Fresh Concrete: Batching, Mixing, Transportation, Placing

Lecture No. 07
Compaction of Concrete

- Compaction of concrete is the process adopted for expelling the entrapped air from the concrete.
- In the process of mixing, transporting and placing of concrete air is likely to get entrapped in the concrete.
- In other words, stiff concrete mix has high percentage of entrapped air and, therefore, would need higher compacting efforts than high workable mixes.
- In order to achieve full compaction and maximum density, with reasonable compacting efforts available at site, it is necessary to use a mix with adequate workability.
Compaction of Concrete

The following methods are adopted for compacting the concrete:

(a) Hand Compaction
   (i) Rodding (ii) Ramming (iii) Tamping

(b) Compaction by Vibration
   (i) Internal vibrator (Needle vibrator)
   (ii) Formwork vibrator (External vibrator)
   (iii) Table vibrator
   (iv) Platform vibrator
   (v) Surface vibrator (Screed vibrator)
   (vi) Vibratory Roller.

(c) Compaction by Pressure and Jolting

(d) Compaction by Spinning.
Compaction of Concrete: Hand Compaction

- Hand compaction of concrete is adopted in case of unimportant concrete work of small magnitude.

- Rodding is done continuously over the complete area to effectively pack the concrete and drive away entrapped air.

- Light ramming can be permitted in unreinforced foundation concrete or in ground floor construction.

- Tamping is one of the usual methods adopted in compacting roof or floor slab or road pavements where the thickness of concrete is comparatively less and the surface to be finished smooth and level. Tamping consists of beating the top surface by wooden cross beam
Compaction of Concrete: Hand Compaction
Where high strength is required, it is necessary that stiff concrete, with low water/cement ratio be used. To compact such concrete, mechanically operated vibratory equipment, must be used.

A concrete with about 4 cm slump can be placed and compacted fully in a closely spaced reinforced concrete work, whereas, for hand compaction, much higher consistency say about 12 cm slump may be required.

The action of vibration is to set the particles of fresh concrete in motion, reducing the friction between them and affecting a temporary liquefaction of concrete which enables easy settlement.
Compaction of Concrete: By Vibration

- **Internal Vibrator:** Of all the vibrators, the internal vibrator is most commonly used. This is also called, “Needle Vibrator”, or “Poker Vibrator”. This essentially consists of a power unit, a flexible shaft and a needle.

- **Formwork Vibrator (External Vibrator):** Formwork vibrators are used for concreting columns, thin walls or in the casting of precast units. The machine is clamped on to the external wall surface of the formwork.

- **Table Vibrator:** This is the special case of formwork vibrator, where the vibrator is clamped to the table. They are commonly used for vibrating concrete cubes.
Compaction of Concrete: By Vibration

- **Platform Vibrator:** Platform vibrator is nothing but a table vibrator, but it is larger in size. This is used in the manufacture of large prefabricated concrete elements such as electric poles, railway sleepers, prefabricated roofing elements etc.

- **Surface Vibrator:** Surface vibrators are sometimes known as, “Screed Board Vibrators”. A small vibrator placed on the screed board gives an effective method of compacting and leveling of thin concrete members, such as floor slabs, roof slabs and road surface.

- **Vibratory Roller:** One of the recent developments of compacting very dry and lean concrete is the use of Vibratory Roller. Such concrete is known as Roller Compacted Concrete.
Compaction of Concrete: By Vibration
Compaction of Concrete: By Vibration
Compaction of Concrete: By Vibration
Curing of Concrete

- Concrete derives its strength by the hydration of cement particles. The hydration of cement is not a momentary action but a process continuing for long time. The quantity of the product of hydration and consequently the amount of gel formed depends upon the extent of hydration.

- Cement requires a water/cement ratio about 0.23 for hydration and a water/cement ratio of 0.15 for filling the voids in the gel pores. In other words, a water/cement ratio of about 0.38 would be required to hydrate all the particles of cement and also to occupy the space in the gel pores.
Curing of Concrete

- Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration.

- Curing can also be described as keeping the concrete moist and warm enough so that the hydration of cement can continue.

- Curing methods may be divided broadly into four categories: (a) Water curing (b) Membrane curing (c) Application of heat (d) Miscellaneous.
Curing of Concrete

Figure 1: Effect of duration of water curing on strength of concrete.
Curing of Concrete: Water curing

This is by far the best method of curing as it satisfies all the requirements of curing, namely, promotion of hydration, elimination of shrinkage and absorption of the heat of hydration.

- Immersion
- Ponding
- Spraying or Fogging
- Wet covering
Curing of Concrete

Water curing is when the concrete is covered with a layer of water for a period of time and the evaporation of moisture is from the surface of the water.

Membrane curing is the most practical with today's Construction schedules.
Curing of Concrete: Membrane Curing

- Sometimes, concrete works are carried out in places where there is acute shortage of water.

- The quantity of water, normally mixed for making concrete is more than sufficient to hydrate the cement, provided this water is not allowed to go out from the body of concrete.

- Concrete could be covered with membrane which will effectively seal off the evaporation of water from concrete.

- Curing compounds are liquids which are usually sprayed directly onto concrete surfaces and which then dry to form a relatively impermeable membrane that retards the loss of moisture from the concrete.
Curing of Concrete: Membrane Curing
Curing of Concrete: Application of heat

- When concrete is subjected to higher temperature it accelerates the hydration process resulting in faster development of strength.

- Therefore, subjecting the concrete to higher temperature and maintaining the required wetness can be achieved by subjecting the concrete to steam curing.

- The exposure of concrete to higher temperature is done in the following manner:
  - (a) Steam curing at ordinary pressure.
  - (b) Steam curing at high pressure.
  - (c) Curing by Infra-red radiation.
  - (d) Electrical curing.
Curing of Concrete: Application of heat

- A faster attainment of strength will contribute to many other advantages mentioned below.
  - (a) Concrete is vulnerable to damage only for short time.
  - (b) Concrete member can be handled very quickly.
  - (d) A smaller curing tank will be sufficient.
  - (e) The work can be put on to service at a much early time,
  - (f) Prestressing bed can be released early for further casting.
  - (g) A fewer number of formwork will be sufficient or alternatively with the given number of formwork more outturn will be achieved.
Steam curing at ordinary pressure

- Application of steam curing to in situ construction will be a little difficult task. However, at some places it has been tried for in situ construction by forming a steam jacket with the help of tarpaulin or thick polyethylene sheets.
High Pressure Steam Curing

- The high pressure steam curing is something different from ordinary steam curing, in that the curing is carried out in a closed chamber.

- High pressure steam cured concrete develops in one day, or less the strength as much as the 28 days’ strength of normally cured concrete. The strength developed does not show retrogression.

- High pressure steam cured concrete exhibits higher resistance to sulphate attack, freezing and thawing action and chemical action. It also shows less efflorescence.
High Pressure Steam Curing

- High pressure steam cured concrete exhibits lower drying shrinkage, and moisture movement.

- In high pressure steam curing, concrete is subjected to a maximum temperature of about 175°C which corresponds to a steam pressure of about 8.5 kg/sq.cm.
Curing by Infra-red Radiation

- Curing of concrete by Infra-red Radiation has been practised in very cold climatic regions in Russia.

- It is claimed that much more rapid gain of strength can be obtained than with steam curing and that rapid initial temperature does not cause a decrease in the ultimate strength as in the case of steam curing at ordinary pressure.

- The system is very often adopted for the curing of hollow concrete products. The normal operative temperature is kept at about 90°C.
Electrical Curing

- Concrete can be cured electrically by passing an alternating current (Electrolysis trouble will be encountered if direct current is used) through the concrete itself between two electrodes either buried in or applied to the surface of the concrete.

- Care must be taken to prevent the moisture from going out leaving the concrete completely dry.