UNIT-5 CONCRETE TECHNOLOGY

What is concrete mix design?

Concrete mix design is defined as the appropriate selection and proportioning of constituents to produce a concrete with pre-defined characteristics in the fresh and hardened states. Moreover, concrete mixes are designed in order to achieve a defined workability, strength and durability . Finally, this article presents factors affecting the choice of concrete mix design.

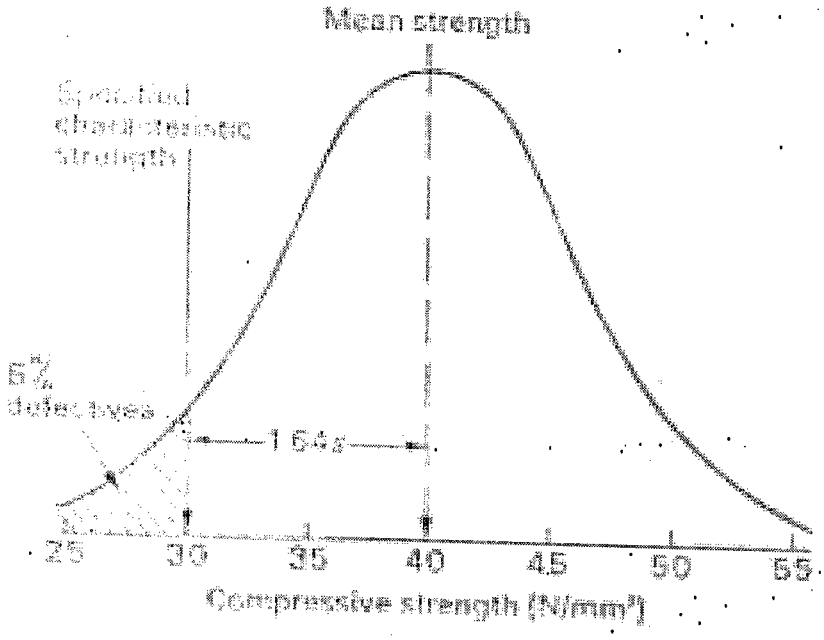
Basis for selection and proportioning of materials

- The structural requirements of the concrete
- environmental conditions
- The job site conditions, especially the methods of concrete production, transport, placement, compaction and finishing
- The characteristics of the available raw materials

The various factors affecting the choice of concrete mix design are:

1. Compressive strength of concrete

- Concrete compressive strength considered as the most important concrete property. It influences many other describable properties of the hardened concrete.
- The mean compressive strength (fcm) required at a specific age, usually 28 days, determines the nominal water-cement ratio of the mix.
- ISO 456-200, British Standard, and Euro code utilize the term mean compressive strength which is slightly greater than characteristic compressive strength. However, ACI Code do not use such term.
- Other factors which influences the concrete compressive strength at given time and cured at a specified temperature is compaction degree.
- Finally, it is demonstrated that, concrete compressive strength of fully compacted concrete is inversely proportional to the water-cement ratio.

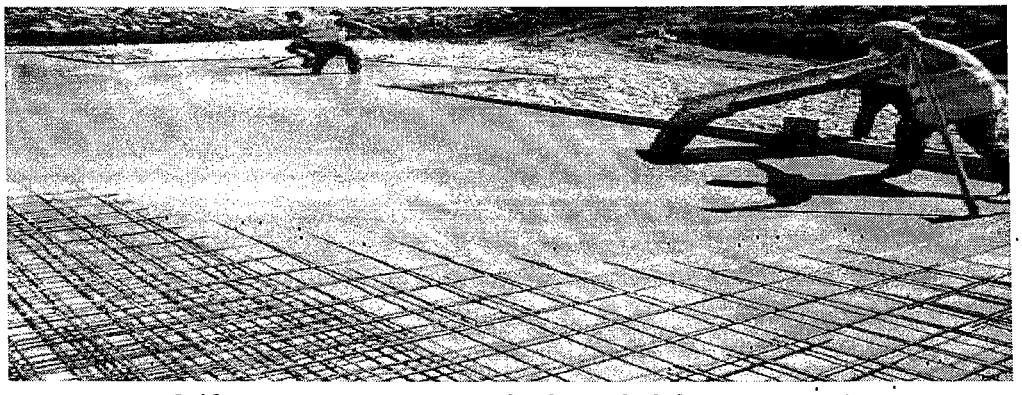


Compressive strength vs. characteristic compressive strength

2. Workability of concrete

- Concrete workability for satisfactory placement and compaction depends on the size and shape of the section to be concreted, the amount and spacing of reinforcement, and concrete transportation; placement; and compaction technique.
- Additionally, use high workability concrete for the narrow and complicated section with numerous corners or inaccessible parts. This will ensure the achievement of full compaction with a reasonable amount of effort.
- Frequently, slump test values used to evaluate concrete workability.
- Lastly, ACI 211.1 provides slump test values for various reinforced concrete sections which ranges from 25 mm to 175 mm.

Workability of concrete



Self compacting concrete, high workability concrete

3. Durability of concrete

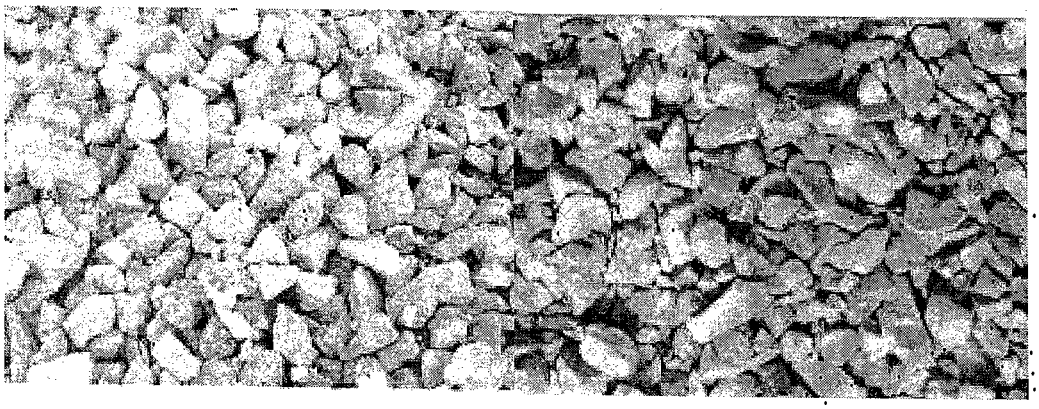
- The ability of concrete to withstand harmful environment conditions termed as concrete durability.
- High strength concrete is generally more durable than low strength concrete.
- In the situations when the high strength is not necessary but the conditions of exposure are such that high durability is vital, the durability requirement will determine the utilized water-cement ratio.
- Concrete durability decreases with the increase of w/c ratio.

Durability of concrete

4. Maximum nominal size of aggregate

- Reinforcement spacing controls maximum aggregate size.
- Aggregate size is inversely proportional to cement requirement for water-cement ratio. This is because workability is directly proportional to size of aggregate.

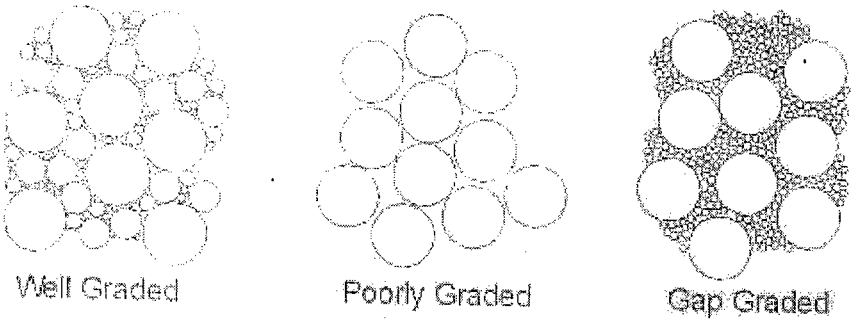
- However, the compressive strength tends to increase with the decrease in size of aggregate. smaller aggregate size offers greater surface area for bonding with mortar mix that give higher strength.
- IS 456:2000 and IS 1343:1980 recommends that the nominal size of the aggregate should be as large as possible.
- Finally, in accordance with ACI code, maximum aggregate size shall not exceed minimum reinforcement spacing, bar diameter, or 25mm.



Maximum aggregate size

5. Grading and type of aggregate

- Aggregate grading influences the mix proportions for a specified workability and water-cement ratio.
- The relative proportions between coarse and fine aggregate in concrete mix influence concrete strength.
- Well graded fine and coarse aggregate produce a dense concrete because of the achievement of ultimate packing density.
- If available aggregate, which obtained from natural source, does not confirm to the specified grading, the proportioning of two or more aggregate become essential.
- Additionally, for specific workability and water to cement ratio, type of aggregate affects aggregate to cement ratio.
- Lastly, an important feature of a satisfactory aggregate is the uniformity of the grading that achieved by mixing different size fractions.



Aggregate grading types

6. Quality Control at site

- The degree of control could be evaluated by the variations in test results.
- The variation in strength results from the variations in the properties of the mix ingredients, in addition to lack of control of accuracy in batching, mixing, placing, curing and testing.
- Finally, the lower the difference between the mean and minimum strengths of the mix lower will be the cement-content required. The factor controlling this difference is termed as quality control.