UNIT- IV

FRESH AND HARDENED PROPERTIES OF CONCRETE

SYLLABUS

Workability - Tests for workability of concrete - Segregation and Bleeding - Determination of strength Properties of Hardened concrete - Compressive strength – split tensile strength - Flexural strength - Stress-strain curve for concrete - Modulus of elasticity – durability of concrete – water absorption – permeability – corrosion test – acid resistance.

4.1 WORKABILITY

- Workability is the property of concrete which determines the amount of internal work necessary to produce full compaction. It is a measure with which concrete can be handled from the mixer stage to its final fully compacted stage.
- Workability is one of the physical parameters of concrete which affects the strength and durability as well as the cost of labor and appearance of the finished concrete. Concrete is said to be workable when it is easily placed and compacted homogeneously i.e. *without bleeding or Segregation.*

Requirements of fresh concrete

- Mixability
- Stability
- Mobility

- Compactability
- Finishability

Factor affecting the workability:

a) Water content

b) Mix proportion

c) Size of aggregate

d) Shape of aggregate

e) Surface texture of aggregate

f) Grading of admixture

g) Use of admixtures (Chemical / mineral admixtures)

Water content or Water Cement Ratio

►More the water cement ratio ,more workability of concrete. Since by simply adding water the inter particle lubrication is increased.

► High water content results in a higher fluidity and greater workability. Increased water content also results in bleeding. another effect of increased water content can also be that cement slurry will escape through joints of formwork.

► More water can be added, provided a correspondingly higher quantity of cement is also added to keep the water/cement ratio constant, so that the strength remains the same.

Mix proportion

▶ The higher the aggregate / cement less quantity of paste is available for providing lubrication, per unit surface area of aggregate and hence the mobility of aggregate is restrained.

▶ On the other hand, in case of rich concrete with lower aggregate/cement ratio, more paste is available to make the mix cohesive and fatty to give better workability.

Size of Aggregate & Surface Texture

▶ The bigger the size of the aggregate, the less is the surface area and hence less amount of water is required for wetting the surface and less matrix or paste is required for lubricating the surface to reduce internal friction.

▶ Greater size of Aggregate- less water is required to lubricate it, the extra water is available for workability

▶ Porous aggregates require more water compared to non-absorbent aggregates for achieving same degree of workability**.**

Shape of aggregate

▶ Angular, elongated or flaky aggregate makes the concrete very harsh when compared to rounded aggregates or cubical shaped aggregates.

▶ Contribution to better workability of rounded aggregate will come from the fact that for the given volume or weight it will have less surface area and less voids than angular or flaky aggregate.

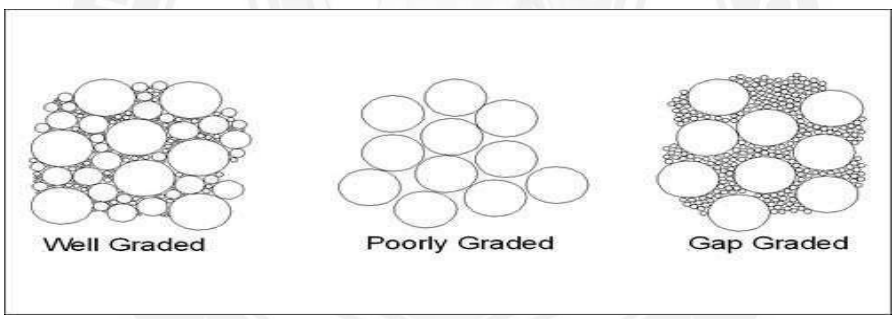
▶ Not only that, being round in shape, the frictional resistance is also greatly reduced. This explains the reason why river sand and gravel provide greater workability to concrete than crushed sand and aggregate.

Grading of admixture

▶ A well graded aggregate is the one which has least amount of voids in a given volume and higher the workability.

▶ Other factors being constant, when the total voids are less, excess paste is available to give better lubricating effect.

▶ With excess amount of paste, the mixture becomes cohesive and fatty which prevents segregation of particles.



Use of admixtures

▶ Chemical admixtures can be used to increase workability.

▶ Use of air entraining agent produces air bubbles which acts as a sort of ball bearing between particles and increases mobility, workability and decreases bleeding, segregation.

▶ The use of fine pozzolanic materials also have better lubricating effect and more workability.

Weather Conditions

►If temperature is high, evaporation increases, thus workability decreases.

►If wind is moving with greater velocity, the rate of evaporation also increase reduces the amount of water and ultimately reducing workability.

4.1.1 TESTS FOR WORKABILITY OF CONCRETE

a. Slump Test

b. Compaction Factor

c. Vee - Bee Consistometer

d. Kelly Ball Penetration test

e. Flow table Test

f. Vibrating table

4.1.1.1 Slump Test

Definition

A slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicates how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirements for the finished product quality

- Slump is a measurement of concrete's workability, or fluidity.
- It's an indirect measurement of concrete consistency or stiffness.

Principle

The slump test result is a measure of the behaviour of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.

Apparatus

- Slump cone : inverted cone, 300 mm (12 in) of height. The base is 200 mm (8in) in diameter and it has a smaller opening at the top of 100 mm
- Scale for measurement,
- Temping rod(steel) 16mm diameter, 60cm length.

Procedure

- The base is placed on a smooth surface and the container is filled with concrete in three layers, whose workability is to be tested.
- Each layer is temped 25 times with a standard 16 mm (5/8 in) diameter steel rod, rounded at the end.
- After the top layer has been tamped, the concrete is struck off level with trowel and tamping rod.
- Then, the mould is removed by lifting it slowly and carefully in a vertical direction.
- This allows the concrete to subside. This subsidence is referred as slump concrete.
- The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured. This difference in height in mm is taken as slump of concrete.

a. True slump:

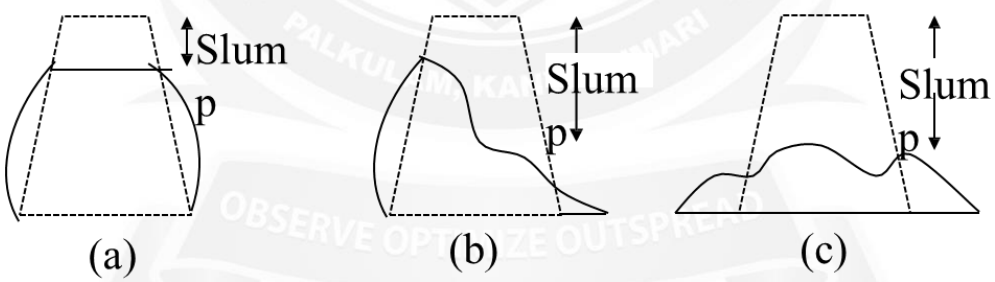
In this type of slump, the concrete is settled less from the top, and there is no any segregation on its shapes and indicate low workability

b. Shear slump:

In a shear slump, the top portion of the concrete shears off and slips sideways This kind of shear slip of concrete is clearly indicating the lack of cohesion of the concrete mix.

c. Collapse slump*:*

In this type of slump, the concrete is completely collapsed due to higher water cement ratio of the mix. This collapse indicates that the higher fluidity of the mix and instability of the mix, which cannot be used in any kind of important structures.

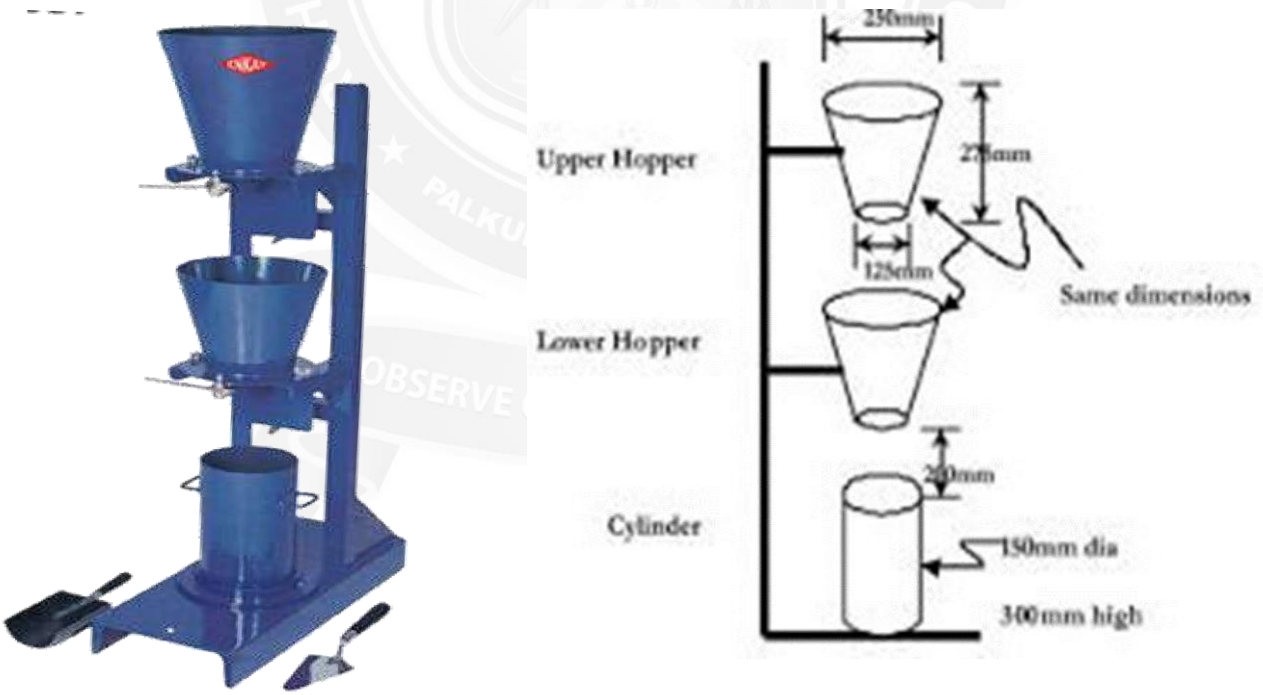


(a) True Slump (b) Shear Slump (c) Collapse Slump

4.1.1.2 Compacting factor test

Introduction

- Compacting factor test, developed at the road research laboratory UK is more precise and sensitive than the slump test. It is primarily designed for laboratory work but can also be used in the field. It is particularly useful for concrete mixes of very low workability as are normally used when concrete is to be compacted by vibration such concrete may constantly fail to slump.
- For the normal range of concrete the compacting factor lies between 0.8-0.92



Compaction factor test apparatus

Apparatus

- Trowels
- Hand Scoop (15.2 cm long)
- Rod of steel or other suitable material (1.6 cm diameter, 61 cm long rounded at one end).
- Balance.

Procedure

1) Ensure the apparatus and associated equipment are clean before test and free from hardened concrete and superfluous water .
2) Weigh the bottom cylinder to nearest 10gm , put it back on the stand and cover it up with a pair of floats .
3) Gently fill the upper hopper with the sampled concrete to the level of the rim with use of a scoop .
4) Immediately open the trap door of the upper hopper and allow the sampled concrete to fall into the middle hopper .
5) Remove the floats on top of the bottom cylinder and open the trap door of the middle hopper allowing the sampled concrete to fall into the bottom cylinder .

6) Remove the surplus concrete above the top of the bottom cylinder by holding a float in each hand and move towards each other to cut off the concrete across the top of cylinder.

7) Wipe clean the outside of cylinder of concrete and weigh to nearest 10gm .

8) Subtract the weight of empty cylinder from the weight of cylinder plus

Concrete to obtain the weight of partially compacted concrete .

9) Remove the concrete from the cylinder and refill with sampled concrete in layers .

10) Compact each layer thoroughly with the standard Compacting Bar to achieve full compaction .

11) Float off the surplus concrete to top of cylinder and wipe it clean .

12) Weigh the cylinder to nearest 10gm and subtract the weight of empty cylinder from the weight of cylinder plus concrete to obtain the weight of fully compacted concrete .

$$\text{The Compacting Factor } (CF) = \frac{\text{weight of partially compacted concrete}}{\text{weight of fully compacted concrete}}$$

Workability	Slump (mm)	C.F	Uses
Very Low	0 - 25	0.78	Roads - Pavements
Low	25 - 50	0.85	Foundations Concrete
Medium	25 - 100	0.92	Reinforced Concrete
High	100 - 175	0.95	Reinforced Concrete (High Reinforcement)

4.1.1.3 Flow Test

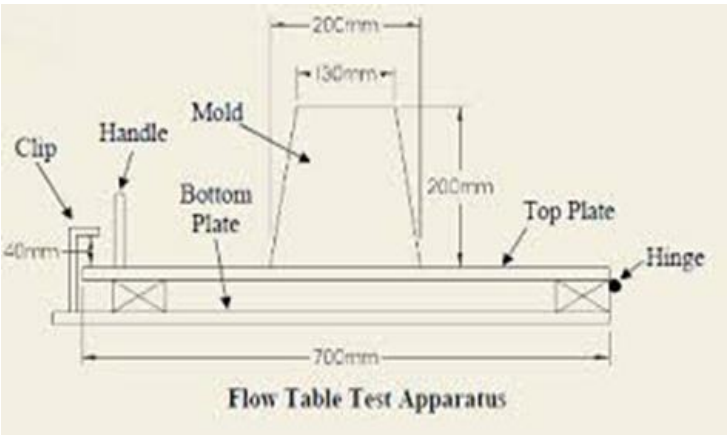
Definition

The **flow table test** or **flow test** is a method to determine the consistency of fresh concrete.

- Application When fresh concrete is delivered to a site by a truck mixer it is sometimes necessary to check its consistence before pouring it into formwork.
- If the consistence is not correct, the concrete will not have the desired qualities once it has set, particularly the desired strength. If the concrete is too pasty, it may result in cavities within the concrete which leads to corrosion of the rebar, eventually leading to the formation of cracks (as the rebar expands as it corrodes) which will accelerate the whole process, rather like insufficient concrete cover. Cavities will also lower the stress the concrete is able to support.

Equipment

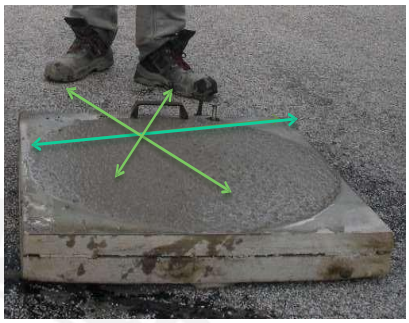
- Flow table with a grip and a hinge, 70 cm x 70 cm.
- Abrams cone, open at the top and at the bottom - 30 cm high, 17 cm top diameter, 25 cm base diameter
- Water bucket and broom for wetting the flow table.
- Tamping rod, 60 cm height
- Scale for measurement



Flow Table Test Apparatus

Procedure:

- The flow table is wetted
- The cone is placed on the flow table and filled with fresh concrete in two layers, each layer 25 times tamp with tamping rod.
- The cone is lifted, allowing the concrete to flow.
- The flow table is then lifted up several centimeters and then dropped, causing the concrete flow a little bit further.
- After this the diameter of the concrete is measured in a 6 different direction and take the average.



Flow table apparatus

$$\textbf{\textit{Flow}}\ \% = \frac{Diameter\ of\ flow\ (cm) - 25}{25} \times 100$$

Percent of Flow	0 – 20 %	20 – 60 %	60 – 100 %	100 – 120 %	120 – 150 %
Consistency	Dry	Stiff	Plastic	Wet	Sloppy