CONCRETE IN PRACTICE

CIP 10

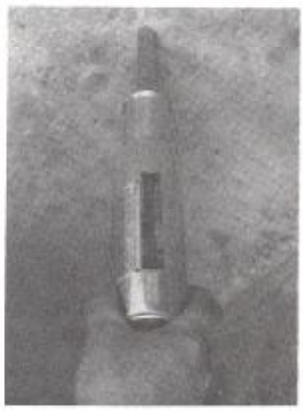
What, Why & How? Strength of In-Place Concrete

WHAT is the Strength of In-Place Concrete?

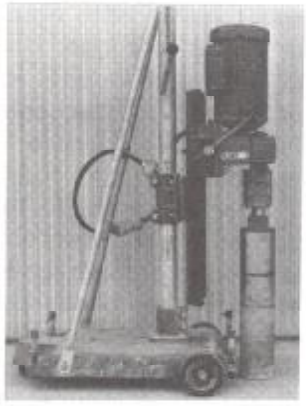
Drilled cores test lower than *properly made and tested* standard molded 6 in. × 12 in. cylinders.[1] This applies to all formed structural concrete. Exceptions may occur for cores from concrete cast against an absorptive subgrade or cores from lean, low strength mass concrete.

Means of measuring or comparing the strength of in-place concrete include: rebound hammer, penetration probe, pullouts, cast-in-place cylinders, tests of drilled cores, and load tests of the structural element.

The standard ASTM test procedure evaluates the strength potential of the concrete.[2] Cylinders are molded and cured at 60 to 80F for one day and then moist cured in the laboratory until broken in compression, normally at 7 and 28 days age. Job practices for handling, placing, compaction, and curing of job concrete are relied upon to provide an adequate percentage of that potential strength in the structure. The ACI Building Code recognizes that under current design practices, concrete construction can be considered structurally adequate if cores average at least 85 percent of specified strength with none below 75 percent.



Rebound Test (ASTM C805)



Core Test (ASTM C42)

WHY Measure In-Place Strength?

Tests of in-place concrete may be needed when standard cylinder strengths are low; however, do not investigate in-place without first checking to be sure that: the concrete strengths actually failed to meet the specification provisions; low strengths are not attributable to faulty testing practices; and the specified

strength is really needed. (See CIP-9 on "Low Concrete Cylinder Strength.") In many cases, the concrete can be accepted for the intended use without in-place strength testing.

There are many other situations which may require the investigation of in-place strength, including: shore and form removal, post-tensioning, or early load application; investigation of damage due to freezing, fire, or adverse curing exposure; evaluation of older structures; and when a lower strength concrete is placed in a member by mistake. When cores or other in-place tests fail to assure 85 percent of the design strength, additional curing of the structure may provide the necessary strength. This is particularly possible with concretes containing slow strength-gaining cement, fly ash, or slag.

HOW to Investigate In-Place Strength

If only one set of cylinders is low, often the question can be settled by comparing rebound hammer or probe results on concrete from areas with good cylinder results. Where the possibility of low strength is such that large portions need to be investigated a well organized study will be needed. Establish a grid and obtain systematic readings including good and questionable areas. Tabulate the hammer or probe readings. If areas appear to be low, drill cores from both low and high areas. If the cores confirm the hammer or probe results, the need for extensive core tests is greatly reduced.

Core Strength, ASTM Method C 42—If core drilling is necessary observe these precautions: (a) test 3 cores, (b) use 3½ in. minimum diameter and larger cores for over 1 in. aggregate, (c) try to obtain a length at least 1½ times the diameter, (d) trim to remove steel if the 1½ L/D ratio can be maintained, (e) trim ends square with an automatic feed diamond saw, (f) keep cap thickness under ⅛ in., (g) use high strength capping material, (h) check planeness of caps and bearing blocks, (i) do not drill cores from the top layers of columns, slabs, walls, or footings. They will be 10 to 20 percent weaker than cores from the mid or lower portions, and (j) test cores after drying for 7 days if the structure is dry in service; otherwise soak cores 40 hours prior to testing.

Probe Penetration Resistance, ASTM Method C 803—Probes driven into concrete can be used to study variations in concrete quality: (a) different size probes or a change in driving force may be necessary for large differences in strength or unit weight, (b) accurate measurement of the exposed length of the probe is required, (c) probes should be spaced at least 7 in. apart and not be close to the edge of the concrete, (d) probes not firmly embedded in the concrete should be rejected and, (e) develop a strength calibration curve for the materials and conditions under investigation.

Rebound Hammer, ASTM Method C 805—Observe these precautions: (a) wet all surfaces for several hours or overnight because drying affects rebound number, (b) don't compare readings on concrete cast against different form materials or concrete of varying moisture content or readings from different impact directions or on members of different mass, or results using different hammers, (c) don't grind unless the surface is soft, finished or textured, (d) test structural slabs from the bottom, and (e) don't test frozen concrete.

Advance Planning—When it is known in advance that in-place testing is required, such as for shore and form removal, other methods can be considered such as: cast-in-place, push-out cylinders and pullout strength measuring techniques covered by ASTM Methods C 873 and C 900.

References

1. ACI Bibliography 13 on Core Tests. American Concrete Institute, P. O. Box 19150, Detroit, Mich. 48219.
2. ASTM C 31, "Making and Curing Test Specimens in the Field" and C 39, "Compressive Strength of Cylindrical Concrete Specimens," American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.
3. ASTM C 805, "Rebound Number of Hardened Concrete."
4. ASTM C 803, "Penetration Resistance of Hardened Concrete."
5. ASTM C 900, Pullout Strength of Hardened Concrete."
6. ASTM C 873, "Strength of Cast-In-Place Cylinders."
7. ASTM C 42, "Obtaining and Testing Drilled Cores and Sawed Beams of Concrete."
8. "Building Code Requirements for Reinforced Concrete." ACI 318
9. "In-Place Strength Evaluation—A Recommended Practice," NRMCA Publication No. 133.

NATIONAL READY MIXED CONCRETE ASSOCIATION

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