Concrete Tech Tip # 9

Low Concrete Test Cylinder Strength

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1. WHAT Constitutes Low Cylinder Strength?

Cylinders are molded from a sample of fresh concrete. Procedures must be in accordance with CSA standards. The average strength of the set of 2 or 3 cylinders, broken at 28 days, constitutes one "test". Additional cylinders are often made for 7 and 56 day tests or to be field cured to check early strength for form stripping. Under CSA Standards, concrete is acceptable if:

1) No single test is lower than specified by more than 3.5 MPa when the specified compressive strength is 35 MPa or less; or where no single is below 0.9 x specified strength when the specified compressive strength is above 35 MPa

2) The average of three consecutive tests equals at least the specified strength.

If an average of three tests in a row dips below the specified strength, steps must be taken to increase the strength of the concrete. If a test falls more than 3.5MPa, or 0.9 times below the specified strength there may be more serious problems. An investigation would be made to ensure structural adequacy: and, again, steps taken to increase the strength level.

2. WHY Are Compressive Tests Low?

Two major reasons are: (a) improper handling and testing - found to contribute in the majority of low strength investigations, and (b) reduced concrete quality due to an error in production, or the addition of too much water to the concrete on the job due to delays in placement or requests for wet concrete. High air content, for example, can be a cause of low strength.

Collect all test reports and analyze results before taking action. Look at the pattern of strength results. Does the sequence actually violate the specification? Do the test reports give any clue to the cause? Look at the slump, air content, concrete and ambient temperatures, number of days cylinders were left in the field, and any reported cylinder defects.

27.5 MPa Specified Strength

Test No.	Individual Cyl. No. 1	Individual Cyl. No. 2	"Test" Average	Average of 3 Consecutive
Acceptable Example				
1	28.3	29.4	28.9	--
2	26.5	28.1	27.3	--
3	30.5	30.7	30.6	28.9
4	25.3	26.3	25.8	27.9
5	31.9	31.5	31.7	29.4
Low Strength Example				
1	25.0	24.5	24.7	--
2	27.4	28.0	27.7	--
3	28.0	27.5	27.9	26.8*
4	33.5	32.4	33.0	29.5
5	23.4	21.4	22.4†	27.7

*Average of 3 consecutive low.
†One "test" more than 3.5 MPa

If the deficiency justifies investigation, first verify testing accuracy and then compare the structural requirements with the measured strength. If testing is deficient or

References:
1. ASTM Standards C31, C39, C172, C1077 ASTM Book of Standards Volume 04.02, American Society for Testing and Materials, West Conshohocken, PA. www.astm.org
2. Specification for Structural Concrete, ACI 301, American Concrete Institute, Farmington Hills, MI. www.concrete.org
3. Building Code Requirements for Reinforced Concrete, ACI 318, American Concrete Institute, Farmington Hills, MI.
4. In-Place Concrete Strength Evaluation – A recommended Practice, NRMCA Publication 133, NRMCA, Silver Springs, MD.
5. Effect of Curing Conditions on Compressive Strength of Concrete Test Specimens, NRMCA Publication 53, NRMCA, Silver Springs, MD.
6. Review of Variables that Influence Measured Concrete Compressive Strength, David N. Richardson, NRMCA Publication 179, NRMCA, Silver Springs, MD.
7. Low strength tests? Maybe not!, E.O. Goeb, Concrete Products, December 1992.
8. Why Low Cylinder Tests in Hot Weather?, E.O. Goeb, Concrete Construction, January 1986.
9. CSA A23.1 -14 Concrete materials and methods of construction, CSA Group, Mississauga, Ontario, Canada.
10. Concrete in Practice # 9: Low Concrete Cylinder Strength with permission from the National Ready-Mixed Concrete Association

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if strength is greater than that actually needed, there is little point in investigating the in-place strength. However, if procedures conform to the standards and the specified strength is lower than for the member in question refer to CTT-10 strength of in-place concrete.

3. HOW To Make Standard Cylinder Tests

It is essential that testing personnel be trained in the proper application of the CSA Standards for strength tests of field-made, laboratory-cured cylinders:

A) Sample concrete falling from chute, ensure to take the sample between the 10% and 90% of the dis charge. The sample should be a complete section of the material falling down the chute.

B) Transport sample to the location of curing for the first day.

C) Remix the sample to ensure homogeneity.

D) Use molds conforming to standards.

E) Rod concrete in 3 layers and tap sides of the mold to close rod holes.

F) Finish tops smooth and level to allow thin caps.

G) If necessary, move cylinders immediately after molding; support the bottom.

H) Cure cylinders in the field at 15°C - 25°C, in an area free of vibration.

I) Protect from loss of moisture

J) Transport cylinders within 28 +/- 8hrs to the laboratory. Handle gently.

Test reports must be promptly distributed to the concrete producer, as well as the contractor and engineer. This is essential to the timely solution of problems. The specification set by the CSA is for standard-cured cylinders and therefore does not cover field cured cylinders.

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