GOVERNMENT OF TELANGANA
ROADS AND BUILDINGS DEPARTMENT

Office of the Engineer-In-Chief(R&B)
Administration& Quality Control,
Errum Manzil, Hyderabad,
Telangana State.

Circular Memo No:2609150009/ENC(Admn&QC)/EE(QC&MC)/DEE/AEE2/2015/2,Dt:30-01-2017

Sub:-(R&B) Department- Quality Control wing- Assurance and Management of Quality of Buildings works- Quality Assurance and Management Plan–Implementation-Instructions-Issued -Regarding.

Ref:-1)T.O. Lr.No.2609150009/ENC(Admn&QC)/DEE/AEE2/2015 , Dt:31.03.2016 addressed to the ENC(R&B) Buildings NH, CRF, LWE,PPP & Buildings, Hyd
2) T.O. Lr.No.2609150009/ENC(Admn&QC)/DEE/AEE2/2015,Dt:14-05-2016 addressed to the ENC(R&B) Buildings NH, CRF, LWE,PPP & Buildings, Hyd

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The department is taking up Building works on large scale in the state. A need is felt for executing the above buildings works to the required quality to ensure longevity of buildings undertaken by the (R&B) department. Hence, the Quality Assurance and Management Plan for building works in (R&B) Department is here with communicated to all the Superintending Engineers (R&B) with a request to adopt the same in execution of building works in order to perform the construction tasks in a systematic way within the quality system to achieve proper quality assurance and quality control during the execution phase. Further, the SEs are directed to furnish a copy of the same to all field officers up to the AEE/AE cadre for effective implementation during execution of works. The Quality Assurance and Management Plan is also placed in the (R&B) Department website.

Encl: Quality Assurance and Management Plan is mailed to the SEs. to their e-mail IDs.

Attended
2/2/2017

For Engineer-in-Chief(R&B)
Administration &QC

8
2/2/17

To

► **The Superintending Engineers (R&B)** i.e, 1) Rural Circle, Hyderabad 2) Head Quarter Circle, Hyderabad 3) Karimnagar 4) Warangal 5) Sangareddy 6) Nalgonda 7)Khammam 8) Nizambad 9) Mahabubnagar 10) Adilabad11) NH Circle, Hyderabad 12) NH Circle, Karimnagar. 13) Electrical Circle, Hyderabad

► Copy to

1) The Engineer-in- Chief(R&B) NH, CRF, LWE,PPP & Buildings, Hyderabad for information and necessary action.
2) The Engineer-in-Chief(R&B) State Roads &CRN, Hyderabad for information
3) The Chief Engineer(R&B) Rural Roads, Hyderabad for information
4) The Chief Engineer (R&B) D&P, Hyderabad for information and necessary action.

► Copy to

1) The Superintending Engineer(R&B)I&QC Circle, Hyderabad for information and necessary action.
2) The Superintending Engineer(R&B)I&QC Circle, Warangal for information and necessary action
3) The Executive Engineer(R&B),QC Division, Hyderabad-I for information and necessary action.
4) The Executive Engineer(R&B),QC Division, Hyderabad- II for information and necessary action.
5) The Executive Engineer(R&B)QC Division, Warangal & Karimnagar for information and necessary action.
6) The Executive Engineer(R&B)QC Division, Karimnagar for information and necessary action.

► Copy to

1) The Dy. Engineer-in-Chief(R&B) Admn. &QC, Hyderabad Table.

2) The Dy. Executive Engineer(R&B),E-Governance, O/o Engineer-in-Chief(R&B), Hyderabad to place in website **roadbuild.telangana.gov.in**

Spare

GOVERNMENT OF TELANGANA
ROADS AND BUILDINGS DEPARTMENT

QUALITY ASSURENCE AND MANAGEMENT PLAN FOR BUILDING WORKS

" Prepared by "

M. Krishna Murthy , M.E.
Superintending Engineer(R&B),
I&QC Circle, Hyderabad
Assisted by
(1) Sri. I. NarsinghRao DEE (R&B)
QC Sub division Hyderabad.
(2) Smt. G. Jayalaxmi AEE (R&B)
I&QC Circle, Hyderabad

"Approved by "

Sri K. Bikshapathi , M.E.
Engineer-In-Chief(R&B)
Administration & Q.C,
Hyderabad, Telangana.

GOVERNMENT OF TELANGANA
ROADS AND BUILDINGS DEPARTMENT

QUALITY ASSURENCE &MANAGEMENT PLAN FOR BUILDING WORKS

Preface: Roads and Building Department is vested with the responsibility of construction and maintenance of Buildings of many Government departments. These include small size buildings to major, very large buildings. Buildings vary to a great extent in size and in height ranging from one room house to very large complex, housing several departments, ranging from less than 1000sq.ft.in a floor to severalthousand sq.ft.in a single floor.In height also, buildings vary to a great extent ranging from one story building i.e., about 3.00m height to even 30 story height building i.e., height up to 100 m.

The construction material and type also vary largely. Hence it is very important to have properly documented QAP in place to have uniformity in construction and maintenance methods and to achieve required standard in building construction. With this objective, this QAP is prepared.

QAP covering road works was already approved by the E in C (R&B) Admin and Quality control, Telangana state and communicated to all field engineers in the department vide Circular Memo No:2609150009/ENC(Admn&QC)/DEE/AEE2/2015/2, Dt:16.11.2015.The definitions and methods ofachieving Quality assurance and achieving Quality control covered in first part hold good for this also.

The contractor shall draw up qualitymanagement system in accordance with ISO 9001-2000 and submit to the S.E concerned in case of work costing more than Rs2.00 crores. Further,it is essential to have requisite contractor's technical persons on the site.

Detailed quality assurance and control plan for Building works covering the wholegamut of work items will be too lengthy. Hence this plan mainly covers items/materials, construction techniques that are mostcommonly used in building construction activities in the department.

(i)Materials Part:

(a) Bricks used in Construction:

Common Burnt clay Bricks: The bricks shall be hand or machine moulded. Bricks shall be of specified size. The bricks are classified as first class or second class on the basis of dimensional tolerances.

First class bricks: These shall be uniform in colour and shall have sharp edges. The tolerance on the specified dimension shall not exceed ±3%.

Second class bricks: These bricks may exhibit some variation in colour and need not necessarily have sharp edges as long as they permit laying of uniform courses. The tolerance on the specified dimension shall not exceed ± 8%.

The physical characteristics of bricks shall be as follows.

Physical Characteristics of Bricks

Sl No.	Characteristics	Requirements
1	Compressive Strength	As specified
2	Absorption after 24 hours immersion in cold water.	Not more than 20% by weight
3	Efflorescence	Not more than “moderate”

Bricks are also classified based on the compressive strength of bricks. This classification is as follows.

Classes of Common Burnt Clay Bricks

Class Designation	Average Compressive Strength not Less Than	
	N/mm2	Kg/cm2 (approx)
35	35.0	(350)
30	30.0	(300)
25	25.0	(250)
20	20.0	(200)
17.5	17.5	(175)
15	15.0	(150)
12.5	12.5	(125)
10	10.0	(100)
7.5	7.5	(75)
5	5.0	(50)
3.5	3.5	(35)

Pulverized fuel ash- lime Bricks

Fly Ash Lime Bricks (FLAG Bricks): The Fly Ash Bricks (FLAG Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with or without frog on one of its flat sides. The classification of FLAG Bricks is as follows.

Classes of Pulverized Fuel Ash-lime Bricks

Class Designation	Average Compressive Strength not Less Than	
	N/mm2	Kg/cm2 (approx)
35	35.0	(350)
30	30.0	(300)
25	25.0	(250)
20	20.0	(200)
17.5	17.5	(175)
15	15.0	(150)
12.5	12.5	(125)
10	10.0	(100)
7.5	7.5	(75)
5	5.0	(50)
3.5	3.5	(35)

The dimensional tolerances shall be as follows.

Tolerances

Type	**Dimensional Tolerances for 20 nos of Bricks**
Modular	**L=3800±80** **B=1800±40** **D=1800±40** **(for 90mm high bricks)** **D=800±40** **(for 40mm high bricks)**
Non Modular	**L=4600±80** **B=2200±40** **D=1400±40** **(for 70mm high bricks)** **D=600±40** **(for 30mm high bricks)**

Lot: A collection of bricks of the same class and size, manufactured under relatively similar conditions of production. For the purpose of sampling, a lot shall contain a maximum of 50,000 bricks. In case a consignment has bricks more than 50,000 of the same classification and size, and manufactured under relatively similar condition of the production. It shall be divided into lots of 50,000 bricks or part thereof.

Sample: A collection of bricks selected for inspection and/or testing from a lot to reach the decision regarding the acceptance or rejection of the lot.

METHODS OF SAMPLING:

The sample shall taken by one of the methods given below so as to yield the number of bricks required.

Sampling in motion: Whenever practicable the sample shall be taken while the bricks are being moved, for example, during loading or unloading. The lotshall be divided into a number of convenient portions(not less than ten). Approximately equal number of bricks shall be drawn from each of these portions at regular intervals, such that the requisite number of bricks for inspection and testing is provided.

Sampling from stack: When it is necessary to take a sample from a stack, the stack shall be divided into a number of real or imaginary sections and the required number of bricks drawn from each section. For this purpose bricks in the upper layers of the stack shall be removed to enable units to be sampled from places within the stack.

Sampling from Lorries or Trucks - When it is necessary to take a sample from bricks loaded in lorries or trucks, the sample bricks shall be taken from a number of lorries/trucks (not less than ten, if possible) such that when equal number of bricks are drawn from each of the lorries/trucks the number of bricks required for the inspection and testing is provided.

SCALE OF SAMPLING AND CRITERIA FOR CONFORMITY FOR VISUAL AND DIMENSIONAL CHARACTERISTICS

The bricks shall be selected and inspected for each lot separately for ascertaining their conformity to the requirements of the relevantspecification.

The number of bricks to be selected from a lot shall depend on the size of the lot and shall be in accordance with column 1 and 2 of Table given below for visual characteristics in all cases and dimensional characteristics if specified for individual brick. In case dimensions are specified for a group of 20 bricks, the scale of sampling for dimensional characteristics shall be in accordance with column 1 and 4 of the Table given below. All these bricks shall be selected following the methods as stated above.

Visual Characteristics-All the bricks selected as above in accordance with column 1 and 2 of the Table given below shall be examined for visual characteristics. If the number of defective bricks found in the sample is less than or equal to the corresponding number as specified in column 3 of the Table given below, the lot shall be considered as satisfying the requirements of the visual characteristics. However, if the number of defective bricks in the sample is greater than the corresponding permissible number of defectives, the lot shall be deemed as not having met the visual requirements.

TABLE SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES FOR VISUAL AND DIMENSIONAL CHARACTERISTICS

No. of Bricks in the Lot	For Characteristics Specified for Individual Brick		For Dimensional Characteristics Specified for Group of 20 Bricks — No. of Bricks to be Selected
	No. of Bricks to be Selected	Permissible No. of Defectives in the Sample	
(1)	(2)	(3)	(4)
2 001 to 10 000	20	1	40
10 001 to 35 000	32	2	60
35 001 to 50 000	50	3	80

NOTE — In case the lot contains 2 000 or less bricks, the sampling shall be subject to agreement between the purchaser and the supplier.

Dimensional Characteristics-The dimensions and tolerances have beenspecified in various standards for clay building bricks. In some standards the dimensions and tolerances have been specified for individual brick. In some other standards the dimensions and tolerances have been specified for a group of 20 bricks.

In case the dimensions and tolerances have been specified for individual brick, the scale of sampling and criteria for conformity shall be the same as laid down in for visual characteristics.

In case the dimensions and tolerances for bricks are specified as overall on a group of 20 bricks, the number of bricks to be selected for inspecting the dimensions and tolerances shall be in accordance with column 1 and 4 of the Table given above. These bricks will be divided into groups of 20 bricks at random and each of the groups thus formed tested for all the dimensions and tolerances. A lot shall be considered having found meeting the requirements of dimensions and tolerancesif none of the groups of bricks inspected fails to meet the specified requirements.

SCALE OF SAMPLING AND CRITERIA FOR CONFORMITY FOR PHYSICAL CHARACTERISTICS

The lot which has been found satisfactory in respect of visual and dimensional requirements shallnext be tested for physical characteristics like compressive strength, breaking load, transverse strength, bulk density, water absorption, efflorescence and warpage as specified in relevant material specification. The bricks for this purpose shall be taken at random from those already selected as above. The number of bricks to be selected and tested for each of these characteristics shall be in accordance with relevant columns of Table given below.

TABLE SCALE OF SAMPLING FOR PHYSICAL CHARACTERISTICS

Lot Size	Sample Size for Compressive Strength, Breaking Load, Transverse Strength, Bulk Density, Water Absorption and Efflorescence	Permissible No. of Defectives for Efflorescence	Warpage	
			Sample Size	Permissible No. of Defectives
(1)	(2)	(3)	(4)	(5)
2001 to 10 000	5	0	10	0
10 001 to 35 000	10	0	20	1
35 001 to 50 000	15	1	30	2

Note: In case the lot contains 2000 or less bricks, the sampling shall be subject to agreement between the purchaser and the supplier.

A lot shall be considered having satisfied the requirements of physical characteristics if all the conditions as stipulated below are all satisfied.

From the test results for compressive strength, breaking load, and transverse strength (whichever applicable), the average shall be calculated and shall satisfy the requirements specified in the relevant material specification.

NOTE - In case any of the test results for compressive strength exceeds the upper limit for theclass of brick, the same shall be limited to the upper limit of the class (or the purpose of averaging.

Wherever specified in the material specification the compressivestrength of any individual brick tested in the sample shall not fall below the minimum average compressive strength specified for the corresponding class ofbrick by more than 20 percent.

From the test results for water absorption and bulk density the average for the bricks in the sample shall be calculated and shall satisfy the relevant requirements specified in the material specification.

The number of bricks failing to satisfy the requirements of the efflorescence specified in the relevant specification shall not be more than the permissible number of defectives given in col 3 of the above Table

The number of bricks failing to satisfy the requirements of warpagewherever specified in the relevant specifications shall not be more than thepermissible number of defectives given in column 5 of the above Table.

(b) Stones for Masonry: The stone shall be of specified type like granite, basalt, limestone, sand stone etc., The stones shall be free from defects like decay, cavities, flaws, sand, holes, soft seams, veins, patches of soft or loose materials or any other deleterious material like iron oxide, organic impurities. Stones shall be free from rounded, worm or weathered surfaces or skin or coating which prevents the adherence of mortar.

The crushing strength of stone is as follows

Crushing strength of stone as determined in accordance with IS: 1121-1974

Sl No	Type of stone	Minimum crushing strength in kg/cm^2
1	Granite	1,000
2	Basalt	400
3	Lime stone (Except very soft stone)	200
4	Sand stone	300
5	Marble	500
6	Laterite	30

Water absorption shall not be more than 5% [Tested as per IS 1124]

(c) Course Aggregate for Concrete: The size of the aggregate is almost all is retained on 4.75mm size sieve. The aggregate shall consist of hard, sharp, angular pieces, broken to specified sizes. Aggregate shall be free from dust and dirt. The grading requirement for single size and graded aggregate for specified nominal size are as follows

Nominal sizes and Corresponding grading for single size and graded aggregate

IS: Sieve Designation	Percentage passing by weight for single size aggregate for nominal size						Percentage passing by weight for Graded aggregate			
	63mm	40mm	20mm	16mm	12.5mm	10mm	40mm	20mm	16mm	12.5 mm
1	2	3	4	5	6	7	8	9	10	11
80mm	100	--	--	--	--	--	100	--	--	--
63mm	85-100	100	--	--	--	--	--	--	--	--
40mm	0-30	85-100	100	--	--	--	95-100	100	--	--

20mm	0-5	0-20	85-100	100	--	--	30-70	95-100	100	100
16mm				85-100	100	--	--	--	90-100	--
12.5mm	--	--	--	--	85-100	100	--	--	--	90-100
10mm	0-5	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75mm	--	--	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36mm	--	--	--	--	--	0-5	--	--	--	--

Sizes of course aggregate for use in mass concrete

Class and size	IS Sieve Designation	Percentage passing by weight
1	2	3
Very large 150 to 80mm	160mm 80mm	90-100 0-10
Large 80 to 40mm	80mm 40mm	90-100 0-10
Medium 40 to 20mm	40mm 20mm	90-100 0-10
Small 20 to 4.75mm	20mm 4.75	90-100 0-5

For RCC works, the nominal maximum size of the aggregate shall be 20mm. The max size shall also be such that it is 5mm less than the clear distance between the bars and 5mm less than minimum clear cover to the reinforcement. The aggregate crushing value shall not exceed 45% for concrete other than wearing course and shall not exceed 30% for concrete in wearing course.[IS 2386 part iv] or AIV shall not be more than 45%[IS 2386 part iv] OR Los Angeles Abrasion value should not be more than 50%[IS 2386 part iv]

(d) Fine aggregate/Sand: Granular material almost entirely passing through 4.75mm sieve and retained on 75µ sieve. Classified in to two categories i.e., course sand and fine sand.

Course sand: The fineness modulus shall not be less than 2.5.

Fine sand: The fineness modulus shall not be less than 1.0.

Sand shall be composed of hard silicon material. It shall be clean, sharp and angular. Clay, fine silt and fine dust shall not exceed the limits as given below [IS 2386 part ii]

Natural sand or crushed gravel sand ≤4% by weight
Crushed stone sand ≤10% by weight

The grading of sand for masonry work shall be as follows

Requirements of grading for sands for Masonry work

IS Sieve Designation	Percentage by weight passing IS Sieve
(1)	(2)
4.75mm	100
2.36mm	90-100
1.18mm	70-100
600micron	40-100
300micron	5-70
150micron	0-15

Grading requirement of sand for plastering for the internal walls & ceiling shall be as follows

Requirements of grading for sand for internal wall and ceiling plastering

IS Sieve Designation	Percentage by weight passing IS Sieve	
	Class A	Class B
(1)	(2)	(3)
2.36mm	98-100 for under coats 100 for finishing coats	98-100 for under coats 100 for finishing coats
1.18mm	80-95 for under coats 95-100 for finishing coats	80-95 for under coats 95-100 for finishing coats
600 microns	30-85	30-95
300 microns	5-50	5-65
150 microns	0-10	0-15

Generally Class A sand shall be used for plaster works.When class A sands are not available, class B may be used.

Fineness modulus of the sand used for plastering shall not be less than 1.4 in case of crushed sand and shall not be less than 1.5 in case of natural sand as per clause: 5.2 of IS:1542-1992.

The grading requirements of sand for external plastering and renderings shall be as follows

Requirements of grading for sand for external plastering and renderings

IS Sieve Designation	Percentage by weight passing IS Sieve	
	Class A	Class B
(1)	(2)	(3)
4.75mm	100	100
2.36mm	90-100	90-100
1.18mm	70-100	70-100
600 micron	40-85	40-95
300 micron	5-50	10-65
150 micron	0-10	0-15

The grading requirement of sand for cement concrete works, plain and reinforced, shall be as follows

Natural or crushed stone sands percentage passing for

IS Sieve Designation	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
(1)	(2)	(3)	(4)	(5)
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

For crushed stone sands, the permissible limit on 150µ sieve is 20%. Sand conforming to zone IV shall not be used in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

(e) Cement: Cement shall be stored in such a way that the bags are about 150mm to 200mm above ground/floor and 250mm to 300mm clear of walls. The height of stacks shall be 10 bags. In no case shall be more than 15 bags to prevent possibility of lumping up under pressure.

Cement when stored for longer periods will loose its strength gradually. Estimation of probable loss of strength of cement for storing longer periods is as follows.

Sl.No	**Period**	**Reduction in strength**
1	3 months	20%
2	6 months	30%
3	12 months	40%
4	24 months	50%

Cement used shall be any of the following types.

33 Grade OPC confirming to IS269
43 Grade OPC confirming to IS8112
53 Grade OPC confirming to IS812269

The following tests are to be conducted on the cement and their limits as per IS8112:1989 are as follows.

Fineness modulous – 225sqm per kg.

Soundness test

Le-chatlier expansion in mm--- max-10mm

Autoclave expansion (in%)—max-0.8%

Setting time:

Initial setting time – Minimum-30min.

Final setting time --Maximum-600min.

Compressive strength – As per the Grades used 33, 43, 53Mpa at 28days ±4hours for the grades of cement 33, 43 and 53 respectively.

(f) Cement Mortar: Cement mortar shall be in the proportion specified in particular item and preferably shall be mixed in a mechanical mixer.

Cement mortar shall be used with in 30mts or before it starts setting. Mortar unused for more than 30minutes after mixing with water shall be rejected.

(g) Marble: marble shall be white or coloured. The classification shall be as per IS 1130. Marble shall be free from any foreign matter and cracks. The physical properties of marble shall be as follows.

Sl No	Characteristic	Requirement	Method of test
(1)	(2)	(3)	(4)
I	Moisture absorption after 24 hours immersion in cold water	Max. 0.4% by weight	IS: 1124-1974
II	Hardness	Min. 3	Mohs. Scale
III	Specific Gravity	Min. 2.5	IS: 1122-1974

(h) Steel for Reinforcement: The type of steel shall be as specified in the contract andshall conform to IS specification applicable to that type of steel. All steel shall be clean, free from dust, oil, grease, mill scale or rust. Steel shall be stored above ground or on aplatform and shall be supported to avoid sagging and distortion. The various types of steel used in structures are as follows.

(a) Mild steel and medium tensile bars conforming to IS 432 (Part I)
(b) High strength deformed steel bars conforming to IS 1786
(c) Hard drawn steel wire fabric conforming IS 1566
(d) Structural steel conforming to Grade A of IS 2062.

Tests: selection and preparation of Test sample. All the tests pieces shall be selected by the Engineer- in- Charge or his authorized representative either

(a) From cutting of bars
Or
(b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-Charge or his authorized representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test pieceshall be enacted or otherwise subject to heat treatment. Any straightening of piece ifrequired, shall be done cold.

Water: Water used for mortars, concrete and curing shall be clean, free from injurious amounts of deleterious materials like oils, acids, alkaline, salts, silt and organic matter. The permissible limits are as follows.

To neutralize 200ml. sample it shall not require more than 2ml. 0f 0.1 normal NaOH
To neutralize 200ml. sample it shall not require more than 10ml. 0f 0.1 normal HCL.
Percentage of solids should not exceed the following:

Organic	----	0.02
Inorganic	-----	0.30
Sulphates	-----	0.05
Alkali chlorides	----	0.10

(ii) Construction part

(a) Cleaning of site, Dismantling of structure and Blasting,

The area described or shown on the relevant site shall be cleaned of all obstructions, loose stones, rubbish, Big size stones or boulders, are broken/blasted, are removed and stacked separately. When trees are removed by cutting, the roots of the same shall be 600mm below ground level or 150mm below formation level whichever is lower.

Anti termite treatment before construction and during early stages of construction where specified shall be as per [IS 6313 part II].

The chemicals which may be used shall be as follows

Sl No (1)	Particulars of Chemicals (2)	Concentration by weight percent. (3)
1	Dialdrinemulsifiable concentrates (IS: 1054-1962)	0.50
2	Aldrinemulsifiable concentrates (IS: 1307-1958)	0.50
3	Reptachloremulsifiable concentrates (IS: 6439-1972)	0.50
4	Chlordane emulsifiable concentrates (IS: 2682-1966)	1.00

Soil treatment shall be started when the foundation excavations are ready for laying foundation. Treatment, shall not be carried when it is raining or when the soil is water logged. Once the treatment is completed, the treated soil shall not be disturbed. The area and location of treatment shall be as specified in drawing and contract.

(b) Earth Work (APSS 308): Excavation of foundation shall be as per dimensions and depths shown in the drawing. The bed of excavation shall be dressed level and rendered firm by watering and tamping. Soft pockets if any shall be dugout and filled with concrete of same mix as that of foundation. If extra depth is excavated by contractor's mistakes it shall be made good with same mix of concrete as that of foundation.

(c) Filling in foundations:[APSS 309]: Earth used for back filling shall be free from salts, organic or other deleterious matter. Soil of type GC or SC may be used. Back filling shall be in layers of not more than 150mm thick, watered and well compacted.

(d) Filling in Basement:[APSS 310]: Earth shall be of approved quality, free from salts, organic or other deleterious matter. Expansive soils shall not be used. Filling shall be in layers not exceeding 150mm, each layer watered and compacted. Finished level shall be bottom layer of concrete for flooring.

(e) Concrete: It is defined as a mixture of cement, water and inert aggregates with or without admixtures. The grade of concrete shall be as specified in the agreement. The grades of concrete are as below.

GRADES OF CONCRETES

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm Cube at 28 Days in N/mm^2.
(1)	(2)	(3)
Ordinary Concrete	M 10	10
	M 15	15
	M 20	20
Standard Concrete	M 25	25
	M 30	30
	M 35	35
	M 40	40
	M 45	45
	M 50	50
	M 55	55
High Strength Concrete	M 60	60
	M 65	65
	M 70	70
	M 75	75
	M 80	80

NOTES

1. **In the designation of concrete mix M refers to the mix and the number to the specified compressive strength of 150 mm size cube at 28 days, expressed in N/mm^2.**
2. **For concrete of compressive strength greater than M 55, design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.**

The workability of concrete shall be as follows

Placing condition	Degree of workability	Slump (mm)
(1)	(2)	(3)
Blinding concrete; Shallow sections; Pavements using pavers	Very low	In cases where strict control is necessary like PQC workability may be determined from compacting factor. And values shall bebetween 0.75 to 0.80.
Mass concrete; Lightly reinforced sections in slab, beams, walls, columns; Floors;	Low	25-75

Hand placed pavements; Canal lining; Strip footings		
Heavily reinforced sections in slab, beams, walls, columns; Slip form work; Pumped concrete	Medium	50-100 75-100
Trench fill; In-situ piling	High	100-150
Tremie concrete	Very high	In this case workability may be measured by determination of flow

Note: For most of the placing conditions, internal vibrators (needle vibrator) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used. It is essential to compact just adequately as both under compaction and over compaction are harmful to the concrete. Vibration of very wet mixes shall be avoided.

The conditions of exposure to which a concrete member may subjected to are classified as follows

Environmental Exposure Conditions

Sl. No.	Environment	Exposure Conditions
(1)	(2)	(3)
i)	Mild	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
ii)	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wet. Concrete exposed to condensation and rain Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ground water Concrete surfaces sheltered from saturated salt air in coastal area.
iii)	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation. Concrete completely immersed in sea water Concrete exposed to coastal environment.
iv)	Very severe	Concrete surfaces exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. Concrete in contact with or buried under aggressive subsoil/ground water.
v)	Extreme	Surface of members in tidal zone. Members in direct contact with liquid/solid aggressive chemicals.

Minimum cement content, maximum water-cement ratio and min grade of concrete for different exposure conditions are as follows

Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Nominal Weight Aggregate of 20mm Nominal Maximum Size

Sl. No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement content $Kg.m^3$.	Maximum Free Water Cement Ratio	Minimum Grade of Concrete	Minimum Cement content $Kg.m^3$.	Maximum Free Water Cement Ratio	Minimum Grade of Concrete
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Mild	220	0.60	-	300	0.55	M 20
ii)	Moderate	240	0.60	M 15	300	0.50	M 25
iii)	Severe	250	0.50	M 20	320	0.45	M 30
iv)	Very Severe	260	0.45	M 20	340	0.45	M 35
v)	Extreme	280	0.40	M 25	360	0.40	M 40
	NOTES **1. Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions like mineral admixtures i.e. (i) Pozzolonas (ii) Flyash (iii) Silica flume (iv) Rice husk ash (v) Metakao lime and (vi) Ground granulated blast furnanceslag.The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water – cement ration if the suitability is established and as long as maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part I) and IS 455 respectively.** **2. Minimum grade for plain concrete under mild exposure condition is not specified.**						

These values are for maximum nominal size of aggregates of 20mm. For other maximum nominal size of aggregates, the minimum cement content shall be adjusted as follows.

Adjustment to Minimum Cement Content for Aggregate Other Than 20mm Nominal Maximum Size

Sl. No.	Nominal Maximum Aggregate Size mm	Adjustments to Minimum Cement Concrete in above table
(1)	(2)	(3)
i)	10	+40
ii)	20	0
iii)	40	-30

Concrete in sea water or exposed directly along the sea coast shall be of at least M20 grade in case of plain concrete and M30 in case of reinforced concrete.

Concrete Mix Proportion

Concrete mix proportioning is done in the following two methods

Nominal Mix Concrete
Design Mix Concrete

Design of mix shall be done whenever there is change in ingredients of concrete. Nominal mix concrete may be adopted for concrete of grade M20 and lower. The proportioning of various ingredients of mix for nominal mix of concrete shall be as follows.

Grade of Concrete	**Total Quantity of Dry Aggregates by Mass per 50 Kg of Cement, to be taken as the Sum of the Individual Masses of Fine and Coarse Aggregates, Kg, Max**	**Proportion of Fine Aggregate to Coarse Aggregate (by Mass)**	**Quantity of Water per 50 Kg of Cement, *Max***
(1)	(2)	(3)	(4)
M 5	800	Generally 1:2 but subject to an upper limit of $1:1^1/_2$ and a lower limit $1:2^1/_2$	60
M 7.5	625		45
M 10	480		34
M 15	330		32
M 20	250		30
NOTE—The proportion of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used. *Example.* For an average grading of fine aggregate (that is, Zone II of Table 4 of IS 383), the proportions shall be $1:1^1/_2$, 1:2 and $1:2^1/_2$ for maximum size of aggregates 10 mm, 20mm and 40mm respectively.			

To avoid confusion and error in batching it is always advisable to use minimum number of grades of concrete on a project site. In case of different members with different grades of concrete meeting at a joint, that joint shall be first concreted with the highest grade of concrete of a member meeting at that joint.

The accuracy of the measuring equipment used in concrete mixes shall be as follows.

Cement measuring equipment	±2%
Aggregate, admixture and water	±3%

The moisture content of aggregate shall be taken in to account to adjust the water quantity. Only in case of nominal mixes, the moisture content of the aggregate shall be taken as follows.

Surface Water Carried By Aggregate

Sl. No.	Aggregate	Approximate Quantity of Surface Water	
		Percent by Mass	l/m³
(1)	(2)	(3)	(4)
i)	Very Wet Sand	7.5	120
ii)	Moderately wet sand	5.0	80
iii)	Moist Sand	2.5	40
iv)	Moist gravel or crushed rock	1.25-2.5	20-40
"Coarser the aggregate, less the water it will carry.			

Concrete shall be mixed in mechanical mixtures. Dosage of retarders, plasticizers and super plasticizers shall be restricted to 0.5, 1.0 and 2.0 respectively.

The tolerances on shapes of lines and dimensions are as follows.

a) Deviation from specified dimensions of cross-section of columns and beams **+ 12, - 6 mm**

b) Deviations from dimensions of footings

1) Dimensions in plan **+ 50, - 12 mm**

2) Eccentricity **0.02 times the width of the footing in the direction of deviation but not more than 50 mm**

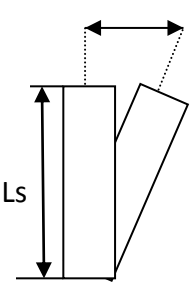
3) Thickness **± 0.05 times the specified thickness.**

4) Inclination of columns from vertical

i) For column length

Ls<1450mm, $\Delta v \not> 5mm$,

Ls>1450mm, $\Delta v \not> 0.0035$ Ls or 25mm whichever is lesser



Where Ls is length of column.

The minimum period for stripping of form work shall be as follows

Type of Formwork		**Minimum Period Before Striking**
a)	**Vertical formwork to columns walls, beams**	**16 – 24 h**
b)	**Soffit formwork to slabs (Props to be refixed immediately after removal of formwork)**	**3 days**
c)	**Soffit formwork to beams (Props to be refixed immediately after removal of formwork)**	**7 days**
d)	**Propos to slabs:**	
	1) Spanning up to 4.5 m	**7 days**
	2) Spanning over 4.5 m	**14 days**
e)	**Props to beams and arches:**	
	1) Spanning up to 6 m	**14 days**
	2) Spanning over 6 m	**21 days**

The standard form for reinforcement schedule shall be as follows

Standard form for Reinforcement Schedule

LOCA-TION	**MARK DESIG-NATION**	**SIZE AND TYPE**	**NUMBER OF SETS**	**NUMBER PER SET**	**TOTAL NUMBER**	**LENGTH**	**SHAPE (ALL DIMENSIONS ARE IN ACCORDANCE WITH THIS STANDARD UNLESS OTHERWISE STATED)**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Column	**C4 4R 25N**	**MS round 25 mm**	**5**	**4**	**20**	**3000 mm**	**Straight**
Note 1 --- The recommended widths of the above columns are reading from left to right 25, 20, 15, 15, 15, 15, 15 and 75 mm. The 75mm dimension may be reduced to 70 mm for paper sizes other than *A4. Adequate Margin should be provided on either side, the left hand margin being not less than 15 mm. The length of the form should not generally exceed that of *A4 size. **Note 2 --- In col.2, the bar identification that will be put on labels attached to the bars shall appear. It should be simple. The first number in the mark designation refers to the number of identical bars in similar locations in the same section of given member, and the R refers to the round bars, the figure that follows the letter R represents the diameter or the nominal size of the**							

bar in millimeters and N represents the identification number of the bar / bars given consecutively.
Note 3 --- In col. 3, the quality and basic shape of the reinforcement bar shall be specified.
***A4 size is 210 X 297 mm.**

Placing of reinforcement: The spacing of reinforcement steel shall be as specified in the drawing /specifications. The tolerance limits in the spacing of reinforcement shall be as follows

a) for effective depth 200 mm or less ± 10 mm
b) for effective depth more than 200 mm ± 15 mm

The high strength deformed bars shall not be re bent.

Nominal Cover: It is depth of concrete cover to all reinforcements, including links. The nominal cover for durability requirement shall be as follows.

Nominal Cover to Meet Durability Requirement

Sl. No.	Exposure	Nominal Concrete Cover in mm not Less Than
i)	Mild	20
ii)	Moderate	30
iii)	Severe	45
iv)	Very Severe	50
v)	Extreme	75
NOTES: 1. For main reinforcement up to 12 mm diameter bar for mild exposure, the cover may be reduced by 5 mm. 2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by +10 mm 3. For exposure condition 'severe' and 'very severe' reduction of 5mm may be made, where concrete grade is M 35 and above.		

Nominal cover to meet the specified period of fire resistance shall be as follows

Nominal cover to Meet Specified Period of Fire Resistance

Fire Resis-tance	Nominal Cover						
	Beams		Slabs		Ribs		Columns
	Simply Supported	Continuous	Simply Supported	Continuous	Simply Supported	Continuous	
h	Mm	mm	mm	mm	mm	mm	Mm
0.5	20	20	20	20	20	20	40
1	20	20	20	20	20	20	40
1.5	20	20	25	20	35	20	40
2	40	30	35	25	45	35	40
3	60	40	45	35	55	45	40
4	70	50	55	45	65	55	40
NOTES							

1. The nominal cover given relate specifically to the minimum member dimensions given in **Fig. 1.of IS 456**
2. **Cases that lie below the bold line require attention to the additional measures necessary to reduce the risks of spalling as per cluse 21.3.1 of IS 456.**

For columns the minimum cover to longitudinal reinforcement shall not be less than 40mm or diameter of the largest bar. For column of least dimension 200mm or under, and diameter of longitudinal bars not greater than 12mm, nominal cover may be 25mm. For footing nominal cover shall be 50mm. The tolerance on the nominal concrete cover is +10mm. In case of bundled bars, for spacing requirement and minimum cover, diameter of bundled bars shall be that of a bar of equivalent area of bundled bars.

In case of bundled bars, for spacing requirement and minimum cover, diameter of bundled bars shall be that of a bar of equivalent area of bundled bars.

Curing: Moist Curing: All composed surfaces of concrete shall be kept in wet condition for at least in 7 days in case of OPC and 10days in case of mineral admixtures or blended cements are used and desirable to cure up to 14 days.

Membrane curing: Approved curing compounds may be applied on all exposed surfaces.

Sampling and strength of concrete mix:

Sample: The composite sample shall be truly representative of the batch and shall be not less than 0.02m3 in volume. It shall be composed of a mixture of portion taken from different points in the batch. When continuous mixers are used, a batch shall be regarded as the discharge from the mixture during one minute.

Sampling Procedure

From mixers: At least three approximately equal sample increments totaling 0.02cu.m shall be taken from a batch during its discharge and each sample increment shall be collected by passing a clean and dry receptacle across the stream of concrete. This receptacle shall be constructed of non-absorbent material, preferably of metal and shall be such that the sample retained is not segregated. A flat surface without retaining sides will not be fulfill this purpose. Where three sample increments are taken they shall be taken at about the time when one-quarter, one-half and three-quarters of the concrete have been discharged from the mixer and if more than three are taken they shall be at correspondingly shorter, but equally spaced, intervals.

From concrete at the time and place of deposition: The sample shall be taken while a batch of concrete is being, or immediately after it has been, discharged on the site. The sample shall be collected from not less than five well distributed position, avoiding the edge of the mass where segregation may have occurred.

Mixing the Composite Sample: The composite sample obtained by either of the methods described above, shall be mixed on a non-absorbent base either with a shovel or by other suitable implement in such a manner so as to ensure uniformity. The sample thus obtained shall be used immediately for the purpose of carrying out the tests. Care shall be taken to protect the sample from the weather.

In all cases, the strength of concrete at 28days is sole criteria for acceptance or rejection.

Frequency of sampling: The minimum frequency of sampling of concrete of each grade shall be in accordance with the following.

Quantity of Concrete in the Work, m^3	*Number of Samples*
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
51 and above	4 plus one additional sample for each additional $50m_3$ or part thereof.
NOTE ---- Atleast one sample shall be taken from each shift. Where concrete is produced at continuous production unit, such as ready mixed concrete plant, frequency of sampling may be agreed upon mutually by suppliers and purchasers.	

Three test specimens will make a sample. The results of tests of sample are average of 3specimen.

The variation in individual results shall not be more than ±15% of specimen average. If the variation is more, the sample results are invalid.

Acceptance Criteria:

Compressive strength

The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:

The mean strength determined from any group of four consecutive test results comply with the appropriate limits in column 2 of the table given below.

Any individual test result complies with the appropriate limits in column 3 of the table given below.

Flexural strength

When both the following conditions are met, the concrete complies with the specified flexural strength.

The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm^2

The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm^2

CHARACTERISTIC COMPRESSIVE STRENGTH COMPLIANCE REQUIREMENT

Specified Grade	Mean of the Group of 4 Non-Overlapping Consecutive Test Results in N/mm^2	Individual Test Results in N/mm^2
(1)	(2)	(3)
M 15	≥ f_{ck} + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm^2) Or f_{ck} + 3 N/mm^2 whichever is greater	≥ f_{ck} $^{-3}$ N/mm^2.
M 20 or above	≥ f_{ck} + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm^2) Or f_{ck} + 4 N/mm^2 whichever is greater	≥ f_{ck} $^{-4}$ N/mm^2.

NOTE ----- In the absence of established value of standard deviation, the values given in **Table 8of IS 456** may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

The four test samples represent the quantity of concrete from the first batch from which first sample was taken to last batch from which four consecutive test samples were taken. For individual samples, the batch only from which the sample is taken shall be at risk.

Maximum quantity of concrete, the four consecutive sample results represent shall be limited to $60m^3$.

Core test: For determining the concrete grade which is already cast shall be based on core test. If average equivalent cube strength of core is equal to at least 85% of cube strength of concrete of specified grade of corresponding age and no individual core has strength less than 75%.

Preparation of core specimens: Core shall not be removed before the concrete is 14 days old.

Thickness at the edge of footing shall not be less than 150 for footings on soils nor less than 300mm above the top of piles for footing on piles.

(f) Construction joints

Concreting shall be carried out continuously up to construction joints, whose position and arrangement are indicated on the drawing.

Construction joints shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete, in order to create rough/uneven surface. It is recommended to clean out laitance and cement slurry by using wire brush on the surface of joint immediately after initial setting of concrete and to clean out the same immediately thereafter. The prepared surface should be in a clean saturated surface dry condition when fresh concrete is placed, against it.

In the case of construction joints at locations where the previous pour has been cast against shuttering the recommended method of obtaining rough surface for the previously poured concrete is to expose the aggregate with a high pressure water jet or any other appropriate means.

Fresh concrete should be thoroughly vibrated near construction joints so that mortar from the new concrete flows between large aggregates and develop proper bond with old concrete.

Where high shear resistance is required at the construction joints, shear keys may be provided.

Sprayed curing membranes and release agents should be thoroughly removed from joint surfaces.

(g) Form Work: The form work shall be rigid and strong to with stand the loads during and after placement of concrete. The form work shall be rigid to maintain the required shapes of the members cast. The material for centering/ false work shall be as specified. The material for false work may consists of timber, plywood, steel, aluminium, PVC, plastics, ferro-cement or any engineering material. General requirements and specific use of these materials are as given below

TIMBER

Timber should be softwood of partially seasoned stock to avoid swelling or warping. Timber which may be used for making strong scaffolding, beams, columns, props and bracings shall conform to IS 883.

PLYWOOD

Plywood conforming to IS 4990 may be used for form lining, sheathing and panel.

STEEL

Steel sheet plates conforming to IS 2062 or IS 8500 or IS 1977 may be used for form and form lining and rolled sections and tubes conforming to IS 2062 or IS 8500 or IS 1161 may be used for steel forming and bracings.

Whenever proprietary systems are intended to be used, technical information on the use, capacityetc of each individual part should be obtained from the manufacturer beforehand. Steel clamps and couplers shall conform to IS 2750.

OTHER MATERIAL

Other materials which may be used in false work include alluminium, PVC, reinforcedplastics, high density polyethylene, polypropylene, ferro-cement and polythene sheet for lining, etc. In certain applications, masonry, concrete and earthwork may be used as part of falsework.

FALSEWORK ACCESSORIES

Form Ties

Form ties may be used in the form of variety of threads and wing nuts having varying diameter from 10 to 30mm and of a suitable length as per the requirements of each job. A plastic tube may be used covering the tie for easy removal of the tie after concrete is set.

The form ties may be fitted with plastic or wooden sleeving cones at each end. Ties may also be used in association with concrete blocks with central holes.

The part of form tie, if left inside the concrete, shall have minimum cover as specified for reinforcement.

Form Anchors

Form anchors should be embedded during concrete placement at specified locations in case formwork for the next lift is to be secured to the concrete being placed. The securing of formwork should be done only after the previously placed concrete has gained adequate strength.

Form Hangers

Form hanger devices may be used for hanging formworks loads form structural steel or precast concrete structural members or other members.

Form Jacks

These proprietary systems may be used to facilitate supporting of the formwork from the lower flanges of steel beams (as an alternate to hanging the forms)

Spreaders, Spacers

These devices may be used to keep forms in the proper position and to maintain a correct spacing between vertical form and reinforcing bars. These may be made of high strength mortar (vibrated or pressed), concrete, various grades of plastic, steel, etc.

Column Clamps

The column clamps may be used to hold the column form together and to resist the lateral pressure of the freshly poured concrete.

Sealing Strip

T-strips made of PVC sections and dimensions ranging from 15mm to 40mm may be used for sealing the joints between the faces of formwork against leakage of mortar or slurry.

Chamfer Fillets

Proprietary fillets made of PVC to provide chamfers of various dimensions from 10 to 30mm may be used.

Adjustable Steel Props

Adjustable steel props may be used.

Formwork Coatings and Releasing Agents

Formwork in contact with concrete may be treated with a coating or releasing agent of approved composition. The type of coating and its composition depends upon the type of shuttering material used and its surface which would be in contact with concrete. Coating and release agent should:

a) Provide a clean easy release or strike without damage to either the concrete face or the form,
b) Contribute to the production of blemish free concrete surface,
c) Have no adverse effect upon either the form or concrete,
d) Be easy to apply evenly at the recommended coverage, and
e) Not inhibit adhesive of any finish applied to the formed surface.

Shuttering should be coated with suitable form release agents for easy stripping, before each use. The form release agents are temporary coatings consisting of fatty acids which react with the alkali in cement and leave behind a soap like substance on the contact surface. This helps release of the form. These may be oils, emulsified wax, oil phased emulsions with water globules, petroleum based products, catalysed polyurethane foam, etc.

Careful consideration should be given to the choice of release agent taking account of the type of surface to which it is to be applied, the conditions under which it is to be used, the type of concrete, the quality of finish, the area of form and the ease of application.

The conventional use of waste oil as release agent should not be encouraged since it does not contain fatty acids.

(h) Brick Masonry: Bricks shall be of specified type. The thickness of joints shall be as follows.

First class Brick---- not more than 10mm
Second class Brick----not more than 12mm

Bricks shall be soaked at least for an hour.Half or cut bricks shall not be used except where necessary to complete the bond. When plastering is to be done, all joints shall be raked to 15mm depth. If plastering is not be done, joints shall be made flush. The brick work in C.M shall be kept wet for a period of 2 weeks.

Reinforced Brick Masonry: Height shall not be more than 4m. Reinforcement shall be completely embedded in mortar. Reinforcement over lap shall not be less than 300mm. The joints shall be not more than 10mm and where reinforcing bars are present, the joints shall be not more than 15mm.

(i) Stone Masonry: Stones shall be of specified type like granite, sand stone etc.,

The stones for masonry in different situations shall be as follows.

COMMON TYPE OF STONES

S.NO	Situation	Types of stones
(1)	(2)	(3)
I	Masonry work submerged in water	Dense stones like granite and gneisses
II	Masonry work exposed to smoke and chemical fumes	Granite, quartzite.
III	For fire resistant masonry	Sand stone
IV	For carved or ornamental works, arches etc.,	Granite, Marble, Sand stone etc.
V	For masonry below plinth course or in contact with soil	Dense stones like granite, gneisses.

The stones used in stone masonry are dressed in the following types.

(i) **Pitched faced dressing:** The edge of pitched faced dressing shall be level and shall be in same plane. The minimum widths of pitched face dressing, all-round, i.e four edges of the face shall be 25mm.

(ii) **Hammer dressing:** Shall have no sharp and irregular corners. The bushing on the face shall not be more than 40mm.

(iii) **Rock facing, rock rustic or quarry faced:** In this dressing, the stone shall have chisel drafts of 25mm min on all four edges and all edges are in same plane. The bushing on the exposed surface shall not be more than 40mm.

(iv) **Rough tooling:** It shall have series of bands, 40mm to 50mm wide, more or less parallel to the tool marks all over the surface. The edges and corners shall be rendered square. The stone may have depressions not more than 3mm when straight edge is pressed against the surface.

(v) **Punched dressing:** This type of dressing will have series of parallel ridges. The depths of gap between the surface and straight edge shall not be more than 3mm.

(vi) **Close pitched dressing**: This type of dressing chisel marks shall be very tiny, the depth of gap between straight edge and the surface shall not be more than 1.5mm.

(vii) **Fine tooling:** The stone shall have fairly smooth surface. The surface shall have 3 to 4 lines per 10mm width.

The different types of dressing are used as follows

USES FOR SOME TYPES OF DRESSINGS.

SL. NO	Type of dressing	Specific use
(1)	(2)	(3)
I	Rock facing	Used in buildings as quoin stones in the corners of brick masonry or rubble masonry and in plinth to give an appearance of strength and solidity.
II	Rough tooling	Used where fairly regular plane faces are required for masonry work
III	Punched dressing	Used where even surfaces are required.
IV	Fine tooling	Very commonly adopted for Ashlar work.

Size of stone: Except in dams stones used in rubble masonry shall be limited to 250mm. Length of stones shall not exceed three times the height. Breadth on the base shall not be greater than three fourths of the thickness of wall nor less than 150mm, for rubble masonry the breadth shall not be less than 150mm. The least thickness of laterite stone shall be 175mm. The joints shall be staggered by at least by 75mm. The stones shall be laid on their natural bed. The stones shall be sufficiently well wetted before laying. Stone masonry with CM shall be cured for two weeks.

Joints: The masonry joints and beds in cut stone in cement mortar in no case be more than 3mm in thickness. The stones shall be laid header and stretcher alternatively.

Coursed rubble in cement mortar

First sort: Joints shall not be more than 12mm [IS 1322]

Hearting in stone masonry: The space between the facing and backing in a stone masonry shall be filled with stone chips of same type and flushed in mortar. This is called as 'Hearting'. All stones, chips, spall, etc., shall be washed clean with water before use so as to ensure a clean surface for the mortar to adhere to. They shall be sprinkled with water before actually placing in work to prevent absorption of water from the mortar. This is specially necessary in the case of sand stone and other highly absorbent stones. The interior shall be filled in with good flat bedded stones set as close as possible, well flushed in mortar. Chips and spalls of stone shall be wedged in wherever necessary so as to avoid thick beds or joints of mortar care being taken that no dry work or hollow space shall be left anywhere in the masonry. The face work and backing shall be brought up evenly but the backing shall not be leveled up at each course by the use of chips.

(iii)Roof Trusses

Truss: it is an assembly of members subjected to axial forces only, compressive or tensile and joined together at nodes. Truss consists of a series of triangles connected together.

Planar truss: In this type all members and nodes lie in same plane.

Pitch of truss: It is defined as the ratio of rise of the slope to the length of the span. This varies from $\leq$ 1/5 and greater depending upon the type of roofing material.

The steel truss is either made of tubes, angles, channels or beam sections.

Tubular Truss: Most commonly used trusses are tubular trusses. These trusses are made up of structural steel tubes. These tubes are classified light, medium and heavy. The steel used for tubes is classified as Yst 210, Yst 240 and Yst 310.

The dimensional tolerances shall be as follows

a) *Outside Diameter:*

1)Up to and including 48.3 mm	+0.4mm -o. 8 mm
2) Over48.3mm	± 1 .0 percent

b) *Thickness for all sizes:*

1) Welded tubes	+ Not limited - 10 percent
2) Seamless tubes	+ Not limited - 12.5 percent

c) *Weight:*

1) Single tube light	+ 10percent - 8 percent
Medium Heavy	± 10 percent
2) 10 tonne lots light	± 5 percent

Medium
Heavy } ± 7.5 percent

NOTE: - For 10 tonne lots, the weighment may be done in convenient smaller lots and added up at the option of the manufacturer.

The properties of various grades of steel tubes are as follows

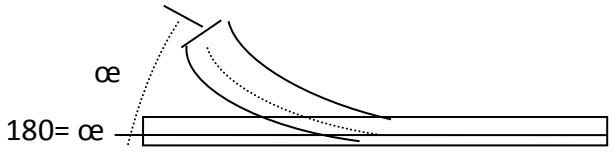
Grade	**Tensile strength (min)**	**Yield Stress**	**Elongation on guage length 5.65 √S, Min Percent**
	(Mpa)	(Mpa)	
Yst 210	330	210	20
YSt 240	410	240	17
Yst 310	450	310	14

NOTES

1. 1 MPa = lN/mm^2= 0.102 kgflmm^2
2. Elongation percent for tubes up to and including 25 mm nominal bore for all grades shall be 12 minimum.

Tubes shall pass these tests

Ductility test: The straight length of tube sample when bend around grooved former of a dia 6x0.D of tube, shall not show any crack when it is bent up to an angle of 180



Flattening Test:

A 40 mm test piece in length cut from the ends of selected tubes with edges rounded shall be flattened between two parallel plates. No opening shall occur by fracture in the weld until the distance between the plates is less than the value as indicated below.

S.No	Manufacturing Process Metal	Steel Grade	Weld (Distance between the plates)	parent (Distance between the plates)
i)	HFW/HFS/ERW/HFIW	Yst 210	75 percent of 0.D	60 percent of 0.D.
ii)	HFW/HFS/ERW/HFIW	Yst 240	85 percent of O.D	75 percent of 0.D.
iii)	FHS/ERW/HFIW	Yst 310	85 percent of O.D	75 percent of O.D.

O.D. = Outside diameter.

Trusses for heavy loads and cranes:

For these trusses members are made up of channels and angles. The steel for these trusses shall confirm to IS: 2062

Angle iron in trusses: Dimensional tolerances for these trusses are as follows

Leg Length — The tolerance on leg length shall be as follows:

Leg Length		*Tolerance*
Over	Up to and including	
mm	mm	
—	45	± 1·5 mm
45	100	± 2·0 mm
100	—	± 2 percent

In the case of unequal leg angle 45 × 30 mm, the tolerance on longer leg length shall be $^{+\ 2\cdot0}_{-\ 1\cdot5}$ mm. The tolerance on the shorter leg length shall be as specified in above table.

Out-of-Square — The legs of angles shall be perpendicular to each other within a tolerance of ±1·0 degree.

The differences between the leg lengths of equal leg angles shall be limited to 75 percent of the total tolerance (plus and minus) specified on the leg length.

Camber — The permissible limits for camber (*see* Fig.) shall be as follows:

Leg Length mm	*Camber Max*, mm
Less than 100	To be agreed between the manufacturer and the purchaser
Including and over 100	0·2 percent of length

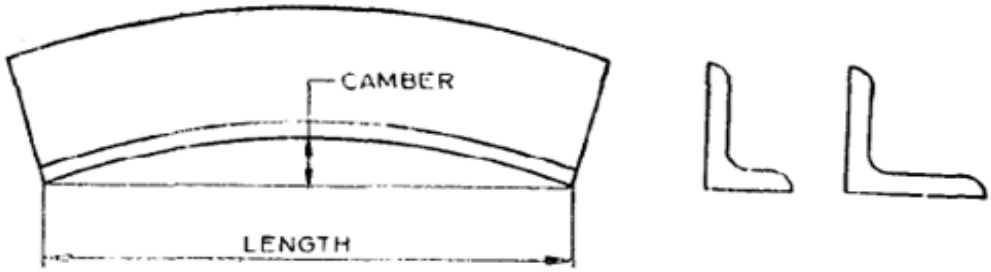


FIG CAMBER IN ANGLES

Trusses made up of Channels: Dimensional tolerance shall be as follows:

Channels

1 *Depth* — The tolerance on depth of channels shall be as follows:

Depth		*Tolerance*
Over	Up to and including	
mm	mm	mm
—	200	± 2·5
200	400	± 3·0

2 *Width of Flange* — The tolerance on flange width up to and including 100 mm shall be ± 2 mm.

3 *Flanges Out-of-Square or Out-of-Parallel* — The flanges shall be parallel within 1 in 60 tolerances (*see* Fig. below)

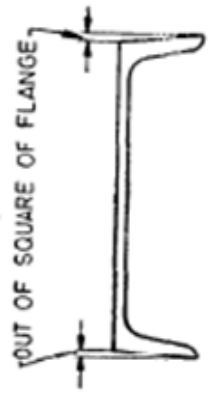


FIG. FLANGES OUT-OF-SQUARE OR OUT-OF-PARALLEL

4 *Flatness of Web* — The tolerance on flatness of outer face of web shall be as follows (*see* Fig.below)

Convexity	Not permitted
Concavity	15 percent of nominal thickness of web

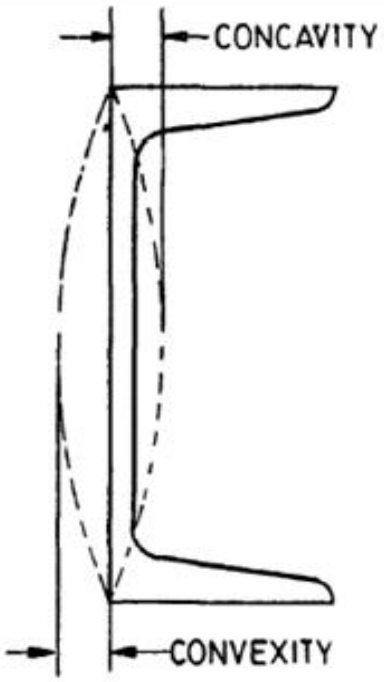


FIG. FLATNESS OF WEB

Camber and Sweep — The maximum permissible camber and sweep for channels shall be 0·20 percent of the length see figure below .

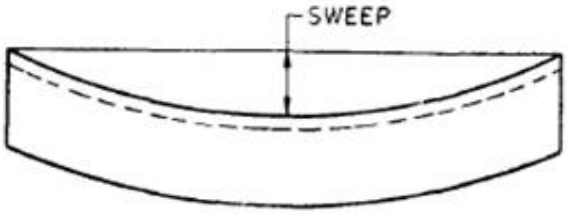


FIG. MEASUREMENT OF SWEEP

Min thickness of steel section:**6mm** when exposed to weather, accessible to repair and Painting.

8mm when exposed to weather, but not accessible to repair and Painting.

Not exposed to weather: i) Main Members 6mm

ii)Secondary Members 4.5mm