EXPERIMENT NO.- 08

EXPERIMENT NAME:

COMPRESSIVE STRENGTH OF CONCRETE CYLINDERS AND CUBES

INTRODUCTION

- The compressive strength of concrete is one of the most important and useful properties of concrete.
- In most structural applications, concrete is employed primarily to resist compressive stresses.
- Nevertheless, strength usually gives an overall picture of the quality of concrete because it is directly related to structure of the hardened cement paste.
- Values obtained will depend on the size and shape of the specimen, batching, mixing procedures, the methods of sampling, molding & fabrication and the age, temperature & moisture contents during curing.
- The test method covers determination of compressive strength of cylindrical concrete specimens such as molded cylinders and drilled cores. It is limited to concrete having a unit weight in excess of .

INTRODUCTION (Contd..)

- The test method consists of applying a compressive axial load to molded cylinders or cores at a rate which is within a prescribed range until failure occurs.
- The compressive strength of the specimen is calculated by dividing the maximum load attained during the test by the cross – sectional area of the specimen.
- The results of this test method may be used as a basis for quality control of concrete proportioning, mixing & placing operations; determination of compliance with specifications; control for evaluating effectiveness of admixtures and similar uses.

STANDARD REFERENCE

- ASTM C 39 for cylinders.
- BS 1881 for cubes.

APPARATUS

Compression Testing Machine:

1. The testing machine shall be of a type having sufficient capacity and capable of providing the rates of loading as required.

Design: The machine must be power operated and must apply the load continuously rather than intermittently and without shock.

Accuracy: The percentage of error for the loads within the proposed range of use of the testing machine shall not exceed of the indicated load.

Compression Testing Machine (Contd..)

- The testing machine shall be equipped with two steel bearing blocks with hardened faces (Note 1), one of which is a spherical seated block that will bear on the upper surface of the specimen, and the other a solid block on which the specimen shall rest.
- Bearing faces of the blocks shall have a minimum dimension at least 3% greater than the diameter of the specimen to be tested.
- When the diameter of the bearing face of the spherically seated block exceeds the diameter of the specimen by more than , concentric circles not more than deep and not more than wide shall be inscribed to facilitate proper centering.

Note 1
It is desirable that the bearing faces of blocks used for compression testing of concrete have a Rockwell hardness of not less than 55 HRC.

2. Bottom bearing blocks shall conform to the following requirements:

- The bottom bearing block is specified for the purpose of providing a readily machinable surface for maintenance of the specified surface conditions (Note 2).
- The top and bottom surfaces shall be parallel to each other.
- The block may be fastened to the platen of the testing machine.
- Its least horizontal dimension shall be at least 3% greater than the diameter of the specimen to be tested.
- Final centering must be made with reference to the upper spherical block.
- When the lower bearing block is used to assist in centering the specimen, the center of the concentric rings, when provided, or the center of the block itself must be directly below the center of the spherical head.
- Provision shall be made on the plate of the machine to assure such a position.
- The bottom bearing block shall be at least 1 in. (25 mm) thick when new and at least 0.9 in. (22.5 mm) thick after any resurfacing operations.

Note 2

If the testing machine is so designed that the platen itself can be readily maintained in the specified surface condition, a bottom block is not required.

3. **The spherically seated bearing block shall conform to the following requirements:**

- The maximum diameter of the bearing face of the suspended (Note 3) spherically seated block shall not exceed the values given below:

Note 3
Square bearing faces are permissible, provided the diameter of the largest possible inscribed circle does not exceed the above diameter.

- The center of the sphere shall coincide with the surface of the bearing face within a tolerance of the radius of the sphere.
- The diameter of the sphere shall be at least 75% of the diameter of the specimen to be tested.

- The curved surfaces of the socket and of the spherical portion shall be kept clean and shall be lubricated with petroleum type oil such as conventional motor oil, not with pressure type grease.
- After contacting the specimen and application of small initial load, further tilting of the spherically seated block is not intended and is undesirable.
- If the radius of the sphere is smaller than the radius of the largest specimen to be tested, the portion of the bearing face extending beyond the sphere shall have a thickness not less than the difference between the radius of the sphere and radius of the specimen.
- The least dimension of the bearing face shall be at least as great as the diameter of the sphere.
- The movable portion of the bearing block shall be held closely in the spherical seat, but the design shall be such that the bearing face can be rotated freely and tilted at least 40 in any direction.

Load Indication:

- If the load of a compression machine used in concrete testing is registered on a dial, the dial shall be provided with a graduated scale that can be read to at least the nearest 0.1% of the full scale load.
- The dial shall be readable within 1% of the indicated load at any given load level within the loading range.
- In no case shall the loading range of a dial be considered to include loads below the value that is 100 times the smallest change of load that can be read on the scale.
- The scale shall be provided with a graduation line equal to zero and so numbered.
- The dial pointer shall be of sufficient length to reach the graduation marks; the width of the end of the pointer shall not exceed the clear distance between the smallest graduations.
- Each dial shall be equipped with a zero adjustment that is easily accessible from the outside of the dial case, and with a suitable device that at all times until reset, will indicate to within 1% accuracy of the maximum load applied to the specimen.

SPECIMENS

- Specimens shall not be tested if any individual diameter of a cylinder differs from any other diameter of the same cylinder by more than 2%.
- Neither end of compressive test specimens when tested shall depart from perpendicularity to the axis by more than (approximately equivalent to 1/8 in. in 12 in. (3 mm in 300 mm)) .
- The ends of compression test specimens that are not plane within 0.002 in. (0.050 mm) shall be capped to meet that tolerance.
- The diameter used for calculating the cross sectional area of the test specimen shall be determined to the nearest 0.01 in. (0.25 mm) by averaging two diameters measured at right angles to each other at about mid-height of the specimen.

SPECIMENS (Contd..)

- The number of individual cylinders measured for determination of average diameter may be reduced to one for each ten or three specimens per day, whichever is greater, if all cylinders are known to have been made from a single lot of reusable or single use molds which consistently produce specimens with average diameters within a range of 0.02 in. (0.51 mm).
- When the average diameters do not fall within the range of 0.02 in. or when the cylinder tested must be measured and the value used in calculation of the unit compressive strength of that specimen.
- When the diameters are measured at the reduced frequency, the cross-sectional areas of all cylinders tested on that day shall be computed from the average of the diameters of the three or more cylinders representing the group tested that day.
- The length shall be measured to the nearest 0.05 D (D being the diameter for the cylinder and the diagonal for cube) when the length to diameter ratio is less than 1.8, or more than 2.2, or when the volume of the cylinder is determined from measured dimensions.

MATERIALS

- Determine the mix ratio from the available data and for the specified compressive strength desired as instructed in the class.
- Compute the amounts of cement, water, coarse aggregate and fine aggregate from the mix ratio for 9 cylinders and for 9 cubes .

PROCEDURE

Cylinders

- Fill each mold with concrete in four layers, tamping each layer 25 times with Steel tamping rod.
- If vibrator is used, its frequency should not be greater than 7000/minute if it is an internal electric vibrator.
- In case of an external vibrator, the frequency will be 3600/minute.
- While filling the molds, occasionally stir and scrape together the concrete remaining in the mixing pan to keep the materials from separating.
- Fill the molds completely, smooth off the tops evenly.
- Cover the cylinders immediately and place in the moist storage for hours at a temperature of .
- Then remove the specimens from the molds and immerse in saturated lime water until testing.

Cubes

- Fill each mold in three layers, tamping each layer 35 times with 25 sq. mm, 380 mm long and 1.8 Kg compacting bar, or vibrator (if possible).
- After filling the specimens shall be stored in moist condition (free from vibration) in at least 90% relative humidity and temperature for 16 to 24 hours.
- Then remove the specimens and immerse in saturated lime water until testing.

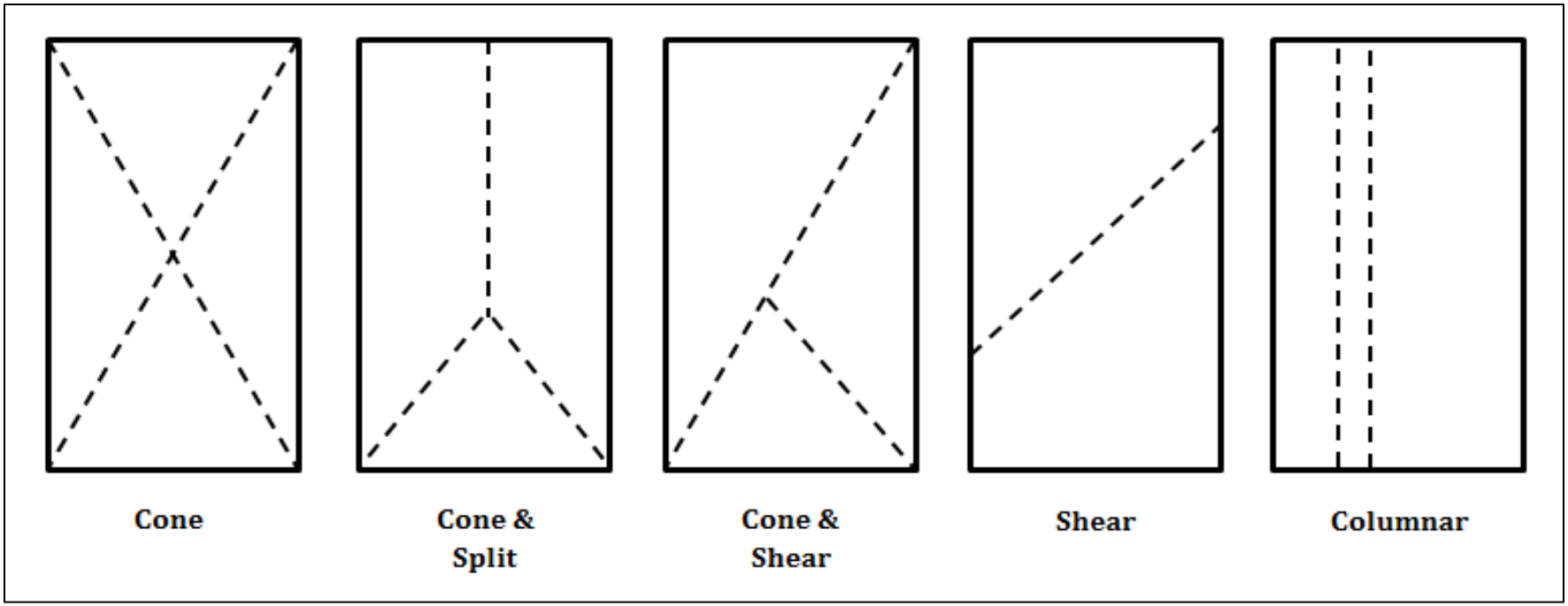

Figure 8.1 Sketches of different types of failure

METHOD OF TESTING

- Compression tests of moist cured specimens shall be made as soon as practicable after removal from moist storage.
- Test specimens shall be kept moist by any convenient method during the period between removals from moist storage and testing.
- They shall be tested in the moist condition.
- All test specimens for a given test age shall be broken within the permissible time tolerances prescribed as follows:

Test Age	Permissible Tolerance
24 hours	+/-0.5 Hours or 2.1%
3 days	2 hours or 2.8%
7 days	6 hours or 3.6%
28 days	20 hours or 3.0%
90 days	2 days or 2.2%

Figure 8.2 Compressive Strength Test of Cylinder

Placing the Specimen:

- Place the plain (lower) bearing block, with its hardened face up, on the table or platen of the testing machine directly under the spherically seated (upper) bearing block.
- Wipe clean the bearing faces of the upper and lower bearing blocks and of the test specimen and place the test specimen on the lower bearing block.
- Carefully align the axis of the specimen with the center of thrust of the spherically seated block.
- As the spherically seated block is brought to bear on the specimen, rotate its movable portion gently by hand so that uniform seating is obtained.

Rate of Loading:

- Apply the load continuously and without shock.
- For hydraulically operated machines, the load shall be applied at a rate of movement (platen to crosshead measurement) corresponding to a loading rate on the specimen within the range of 20 to 50 psi/sec (0.14 to 0.34 MPa/sec).
- The designated rate of movement shall be maintained at least during the latter half of the anticipated loading phase of the testing cycle.
- During the application of the first half of the anticipated loading phase a higher rate of loading shall be permitted.
- Make no adjustment in the rate of movement of the platen at any time while a specimen is yielding rapidly immediately before failure.
- Apply the load until the specimen fails, and record the maximum load carried by the specimen during the test.
- Note the type of failure and the appearance of the concrete.

CALCULATION

- Calculate the compressive strength of the specimen by dividing the maximum load carried by the specimen during the test by the average cross-sectional area and express the result, to the nearest 10 psi (69 KPa).
- If the specimen length to diameter ratio is less than 1.8, multiply the obtained result by the appropriate correction factor shown in the following table:

L/D	1.75	1.50	1.25	1.00
Factor	0.98	0.96	0.93	0.87 (Note 4)

Note 4
These correction factors apply to lightweight concrete weighing between and to normal weight concrete. They are applicable to concrete dry or soaked at the time of loading. Values not given in the table shall be determined by interpolation. The correction factors are applicable for nominal concrete strengths from 2000 to 6000 psi (13.8 to 41.4 MPa).

REPORT

The report shall include the following:

- Identification number
- Diameter, cross-sectional area
- Maximum load in pounds-force or newtons
- Compressive strength to the nearest 10 psi or 69 KPa.
- Type of failure
- Age of specimen

Draw the followings in plain graph paper:

- Compressive strength (for cylinder) vs. age
- Compressive strength (for cube) vs. age

QUESTIONS??

- What is the effect of age of concrete upon the water-cement ratio and strength curve?
- Discuss the effect of rate of loading upon the compressive strength.
- Discuss the effect of capping upon the compressive strength.
- Cube strength is greater than cylinder strength – why? Discuss.
- What is the effect upon the compressive strength if L/D ratio is other than 2?

EXPERIMENT 08
Data Sheet
Compressive Strength of Concrete Cylinders and Cubes

Sl. No.	Age (days)	Specimen Designation	Specimen Area	Maximum Load	Crushing Strength	Average Crushing Strength	Type of Failure
1	3						
2							
3							
4	7						
5							
6							
7	28						
8							
9							

For Cylinder

Sl. No.	Age (days)	Specimen Designation	Specimen Area	Maximum Load	Crushing Strength	Average Crushing Strength	Type of Failure
1	3						
2							
3							
4	7						
5							
6							
7	28						
8							
9							

For Cube

Student No. :
Group :
Date :

Signature of Course Teacher