Factors Affecting Concrete Strength

The factors affecting the strength of concrete are mentioned below. These factors can be either dependent or independent of each other when comes to the concrete strength. Most of the factors are interrelated in certain means. The primary factor that has a higher influence on the strength of the concrete is the mix design factors. Each of them is mentioned and explained in detail one by one.

1. Ratio of Cement to the Mixing Water

For concrete that has to be compacted by a vibrator, a lower water cement ratio may be used. The maximum strength is derived at w/c = 0.4. When the water cement ratio is less than 0.4, there is improper consistency and workability of the cement and honeycombed structure.

2. Ratio of Cement to Aggregates

With an increase in the cement to aggregate ratio, the ultimate strength will increase to some extent. Aggregates are the key factors that will affect the impact strength of the concrete under aggressive load condition. Good quality aggregates will absorb less water content that is meant for hydration of cement.

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3. Grading of the Aggregates

Among the three group of aggregates we have:- Gap Graded, Poorly graded and Well-graded aggregates, the use of well-graded aggregates imparts higher strength to the concrete.

A rounded spherical shaped aggregate when compacted contains fewer voids than an irregular and flaky aggregate of the same nominal size. Therefore, the rounded spherical aggregates give higher strength.
Larger the aggregate size, smaller will be the surface area for developing the gel bonds that will lead to lower strength of concrete. Larger aggregates will also bring a heterogeneous structure for the concrete thus making the non - uniform distribution of the loads when it is stressed.

4. Type and the Size of Aggregate

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5. Degree of Compaction

Inadequate compaction leading to air void content of 5% and 10% results in a loss of strength of 30% and 55% respectively. The concrete compacted by the vibrator displays higher strength even up to a water cement ratio of 0.3.

6. Curing Method and Curing Temperature

The higher the curing temperature, the greater is the rate of hardening of concrete. Ten hours curing at a temperature of about 90 degree Celsius will make attain 70% of its 28 days of strength.

7. Rate of Loading

The strength of concrete increase with the increase in the rate of loading. At low rates of loading, there is more time for creep to occur so that the increase of strength with the rate of loading provides. The evidence for the theory that the failure occurs at limiting values of strain rather than the stress.

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8. Moisture Conditions of the Specimen

9. Age of the Cement

10. Size of the Specimen relative to the maximum size of the aggregates

11. Gel-Space Ratio

The gel-space ratio can be defined as the ratio of the volume of the hydrated cement paste to the sum of the volumes of the hydrated cement and the capillary pores. The strength of the concrete can be more correctly related to this ratio.

12. Gain of Strength with the Age

The rate of gain of strength will depend on the age. In the actual case, the strength of the concrete will develop beyond 28 days. The increase in the strength beyond 28days is taken in into consideration in the design of structures.

The strength of the concrete at a lower age and 28 days depends upon the cement composition, fineness of the cement and the curing temperature. Concrete with lower water cement ratio gains strength, more rapidly than the mix with high w/c.

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13. Maturity Concept of Concrete

The strength development of concrete depends on both time and the temperature. The strength of the concrete is a function of the summation of the product of time and temperature. This summation is called as the **maturity of concrete.**

14. Effect of Size of Maximum Size of Aggregates on the strength

The use of larger size aggregates leads to higher strength i.e larger the size, lower will be the surface area and the water requirement is lower. Hence a lower water cement ratio can be used which will result in higher strength.

When large size aggregates is used due to the internal bleeding, the transition zone becomes weaker and will lead to lower strength. In the case of lean mixes, the larger aggregates will give higher strength.

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15. Water - Cement Ratio (W/C Ratio)

The water-cement ratio is the ratio of volume of water mixed in concrete to volume of the cement used. The strength and the durability of the concrete depend to a great extend on the amount of water used. Lesser the water cement ratio for a workable concrete mix, the strength will be greater. For Abram's law, it follows that provided the concrete is fully compacted, the strength is not affected by the aggregate shape, type, texture or the grading, workability and the richness of the mix. The cement requires about 1/5 to 1/4 of its weight of water to become completely hydrated. The strength of the concrete increases with the cement content and decreases with air and water content.