

Analysis of Compressive Strength between Cubical and Cylindrical Concrete

Nidhi Sharma, Aashish Kumar Jha

Abstract— The compressive strength of concrete is the prevalent performance attribute engulfed by engineers while designing structures. This test is basically performed by breaking the cube and cylindrical specimens under compression testing machines. The compressive strength of the concrete tests formulates an idea about all the properties of concrete. Through these tests one can find out that whether Concreting has been performed in a corrected manner or not. For general construction, the Concrete compressive strength varies from 15 MPa to 30 MPa and in industrial structures and commercial structures is higher. The formula of Compressive strength for any of the material is the given as the load applied at the point of failure to the cross-section area of the face on which load was applied. This paper will clearly provide a difference between two different types of specimens of concrete for testing the compressive strength.

Index Terms— Cubical Concrete, Cylindrical Concrete, Compressive Strength, lateral restraint

INTRODUCTION

Achieving high strength property is not only the dependency of creating quality concrete in the present climate. upgrading the strength and durability of the concrete to assist a prolonged life span and manufacture a greener concrete has been getting one of the main basis in acquiring a good quality concrete. The main properties of concrete such as elastic modulus, tensile strength are related to the Compressive strength of concrete which is considered to be important as the Concrete compressive strength also forms to take a part of being an essential role when the load bearing capacity of structures forms the main focal centre. The majority of the desirable characteristics of concrete are qualitatively connected to its own compressive strength. Compression test is one of the easiest and mostly common test performed on the hardened concrete

Procedure: Compressive Strength Test of Concrete Cubes

For this test i.e. cube test, two types of specimens of cubes that is either of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm is used depending on the size of aggregates. Almost for many of the works cubical models or molds of size 15cm x 15cm x 15cm are generally taken into consideration. Now this concrete is poured in the mold and properly being tempered so as to avoid having any voids. Molds are removed after 24hour and test specimens are now placed in the water for the process of curing. The top surface of the specimen must be even and smooth which can be done by placing cement paste and laying it on the entire area of the specimen smoothly. Then these specimens are tested by compression testing machine after 28 days curing or after seven days curing. Load

must be applied gently at the rate of 140 kg/cm² per minute until the Specimens fails. The compressive strength of concrete is given by dividing the load at the failure divided by area of specimen.

Preparation of Cube Specimen of concrete-

The material used for making these test specimens are basically from the same concrete that is used in the field and also its proportion.

Apparatus for Cube Test-

Compression testing machine(CTM)



Fig1: : cube kept in CTM before testing (left) cube kept in CTM after testing (right)

Specimen size-

- 6 cubes of 15 cm size
- Mix. M15 or above
- Mixing the concrete either manually or in a laboratory batch mixer.

Sampling of concrete Cubes -

1. Clean the moulds
2. Apply oil.
3. Fill the concrete material in the mold in specific layers that must be approx. 5 cm thick.
4. Then Compact each layer with not less than 35 strokes per layer using a tamping rod i.e. steel bar 16mm diameter and 60cm long, bullet-pointed at lower end.
5. Levelling the top surface and then smoothen it with the help of a trowel

Curing of concrete Cubes-

These specimens are saved in moist air for 24 hours following this span, the specimens are pronounced or marked and then separated from the molds.

Analysis of Compressive Strength between Cubical and Cylindrical Concrete

Procedure for Concrete Cube Test-

1. After specified curing time take out the specimen from the water and clean out excess water.
2. The dimension of the specimen should be taken nearest to 0.2m
3. Swab the bearing surface of the machine.
4. locate the specimen in the machine in a way that the load could be applied to the opposite sides of the casted cube.
5. Range the specimen specifically on the base plate of the machine.
6. The movable portion should be gently rotated by hand such that it touches the top surface of the specimen.
7. The load must be applied gently without shock and constantly at the rate of 140 kg/cm²/minute until the specimen reaches failure.
8. The maximum load must be recorded.

Observation Result (Example)-

Calculation-

Compressive Strength of concrete = Maximum compressive load / Cross Sectional Area

Details	Samples		
	Specimen 1	Specimen 2	Specimen 3
Compressive Load (KN)	375 KN	425 KN	435 KN
Compressive Strength (Kg Cm ²)	$(375000/225) / 9.81 = 170 \text{ kg/cm}^2$	$(425000/225) / 9.81 = 192.5 \text{ kg/cm}^2$	$(435000/225) / 9.81 = 197.0 \text{ kg/cm}^2$
Average Compressive Strength	$= (170+192.5+197) / 3 = 186.5 \text{ Kg/cm}^2$		

Cross sectional Area = 150mm X 150mm = 22500 mm² or 225 cm²

Assume the compression load is 450 KN,

Compressive Strength = $(450000 \text{ N} / 225) / 9.81 = 204 \text{ kg/cm}^2$

Note – 1 kg is equal to 9.81 N

Results of Concrete Cube Test—(Format of writing results)

Average compressive strength of the concrete cube =(result)..... N/mm² (at 7 days)

Average compressive strength of the concrete cube =(result)..... N/mm² (at 28 days)

Hence, the compressive strength of the concrete is 204kg/cm² (in the given above example)

NOTE:

The strength of concrete increases with age. The table shows the strength of concrete at different ages in comparison with the strength at 28 days after casting.

Compressive Strength of Concrete at Various Ages

Age	Strength percent
1 day	16%
3 days	40%
7 days	65%
14 days	90%
28 days	99%

Table-1 shows the strength of concrete at different ages in comparison with the strength at 28 days after casting

Compressive Strength of Different Grades of Concrete at 7 and 28 Days

Grade of Concrete	Minimum compressive strength N/mm ²	Specified characteristic compressive
M15	10	15
M20	13.5	20
M25	17	25
M30	20	30
M35	23.5	35
M40	27	40
M45	30	45

Table.2: Compressive Strength of Different Grades of Concrete at 7 and 28 Days

Precautions for Test-

At the temperature 27+-2oC of the water it must be the cured and should be tested every 7 days.

Cylinder test--

Apparatus for Concrete Cylinder Test

The sample prepared might be of the two dimensions as introduced below.

The diameter of the cylinder cast should be at least 3 times the nominal maximum size of the coarse aggregate engaged in the concrete manufacturing work.

Apparatus required

1. Compression testing machine
2. Cylinder mold (150mm diameter, 300mm height or 100 x 200mm).
3. Weighing balance.



Fig.2: Fractured Concrete Cylinder Specimen at Failure

Procedure for Concrete Cylinder Test-

➤ **Sample Preparation-**

The cylinder specimens are cast in mold made of non-absorbent material in steel, cast iron. under acute conditions also the molds used must hold on to its original shape and dimensions. without any leakage, the mold should hold the concrete. prior to the placement of the concrete mix within the mold, the greasing of the inside part of the mold must be done to ease the removal of the hardened cylinder.

- The mixed concrete must be placed into the molds in the form of layers which should be not less than 5cm in depth.
- The blows per layer during the compaction not be less than 30 in number.
- Compaction must hold out to primary layers permitting the majority of the air voids to escape.
- The specimens are placed without disturbing in a place at a temperature of $27^{\circ} \pm 2^{\circ}\text{C}$ for 24 hours' with least 90% of the relative humidity.
- After this interval, the samples are taken and placed submerged in clean and till the testing age is finally attained.

➤ **Test Procedure-**

1. The concrete cylinder is cast of standard size.
2. Then Allowed to cure for 28 days.

3. For testing, three specimens of the same dimension are prepared due to casting.
4. remove the specimen from the curing tank.
5. clean out the surplus water from the surface of the specimen.
6. Place the specimen vertically on the platform of compression testing machine.
7. application of the Uniform load and distribution is ease by placing pad caps at the ends of the cylinders.
8. Prior to the load application, make it sure that the loading platforms touch the top of the cylinder.
9. the load must be applied gently without shock and uniformly at the rate of 315 kN/min.
10. And continue the loading until the specimen fails.
11. Record the maximum load taken.
12. The test is repeated for the remaining two specimens.

Compressive Strength of Concrete at Various Ages

Age	Strength per cent
1 day	16%
3 days	40%
7 days	65%
14 days	90%
28 days	99%

Table.3: The strength of concrete at different ages in comparison with the strength at 28 days

Compressive Strength of Different Grades of Concrete at 7 and 28 Days-

Grade of Concrete	Minimum compressive strength N/mm^2 at 7 days	Specified characteristic compressive strength (N/mm^2) at 28 days
M15	10	15
M20	13.5	20
M25	17	25
M30	20	30
M35	23.5	35
M40	27	40
M45	30	45

Table.4: Compressive Strength of Different Grades of Concrete at 7 and 28 Days

Calculations for Compressive Strength of Concrete

Cylinder --

Compressive strength = (Maximum load/ Cross-sectional area)

Result--

The compressive strength of cylinder at the 28th day is =.....(RESULT).....N/mm²

CONCLUSION

Why cylinder test is considered more accurate but cube test is generally performed?

This is mainly because of lateral Restrain . The restraint that limits lateral movement of the compression flange of a beam .Compared with the cube test the,the advantages of the cylinder are more uniform distribution of stress over the cross section, for these reasons the cylinder strength is ,more likely to be closer to the true uniaxial compressive strength of concrete than the cube strength and also are less end restraint. The cylinder tested under compression, the maximum strength obtained is called as the strength of cylinder or the cylinder's strength.Cylinder strength equals to 0.8 * cube strength.

Cylinder is also being tested to obtain stress-strain curve as the condition needs to be obtained of uniaxial strength.Incase of cubes basically, due to the friction between the concrete surface and the steel plate of machine; Lateral restraint occurs. The effects of this particular restraint is to show an increment in the longitudinal direction. Therefore, there happens an increment from the friction surface that is the height/width ratio is being increased and so the compressive strength is being decreased

REFERENCES

1. M.S. Pawar, A.C.Saoji, "performance of self compacting concrete using alccofine", International journal of engineering Research and application, Aug 2013
2. A.M Neville, Properties of concrete, 4th edition (1995), Addition Wesley Lapman Ltd England. Page 269-317,359-405
3. M.S.Shetty, Concrete technology-theory and practice, S Chand publication (2005)
4. IS: 456-2000 Code of practice for plain and reinforced concrete (third edition). Bureau of Indian standards, New Delhi, India
5. IS: 516-1959 Methods of tests for strength of Concrete.BIS, New Delhi, India
6. IS: 1199-1959 Methods of sampling and analysis of Concrete.BIS, New Delhi, India
7. IS 383:1970 Specification for coarse and fine aggregates from natural sources for concrete (second revision) Jan 2007
8. IS 2386(Part 1):1963 Methods of test for aggregates for concrete: Part 1 Particle size and shape Jan 2007
9. IS: 4031-1988 Methods for Physical Tests for Hydraulic Cement. Bureau of Indian Standards, New Delhi, India.
10. IS: 8112-1989 Standard Code of Practice for 43-Grade Ordinary Portland cement. Bureau of Indian Standards, New Delhi, India.
11. Iliana Rodriguez Viacava, Antonio Aguado dea Cea, Gemma Rodriguez de Sensale, "Self Compacting

Concrete of medium concrete characteristics Strength." Construction and Building Materials 30(2012) p.p. 776-782.

12. Nan, Su; Kung -Chung, H; His - Wen, C; "A simple mix design method for self compacting concrete." Cement and Concrete Research 31(2001)p.p. 1799-1807