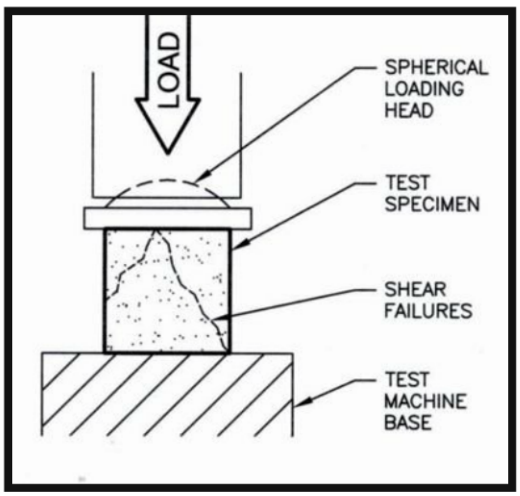
Compressive Strength ◄ ► My Opinion

Have a technical question? Check MIA's Dimension Stone Design Manual 7.2 first. If you can't find the answer there, contact MIA's Technical Director, Chuck Muehlbauer, at technical@marble-institute.com. This FREE service is for MIA members only! (Non-member charge: $85/hour) As a courtesy to other members, please limit phone conversations to ten minutes per call. *All opinions and advice provided by Chuck Muehlbauer or anyone else from MIA are provided as general information only. MIA assumes no responsibility and shall not be liable for any damages resulting from your use of this information. Any information provided by the MIA is the exclusive property of MIA and shall not be disseminated, republished, or reproduced in any manner without the prior written consent of MIA.*

Q: Why is it that when we test compressive strength in stones, we use a wimpy little 2" sample, but when the concrete people test their product, they use a big foot-long cylinder. Wouldn't we get higher values if we used a larger sample?

A: If we were to test stone in compression in the same way they test concrete, we would likely see lower numbers, not higher. In stone testing, we don't necessarily regard compressive strength as a design influential number. It is very seldom that we would have a stone that is loaded in compression anywhere close to its capacity.



Compression Testing

The compressive strength value is rather a general strength measurement that we use more for comparison purposes between stone types. It's a relatively inexpensive specimen to produce, and a relatively inexpensive test to perform, so it's a reasonable investment to make in exchange for data of limited usability. You will likely never see it actually used in an engineer's calculation submittal documenting structural adequacy of the design.

The most fundamental difference in how concrete is tested versus stone is the ratio of height to width (or diameter) of the test specimen. In concrete, the ratio will be 2 to 1, and most frequently a 6" diameter x 12" high (150 mm Ø x 300 mm) cylinder is used. The typical failure mode of this specimen isn't really a crushing of the specimen from top to bottom, but rather a shear failure, or multiple shear failures somewhat diagonally through the specimen. It is because of this failure mode that the height to diameter ratio becomes influential. In compression testing of stones, we are allowed to use cubes of 2" x 2" x 2" up to 3" x 3" x 3" (50 x 50 x 50 up to 75 x 75 x 75 mm) or cylinders of 2" Ø x 2" up to 3" Ø x 3" (50 mm Ø x 50 mm up to 75 mm Ø x 75 mm), but our height to width (or diameter) ratio is 1 to 1. This artificially inflates the value, as the shear plane within the sample cannot be as close to vertical as it would be in the concrete sample.

Changing of the test specimen profile has been discussed within ASTM Committee C18, but it has been decided to not change the profile because the data is not likely to be influential to the design, and because changing it would invalidate all historical data. There is a second caveat regarding compression testing of dimension stone, and that is the preparation of the test specimen itself. Parallelism and flatness of the two bearing surfaces become critical factors in this test. The test machine, due to a spherical loading head, can accommodate an error in parallelism provided it isn't extreme. Flatness errors however, cannot be corrected.

There are capping methods (sulfur mortar or neoprene) available to true the bearing surfaces of concrete specimens and provide uniform load distribution, but these compounds are only useful up to about 10,000 to 12,000 lbs/in² (±70 to 80 MPa). At strengths above that, the cap will fail before the test specimen. If, during fabrication of the test specimen, the bearing surface is left even slightly crowned or dished, the specimen will fail prematurely and an erroneously low value will be recorded. Another topic of study by ASTM Committee C18 is compressive testing of specimens smaller than 2" (50 mm). Since many materials are imported into this country in only ¾" or 1¼" (20 or 30 mm) slab stock, correct test specimen sizes cannot be obtained.

Thus far the study has not been very encouraging, as the data sets are quite noisy and correlation to traditionally sized specimens has been poor.

Continued on page 5