Hardened Concrete Properties

Testing of concrete

- ***The basic method of verifying that concrete complies with the specifications is to test its strength using cubes or cylinders made from samples of fresh concrete.***

- ***concrete assumed as a brittle material***

Compressive Strength

Cylinder : ASTM C 39

Cubes:British standard : 150 mm× 150 mm×150 mm

Other sizes:

Cylinder:100 mm× 200 mm or 150 mm×300 mm

Cubes: 100 mm × 100 mm × 100 mm or

$$\sigma_c = \frac{P}{A}$$

- ***For 150 mm cubes fill in 3 layers compact each layer 35 times.***
- ***For 100 mm cubes fill in 3 layers compact each layer 25 times.***
- ***No need for capping.***




- ***For 150 mm × 300 mm cylinder, fill in 3 layers compact each layer 25 times.***
- ***Capping to obtain a plane and smooth surface (thin layer ≈ 3mm), using:***

Stiff Portland cement paste on freshly cast concrete, or mixture of sulphur and granular material, or high-strength gypsum plaster on hardened concrete.


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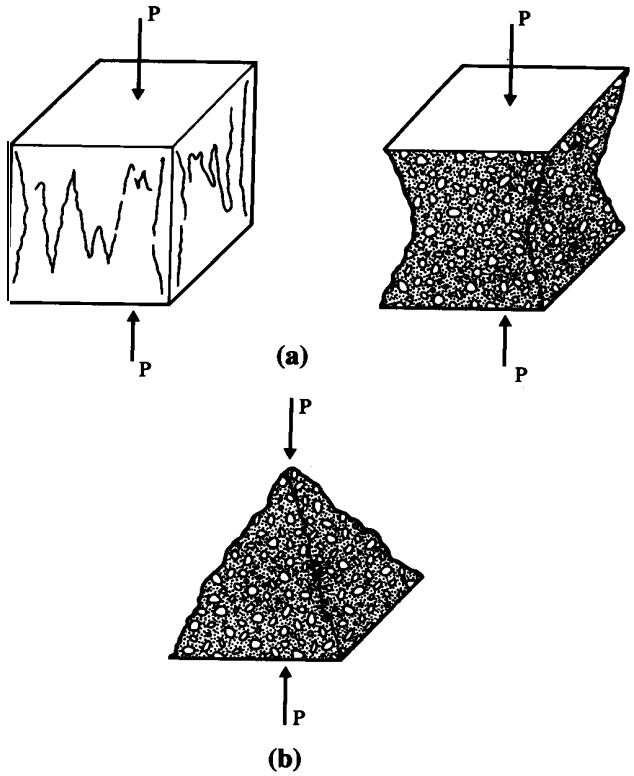
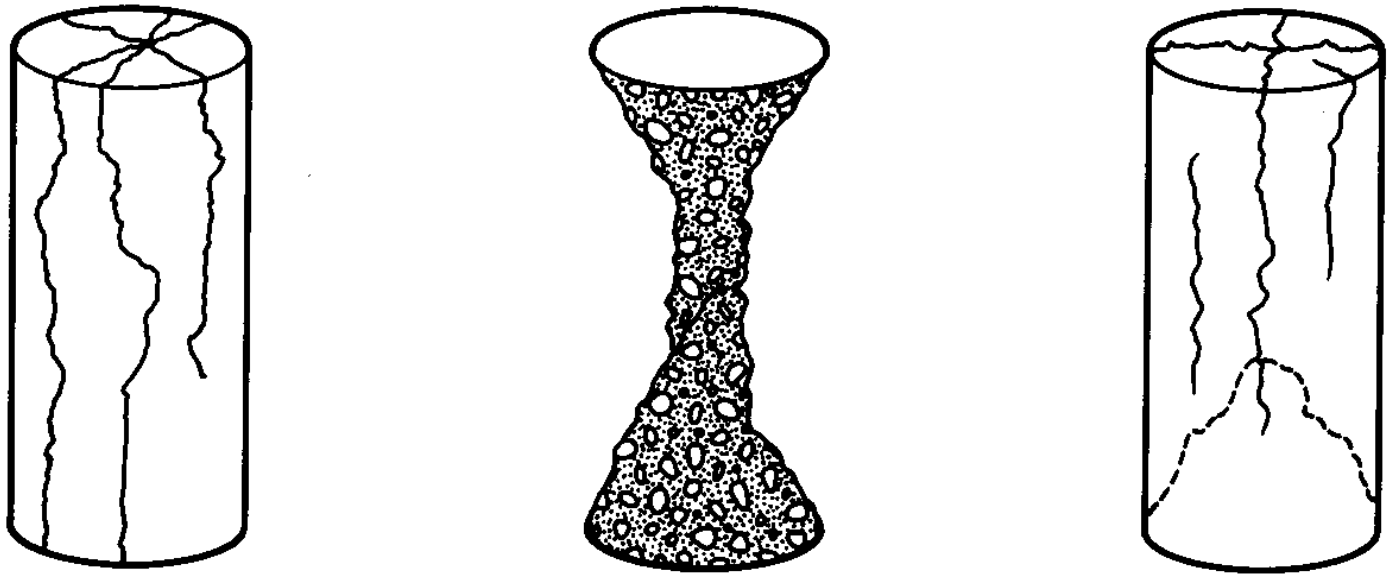
CAUTION



Typical Failure Modes for Test Cubes: (a) Non-explosive; (b) explosive

Typical Failure Modes for Testing Standard Cylinders:

(a) Splitting; *(b) Shear;* *(c) Splitting and shear (cone)*



(a) (b) (c)

Tensile strength:

1. Direct Tensile: No standard ASTM or BSI

Problem is referred to secondary stresses induced through gripping, which makes the test results difficult to interpret.

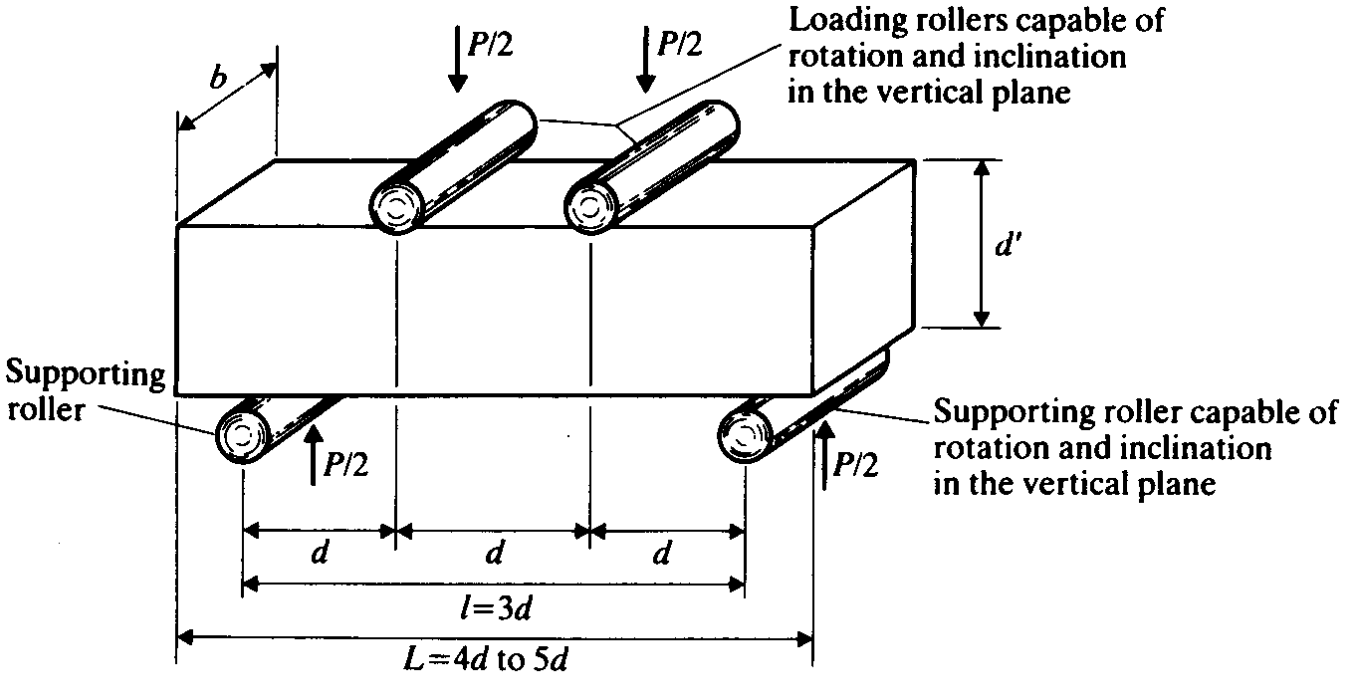
2. Indirect Tensile:

A. Splitting Tension Test.

$$\sigma_{sp} = \frac{2P}{\pi LD}$$

B. Flexural strength

- ***The test is useful since most concrete members are loaded in bending rather than in axial tension. Thus, it represents the concrete property of interest. σ_f is calculated as:***



$$\sigma = \frac{MC}{I}$$

$$\sigma_f = \frac{PL}{bd^2}\text{; If specimen breaks between loads.}$$

$$\sigma_f = \frac{3Pa}{bd^2}\text{, If specimen breaks between load and support}$$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- ***This test is mostly used for quality control of highways and airport runways. It gives more useful information than do compression tests.***

- ***Flexural strength:***

Affected by:

- Specimen Size ↑ → strength ↓

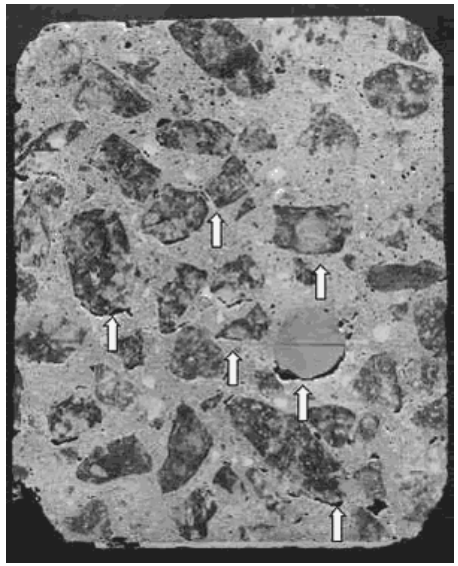
- Temperature: Same as in compression.

Strength of concrete

- *Strength = ability to resist stress without failure.*
- *Concrete strength is made of:*

1. *Strength of paste or mortar.*
2. *Strength of CA-paste (mortar) interface.*
3. *Strength of CA.*

Cracks at the interface between the aggregate, rebar, and paste (see arrows).



Factors Affecting Strength of Concrete

1. Water/Cement Ratio

Since the W/C ratio controls the porosity of concrete; it controls the strength as well.

W/C ↑ → strength ↓

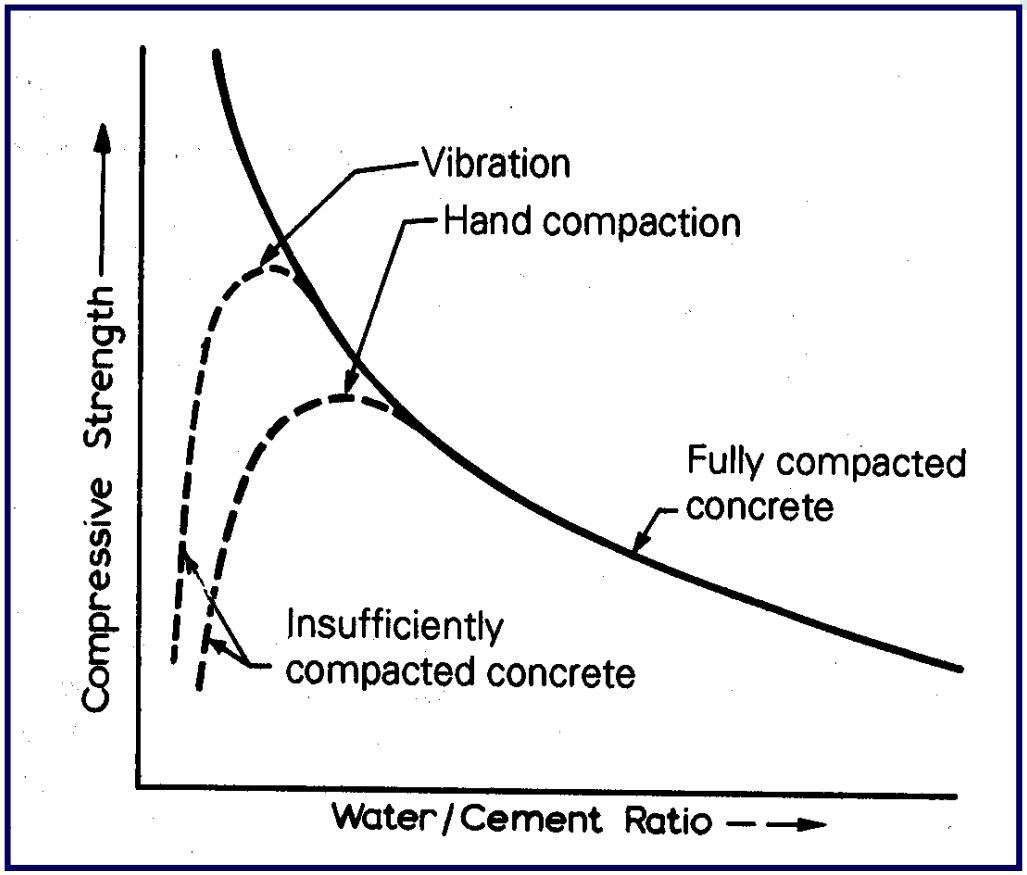
2. Degree of Compaction

Strength = f (full compaction)

3. Curing

4. Aggregates

5. Temperature



Relation between strength and W/C ratio