Unit - IV

Fresh and Hardened properties of concrete.

Fresh concrete:

Fresh concrete is plastic concrete. It is a freshly mixed material which can be moulded into any shape. The relative quantities of cement, aggregates and water mixed together, control the properties of concrete in the wet state as well as in the hardened state.

Workability:

It can be stated that the workability of concrete means the ability to work with concrete.
Factors affecting workability:

- Water content,
- Mix proportions,
- Size of aggregate,
- Shape of aggregate,
- Surface texture of aggregate,
- Grading of aggregates,
- Use of admixtures.

Test for workability of concrete

The following tests are commonly employed to measure workability:

- Slump test,
- Compaction factor test,
- Vee-Bee Consistometer test,
- Kelly Ball test.

Slump test:

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either
in laboratory or at site of work.

It is not suitable method for very wet or very dry concrete.

It does not measure all factors contributing to workability, nor is it always representative of the placeability from batch to batch.

Apparatus Required:
The apparatus for conducting the slump test essentially consists of a metallic mould in the form of a frustum of a cone having the internal dimensions as under:

- Bottom diameter = 200 mm
- Top diameter = 100 mm
- Height = 35 cm

The thickness of the metallic sheet for the mould should not be thinner than 1.6 mm.

For tamping the concrete, a steel tamping rod 16 mm dia., ø 0.6 meter along
with bullet end is used.

sometimes the mould is provided

with suitable guides for lifting

vertically up.

Test Procedure:

The internal surface of the
mould is thoroughly cleaned from
superfluous moisture and adherence of
or of any old set concrete before
commencing the test.

The mould is placed on a
smooth, horizontal, rigid and non-absorbent
surface. The mould is then filled
in 3 layers.

Each layer is tamped, 25 times
by the tamping rod taking care to
distribute the strokes evenly over the
cross section.

After the top layer has been
vibrated, the concrete is struck off
level with a trowel.
The mould is removed from the concrete immediately by raising it slowly and carefully in a vertical direction.

This allows the concrete to subside. The subsidence is referred as slump of 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 the concrete.

ASTM measures the centre of the slumped concrete as the difference in height. It indicates the characteristic of concrete in addition to the slump value.
* If the concrete slump evenly it is called true slump.
* If one half of the cone slides down it is called shear slump.

Mould for slump test

![Slump Diagram]

Compaction factor test

The compaction factor test is designed primarily for use in the laboratory but it can also used in the field.
Test procedure:

* The sample of concrete to be tested is placed in upper hopper upto the brim.

* The trap door is opened so that the concrete falls into the lower hopper. Then the trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder.

* In case of a dry-mix, it is likely that the concrete may not fall on opening the trap-door.
* In such case, a slight poking by a rod may be required to set the concrete motion.

* The excess concrete remaining above the top level of the cylinder is then cut off with the help of flavor blades supplied with the apparatus.

* The outside of the cylinder is wiped clean. The concrete is filled up exactly upto the top level of the cylinder. This weight is known as weight of partially compacted concrete.

* The cylinder is emptied and then refilled with the concrete from the same sample in three layers approximately.

* Each layer is tamped 25 times by the tamping rod or preferably vibrated so as to obtain full compaction.

* The top surface of the fully compacted concrete is then carefully
Struck off level with the top of the cylinder. This weight is known as weight of fully compacted concrete.

\[
\text{Compaction factor} = \frac{\text{Weight of partially compacted concrete}}{\text{Weight of fully compacted concrete}}
\]

Segregation:

Segregation can be defined as the separation of the constituent materials of concrete.

A good concrete is one in which all the ingredients are properly distributed to make a homogenous mixture.

Segregation may be three types

* The coarse aggregate separating out or settling down from the rest of the matrix.
* The paste or matrix separating away from coarse aggregate.
water separating out from the rest of the material being a material of lowest specific gravity.

Remedies for segregation.

* By correctly proportioning the mix,
* By handling properly
* By proper transportation
* By placing properly
* By proper compaction,
* By proper finishing.

Bleeding:

Bleeding is referred as water gain. It is particular from of segregation, in which some of the water from the concrete comes out to the surface as the concrete being of the lowest specific gravity among all the ingredients of concrete.
* Bleeding is observed in a highly wet mix, badly proportioned and insufficiently mixed concrete.

* In this members like roof slab or road slabs, when concrete is placed in sunny weather shows excessive bleeding.

* Due to bleeding, water comes up and accumulates at the surface, sometimes along with this water, certain quantity of cement also comes to the surface.

Hardened concrete:

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works.

Determination of Compressive Strength as per BIS:-

Compression test is the most common test conducted on hardened concrete,
because it is an easy test to perform and most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength.

Compressive strength of hardened concrete is done in cube and cylinder specimens.

The test specimens recommended are 150 x 150 x 150mm cubes or cylinders of 150mm diameter and 300mm height.

The specimen should be tested immediately after taking out them from water with surface water wiped off.

The specimen is placed between the platens of the compression testing machine with the care that the axis of specimen is aligned with the centre of thrust of the spherically seated platen.

The compression testing machine should be able to apply gradual
and at 1 AN/min until the specimen is crushed.

\[ \text{Compressive strength} = \frac{\text{Maximum load}}{\text{Cross sectional area}} \]

The average of the three values is taken as the compressive strength of concrete of the batch, provided the individual variation is not more than \( \pm 15 \% \) of the average.

Determination of Flexural Strength as per BIS:

A plain concrete specimen is tested to failure in bending. The theoretical maximum tensile stress at the bottom face at failure is calculated. This is termed as the modulus of rupture.

The flexural tensile strength test is performed to estimate the tensile...
load at which concrete may crack. This is an indirect test for assessing the tensile strength of concrete.

The test consists in determining the tensile strength at failure or the modulus of rupture. The ingredients of concrete are mixed as explained in the compression strength test.

**Arrangement for loading of flexural test apparatus.**

**Principles of flexural testing.**
The concrete is filled in the mould of size 150 x 150 x 700 mm and compacted with the tamping bar weighing 8 kg, 400 mm long and with a ramming face 25 mm square.

The specimen to be tested are placed in the testing machine on two 38 mm diameter rollers with a c/c distance of 600 mm.

The load is applied through two similar rollers mounted at the third points, i.e., spaced at 800 mm c/c.

The specimen are stored in water at a temperature of 27 ± 3°C for 48 hours before testing and are tested in wet condition.

The load is applied without
Shook and increasing continuously at a rate of 0.1 N/mm²/minute until the specimen fails.

Modulus of rupture \( = \frac{bl}{bd^2} \) (if \( a > 200 \text{mm} \))

or

\[ = \frac{3ba}{bd^2} \text{ (} 280 \text{mm} < a < 170 \text{mm} \) \]

where,
- \( a \) is the distance between the line of fracture and the nearest support.
- \( b \) and \( d \) are width and depth of specimen.
- \( l \) is the length of the span on which the specimen is supported.
- \( P \) is the maximum load applied to the specimen.
Stress-strain curve for concrete:

The stress versus strain behaviour of concrete under uniaxial compression is initially linear (stress is proportional to strain) and elastic (strain is recovered at unloading) with the generation of microcracks. The behaviour becomes nonlinear and inelastic. After the specimen reaches the peak stress, the resisting stress flat plates with increase in strain. The stress-strain curve for hardened cement paste is almost linear as shown in the figure.

![Stress-strain curve](image)
determination of Young's modulus.

To determine the modulus of elasticity for concrete, standard size of test specimen shall consist of concrete cylinders 150mm diameter and 300mm height can be used.

Alternatively if the largest nominal size of the aggregate does not exceed 20mm, specimen 100mm diameter and 200mm height cylinder may also be used.

At least three specimens shall be made and tested. Normally test shall be made when the specimens reach at the age of 28 days.
An instrument named compressometer is used in this test.

A sample testing of modulus of elasticity of concrete specimen using compressometer is shown in above figure.

Procedure:

The dimension of each specimen should be noticed before testing (surface diameter and the height of the cylinder).

Capping of specimen is to be done of necessary.

Immediately on removing the cylinder from water and while it is still in a wet condition, the compressometer shall be attached.

Mark the center line all around the cylinder specimen.
Place the compressometer over the cylinder and mark the gauge distance in such a way that the center of specimen and the center of compressometer shall coincide each other.

In this condition, place a cylindrical specimen with compressometer vertically between the loading surfaces of a compression testing machine and accurately centered.

Reading shall be taken at each stage of loading with as little delay as possible.

---

[Signature]