500mg/l for reinforced concrete work
Suspended matter	2000mg/l

Field test:

PH value paper may be used to identify the quality of water.

AGGREGATE

Circular No. 3

Aggregates :TNPHC -Using of good suitable – Aggregates Instructions – Regarding.

Aggregates shall consist of naturally occurring stones, gravel and sand, and shall be hard, strong, dense, durable, clear and free from veins, adherent coating and injurious amount of disintegrated pieces and deleterious substances.

Deleterious materials:

i. Aggregates shall not contain in excess of the limits. Harmful materials such as pyrites laminated materials alkali seashells and organic impurities and those which may attack the reinforcement. Aggregates shall not be chemically reacting with alkalies of cement.

ii. Aggregate crushing value shall not exceed 30 percent for concrete for wearing surfaces (such as runways and roads) 45 percent for other concrete.

iii. Aggregate impact value shall not exceed 30 percent by weight for concrete for wearing surface and 45 percent by weight for other concrete.

iv. Aggregate abrasion value shall not exceed 30 percent for concrete for wearing surfaces and 50 percent for other concrete.

SIZE AND QUALITY

i.The single sized and graded coarse aggregate as follows.

I.S. Sieve Designation	Percentage passing for single –sized Aggregate of Nominal size					
	63 mm	40 mm	20 mm	16 mm	12.5mm	10 mm
80 mm	100	--	--	--	--	--
63 mm	85 – 100	100	--	--	--	--
40 mm	0 – 30	85 – 100	100	--	--	--
20 mm	0 – 5	0 – 20	85 – 100	100	--	--
16 mm	--	--	--	85 – 100	100	--

12.5 mm	--	--	--	--	85 – 100	100
10 mm	0 – 5	0 – 5	0 – 20	0 – 30	0 – 45	85 – 100
4.75 mm	--	--	0 – 5	0 – 5	0 –10	0 – 20
2.36 mm	--	--	--	--	--	0 – 5

I.S.Sieve Designation	Percentage Passing for Graded Aggregate of Nominal size			
	40 mm	20 mm	16 mm	12.5 mm
80 mm	100	--	--	--
63 mm	--	--	--	--
40 mm	95 – 100	100	--	--
20 mm	30 – 70	95 – 100	100	100
16 mm	--	--	90 – 100	--
12.5 mm	--	--	--	90 – 100
10 mm	10 – 35	25 – 55	30 – 70	40 – 85
4.75 mm	0 – 5	0 –10	0 – 10	0 – 10
2.36 mm	--	--	--	--

ii.Coarse Aggregate for mass concrete as follows.

Class and size	sieve designation	Percentage of passing
Very large, 160 – 80 mm	160 mm	90 – 100
	80 mm	0 – 10
Large, 80 – 40 mm	80 mm	90 – 100
	40 mm	0 – 10
Medium, 40 – 20 mm	40 mm	90 – 100
	20 mm	0 – 10
Small, 20 – 4.75 mm	20 mm	90 – 100
	4.75 mm	0 – 10
	2.36 mm	0 – 2

Iii. Fine Aggregates – grading in zones I to IV

I.S.Sieve Designation	Percentage of passing for			
	Grading zone I	Grading zone II	Grading zone III	Grading zone IV
10 mm	100	100	100	100
4.75 mm	90 – 100	90 – 100	90 – 100	95 – 100
2.36 mm	60 – 95	75 - 100	85 - 100	95 – 100
1.18 mm	30 – 70	55 - 90	75 - 100	90 – 100
600 microns	15 – 34	35 – 59	60 – 79	80 – 100
300 microns	5 – 20	8 - 30	12 - 40	15 – 50
150 microns	0 – 10	0 - 10	0 - 10	0 – 15

iv. All in aggregates – When available, grading shall be according to the following.

I.S.Sieve Designation	Percentage of passing for All – in Aggregate of 40mm Nominal Size 20mm	
80 mm	100	--
40 mm	95 – 100	100
20 mm	45 – 75	95 – 100
4.75 mm	25 – 45	30 – 50
600 microns	8 – 30	10 – 35
150 microns	0 - 6	0 – 6

1. Coarse aggregate to be used should be clean, hard no porous, free from lumps of clay, organic and vegetable matter.

2. **Water absorption**: They should not absorb water after more than 24 hours immersion in water. Porous aggregate corrode reinforcement. Lime stone and sand stone both are very porous material and should not be used concreting specially under water.

3. Angular and Roughly cubical particles are ideal, aggregates should be chemically inert materials.
4. Brick aggregate should not be used as a aggregates for RCC works because of absorption of water.

SAND

Circular No: 4

Types of Sand:

1. Pit sand
2. River sand
3. Sea sand

Pit sand:

It is obtained by forming pits into soils from Quarries. Pit sand consist of sharp angular grains which are free from salts. It is coarse and colour is normally Reddish Yellow. It is usually used for filling Basement etc.

River sand:

The sand which obtained from bank or beds of rivers. River sand is fine and consist of fine rounded grains. Colour of river sand is almost White and Greyish. River sand usually available in clean condition and it is used for all construction purposes.

Sea sand:

Which is obtained from sea shores. It has fine rounded grains of light Brown colour. Sea sand contains salts. Salts

attract moisture from the atmosphere such absorption cause dampness and disintegration of work. Sea sand also retards setting action of cement due to all such reasons. This generally avoided for construction purpose.

Properties of Good Sand:

1. It should be chemically inert.
2. It should be clean and coarse and should be free from any organic or vegetable matter.
3. It should contain sharp angular grains.
4. It should not contain salt which attract moisture from the atmosphere
5. It should be well graded i.e should contain particles of various sizes in suitable proportions.
6. It should be free from silt and clay.

Classification of Sand:

0.075mm to 0.425mm	-	Fine sand.
0.425mm to 0.75mm	-	Medium sand.
2.00mm to 4.75mm	-	Coarse sand.

Bricks

Circular No: 5

1. Highly superior heavy duly bricks	-	Prepared from specially selected Earth.
2. First class bricks	-	Table moulded bricks.
3. Second class bricks	-	Ground moulded and burnt in kiln
4. Third class bricks	-	Ground moulded and burnt in clamps.
5. Fourth class bricks	-	Over burnt bricks.

Test of Bricks:

1. Water Absorption

The average water absorption of common burnt clay bricks shall not be more than 20% by weight.

2. Effluence

1.When there is no white deposit.	-Effluence is nil
2.When there is a heavy deposit salts accompanied by powdering of the exposed surfaces	-Effluence is serious.
3.White deposit less than 10%	-Effluence is slight.

4.White deposit 10 to 15% -Effluence is moderate.

5.White deposit more than 50% -Effluence is heavy.

3. Soundness

1.Clear ringing sound when two bricks stretch together.

2.Brick should not break when dropped flat on hard ground from a height of about 1m.

Classification of Bricks:

Class Designation	Average compressive strength			
	Not less than		Less than	
	Kgf/cm^2	N/mm^2	Kgf/cm^2	N/mm^2
350	350	35	400	40
300	300	30	350	35
250	250	25	300	30
200	200	20	250	25
175	175	17.5	200	20
150	150	15	175	17.5
125	125	12.5	150	15
100	100	10	125	12.5
75	75	7.5	100	10
50	50	5	75	7.5
35	35	3.5	50	5

Defects in Bricks

Table gives the main defects commonly met with in india.

Name of Defect	Remarks
1. Under burnt	Less compressive strength and excess of absorption of water.
2. Over burnt	The brick lose their shape. Unsuitable for building work. The brick is called **Jhama**.
3. Efflorence	Brick contains large proportion of soluble salts. The brick gets discoloured by formation of whitish deposits.
4. Black core	The exterior surface gets vitrified while interior becomes black. This is due to too rapid heating.
5. Bloating	The bricks 'swell' due to excess of carbonaceous matter and due to rapid forming.
6. Laminations	These are due to air voids in the brick clay. The lamination scale off due to weathering.
7. Lime modules	These are formed by uncrushed lime. When they absorb water they expand causing disintegration of brick.
8. Chuffs	This is deformation of brick by falling of rain water on hot brick.
9. Iron spots	These are dark spots due to iron sulphate. Such bricks are unsuitable for exposed work.

Bricks shall be tested for the compressive strengths, water absorption and Effluence. For carrying out the above test a sample shall be taken random according to the size of lots given below:

Brick Designation	Lot size	Sample Size
100	More than 50,000 bricks	20 bricks
75 50 35	More than1,00,000 bricks	20 bricks

Steel

Circular –6

Mild steel and Medium Tensile Steel
Is : - 432 Part – I 1982.

I Type and grade

a. Mild steel bars grade I and grade II
b. Medium Tensile steel bars

II Nominal sizes

Diametres of round bars 5mm, 6, 8, 10, 12, 16, 20, 22, 25, 28, 32,36,40 and 50mm

III Tolerance in size

Size		Tolerance mm
Over mm	Up to and including mm	
-	25	± 0.5
25	35	± 0.6
35	50	± 0.8
50	80	± 1.0
80	100	± 1.3
100	-	± 1.6 per cent of dia or side width

Tolerance in weight

Size		Tolerance Percent
Over mm	Up to and including Mm	
-	10	± 7
10	16	± 5
16	-	± 3

Mechanical Properties of Bars

Sl. No	Type and Nominal Size of Bar	Ultimate Tensile Stress (min)	Yield Stress (min)	Elongation percent (min)
I	**Mild Steel Grade I**			
	For bars up to and including 20mm	410	250	23
	For bars over 20mm, up to and including 50mm	410	250	23
ii	**Mild Steel Grade II**			
	For bars up to and including 20mm	370	225	23
	For bars over 20mm, up to and including 50mm	370	215	23
iii	**Mild Tensile Steel**			
	For bars up to and including 16mm.	540	350	20
	For bars over 16mm, up to and including	540	340	20

	up to and including 32mm For bars over 32mm, up to and including 50mm	510	330	20

* Elongation on a gauge length 5.65 √'So where So is the cross sectional area of test piece

Types of steel	**Dia of bar**	**Characteristic yeild strength**
M.S (plain bars)	Upto 20mm Over 20mm	250 N/mm^2 240 N/mm^2
M.S (Hot rolled Deformed bars)	Upto 20mm Over 20mm	250 N/mm^2 235 N/mm^2
Medium tensile steel plain bars	Upto 20mm 20-40mm Over 40mm	350 N/mm^2 340 N/mm^2 320 N/mm^2
High yield strength steel (Hot rolled Deformed bars)	All sizes	450 N/mm^2
High yield strength steel (cold twisted deformed bars)	All sizes	500 N/mm^2

LIME

CIRCULAR 7

BUILDING LI MES (IS : 712 – 1973)

1. Scope – Requirements for building limes used for construction purpose.

2. Classification :

Class A	– Eminently hydraulic lime used for structural purposes.
Class B	– Semi hydraulic lime used for masonry mortars
Class C	– Fat lime used for finishing coat in plastering, White washing, etc and with addition of pozzolanic material for masonry mortar.
Class D	– Magnesium lime used for finishing coat in plastering, whitewashing etc.
Class E	- Kankar lime used for masonry mortars.

3. Chemical Requirements – See Table 1

4. Physical Requirements – See Table 2

Sl.No	Type of Test	**Table 1 Chemical Requ**							
		Class A	Class B		Class C		Cla		
		Hydrate	Quick	Hydrate	Quick	Hydrate	Quick		
1	2	3	4	5	6	7	8		
i	Calcium and magnesium oxide ,percent, Min	60	70	70	85	85	85		
Ii	Magnesium oxide percent Max	5	5	5	5	5	-		
	Min	-	-	-	-	-	5		
Iii	Silica, alumina and ferric oxide, percent, Min	25	15	15	-	-	-		
Iv	Unhydrated oxides, percent, max	-	-	-	-	-	8		
V	Insoluble residue in hydrochloric acid less the silica, percent, max	2	3	2	-	-	-		
Vi	Insoluble matter in sodium carbonate solution, percent , max	5	5	5	5	5	5		
Vii	Loss on ignition, percent , max	-	5 for large lump, 7 for lime other than large lump	-	5 for large lump, 7 for lime other than large lump	-	5 for large lump, 7 for lime other than large lump		
Viii	Carbon –di – oxide, percent, max	5	5	5	5	5	5		
ix	Cementation Value:								
	Min	0.6	0.3	0.3	-	-	-		
	Max	-	0.6	0.6	-	-	-		

TABLE 2 PHYSICAL REQUIREMENTS

SL. NO.	TYPE OF TEST	Class A Hydrated	Class B			
			Quick	Hydrated		
1	2	3	4	5		
i.	Fitness	Shall leave no residue on 2.36 mm I.S. Sieve, not more than 5 percent on 850 micron IS sieve and the fraction passing through 850 micron IS Sieve shall leave not more than 10 percent (of this fraction) on 300 – micron IS Sieve		Shall leave no residue on 2.36 mm IS Sieve, not more than 5 percent on 850 micron IS Sieve and the fraction passing through 850 micron IS Sieve shall leave not more than 10 percent (of this fraction) on 300 micron IS Sieve		
ii	Residue on slaking (on the basis of quick lime taken), *Max* percent, by weight		10 on 850 micron IS Sieve			
iii	Setting time	In the putty of standard consistency, initial set shall take place in not less than 2 hours and final set within 48 hours				

iv	Compressive strength, *Min*	17.5 kgf/cm^2 after 14 days and 28 kgf/cm^2 after 28 days shall, however, show an increase over that at 14 days		12.5 kgf/cm^2 after 14 days and 17.5 kgf/cm^2 at 28 days shall, however, show an increase over that at 14 days		
v	Transverse strength	Modulus of rupture not less than 7.0 kgf/cm^2 at 28 days		Modulus of rupture not less than 7.0 kgf/cm^2 at 28 days		
vi	Workability					
vii	Volume yield					
viii	Soundness	The Le Chatelier moulds shall not exhibit more than 10 mm expansion		The Le Chatelier moulds shall not exhibit more than 10 mm expansion		
ix	Popping and pitting					

Mosaic tiles

Circular 8

For easy maintenance and have smooth surfaces cement concrete flooring tiles were introduced. Based on the IS-1237 - 1980 the tiles were divided as follows

1. Plain cement tiles.
2. Plain colour tiles.
3. Terraso tiles (Mosaic tiles).

Tiles at least 25% of whose wearing surface is compared of stone chips in a matrix of ordinary or coloured Portland cement mixed with or without pigments & mechanically ground and filled.

Dimensions

Length	Breadth	Depth
200mm	200mm	20mm
250mm	250mm	22mm
300mm	300mm	25mm

Tolerance on length or breadth shall be ± 1mm and on thickness + 5mm.

Thickness of wearing layer:

The minimum thickness for various classes of tiles shall be as specified in Table 1.

Sl. No.	Class of Tile	Minimum thickness of wearing layer (mm)
1	Plain cement and plain coloured tiles for general purpose.	5
2	Terrazo tiles with chips of size varying from the smallest upto 6mm, for general purpose.	5
3	Terrazo tiles with chips of size varying from the smallest upto 12mm, for general purpose.	5
4	Terrazo tiles with chips of size varying from the smaller upto 20mm, for general purpose.	6
5	Plain cement and plain coloured tiles, for heavy duty.	6

General Quality: Wearing layer of tiles shall be free from projections, depressions, cracks, holes, cavities, and other blemishes. Edges of wearing layer may be rounded.

Finish: Colour and texture of wearing layer shall be uniform throughout its thickness. No appreciable difference in appearance of tiles from point of view of colour of aggregate, its type and its distribution on surface of wearing layer shall be present.

Physical Requirements: All tests shall be carried out not earlier than 28 days from the date of manufacture.

Flatness of tile Surface: The amount of concavity and convexity shall not exceed 1mm.

Perpendicularity: The longest gap between the arm of the 'square' and the edge of tile shall not exceed 2 percent of length of edge.

Straightness: The gap between the thread and the plane of tile shall not exceed 1 percent of length of edge.

Water Absorption: Average value shall not exceed 10 percent.

Wet Transverse Strength: Average value shall not be less than 3 N/mm^2.

Resistance to wear: The wear shall not exceed the following values:

a) For general purpose tiles:

1. Average wear	-	3.5mm
2. Wear on individual specimen	-	4.0mm

b) For heavy duty floor tiles:

1. Average wear	-	2.0mm
2. Wear on individual specimen	-	2.5mm

BURNT CLAY FLAT TERRACING TILES
MACHINE – MADE
CIRCULAR NO.9

1. **Scope** –Requirements for machine–made burnt clay flat terracing tiles.
2. **General Quality** – Shall be uniform in shape, size and from irregularities.
3. **Dimensions and Tolerances**
    a) Length – 250 to 150 mm in stage of 25mm.
    b) Width – 200 to 100 mm in stages of 25 mm.
    c) Thickness – 20 and 15 mm.
    d) Tolerances - $\pm$ 2 percent.
4. **Warpage** – Shall not exceed I percent in any direction.
5. **Water Absorption** – Shall not exceed 15 percent.
6. **Flexural strength** – Shall be not less than 15 kgf/cm2

Brick Work

Circular No.10

1. Brick work should be constructed alternate coarse consist of stretchers and headers.

2. The thickness of joint in brick masonry should not exceed 1cm. The face joint should be racked to a depth of 15mm by racking tool when the mortar is till green so as to provide proper key for plastering or pointing.

3. The brick should be taken up at a time not exceeding 1m height.

4. The brick work should be checked with plumb.

5. The brick work should be laid in level.

6. During construction no brick bats are used as a queen closer.

7. The strength of mortar should be checked with sharp instrument like screwdriver.

8. The brick should be soaked well by adopting to drum system.

9. Using brick bat should be avoided.

10. The joints of brick work should be filled with mortar fully.

11. Necessary scaffoldings should be provided to construct the brick work to have good perfect ness.

12. The holes left in brick work while execution for supporting scaffolding are filled
with concrete and not with the bricks.

13. The bricks should be used after testing.

14. The mortar should be prepared in a platform. It should be mixed dry and the water should be used when ever required.

15. Necessary shadow should be provided over the mortar mixing platform.

16. Twisted and irregular bricks should be rejected.

17. Preparation of mortar should be measured only by standard measuring box.

Stone Masonry

Circular No.11

1. The good stone should be used for construction.

2. The joints should be filled with the mortar perfectly.

3. Bond stone should be provided at 1.5m to 1.8m clear in every coarse but staged at alternate coarse.

4. Vertical joints should be avoided.

5. The gaps of the wall should be used with suitable stones avoiding placing of stone chips.

6. The corners of the masonry should be well chiseled and dressed for a minimum width of 25mm corner and 90^{o} turning at junctions.

7. Care should be taken in filling the voids in between the stone (filling stones) should be placed vertically before mortaring the joints.

7. The filling joint should be minimum quantity of mortar.

Bond Stone

Bond stone is called as true stone running right through the thickness of the walls shall be provided in wall upto 60cm thick and in case of wall above 60cm thick a set of two or more bond stone overlapping each other at least 15cm shall be provided in a line from face of wall to the back.

At least one bond stone or a set of bond stone should be provided for every $0.5m^2$ of the area of wall structures. All bond stones shall be marked suitably with paint.

R.C.C WORKS

Circular No.12

Concrete is playing an very important role in the construction industry. We can able to compare R.C.C with our body, the reinforcement in concrete is like bones and the concrete is like Flesh in our body if we want to have a healthy body the bone and the flesh should be free from damages and it should be perfect then only it is possible to have a healthy body. Hence in R.C.C work the (Bone) reinforcement and (Flesh) concrete should be done quality The unwanted bone and flesh always give trouble to the body and it will also affect the routine function. Similarly putting unwanted requirement of steel and concrete also lead to over reinforcement and over burdening to the structure and it is also not economical.

Hence the role of an field Engineer is very important during placing concrete and certain general information regarding R.C.C work.

GENERAL INFORMATION REGARDING R.C.C WORK

1	Water requirement for hydration of cement.	30%of the weight of cement
2	Water required for workability of aggregates	Approximate 5% of the work of aggregates, value with fineness and coarseness of aggregates, quantity to be correspondingly reduced.
3	Normally used steel shuttering Plate – size & weight	Size – 1.25m x 0.6m weight – 63kg.
4	Mixing specifications by diesel Mixer	No. of revolution = 20 time of mixing = 2-3 minutes Speed of the mixer= 10 r.p.m
5	Compaction by Nozzle vibrator	r.p.m of the vibrator = 3600r.p.m Effective zone of nozzle vibrator = 3'(Hence points of application of vibrator should be slightly less than 3')

6	(a) Size of gauge box by which ingredients of concrete put in mixer	40cms x 35cms x 25cms (vol=.035m^3=35litres=1.25ft^3=vol. Of one bag of cement)
7	Density of concrete and voids	Bulk density of 1600kg/m3 concrete corresponds to 37% voi in it. An increase of density b 80kg/m3 corresponds to decreas in voids by 3%.

Note: A dense and well hardened concrete shall give a hard metallic sound when struck with hammer while concrete full of voids shall give a hollow type of sound.

8.Reduction in strength of concrete due to voids	(i) 5% voids will cause 30% reduction in strength (ii) 10% voids will cause 50% reduction in strength
9.Size of binding wire used for tying reinforcement.	16 gauge (SWG) annealed soft iron wire.

Removal of formwork for beams, slabs and columns.

Sl. No	Type of Work	Formwork removal period.
1.	Walls, Columns and vertical sides of beams	24-48 hours.
2.	***Slab*** a. Span upto 4.5m b. Span over 4.5m	 7 days 14 days
3.	***Beams*** (a) Span upto 6m (b) Span over 6m	 14 days 21 days

Curing period

Sl. No	Type of Work	Curing period
1.	***Concrete work*** (a) Rapid Hardening Cement (b) High Alumina Cement (c) Ordinary Port Land Cement	 7 days 24 days 14 days

2.	Brick Masonry	10 days
3.	Plaster	7 days

Workability and slump

PERMISSION SLUMPS FOR VARIOUS WORKS

Type of work	With vibration	Without Vibration
Mass Concrete, large section, roads	1.0 to 2.5	5.0 to 7.5
Foundation, sub strs, thick walls & other heavy sections	2.6 to 5.0	4.0 to 11.5
Thin sections such as slabs, beams, columns with congested reinforcement	4.0 to 5.0	10.0 to 17.5
When using Concrete pump	8.0 to 10.0	-

Note:

1.Workability is the ease with which concrete can be mixed, placed and compacted without segregation. It depends on various factors with water as one of the main factors.

2.A concrete with slump more than 10.0cms has high degree of workability and fluidity and is not suitable for vibrations otherwise segregation will start and coarser particles shall settle down and water or cement slurry will come up.

3. For vibrated concrete, quantity of water can be reduced by 20% compared to manually compacted concrete and therefore lesser workability or slump is acceptable.

4. Slump test is done to ensure that water quantity in the mix is optimum (neither more nor less) to give required amount of workability in the mixture.

5. Water requirement to give proper workability to a mix will depend upon various factors:

(a) Thickness of member - If member is thin, more workability and consequently more water is required.

(b) Shape of aggregate (Angular or round) - Angular aggregates need more water than round aggregate. In other words, rounded aggregate will produce a more workable concrete than sharp angular aggregate for the same amount of water.

(c) Grading of Aggregate ad maximum size of aggregate - If mix has more coarser particles, same water shall give more workability because of lesser surface area. With aggregates voids are less so water shall not be wasted in filling the voids and more will be available for lubrication.

6.Fine aggregate or sand improves the plasticity and homogeneity of the mix and not the workability. Rather with more sand than required, more water is required to achieve the same workability or same slump because of more surface area.

Quality control tests for concrete

1. Silt content of sand.
2. Slump test for workability of concrete.
3. Weight of cement bags by random sampling.
4. Cube tests (for comp. strength).
5. Lab. and field tests for cement
6. Lab. and field tests for water.
7. Bulking of sand.
8. Surface water in Aggregates and sand.

Tests on Completed Structure

For ascertaining the quality of concrete in a built up structure, non-destructive tests are used. Two such important tests are:

(1) **Rebound Hammer Test:** In this the concrete is hit by a spring loaded hammer. the extent of rebound suggests the quality of concrete.

(2) **Ultrasonic Test:** In this test sound waves are sent from one end of the concrete to the other and their velocity measured. The higher the velocity the better the concrete.

some more tests as listed below can also be done on the completed structures:

(1) **Load Test:** In case of doubt, actual load test can also be done for the slab while putting props below (equal to bear the total load) leaving some gap between bottom of slab and props.

(2) **Water tightness tests for roof and water tanks:** It is done by filling the roof or water tank with water and left for certain time to observe the leakage, if any. In case of roof, all possible open areas around the roof are blocked before filling the roof with water.

Construction Joint

Construction joints are provide where there is a break in the casting of concrete. Construction joints are made between parts cast at different times. For proper transmission of stresses across the joint, it is necessary to extend the reinforcement of old concrete into the new one and provide shear keys. In water tanks, water bar is required to be provided at construction joint to prevent leakage from construction joint.

Treatment of Construction Joint.

1	Difference in operation up to 4 hour	Remove the laitance on the surface of old concrete with wire brush and clean the water

2	Difference in operation upto 48 hours	Clean the surface with wire brush. Apply water. Place half an inch of layer of cement mortar of similar composition as that of concrete before new concrete is placed.
3	> 48 hours	Old surface be chiseled and hacked and cleaned. Apply water. Apply slurry of neat cement on the roughened surface and work into interstices. Apply 1/2" thick layer of cement mortar before cement slurry dries and then place the concrete immediately.

Notes:

(1) It is to be noticed that new concrete should be placed before cement mortar and cement slurry dries.

(2) Construction joint should be perpendicular to the main reinforcement and should not be inclined and reinforcement of the old concrete should extend into new one.

Movement joints in concrete

These joints are provided in structure to accommodate movements so that unduly high stresses are not set up part of a structure and unsightly cracks are not developed (Please note that construction joints on the other hand prevent movements.)

Type of movement Joints

1.**Expansion Joint**	When a joint permits expansion as well as contraction, it is termed as expansion joint. This consists of a pre-planned break in the continuity of a structure or a component of a structure with a gap 6 to 40mm wide, expected and constructional details. The gap in some cases is filled with flexible material which gets compressed under expansive force and stretched under a pulling force. If there is a possibility of rain water penetrating through the joint, water bar or a sealant or a protective cover, or a suitable combination of these items is provided, depending upon the requirement

	in any particular situation. Width of expansion joint for jobs done in summer could be less than For those done in winter.
2.Contraction or Control Joint	When a joint allows only contraction, it is termed as control or contraction joint. Expansion of structure results in a compressive force and contraction or shrinkage in a tensile force. Since the principle materials used in buildings, namely, concrete and masonry are strong in compression and weak in tension, cracking mainly occurs due to contraction or shrinkage. That is the reason why in concrete pavements/floorings, control joints are provided at closer intervals than the expansion joints. A control joint consists of a straight but joint without any bond at the interface. In case of floors and pavements, control joints are formed by laying concrete in alternative panels. Provision of strips of some materials which do not develop much brand with concrete for example glass, aluminium, plastic, in a grid information, is a convenient method

	of providing control joints in concrete floors to allow for shrinkage. A dummy joint is another form of control joint and consists of a weakened section at the joint (generally 2/3rd of the total thickness of the member) and is provided either by leaving a groove at the time of laying concrete or by mechanically forming a groove later after laying of straight crack develops at this dummy joint being a weak section, and thus uncontrolled and haphazard cracking is obviated. Grooves of the dummy joint are generally filled with some mastic compound to conceal the crack and to prevent water getting into the joint.
3.**Sliding or slip point**	When a joint permits sliding movement of one component over another, it is termed as slip joint. A slip joint is intended to provide sliding movement of one component over another with minimum of restraint at the interface of the two components. A commonly occurring example is a joint between an RCC slab

	and top of supporting wall. The bearing portion of the wall is rendered smooth with plaster, allowed to set and partly dry, and then given a thick coat of whitewash before casting the slab so that there is a minimum bond between the slab and the support. To ensure more efficient functioning of this joint, in place of whitewashing 2 or 3 layers of tarred paper are placed over the plastered surface to allow of ready sliding between RCC slab and the supporting masonry. When the slab expands due to fall in temperature, or contracts due to fall in temperature or shrinkage of concrete,some movement can take place, thus, obviating any excessive thrust or pull on the wall.

Spacing of expansion and control joints in building structures

1	Load bearing brick walls having cross walls at intervals	Expansion joint 25m to 40m apart
2	Load bearing walls having no cross walls (e.g. godowns, warehouses).	Expansion joint 20 to 30m apart.
3	R.C.C roof slab over load bearing walls	**Expansion joint** (i) 15-20m (for slab having adequate thermal insulation). (II) 10-15m(for slabs having no very little thermal insulation.
4	R.C.C framed structure	Expansion joint 30 to 45m interval.
5	Long compound walls of masonry.	(1) Expansion joint at 5-8 m interval (2) Provide expansion joints at every change of direction.

6	Concrete pavements	(1) Provide expansion joints at 25 to 40m interval. (2) Provide control joints at every 3 to 5m. **Notes:** (i) Provide joints both in longitudinal and transverse direction. ii) Thinner the pavement, closer the spacing of control and expansion joints.
7	Concrete/Terrazzo flg.	Provided control joints 1-2 apart in both directions
8	R.C.C balconies, railing sunshades,open verandahs.	Expansion joints 6-9m apart.

Note: The above is only a general guidance for spacing of joints. Accurate spacing and location of joints in a structure depends on many factors e.g.,

1. Properties of materials used in construction.

2. Temperature variations that are anticipated.

3. Temperature prevailing at the time of construction i.e. whether summer or winter.

4. Shape and size of structure.

5. Degree of exposure of the structure or its components to heat and cold.

Shrinkage of concrete

What is Shrinkage ?

With the removal of moisture on drying, concrete undergoes contraction which is termed as shrinkage. Shrinkage phenomenal important in concrete because if concrete is not allowed to contract freely, tensile stresses develop in concrete and when these stressed exceed the tensile strength of concrete, concrete cracks.

Type of Shrinkage: There are Two types of shrinkage in concrete:

1. **Reversible Shrinkage:** This type of shrinkage occurs in concrete due to pores or intermolecular spaces. With the entry of water in these pores, concrete expands and with the removal of moisture from these pores, it contracts. This phenomena is cyclic in nature and occurs in every season and doesn't pose great problem.

2. **Irreversible Shrinkage:** Irreversible shrinkage occurs only once in life time of concrete during the process of initial drying of concrete or during the process of hydration of cement. So we can say that this type of shrinkage is not due to voids in concrete but it is related to hydration of cement and molecular structure of cement .

Initial drying shrinkage of concrete far exceeds any subsequent reversible shrinkage. thus, most of he cracking in concrete occurs due to shrinkage at the time of initial drying.

Since this irreversible shrinkage is related to the process of hydration of cement, hence in the initial stages when the rate of hydration of cement is fast, this shrinkage also more and later when the rate of hydration slows, this shrinkage also becomes less. Hence, if in the initial stages,

water is allowed to evaporate, shrinkage will be much more due to higher rate of hydration of cement in the initial period. Hence, the great importance of curing and not allowing concrete to dry in the initial stages.

Although this shrinkage is irreversible in nature but if concrete is pounded as early as possible after accidental drying, then some portion of this shrinkage becomes reversible.

Factors which increase the Shrinkage in concrete:

(A) More Quantity of water: One single largest factor controlling the shrinkage in concrete is the amount of water in concrete. More the quantity of water in concrete, more the shrinkage. More quantity of water will lead to more amount of reversible also because more the water, more the pores in concrete left later. More the pores in concrete, more the reversible shrinkage.

The following factors lead to more quantity of water in the mixture:

1. More amount of cement so more water required for hydration of cement.

2. More cement of fine aggregates, so more surface area hence more water required for lubrication and workability.

3. Improper grading of aggregates, so more voids. Hence, more water goes in filling the voids.

4. Concreting in thin sections, requires more water for workability.

5. Manual mixing and compaction, which requires more water for workability.

(B) **Rapid Drying of Concrete:** Factors which lead to rapid drying of cement increase shrinkage e.g.,

1. High temperature outside.

2. Less Humidity outside.

3. Windy atmosphere outside.

(c) **Type of cement:** Cements whose rate of hydration are fast are likely to undergo more shrinkage e.g.,

1. Rapid hardening cement.

2. High alumina cement.

(D) **Presence of Chemicals and Impurities:** Use of CaCl as an admixture in concrete and presence of clay in sand/aggregate also increases the shrinkage of concrete.

Measures to Prevent Shrinkage and Shrinkage Cracks

(1) If possible casting should preferably take place in winter or rainy season so that 3-4 months pass before the onset of summer**.**

(2) If concrete is cast in summer, it should be kept pounded for as long as possible (preferably one month). By this measure, concrete is saved from the hydration process of cement becomes quite slow, so drying shrinkage

becomes very less and moreover at that stage slab is also strong enough to bear the stresses without cracking.

(3) Protection of concrete against high temperature and winds in the initial stages of setting/hardening before curing starts, by covering it with suitable materials or application of suitable chemicals which prevent moisture from evaporation.

(4) Casting un reinforced concrete in panels and leaving control joints (see subhead 5-12 details).

(5) Provide shrinkage reinforcement in concrete if bigger size panels are cast.

(6) Reduction in quantity of water at the time of production of concrete by taking following measures.

(a) Use of coarse graded aggregates.

(b) Compaction of concrete by mechanical vibrator.

(c) Keeping slump as low as practicable.

(d) Use plasticizer to reduce water.

Factors governing quality and strength of concrete

(1) **Maximum size Aggregate and Grading of aggregates**

Use coarse graded aggregates starting with the size of coarsest size of particle practically possible (from the consideration of workability, plasticity and homogeneity of he mix). Using coarse graded aggregates has following advantages:

(a) **Less surface of aggregates:** Because of less surface area, same cement can provide better coating to particles and hence more strength.

(b) **Less voids:** This is because when we start grading downwards with coarsest size of particle and go on filling the voids with progressively lesser sizes of particles, the final volume of voids is less as compared to the case when we start grading downwards with less coarser size of particle. Lesser the voids in concrete, more the strength and more the water tightness.

(c) **Less water requirement:** Surface area of aggregates being low, water requirement for lubrication of particles will

be less and hence less shrinkage and more strength using the same amount of cement because of low w/c ratio.

(2) **Mixing** Mixing should be done in Diesel operated mixer so that all constituents are thoroughly mixed and become a homogeneous mass without showing segregation.

(3) **Compaction :-**Vibration or compaction should be done with mechanical vibrator instead of hand compaction. It will have two advantages:

(a) With vibration less water is adequate in concrete for achieving same workability which results in more strength of concrete because of less w/c ratio.

(b) With compaction by vibrator better compaction is achieved leading to less number of voids, and therefore, more water tightness in concrete.

(4) **Use of plasticizer for increasing workability**

Plasticizer can be added in concrete which will increase the workability and reduce water requirement. It will further increase the strength because of less w/c ratio.

(5) **Quality of materials**

Quality of cement, sand and aggregates should be ascertained by various field and laboratory tests because their quality definitely has a bearing on the strength and quality of concrete.

(6) **Curing**

Curing basically consists of making up the water which evaporates from the concrete surface so that concrete is never dry. Curing of concrete after laying and compaction is absolutely essential for a specified number of days because of the following reasons:

(a) Cement needs water for its hydration. If water is inadequate, it will not hydrate completely and therefore, not harden properly leading to inadequate strength.

(b) Evaporation of water from concrete and its drying leads to shrinkage of concrete and develops tensile stress in concrete leading to its cracking if proper measures are not taken.

(c) Evaporation of water from create more voids in concrete making it more, permeable and more prone to seepage and dampness. Nowadays for cutting, curing compounds are also used which are applied over the concrete surfaces. They make a waterproof membrane over concrete surface and prevents its water from evaporating thus obviating the necessity of water curing. Some of such curing compounds are listed in subhead 5-19(B).

These curing compounds are specially useful in places where water curing is difficult e.g. vertical surfaces of R.C.C columns, R.C.C walls, tall structures like chimneys, silos & overhead water tanks and concrete patch repairs.

Other normal precautions like protection of concrete from drying before curing starts by covering it with some materials (wet gunny bags, tarpaulin etc.), transporting and placing concrete in such a manner as to avoid segregation etc., should invariably be taken care of for getting good quality and strong concrete.

Defects normally observed in execution of R.C.C work

1. Storage of cement was very poor, 'The first in', 'first out' principle was not adopted in storage of cement with the result that old cement was used in the work.

2. The source of water which was used during construction could not be definitely located. Ground water contained high quantity of chlorides and sulphates.

3. The water used for R.C.C was dirty, contained soap as the storage tank was being utilized for washing clothes and for bathing by labourers. Water contained algae as the water tank was not cleaned.

4. RCC work was sagging.

5. The slopes provided in balcony slabs, ***chajjah*** etc. were not proper.

6. The steel reinforcement cage for the R.C.C work was not in proper position. The cage was twisted and dimensionally not stable.

7. The cover of the reinforcement was not uniform and the reinforcement cage was touching the shuttering at few places.

8. Proper cover blocks were not used any many of the blocks were detached from the steel to which they were to be bound. Cover blocks didn't have proper wires jutting out from them for attaching them to reinforcement.

9. Cover blocks were made out of very weak concrete. Sometimes even stones were used as cover blocks.

10. The sections of R.C.C beams, columns etc. were less when compared to the sections shown on the structural drawing.

11. The column beam junctions were seen to be extensively honeycombed.

12. The overlaps were inadequate in length and the overlaps were not staggered. The placement of steel was improper and not in the position as required by the structural drawings.

13. The steel was not provided of the full length as shown in drawing. Cut pieces were used.

14. The column reinforcement at roof level was not bent into the beam for making a proper joint. The steel was just cut and left.

15. In case of R.C.C parapet, the steel was provided on the wrong face.

Defects normally noticed in formwork

1. The props or supports of form work were not in plumb and were not cross braced.
2. The ground supports to props or shores were poor and therefore the formwork settled.

3. Wedges were not tightened properly to the shores.

4. There was insufficient thickness of shuttering unable to bear lateral pressure imposed by wet concrete, specially in columns.

5. Shuttering plates were not cleaned and oiled or oiled with dirty oil.

6. There were many insufficient and loose connections in centering and shuttering.

7. Form work was removed before time.

8. From work was not planned and designed properly.

9. In the case of beam forms. proper provision for retaining the side was not made. Hence, the concrete beam bulged on the sides.

10. The shuttering was poorly made with cracked and wrapped timber planks having lot of holes and knots.

11. through bolts for the R.C.C walls form work for an underground tank were used. Later the holes made by the bolts could not be plugged.

12. 'Ballis' were resting on bricks or brick pillars.

13. 'Ballis' were not in one piece and were having in between. Joint were also improperly made and no additional cross bracing was provided at the joint.

Check list for ensuring quality of R.C.C work

1. Quality and size of coarse aggregate - Whether the metal is over size, under size or improperly graded, whether it contains disintegrated, soft or foreign materials, whether mixed or coated with dust/earth.

2. Quality of sand - its grading, slit content and bulkage to be seen.

3. Water for mixing and curing whether tested for suitability.

4. Record of sump test.

5. Cube test - whether cubes taken, numbered and tested and whether proper arrangements for curing the cubes for 7&28 days are there.

6. Cover blocks - adequacy of thickness and evenness and appropriateness of cover provided with reference to the exposure conditions and types of RCC member.

7. Whether any reinforcement exposed on removal of forms.

8. Honeycombing - extent and quality of repairs.

9. Testing of steel reinforcement for suitability.

10. Gauge of binding wire and whether it has been used at all intersections of the reinforcement. Use of inferior quality of binding wire results in loose tying of reinforcement cage.

11. Regularity/symmetry of steel cage.

12. Spacing of hooks and overlaps, whether suitably staggered and of required length.

13. Rigidity, evenness, lines and levels of the centering and shuttering – whether thickness of finishing of R.C.C surface like rendering and plastering is excessive for making up deficiencies.

14. Final finish of the work.

15. In case of thin sections whether particular attention is given to required.

16. Whether proper throatings and drip mouldings provided wherever required.

17. Whether curing done properly and for specified no. of days.

18. Whether proper expansion joints and contraction joints provided.

19. Whether hacking of green R.C.C work done on surfaces requiring plastering.

Check list for points before allowing concrete pouring

1. Formwork and staging checked for line, levels and their strength.

2. Reinforcement checked.

3. Cover to reinforcement and adequacy of cover blocks checked.

4. Adequacy of chairs for reinforcement and their numbers noted.

5. Whether proper planks or plates provided for walking over reinforcement so that reinforcement is not disturbed by walking directly over it.

6. Adequacy of quantity and quality of materials checked (cement, sand and aggregate, etc.

7. Embedded parts in slab checked (e.g. Fan box, insert plates, etc.)

8. Gaps in shuttering to be properly sealed by jute bags /mortar/rubber beading (for superior work).

9. Whether shuttering plates properly oiled or not.

10. Whether proper access of an and materials to location of slab casting checked.

11. Whether construction joints planned in advance (for break in concrete pouring operation during lunch or after the day.)

12. Curing arrangements to be checked in advance for smooth curing of slab after casting (e.g. condition of water pump, water tank, adequacy of water, etc.)

13. Whether precautionary arrangements are taken in case rain comes e.g. arrangement of tarpaulin , etc.

14. Whether adequate arrangements made for avoiding drying of the slab after casting due to low humidity, heat or wind, by taking any of the following measures.

(a) Placing wt gunny bags over slab;

(b) Application of curing compound (Which doesn't allow water to evaporate);

(c) Application of some water absorbent material like CaCI which absorbs moisture from atmosphere and keeps concrete wet.

15. In case of load bearing walls, whether bearing plaster provided over wall along with white-wash/bitumen/kraft paper/polythene over it.

Note: For all concrete works, a full bag capacity mixer must be used and all aggregates should be used by proper measuring boxes. In exceptional cases, if small mixer is allowed, special boxes to suit 1/2 bag mix should be made and aggregates should be measured by boxes only and not by 'Tokari'. The cement must be mixed on bag basis and

loose cement should not be used. By using loose cement, one is likely to use 20% less cement.

PERMISSIBLE STRESSES IN STEEL REINFORCEMENT

SL. NO.	TYPE OF STRESS IN STEEL REINFORCEMENT	PERMISSIBLE STRESSES IN N/mm^s		
		Mild Steel Bars Conforming to Grade I of IS:432 (Part I) – 1966* or Deformed Mild Steel Bars conforming to IS :1139-1966	Medium Tensile Steel Confirming to IS: 432 (Part I) – 1966 * or Deformed Medium Tensile Steel Bars Conforming to IS: 1139-1169	High Yield Strength Deformed Bars Conforming to IS 1139- 1966 or IS: 1786-1979 (Grade Fe 415)
1.	2.	3.	4.	5.
i.	Tension ($_{st}$ or $_{sv}$) : (a) Upto and including 20 mm	140	Half the guaranteed yield stress subject to a maximum of 190	230
	(b) Over 20 mm	130		
ii	Compression in column bars ($_{sv}$)	130	130	190
iii	Compression in bars in a beam or slab when the compressive resistance of the concrete is taken into account	The calculated compressive stress in the surrounding concrete multiplied by 1.5 times the modular ratio or $_{sv}$		

iv	Compression in bars in a beam or slab where the compressive resistance of the concrete is not taken into account:			
	(a) Up to and including 20 mm	140	Half the guaranteed yield stress subject to a maximum of	190
	(b) Over 20 mm	130	190	190

PLUMBING & SANITARY ARRANGEMENT

CIRCULAR-13

BIB COCK & STOP COCK & SCREW DOWN TAP

IS : NO.781/1967

The Bib cock and stop cock should be polished bright. The minimum finished weight of bib tap (cock) and stop tap (cock) shall be as specific under .

TABLE

Size mm	Minimum finished weight	
	Bib tap Kg	Stop tap Kg
8	0.25	0.25
10	0.30	0.35
15	0.40	0.40
20	0.75	0.75

SOME USEFUL DATA RELATING TO WATER SUPPLY

(A) DELIVERY FROM DIFFERENT SIZES OF TAPS

Dia of pipe (in mm)	15	20	25	32	40	50
Flow (in litres / minute)	10	20	30	45	70	110

(B)RECOMMENDED SIZES OF SERVICE MAINS FOR HOUSING

Sl. No.	Class of building	Size of service main (mm)
1.	Ordinary single family dwelling 2 to 3 storeys and not more than 10 rooms	32
2.	Larger dwelling with about 16 rooms	40
3.	Four apartment building with about 24	50

	rooms	
4.	Twenty five apartment building with about 100 rooms	50

Notes:

1. Service main shouldn't be normally less than 25 mm dia. For very smaller houses it can be reduced to 20 mm and if the pressure is very high then it can be reduced to 15 mm.

2. Where it is necessary for a pipe to pass though a wall or floor, a sleeve shall be fixed therein through which pipe should be passed and the gap later should be filled by a sealant.

3. Tables above are on the assumption of having that much pressure in the system so as to have the exit velocity (at the taps) of about 1 m/s.

RECOMMENDED VELOCITIES FOR WATER PIPES

Pipe dia	Velocity in m/sec.	Pipe dia	Velocity in m/sec
100 mm	0.75 to 0.91	500 mm	1.40
150 mm	0.81 to 1.22	650 mm	1.69
200 mm	0.91 to 1.32	800 mm	1.92
250 mm	0.99 to 1.52	900 mm	1.95
320 mm	1.09 to 1.67	1000 mm	2.00
400 mm	1.27 to 1.83	Service pipes	2.13

REQUIREMENT OF PVC PIPE & UNPLASTICISED

Unplasticised / Rigid P.V.C Pipes

A. For Internal work:-

Outside dia in mm	Tolerance on Outside dia	Wall thickness in mm for 10kg/cm2 working pressure	
		Min	Max
20	+0.3	2.8	3.3
25	+0.3	2.9	3.4
32	+0.3	3.4	3.9
40	+0.3	3.6	4.2
50	+0.3	3.7	4.3

B. For External work*:*

Wall thickness for working pressures									
Outside diameter	Tolerance on outside dia	2.5 kgf/cm2		4 kgf/cm2		6 kgf/cm2		10 kgf/cm2	
		Min	Max	Min	Max	Min	Max	Min	Max
16	+ 0.3	-	-	-	-	-	-	1.1	1.5
20	+ 0.3	-	-	-	-	-	-	1.1	1.5
25	+ 0.3	-	-	-	-	-	-	1.4	1.8
32	+ 0.3	-	-	-	-	-	-	1.8	2.2
40	+ 0.3	-	-	-	-	1.4	1.8	2.2	2.7

50	+ 0.3	-	-	1.2	1.6	1.7	2.1	2.8	3.3
63	+ 0.3	-	-	1.5	1.9	2.2	2.7	3.5	4.1
75	+ 0.3	-	-	1.8	2.2	2.6	3.1	4.2	4.9
90	+ 0.3	1.3	1.7	2.1	2.6	3.1	3.7	5.0	5.7
110	+ 0.4	1.6	2.0	2.5	3.0	3.7	4.3	6.1	7.0
125	+ 0.4	1.8	2.2	2.9	3.4	4.3	5.0	6.9	7.7
140	+ 0.5	2.0	2.4	3.2	3.8	4.8	5.5	7.7	8.7
160	+ 0.5	2.3	2.8	3.7	4.3	5.4	6.2	8.8	9.9
180	+ 0.6	2.6	3.1	4.2	4.9	6.1	7.0	9.9	11.1
200	+ 0.6	2.9	3.4	4.6	5.3	6.8	7.7	11.0	12.3
225	+ 0.7	3.3	3.9	5.2	6.0	7.6	8.6	12.4	13.9
250	+ 0.8	3.6	4.2	5.7	6.5	8.5	9.6	13.8	15.4
280	+ 0.9	4.1	4.8	6.4	7.3	9.5	10.7	15.4	17.2
315	+ 1.0	4.6	5.3	7.2	8.2	10.7	12.0	17.3	19.3

PARTICULARS OF MEDIUM GRADE G.I PIPES

Nominal Bore	Dimension of pipes		Thickness	Weight of pipe	
	Outside diameter			Plain end	Screwed & socket
mm	Max mm	Min mm	mm	kg/m	kg/m
6	10.6	9.8	2.0	0.407	0.410
8	14.0	13.2	2.35	0.650	0.654
10	17.5	16.7	2.35	0.852	0.858
15	21.8	21.0	2.65	1.22	1.23
20	27.3	26.5	2.65	1.58	1.59

25	34.2	33.3	3.25	2.44	2.46
32	42.9	42.0	3.25	3.14	3.17
40	48.8	47.9	3.25	3.61	3.65
50	60.8	59.7	3.65	5.10	5.17
65	76.6	75.3	3.65	6.51	6.63
80	89.9	88.0	4.05	8.47	8.64
100	115.0	113.1	4.50	12.1	12.40
125	140.8	138.5	4.85	16.2	16.70
150	166.5	163.9	4.85	19.2	19.80

Tolerance on Thickness and weight

(a) Thickness

1. Butt welded Medium tubes + not limited
   - 10 percent

2. Seamless tubes + not limited
   - 12.5 Percent

(b) Weight

1. Single tube(irrespective of quantity) + 10 percent
   - 8 percent

2. For quantities of less than 150m of one size + 10 percent
   - 8 percent

3. For quantities of 150m and over of one size $\pm$ 4 percent

DRAINAGE

General Requirements:-

In designing and drainage system for buildings the aim shall be provide a self cleansing conduits for the conveyance of soil, waste and removal of such waste speeding and efficiently to a sewer or other outlet with risk of nuisance and hazard to health. The following are the gradients required for a sewer.

GRADIENTS FOR SEWERS

Diameter	Maximum Gradient		Maximum Gradient	
	Gradients	Discharge	Gradient	Discharge
Mm		m^3/Min		m^3/Min
100	1 in 57	0.18	1 in 5.6	0.59
150	1 in 100	0.42	1 in 9.7	1.32
200	1 in 145	0.73	1 in 14	2.4
230	1 in 175	0.93	1 in 17	2.98
250	1 in 195	1.10	1 in 19	3.60
00300	1 in 250	1.70	1 in 24.5	5.30

Construction of Manholes

1. Every change of alignment / gradient or diameter of drain there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be 30 meters.

2. No drain from home fittings viz Gully trap or soil pipe etc. to manhole shall normally exceed a length of 6 m unless it is unavoidable.

3. Branch lines that can be taken from any given diameter of G.I. lines.

PIPE LINE

MAIN AND BRANCH DETAILS

Sl. No.	Diameter of main line in mm.	Diameter of branch pipe line in mm									
		100 mm	90 mm	80 mm	65 mm	50 mm	40 mm	32 mm	25 mm	20 mm	15 mm
1	100 mm	1	1	2	3	6	10	17	32	53	113
2	90 mm		1	1	2	4	8	13	25	43	88
3	80 mm			1	2	3	6	10	18	32	66
4	65 mm				1	2	3	6	11	19	39
5	50 mm					1	2	3	6	10	20
6	40 mm						1	2	3	6	12
7	32 mm							1	2	3	7
8	25 mm								1	2	4
9	20 mm									1	2
10	15 mm										1

ELECTRICAL WORKS

CIRCULAR-14

Space parameters for electrical fittings

Electrical wiring

House wiring rules as per ISI specification :

1. The no. of points in the light circuit is not exceeded 10 or the total load on the circuit is not exceeded 800 watts.

2. Use only three pin sockets.

3. The minimum size of earth wire is 14 SWG of copper and 4 mm for Aluminium .

4. The fuse wire should be connected to the phase wire only.

5. Connect a neutral link in the neutral wire.

6. Connect all switches in the phase wire.

7. Choose the size of the conductor so that the voltage drop of the lost point of the circuit is not more than 1-2 % of declared voltage of supply.

8. The minimum size of the wire for light circuit is 1 mm2 of aluminium.

9. The power wiring circuit is the circuit connecting electrical appliances. The minimum size of wire 1.5 mm2 of copper and 2 mm2 of aluminium.

10. For power wiring circuit the no.of points in a circuit should not exceed 2000 watts.

11. All materials used in house wiring is wire and accessories should be of good quality, preferably having ISI marks.

Tips on electrical wiring

Colour of insulation of various types of wiring

1. Phase wires : Red, Yellow & Blue
2. Neutral wires : Black
3. Earth wires : Green

SPACE PARAMETERS FOR ELECTRICAL FITTINGS

S.No.	Name of fixture	High from Feet	FFL Cms
1.	Switch plate (Bottom)	4’	120
2.	Tube light/Bracket light	7’	21
3.	Bed light	2 ½’	75
4.	Power Point	6’	15
5.	Bell Point (out side the house)	4’	120
6.	Call Point (In side the house)	7’	210
7.	Mirror light	6’	180
8.	MCB for Geyser	6’	180
9.	Main DB/MCB	6’	180
10.	Bottom of ceiling fan	8’8’’	260
11.	Normal Height of street light poles		700to900
12.	Normal Height of Post top lantern	10’	300

(C)SOME TIPS ON ELECTRICAL WIRING

1. Lighting Circuit – Max.No. of points = 10
   Total load shouldn't exceed 800wait in a circuit

2. Power Circuit - Max. No. of points = 2
   Max.load shouldn't exceed 2000 watt in a circuit

3. Min . size of wire – 1.00mm2 for Cu
   For light Circuit 1.5 mm2 for Al

4. Min.size of earth - wire 16 SWG of CU (for 5 Amp. Socket)

   14 SWG of CU.
   12 SWG of Al. — or 15Amp. Socket)

CHECKLIST FOR INTERNAL ELECTRICAL WIRING WORK

(1) Surface wiring on wooden batten

i. Whether quality of wood used for the batten is proper or not.

ii. Whether breadth and thickness of batten is as per specification.

iii. Spacing of screws for fixing battens.

iv. Shape and size of wooden plug.

v. Finish of batten, varnishing, painting.

vi. Spacing of clips.

vii. Adequacy of size of clips for the number of wires.

viii. Whether nails used for fixing clips are of proper material.

ix. Whether protective covering provided on down drops within 1.5 meters from floor level.

x. Whether wire used is of I.S marking.

xi. Check quality of switch and plug sockets.

xii. Whether round block and boards are of double board construction and of proper size and thickness.

xiii. Whether circuits of different phase coming in the same room have been kept at a distance of 2 metres apart.

xiv. Check height of switch boards.

(**2) Conduit wiring**

1. Check wire
2. Check size and gauge of conduit.
3. Check conduit accessories for thickness and quality.

4. Whether conduit accessories are as per specification.

5. Check mechanical rigidity and electrical continuity of the conduit system.

6. Whether check nuts and bushes used.

7. Whether regulator and switch boxes are of adequate size and depth and thickness is as per specification.

8. Whether regulator mounted inside box.

9. Whether earthing for regulator done.

10. Check loop earth wire for material and gauge.

11. Overall workmanship whether satisfactory or not.

CHECK LIST FOR CABLE LAYING

1. Check width and depth of the trench, thickness of sand cushioning and cover, quality and size of bricks for mechanical protection.

2. Route markers provided or not.

3. Whether cable identification tags have been provided.

4. Whether testing of cable done before and after laying and before energizing .

5. Check radius of bends.

6. Check whether proper loops at the ends have been made.

7. The dimensions of cable trench should be as per specifications. Proper sand cushioning should be provided before laying the cable. The thickness of sand cushion should be checked with reference to

specifications. The quality of bricks used for protection of the cables should be checked. Contractors have a tendency to use inferior quality of bricks.

8. Insulation test should be carried out before and after laying the cable and the results should be recorded in a register signed by contractor and responsible officer. (Due to mishandling the cable may get damaged and the contractor cannot be held responsible unless the tests are performed before and after laying.

9. The cable at entry points in the building should be properly protected by means of C.I. or G.I. Pipe to avoid damage from mechanical injury.

10. Proper size of cable glands should be used at the termination of the cable.

11. Armouring of the cable should be properly earthed.

12. It must be ensured that the cable connection does not remain under tension.

13. Proper size of lugs/ferrules should be used for making connection at the cable termination