Concrete Atlantic béton Atlantique

Concrete Tech-Tip #8

Low Cylinder Breaks

What Constitutes Low Cylinder Strength?

Concrete cylinders are cast in the field from a sample of fresh concrete in accordance with CSA A23.2:24-3C.

The average compressive strength of the set of 2 cylinders broken at the desired age (i.e. 28 days) constitutes one "test". Additional cylinders are often made for 7, 56 days to confirm strength at various ages.

In accordance with CSA A23.1:24 Clause 4.4.2.3.1.1, the concrete compressive strength of standard-cured cylinders is considered satisfactory is for a given strength class, the following two criteria are met:

- Each individual strength test equals or exceeds the acceptable test results (ATR), where ATR = specified strength – 3.5MPa when concrete specified strength is 35MPa or less; or ATR = 0.90 x specified strength when concrete specified strength exceeds 35MPa; and
- The moving average of three consecutive strength tests in the same concrete equals or exceeds the specified strength.

The table below presents two examples, each with five sets of cylinders. In both cases, the specified concrete compressive strength is 27.5 MPa. Since the specified strength is 35 MPa or less, the ATR is 24 MPa, calculated as 27.5 minus 3.5.

In the first example, "Acceptable Example", the "Test" Average exceeds 24 MPa for all sets. The moving average, calculated from the three most recent sets of "Test" results, also exceeds the specified strength of 27.5MPa.

In the second example, "Low Strength Example", the fifth set has a "Test" Average less than the ATR, and the moving average of the first three sets fails to exceed the specified strength.

When analyzing your own data, it is recommended that you present it in this format for each comparison and calculation.

27.5 MPa Specified Strength				
Test No.	Individual Cyl. No. 1	No. 2	Test Avg.	Avg. 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	25.9	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 3.5MPa below avg. strength

What causes low strengths?

Two major reasons are:

1. Improper handling and testing contribute to the majority of low strength investigations, and;
2. 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.

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What steps should be taken when low strengths appear?

Start by collecting all test reports and reviewing the results as a whole before taking action. Look for trends rather than isolated values and confirm whether the sequence of results actually violates the specification. The reports may also provide clues to the cause by reviewing slump, air content, concrete and ambient temperatures, the number of days cylinders were left in the field, initial curing conditions, and any noted cylinder defects.

If procedures and fresh properties, meet the standard and the reported strength is below what is required, steps should be taken to determine in situ strength using coring and or non-destructive testing.

Test reports must be distributed promptly to the concrete producer, contractor, and engineer. Timely sharing of this information is essential for resolving issues before they escalate.

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. Ensure testers on site are CCIL or ACI certified to test concrete.

Items to pay attention to include:

- Sample concrete falling from chute in two increments in the middle part of the load after some has been discharged
- Transport sample to the location of curing for the first day
- Remix the sample to ensure homogeneity
- Use molds conforming to standards
- Ensure cylinders are initially cured on a flat surface at a temperature maintained between 15° and 25°C.
- Ensure cylinders are transported to and tested by a certified laboratory.

Three Rules to Consider:

1. Ensure on site testing is done by certified testers and cylinders are tested by a certified laboratory
2. Check both the acceptable test result and the three test moving average before calling concrete low
3. Use cores or non-destructive testing to confirm in place strength when results fail

References

1. CSA A23.1 A23.2 2024. Concrete materials and methods of concrete construction Test methods and standard practices for concrete. CSA Group

2. Design and Control of Concrete Mixtures. 9th Edition. Cement Association of Canada

3. Building Code Requirements for Reinforced Concrete, ACI 318, American Concrete Institute, Farmington Hills, MI.

4. Standard Specification for Structural Concrete, ACI 301, American Concrete Institute, Farmington Hills, MI.

5. In-Place Concrete Strength Evaluation-A Recommended Practice. NRMCA Publication 133, NRMCA, Silver Spring, MD.

6. Effect of Curing Condition on Compressive Strength of Concrete Test Specimens, NRMCA Publication 53, NRMCA Silver Spring, MD.

7. Review of Variables that Influence Measured Concrete Compressive Strength, David N. Richardson, NRMCA Publication 179, NRMCA, Silver Spring, MD.

8. Low Strength Tests? Maybe Not! E.O. Goeb, Concrete Products, December 1992.

9. Why Low Cylinder Tests in Hot Weather? E.O. Goeb, Concrete Construction, Jan. 1986.