

Concrete in Practice

What, why & how?



CIP 22 - Grout

WHAT is Grout

ACI defines grout as a *mixture of cementitious material and water, or other binding medium, with fine aggregate*. Grout is proportioned to produce a pourable consistency without segregation of the constituents. Grout may contain fly ash, slag cement, and chemical admixtures. For some applications, grout may not contain aggregates.

The terms grout and mortar are frequently used interchangeably but there are clear distinctions. *Grout* need not contain aggregate whereas *mortar* contains fine aggregate. *Grout* is supplied in a pourable consistency whereas *mortar* is not. *Grout* fills empty spaces such as voids or ducts whereas *mortar* bonds units together, such as concrete or clay masonry. Both mortar and grout can encase reinforcement.

Grout is often identified by its application. Some examples are: bonded prestressed tendon grout, auger cast pile grout, masonry grout, and pre-placed aggregate grout. Controlled low strength material (flowable fill) can be considered as a type of grout (CIP 17).

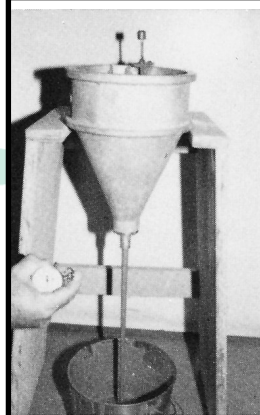
WHY is Grout Used

Grout is used to fill space or cavities and provide continuity between building elements. In some applications, grout will act in a structural capacity, such as in reinforced masonry construction. In building construction, grout can improve fire ratings, acoustic performance, blast resistance, and the thermal mass properties of the building elements.

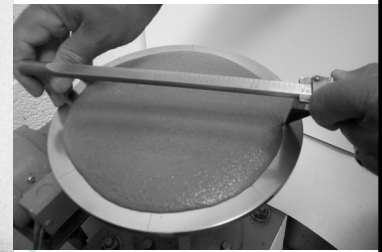
In projects where small quantities of grout are required, it is proportioned and mixed on site. When larger quantities of grout are needed, it is supplied by a ready mixed concrete producer.

HOW is Grout Specified

For masonry grout, the Specification for Grout for Masonry, ASTM C476, provides prescribed



ASTM C939 Flow Cone



ASTM C109 Flow Table

Measuring Consistency of Grout

proportions by loose volumes that are convenient for small quantities of grout mixed on site. These proportions will result in grout with sufficient strength for intended applications of at least 2000 psi [14 MPa]. Grout mixtures meeting the loose-volume proportion table of ASTM C476 have high cement contents and tend to produce much higher strengths than specified compressive strength requirements of ASTM C476, TMS 402/602, or Model Codes. Developing a grout mix design based on testing can produce more economical mixtures than the proportions stated in ASTM C476. In practice, specifying grout by compressive strength is most common.

Two types of masonry grouts are defined in ASTM C476: fine grout with aggregates smaller than 3/8-inch [9.5-mm] and coarse grout that permits coarser aggregate of nominal size 3/8-inch [9.5-mm] provided all aggregate passes the 1/2-inch [12.5-mm] sieve. Each type is further classified as conventional grout or self-consolidating grout (SCG). SCG is a highly fluid and stable mixture. Conventional grout requires consolidation for proper placement and self-consolidating grout does not. Choice of grout type depends primarily on the clear dimensions of the space being filled

by the grout. Grouting of masonry construction should comply with the governing building code provisions. Information on grouts for masonry construction is available from the National Concrete Masonry Association (NCMA) and the Portland Cement Association (PCA).

When grout is ordered from a ready mixed concrete producer, the specifications should be based on consistency and compressive strength. Converting loose volume proportions into batch weights per cubic yard [cubic meter] is subject to errors and can lead to controversies on a project.

Specifications should address the use of any special admixtures for grout that provide specific properties. Conditions of delivery, such as temperature, time limits, and policies on job site addition of water, should be specified. The contractor will need to ensure that the grout consistency is sufficiently flowable. Testing frequency and methods of acceptance must be covered in specifications.

HOW to Test Grout

The consistency of grout affects its strength and other properties. It is critical that grout consistency permit the complete filling of void space without segregation of ingredients.

Consistency of masonry grout is measured with a slump cone, ASTM C143, and slumps of 8 to 11-in. [200 to 275-mm] are generally required for both fine and coarse grout. The consistency of self-consolidating grout is determined by the slump flow test, ASTM C1611, by measuring the spread of the grout using a slump cone. Spreads of 24 to 30 in. [600 to 750-mm] are required, with an additional requirement for visual stability index, or VSI, which evaluates the grout's ability to maintain well-dispersed aggregate with minimal segregation and bleeding.

For other types of grouts without aggregate, or only fine aggregate passing a 2.36-mm (No. 8) sieve, consistency is best determined with a flow cone, ASTM C939. For flow values exceeding 35 seconds, use the flow table in ASTM C109, modified to use 5 drops in 3 seconds.

For masonry grout, often referred to as *blockfill*, strength test specimens should be cast

in molds formed by masonry units having the same absorption characteristics and moisture content as the units used in construction (ASTM C1019). Do not use nonabsorbent cube or cylinder molds for this purpose. The water absorbed from this grout provides a better representation of the strength in the masonry units.

Strength of other types of grout is determined using 2-in. [50-mm] cubes in accordance with ASTM C942. ASTM C942 allows for field preparation, recognizes fluid consistency, and also affords a means for determining compressive strength of grouts that contain expansive agents or grout fluidifiers. This is extremely important since *expansive* grouts can lose substantial compressive strengths if cubes are not confined. For grouts containing coarse aggregate and without expansive agents, cylindrical specimens of size 6 by 12-in. [150 by 300-mm] or 4 by 8-in. [100 by 200 mm], will give more reliable test results for grout strength.

Special application grouts often require modification of standard test procedures. All such modifications should be noted in the specifications and discussed prior to the start of a project or placement.

References

1. *ACI Concrete Terminology*, ACI CT-18, American Concrete Institute, Farmington Hills, MI, www.concrete.org
2. S. H. Kosmatka, *Cementitious Grouts and Grouting*, Portland Cement Association, 1990, www.cement.org.
3. ASTM C476, Standard Specification for Grout for Masonry, and ASTM C1019, Standard Method of Sampling and Testing Grout, Annual Book of ASTM Standards, Vol. 04.05, ASTM International, West Conshohocken, PA, www.astm.org
4. ASTM C143, C 939, C942, C1611, Annual Book of ASTM Standards, Vol 04.02.
5. ASTM C109, Annual Book of ASTM Standards, Vol. 04.01.
6. Hedstrom, E. G., and Hogan, M. B., *The Properties of Masonry Grout in Concrete Masonry*, Masonry: Components to Assemblages, ASTM STP 1063, ed. John H. Matthys, 1990, pp. 47-62.
7. *Building Code Requirements and Specification for Masonry Structures* (TMS 402/602-16), The Masonry Society, Longmont, CO 2016, www.masonrysociety.org.
8. NCMA TEK 9-4A, *Grout for Concrete Masonry*, TEK 3-2A, *Grouting Concrete Masonry Walls* and TEX 18-8B, *Grout Quality Assurance*, National Concrete Masonry Association, Herndon, VA, www.ncma.org.
9. Farny, J. A., Melander, J. M., and Panarese, W. C., *Concrete Masonry Handbook for Architects, Engineers, Builders*, Portland Cement Association, 2008, www.cement.org.

1993, 2005, 2019



©NATIONAL READY MIXED CONCRETE ASSOCIATION

66 Canal Center Plaza, Ste. 250, Alexandria VA 22314 • www.nrmca.org

Technical information prepared by NRMCA. All rights reserved.

No part of this publication may be reproduced in any form, without permission in writing from NRMCA