Grout Voids - Finding & Filling

11.1-1 A plumber was drilling holes through a reinforced concrete masonry wall I built and hit voids where there was supposed to be solid grout. Do I need to tear down the wall or is there some way to fix the grout voids in the wall?

Response by Michael P. Schuller, Atkinson-Noland & Associates

The good news is you do not need to tear down the wall and start over, but you do need to find void areas and verify that in-place grout is interfacing with the surrounding units. The first question is exactly where are any grout voids, and secondly how big are they? Several nondestructive testing methods can be used for finding grout in concrete masonry walls, including infrared thermography, microwave radar, and impact-echo. If you have a good ear you can sometimes detect grout voids by simply “sounding” or tapping the wall with a small ball peen hammer. Once you think you’ve found a void verify the void by drilling into a mortar joint and using a borescope or videoscope to get an idea of its size.

Once the grout voids are located the next step is to fill them with grout. You cannot use a normal masonry grout because there is no way to get a vibrator into the grout void to consolidate the grout. The best approach is to use injection methods to fill the voids with a “compatible injection fill” (CIF), which is introduced at low pressure through small holes drilled into mortar joints (Figure 1 and Figure 2). CIF injection grouts are specially developed for masonry applications. They do not contain epoxies or polymer modifiers, but are special formulations using cementitious materials and aggregate similar to normal fine grout. Vibration is not needed because the injection material is self-leveling and non-shrink. Masonry injection grouts have been used for over 20 years and are manufactured commercially; check online for sources. Epoxies form barrier to water vapor transmission within the wall section, are expensive, and are typically not recommended for filling masonry voids.

If you have a large vertical void to fill you can also use self-consolidating grout, which is recognized by ASTM C476 and the TMS 402 Building Code Requirements for Masonry Structures.

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Self-consolidating grout does not require vibration and can be pumped into a 2 to 4-inch (5 to 10 cm) diameter hole cored into the block at the top of the grout lift (Figure 2). Injection will be required for the last lift above the top of the core hole. Finish the work by patching the core hole to match the block texture.

One final approach is to simply remove face shells at all voids and dry-pack the voids using non-shrink grout (Figure 2). Back-butter a new face shell or a 2-inch (5 cm) soap unit with mortar and press it into place over the non-shrink grout to restore the wall face to its original appearance. This method is invasive and expensive but works well if you cannot find a contractor to use injection CIF or self-consolidating grout.

Figure 2 - These photographs show some methods to fill voids in masonry walls that occasionally occur. In the photograph directly to the right, CIF (compatible injection fill) is injected under low pressure into the wall while the technician observes the process using a borescope. In the top right photography, grout was dry packed into void areas. Below, access ports have been cored into a wall. As shown in the photograph at the bottom right, self-consolidating grout is then pumped into the wall to fill the voids.
11.1-2 Many allowable stresses were substantially increased from the 2008 to the 2011 TMS 402 Code. How do these changes affect the in-plane flexural and axial designs of piers and walls?

Response by Richard M. Bennett University of Tennessee and Vice-Chair for the 2013 Revisions Cycle and Chair for the 2016 Revision Cycle

Many allowable stresses were increased from 2008 to 2011, and the permitted 1/3 stress increase was eliminated. For those increased stresses, designs using the 2011 Code and the 2008 Code with the 1/3 stress increase will be essentially the same. Two specific elements will be examined.

First consider a fully grouted masonry pier that is 2 ft (0.61 m) long, 8 ft (2.44 m) high, and made of 8 inch (203 mm) CMU (Concrete Masonry Units) ($f'_{m}$ =1500 psi (10.34 MPa)) with No. 5 Grade 60 bars in each end. The interaction diagram comparison for in-plane loads is shown in Figure 3. The solid line represents the element designed with the strength design provisions, with the nominal strength reduced to allowable design levels by multiplying by the strength reduction factor (0.9) and by 0.6, the factor which converts strength level wind loads to service level wind loads in ASCE 7. This is almost equivalent to dividing by a load factor of 1.6, which is used for snow and live loads. The dashed line represents the 2011 ASD design provisions. Even with the higher allowable stresses, designs are still slightly conservative with respect to strength design for lower axial forces (tension controlled). Even with the increases in allowable stresses, designs are quite conservative with respect to strength design for higher axial forces (compression controlled). Comparisons are also made to the 2008 ASD code (long, two short dashes), and the 2008 ASD code with the permitted 1/3 stress increase (dotted). The conservatism in the 2008 ASD Code can be seen. Designs with the permitted 1/3 stress increase closely match the 2011 ASD design provisions, except at the very high axial forces. This is due to the allowable axial stress not being increased in the 2011 code. Finally, the interaction diagram is shown obtained using the unity equation (long dashed line). Although the unity equation is not applicable to reinforced masonry design, it has sometimes been used. For reinforced masonry, the unity equation is very conservative.

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![Figure 3 - Interaction Diagram Comparison for a 2 ft long, 8 ft high pier, and made of 8 inch CMU masonry units ($f'_{m}$ =1500 psi) with No. 5 Grade 60 bars in each end.](image-url)
The second element considered is a 16 ft (4.88 m) long, 10 ft (3.05 ft) high partially grouted 8 inch (203 mm) CMU masonry shear wall \((f'_m = 1500 \text{ psi})\) with No. 5 Grade 60 bars at 48 inches (1.22 m). The interaction diagram for in-plane loads is shown below. Similar trends to the pier are observed. One difference is that ASD is more conservative with respect to strength design at low axial forces (tension controlled) than with the pier. When there are multiple layers of steel, ASD becomes increasingly conservative with respect to SD. In SD, most of the layers of steel will have yielded, so they all have the same stress, but a smaller lever arm for steel layers closer to the neutral axis. With ASD, both the stress and the lever arm will decrease in layers closer to the neutral axis since stress is directly proportional to distance from the neutral axis. With ASD there is both a smaller stress and a smaller lever arm contributing to the moment capacity for layers of steel closer to the neutral axis.

Two other topics are worth mentioning. Anchor bolt allowable stresses did not change from the 2008 code. In 2008, the anchor bolt allowable stresses were significantly increased and harmonized with strength design of anchor bolts. As discussed in TMS Responds, Vol. 10, No. 1, the one-third stress increase permitted in the 2008 Code should not be applied to anchor bolt design. Second, there was a major change in the shear design provisions in allowable stress design. The shear provisions now closely match the strength design shear provisions, and allow the shear capacity of the masonry and the reinforcement to be added together.

Editor’s Note: For additional discussion on this topic, refer to Allowable Stress Recalibration in the 2011 TMS 402 Code, by Richard M. Bennett, Edwin T. Huston, David I. McLean, and Diane B. Throop, that appeared in the 11NAMC Proceedings that is available from TMS.