

CONCRETE STRENGTH PROPERTIES

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Concrete is an artificial building material, which consists of binder (cement), water, fine and coarse aggregates and special additives. A concrete, before getting hard and solid, is a concrete mix.

There is a coarse aggregate (gravel or crushed aggregate) and a fine one (sand). Aggregates in a concrete actually fill 85-90 per cent of the whole volume. Aggregates are introduced in order to increase the strength and save binder, which is cement. The size of the aggregate influences on the strength of concrete (1.25 mm and more is for sand; 20 mm and more – for gravel or crushed aggregate); that is to say, the larger the aggregate's size is the more movable, more plastic and more durable a concrete mix is. Changing of the strength properties of a concrete mix depends on the type of the aggregate's surface, which is smooth for gravel and natural sand and rough for crushed aggregate. A concrete mix made of gravel and natural sand is more movable than that made of crushed aggregate. In addition, the strength of the aggregate has a strong influence on concrete. A coarse aggregate creates a frame in concrete, which takes compressive and tensile stresses.

The fundamental law of the concrete strength

The law: The concrete strength depends on the quality of aggregates, cement brand and water-to-cement ratio, where the optimal usage of water (more cement and less water) allows to get concrete with less porosity and larger strength.

The strength is a fundamental property of concrete. It depends on the quality of the material and a concrete mix fabrication method.

The quality of a cement rock depends on two factors: the activity and cement brand and water-to-cement ratio (WCR).

Oversaving of water can cause fragile concrete, because cement paste needs more water for filling of pores between aggregate grains. Thus, as water use is increasing, the quantity of cement paste is increasing too, concrete mix is underpouring more densely and the strength is increasing. However, there is the value of 'the optimum usage' of water, which gives maximum of the strength

Strength grades and concrete strength (According to SNiP 2.03.01-84 and GOST 26633-91)

Concrete strength is counted by means of the tests' results of a particular concrete after 28 days of normal solidification. For this, cubes hardened at $(20 \pm 2)^\circ\text{C}$ in the open air with 95-100% humidity are used.

Concrete generally takes compressive stresses. The ultimate compressive strength is defined by standard samples – cubes with the size 150x150x150 mm. For defining the ultimate bending strength beams with sizes 150x150x600 are used.

Concrete strength (activity) – is defined using concrete's arithmetic mean value of the strength (the value always rounds down).

Concrete strength 50, 75, 100, 150, 200... 600 kg*s/sm², where the values show the ultimate compressive stress, taking into account the ultimate bending strength of the standard

cube samples (15x15x15), hardening 28 days with the temperature $20\pm 2^{\circ}\text{C}$, and 95-100% humidity.

Strength grade – is a numerical characteristic of the strength, used with the usual permissible error of 0.95. Otherwise, concrete strength is achieved at least in 95 cases out of 100.

Strength grade 3,5; 7,5; 10; 12,5; 15; 20; 25... 60 MPa

A concrete is getting stronger steadily, after 28 days it is possible to identify its strength and strength grade:

- on the 3d day – 20-30% of concrete strength.
- on the 7th day – 50-60% of concrete strength.

After 28 days concrete is still getting stronger and 2-3 years later it can be several times stronger than its primary strength.

An important characteristic of concrete is *freeze-thaw resistance*, which is the number of cycles of freezing and unfreezing of waterlogged samples of concrete after 28 days without no more than 15% stress reduction and no more than 5% mass loss.

Research

The strength of concrete can be tested in a laboratory by special machines that test concrete tensile strength. Minimum three concrete specimens of the definite age should be tested. The average value of three specimens gives the crushing strength of concrete.

According to the Fundamental law of concrete strength, strength properties of the concrete depends on the quality of fine and coarse aggregates, brand of binder and water-to-cement ratio – it will allow to get the composition of heavy concrete with a good quality and possible material saving.

Apparatus:

Compression testing machine

Preparation of concrete mix:

The proportion and material for this test are the same for all the cubes: binder (cement), water, fine and coarse aggregates and special additives.

Precautions:

For this test cubes hardening 7 or 14 or 28 days with the temperature $20\pm 2^{\circ}\text{C}$ in the open air with 95 – 100% humidity are used.

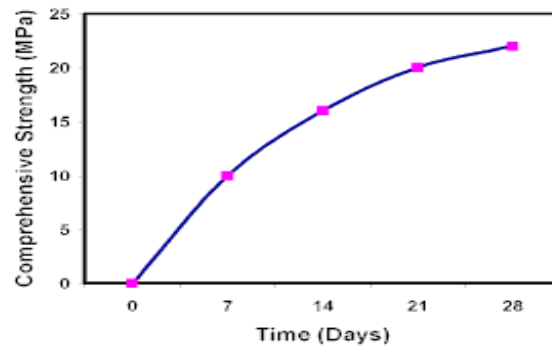
Calculations:

3 equal cube specimens;

the size of the cube is 15cm x 15cm x 15cm;

the area of the specimen is 225cm².

Specimens/day	7 days	14 days	28 days
Force	10 MPa	15 MPa	22,3 MPa



Research results: These specimens are tested by the machine compression testing after 7 days of concrete curing, 14 days of curing and 28 days of curing. The strength of concrete gradually increases with its age. Concrete is getting stronger day by day and after 28 days it is possible to identify its strength and strength grade.