# Quality Control Of Construction Testing Of Concrete Cubes

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The acceptance criteria of quality of concrete is laid down in IS:456-2000. The criteria is mandatory and various provisions of the code have to be complied before the quality of concrete is accepted. In all the cases, the 28-days compressive strength shall alone be the criterion for acceptance or rejection of the concrete. In order to get a relatively quicker idea of the quality of concrete, optional test for 7 days compressive strength of concrete be carried out.

6 Cubes of 150 x 150 x 150 mm size (the nominal size of aggregate does not exceed 38 mm) shall be cast, 3 for 7-days testing and 3 for 28-days testing. A set of 3 cubes (specimen) average strength will be a sample. The individual variation of a set of 3 cubes should not be more than ± 15% of the average. If more, the test result of the sample is invalid.
Note:- For aggregates larger than 38 mm, bigger than 150 mm moulds are to be used. See IS:10086-1982

**CUBE MOULD:**
The cube moulds of required size (150 mm for nominal size of aggregate not exceeding 38 mm) shall be made in such a manner as to facilitate their separation into two parts. Cube moulds shall be provided with a base plate and they shall be as per IS:10086-1982. The dimensions, tolerance and materials of cube moulds shall be as given in table-1.

**Table-1: Dimension, tolerance and materials of 150 mm cube mould.**

| S.No. | Description | Requirements |
|---|---|---|
| 1 | Distance between opposite faces, mm | 150 ± 0.2 |
| 2 | Height of mould, mm | 150 ± 0.2 |
| 3 | Thickness of wall plate, mm | 8 |

| | | |
|---|---|---|
| 4 | Angle between adjacent interior faces and between interior faces and top and bottom plates of mould. | $90 \pm 0.5^0$ |
| 5 | Length of base plate, mm | 280 |
| 6 | Width of base plate, mm | 215 |
| 7 | Thickness of base plate, mm | 8 |
| 8 | Permissible variation in the planeness of interior faces:<br>for new moulds, mm<br><br>for moulds in use, mm | 0.03<br><br>0.05 |
| 9 | Permissible variation in the planeness of base plate, mm | 0.03 |
| 10 | materials<br>a) Side plate<br>b) Base plate | Cast iron<br><br>Cast iron |

**TAMPING ROD**

As per IS:10086-1982, the tamping rod shall be 16±0.5 mm dia and 600±2 mm long with a rounded working end and shall be made of mild steel.

**COMPRESSION TESTING MACHINE:**

The compression testing machine shall be as per IS:14858-2000. The machine shall be capable of applying the load at the specified rate, uniformly without shock using manual or automatic control. The percentage of error shall not exceed ±1.0 percent of the indicated load.

On regular basis the machine should be calibrated with in a period not exceeding 12 months from previous verification. The machine is required to be calibrated on original installation or relocation, subject to major repairs or adjustment and whenever there is reason to doubt the accuracy of the results, without regard to the time interval since the last verification.

The accuracy of the testing machine shall be verified by applying five test loads in four approximately equal increaments in ascending order. The difference between any two successive loads shall not exceed one third of the difference between the maximum and

minimum test loads. The load as indicated by the testing machine and the applied load computed from the readings of the verification devices shall be recorded at each test point. Calculate the error, E, and the percentage of error, EP for each point from these data as follows:

$E = A - B$

$E_p=[E/B]x100$

A = load in N indicated by the machine being verified and

B = applied load in N as determined by the calibrating device

(such as proving ring, load cell, calibrating cylinder etc.)

For checking further accuracy of testing machine concrete cubes of the same grade, batch, age in SSD condition should be tested on the machine being checked and on a already calibrated standard compression testing machine and find the difference. Proper and regular calibration of testing machines is essential.

**SAMPLE OF CONCRETE**

Sample of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of the concrete. The samples thus obtained shall be mixed on a non-absorbent base with shovel until it is uniform in appearance.

Sampling should be spread over the entire period of concreting and the frequency of sampling of concrete of each grade shall be as 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 50 $m^3$ or part thereof. |

Note:- Frequency of sampling may be agreed upon internally by supplier and purchaser.

**CASTING OF CUBES:**

The cube mould plates should be removed, properly cleaned assembled and all the bolts should be fully tight. A thin layer of oil then shall be applied on all the faces of the mould. It is important that cube side faces must be parallel.

After taking concrete samples and mixing them, the cubes shall be cast as soon as possible. The concrete sample shall be filled into the cube moulds in layers approximately 5 cm deep. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete slides from it, in order to ensure a symmetrical distribution of the concrete with in the mould. Each layer shall be compacted either by hand or by the vibration as described below.

**COMPACTION BY HAND:**

Each layer of the concrete filled in the mould shall be compacted by not less than 35 strokes by tamping bar. The strokes shall be penetrate into the underlying layer and the bottom layer shall be rodded throught its depth. Where voids are left by the tamping bar the sides of the mould shall be tapped to close the voids.

**COMPACTION BY VIBRATION:**

When compacting by vibration each layer shall be vibrated by means of an electric or pneumatic hammer or vibrator or by means of a suitable vibrating table until the specified condition is attained.

**CURING :**

The casted cubes shall be stored under shed at a place free from the vibration at a temperature 220C to 330C for 24 hours covered with wet straw or gunny sacking.

The cube shall be removed from the moulds at the end of 24 hours and immersed in clean water at a temperature 240C to 300C till the 7 or 28-days age of testing. The cubes shall be tested in the saturated and surface dry condition.

For the true representation of actual strength of concrete in the structure, extra cubes shall be cast, stored and curded as per the identical conditions of that structure, and tested at required age.

**TESTING OF CONCRETE CUBES:**

The dimensions of the specimens to the nearest 0.2 mm and their weight shall be noted before testing. The bearing surfaces of the testing machine shall be wiped clean and any loose sand or other materials removed from the surface of the specimen which are to be in contact with the compression platens. The cube shall be placed in the machine in such a

manner that the load shall be applied to opposite sides of the cubes as cast that is not to the top and bottom. The axis of the specimen shall be carefully aligned with the centre of the thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine. As the spherically seated block is brought to bear on the specimen, the movable portion shall be rotated gently by hand so that uniform seating may be obtained. The load shall be applied without shock and increased continuously at a rate of approximately 140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted, see fig-1and fig-2. The compressive strength of concrete shall be calculated from:Maximum load/Cross-Sectional area of cube

To be reported to the nearest 0.5N/mm $^2$

**ACCEPTANCE:**

For the acceptance, both the conditions should be met with:

a) The mean strength determined from any group of four-non overlapping consecutive test results should comply with the appropriate limits as given in table-2

b) Any individual test result complies with in the appropriate limit as given in table-2

**Table-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$^2$ |
|---|---|---|
| M-15 | >= fck + 0.825 x established standard deviation<br><br>(rounded off to nearest 0.5 N/mm$^2$)<br>or<br><br>fck + 3 N/mm$^2$<br>whichever is greater | >=fck – 3 N/mm$^2$ |
| M-20 or above | >= fck + 0.825 x established standard deviation<br><br>(rounded off to nearest 0.5 N/mm$^2$) | >= fck – 4 N/mm$^2$ |

| | | |
|---|---|---|
| | or<br><br>fck + 4 $N/mm^2$<br>whichever is greater | |

Note: In absence of established standard deviation, the values given in Table-8 of IS:456-2000 may be assumed.

**INTERPRETATIONS-EXAMPLE FOR M-25 GRADE OF CONCRETE**

For a pour of 31-50 $m^3$ 4 samples (each sample having 3 cubes) are mandatory.

1. The average value of set of three cubes (one sample) should have strength with in the limits of ±15% of the average value. Otherwise the result of that sample will be invalid.
2. The mean value of 4 samples (4 average values obtained from each sample of 3 cubes) should meet the criteria as given in table-2. For M-25 grade of concrete the mean value of these 4 samples should not be less than either 29 N/mm2 or 25 $N/mm^2$ plus 0.825 times the standard deviation whichever is the greater.
3. Any individual test result of a cube out of the above should not have value less than 21 $N/mm^3$.

In case of doubt regarding the grade of concrete used either due to poor workmanship or based on results of cube strength test further tests should be conducted such as non-destructive test by Concrete Test Hammer, Ultrasonic Concrete Tester etc. Partial destructive test by drilling cores and testing them in compression. In no case fewer than three cores be tested. The final test include the load testing on structure.

**DURABILITY OF CONCRETE:**

Cube testing alone is not the criteria for the durability of concrete structure. A durable concrete is one that perform satisfactorily in the working environment during its anticipated exposure conditions during service. The materials and mix proportions specified and used should be such as to maintain its integrity and if applicable, to protect embedded metal from corrosion.

It is essential that every concrete structure should continue to perform its intended functions, that is maintained its required strength and serviceability, during the specified or traditionally expected service life. It follows that concrete must be able to withstand the processes of deterioration to which it can be expected to be exposed. Such concrete is said to be durable.

Both strength and durability have to be considered explicitly at the design stage. The emphasis is on the word both because it would be a mistake to replace overemphasis on strength by overemphasis on durability.

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| | | | |
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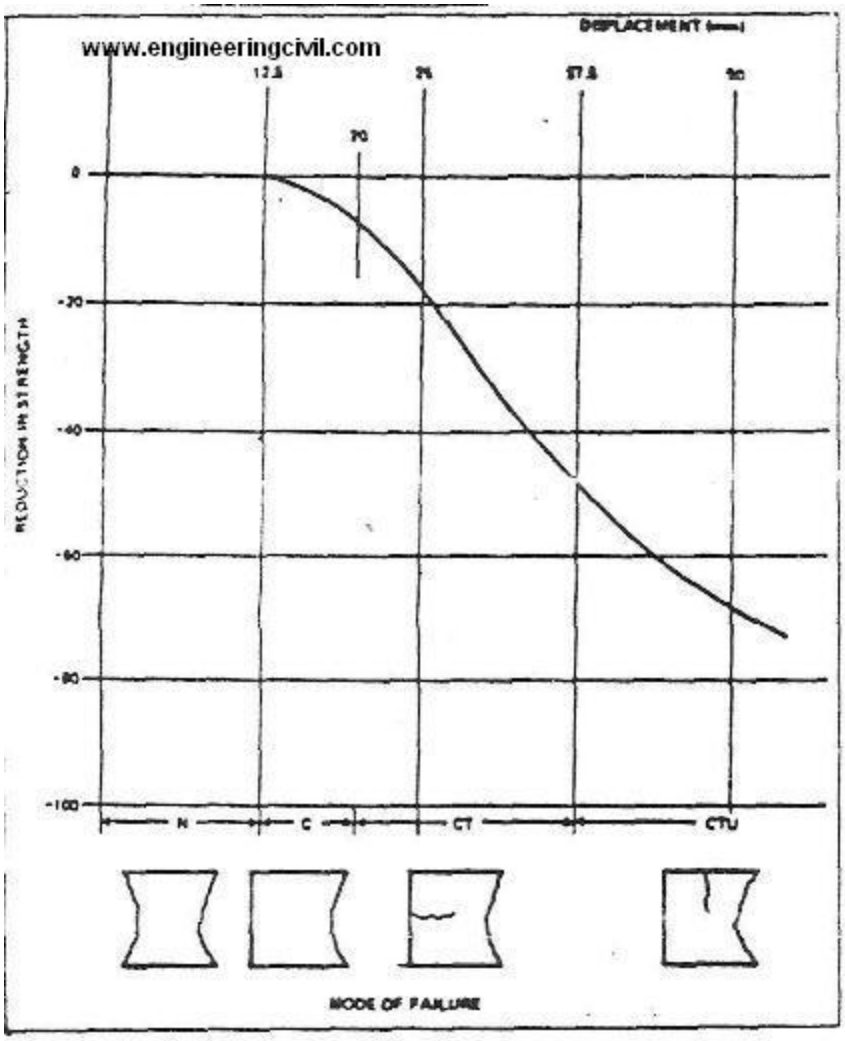


*Fig.2. Association Between Mode Of Cube Failure And Loss In Strength For 100 mm Cubes Placed Eccentrically In A High-Quality Testing Machine (N:Normal Mode; C : Excessive Crushing Of One Face; CT:C Plus Horizontal Tensile Crack In Opposite Face; CTU: C Plus Tensile Crack In Face Against The Upper Platen).*

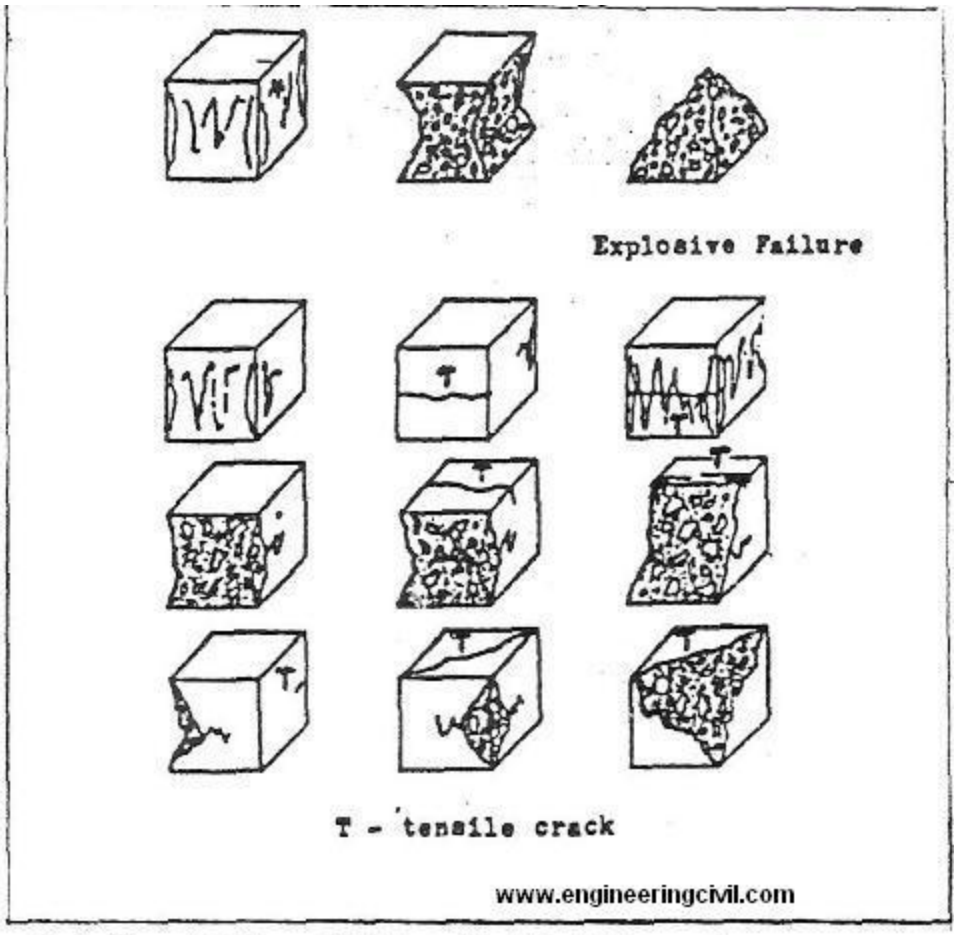


*Fig. 1. Normal Failures Of Cubes (Top) And Abnormal Failures Of Cubes (Bottom).*

*We at engineeringcivil.com are thankful to **Sir Kaushal Kishore** for submitting this research paper and helping all civil engineers understand the Quality Control Of Construction Testing Of Concrete Cubes.*

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