Chapter 9: Fresh Concrete

Fresh concrete:

It is the concrete phase from time of mixing to end of time concrete surface finished in its final location in the structure

Concrete Operations:

They comprise batching, mixing, transporting, placing, compacting, surface finishing . Then curing of in-placed concrete starts 6-10 hours after casting (placing) and during first few days of hardening is important

It is known that fresh state properties enormously affect hardened state properties due to the following reasons:

- The potential strength and durability of concrete of a given mix proportion is very dependent on the degree of its compaction.
- The first 48 hours are very important for the performance of the concrete structure.
- It controls the long-term behavior, influence f'c (ultimate strength), Fc' (elastic modulus), creep, and durability.

Main properties of fresh concrete during mixing, transporting, placing and compacting are:

• **Fluidity or consistency:** capability of being handled and of flowing into formwork and around any reinforcement, with assistance of compacting equipment.

• **Compact ability:** air entrapped during mixing and handling should be easily removed by compaction equipment, such as vibrators.

• **Stability or cohesiveness:** fresh concrete should remain homogenous and uniform. No segregation of cement paste from aggregates (especially coarse ones)

Fluidity & compact-ability known as ***workability***

Higher workability concretes are easier to place and handle but obtaining higher workability by increasing water content decreases strength and durability.

Compaction of Concrete

Finishing of Concrete

Workability

Definition

The amount of useful internal work necessary to produce full compaction without occurrence of the known concrete problems. The useful internal work is the work or energy required to overcome the internal friction between the individual particles in the concrete.

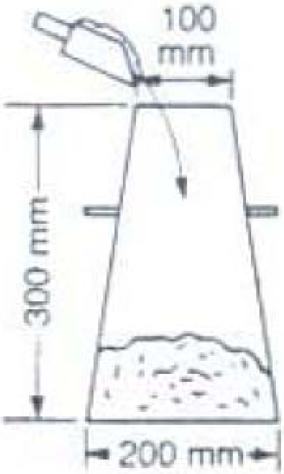
In practice, however, additional energy is required to overcome the surface friction between concrete and the framework or the reinforcement.

Thus, in practice, it is difficult to measure the workability as defined above, and what we measure is workability which is applicable to particular method adopted.

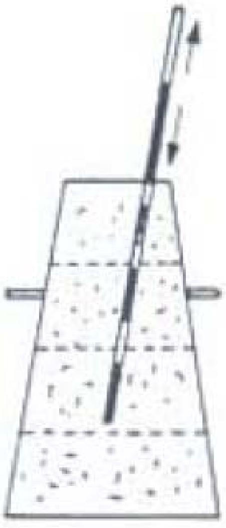
Workability measurement methods

1. Slump test
2. Compacting factor test
3. Vebe test
4. Flow table test

1. Slump test - simplest and crudest test



Fill concrete into frustum of
a steel cone in three layers

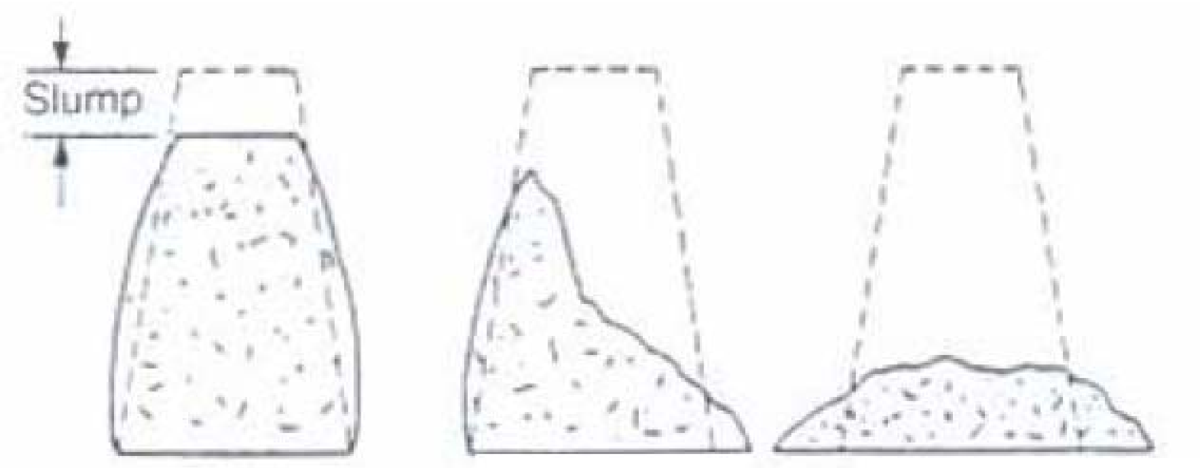


Hand tap concrete
In each layer

Lift cone up. Define slump as
downward
Movement of the concrete

Lift cone up

Define slump as downward
movement of the concrete



True
Valid slump measurement 0-175 mm

Shear
Mixes having tendency to segregate – repeat test

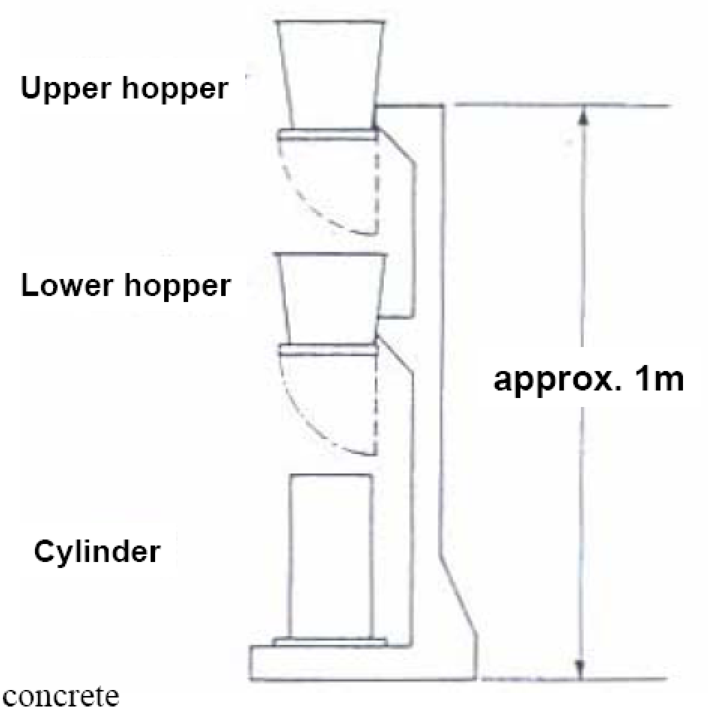
Collapse
Slumps greater than 175 mm - self-leveling concrete

Consistency grade	Slump (mm)	Recommended method of compaction
Stiff, K1	0 - 60	Mechanical compaction like vibration
Plastic, K2	60 – 130	Mechanical or hand compaction (rodding, tampering)
Flowing, K3	130 – 200	Hand compaction or no compaction
Self compacting, K4	≥ 200	No compaction

2. Compacting factor test

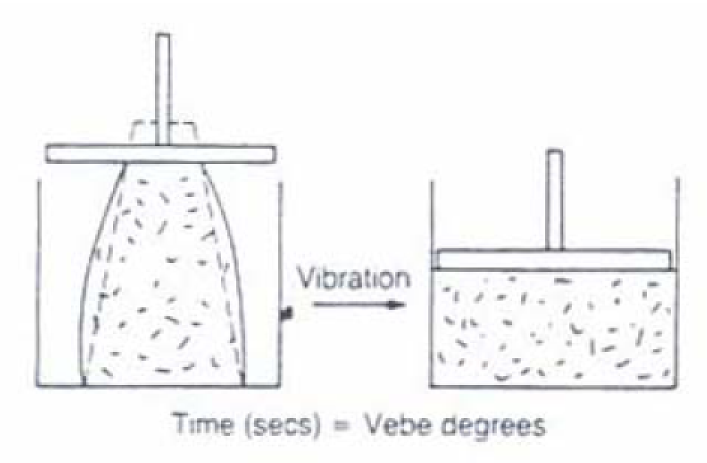
(to distinguish between low slump mixes)

1. Concrete is placed in an upper
2. Dropped into a lower hopper
   to bring it to a standard state and then allowed to fall into a standard cylinder.
3. The cylinder and concrete weighed (partially compacted weight)
5. The concrete is fully compacted, extra concrete added and then conrete and cylinder weighed again (fully compacted weight)



$$\text{Compacting factor} = \frac{\text{weight of partially compact concrete}}{\text{weight of fully compact concrete}}$$

3. Vebe test



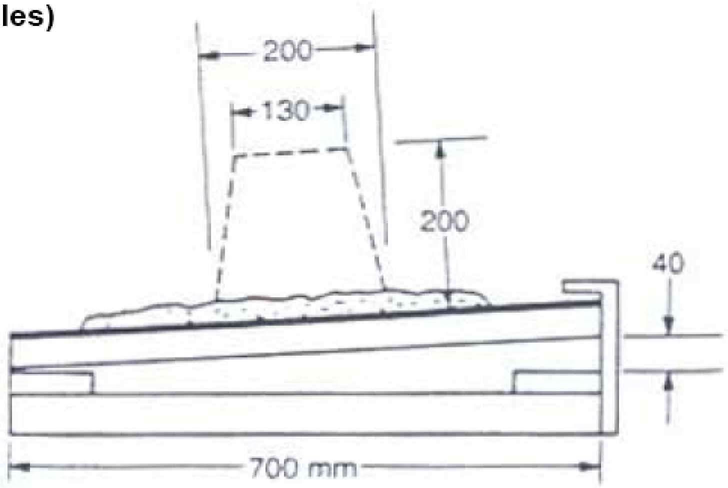
1. **A slump test is performed in a container**
2. **A clear perspex disc, free to move vertically, is lowered onto the concrete surface**
3. **Vibration at a standard rate is applied**

Vebe time is defined as the time taken to complete covering of the underside of the disc with concretecontainer

4. Flow table test
(to differentiate between high workability mixes)

1. A conical mould is used to produce a sample of concrete in the centre of a 700 mm square board, hinged along one edge
2. The free edge of the board is lifted against the stop and dropped 15 times

Flow = final diameter of the concrete
(mean of two measurements at right angles)



Cohesion and Segregation

Concrete mixes should not segregate (i.e it ought to be cohesive; the absence of segregation is essential if full compaction is to be achieved). Segregation can be defined as separation of the constituents of a heterogeneous mixture so that their distribution is no longer uniform. The differences in the size particles of the concrete constituents are the primary cause of segregation, but its extent can be controlled by the choice of suitable grading and by care handling.

There are two forms of segregation:

1- The coarser particles tend tp separate out since they travel further along a slope or settle more than finer particles. It occurs when the mix is too dry

2- It occurs in wet mixes through separation of cement paste from the mix.

Explain how grading of concrete aggregates influences the problem of segregation?

The actual extent of segregation depends on the method of handling and placing of concrete. If concrete does not have far to travel and is transferred directly from the skip or the wheelbarrow to the final position in the formwork, the danger of segregation is small. On the other hand, dropping concrete from a considerable height, passing along a chute, particularly with changes of direction, and discharging against an obstacle, all encourage segregation. Therefore, such circumstances should be under control. With correct method of handling, transporting, and placing, the likelihood of segregation can be greatly reduced.

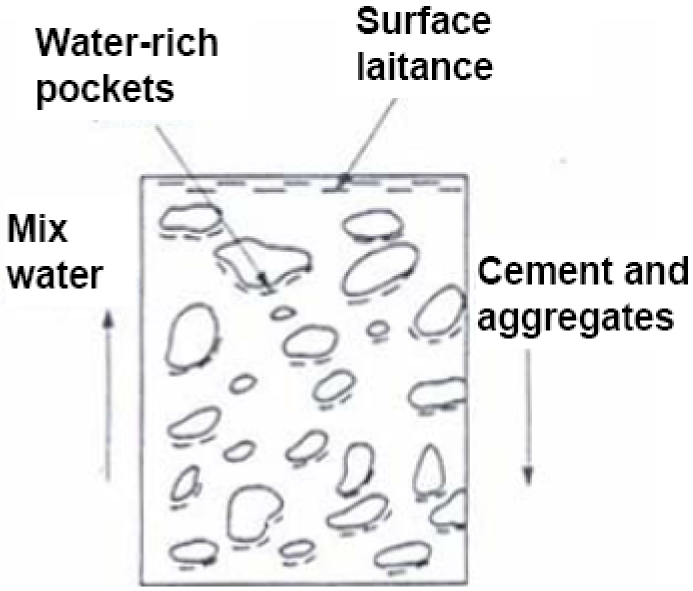
It must be stressed that concrete should always be placed direct in the position in which it is to remain and must not be allowed to flow or be worked along the form. This prohibition includes the use of a vibrator to spread a heap of concrete over a larger area. Vibration provides a most valuable means of compacting concrete, but, because a large amount of work is being done on the concrete, the danger of segregation is increased with improper use of a vibrator. This is particularly so when the vibrator is allowed to continue too long. With many mixes, separation of coarser aggregate toward the bottom of the form and of the cement paste toward the top may result. Such concrete would obviously weak and the laitance on its surface would be too rich and too wet.

The danger of segregation can be reduced by the use of air entrainment. Conversely, the use of coarser aggregate whose specific gravity is appreciably greater than that of the fine aggregate can lead to increased segregation. Segregation is difficult to measure quantitatively but is easily detected when concrete is handed on a site in any of the ways listed earlier as undesirable.

Bleeding of Concrete

Bleeding, known also as water gain, is a form of segregation in which some of the water in the mix tends to rise to the surface of freshly placed concrete. This is caused by the inability of the solid constituents of the mix to hold all of the mixing water when they settle downwards.

Bleeding can be expressed quantitatively as the total settlement (reduction in height) per unit height of concrete, and the bleeding capacity as well as the rate of bleeding can be determined experimentally using the test of ASTM C 232-04. When the cement paste has stiffened sufficiently, bleeding of concrete ceases.



As a result of bleeding, the top of every lift (layer of concrete placed) may become too wet, and, if the water is trapped by superimposed concrete, a porous and weak layer of non-durable concrete will result.

If the bleeding water is remixed during the finishing of the top surface, a weak wearing surface will be formed. This can be avoided by delaying the finishing operations until the bleeding water has evaporated, and also by the use of wood floats and by avoidance of over-working of the surface. On the other hand, if evaporation of water from the surface of the concrete is faster than the bleeding rate, plastic shrinkage cracking may result.

In addition to accumulating at the upper surface of the concrete, some of the rising water becomes trapped on the underside of large aggregate particles or of reinforcement, thus creating zones of poor bond. This water leaves behind voids and, since all these voids are oriented in the same direction, the permeability of the concrete in a horizontal plane may be increased.

Bleeding is often pronounced in thin slabs, such as roads, in which frost generally represents a considerable danger.

Bleeding need not necessarily be harmful. If it is undisturbed (and the water evaporates) the effective water/cement ratio may be lowered with a resulting increase in strength. On the other hand, if the rising water carries with it a considerable amount of the finer cement particles, a layer of laitance will be formed. If this is at the top of a slab, a porous surface will result with a permanently “dusty” surface. At the top of a lift, a plane of weakness would form and the bond with the next lift would be inadequate. For this reason, laitance should always be removed by brushing and washing.

Although dependent on the water content of the mix, the tendency to bleeding depends largely on the properties of the cement. Bleeding is lower with finer cements and is also affected by certain chemical factors: there is less bleeding when the cement has a high alkali content, a high C3A content, or when calcium chloride is added

Methods of reducing segregation and bleed and their effects