Engineering
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MEA MARINO ENGINEERING ASSOCIATES, INC. • Issue 24

ANATOMY OF GROUTING MINE VOIDS

INTRODUCTION

Mine grouting is performed when surface structures are planned over underground mines and where the estimated risk of mine subsidence damage is determined to be too high. There are, however, a number of approaches which can be taken to stabilize the mine void by grouting. In other words, one mine grouting approach is not the same as another. Different approaches can easily result in a 10-15% difference in cost of $150,000-$500,000 or more, depending on the project.

GROUTING METHODS

To identify the scope of the project, the mine area beneath the structure to be stabilized must be determined. This "shadow" area is delineated by projecting an angle downward to mine level (see Figure 1). This angle is called the influence angle. In addition to the size of angle used, whether it is a shallow or deep mine, the methodology specified to stabilize the underground mine can vary. The most conservative approach is to essentially grout all the voids in the shadow area (called saturation grouting, see Figure 2). Other more cost-effective methods include grouting and installing a barrier in and around the perimeter (called barrier grouting, see Figure 3), or strategically installing grout piles (called pile grouting, see Figure 4) in the designated mine area shown in Figure 1. The latter of the two methods' effectiveness depends upon the nature of support required against mine collapse.

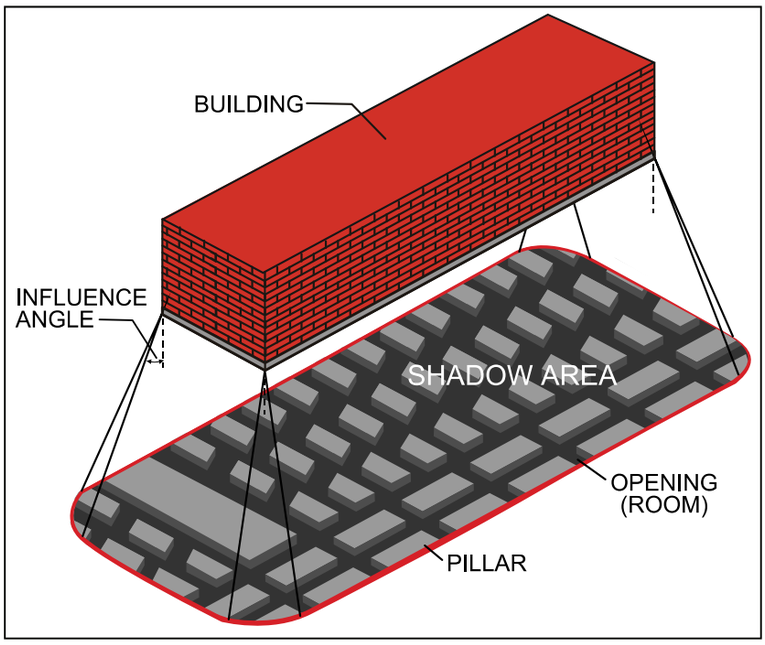

FIGURE 1: MINE AREA WHICH SUPPORTS THE SURFACE STRUCTURE

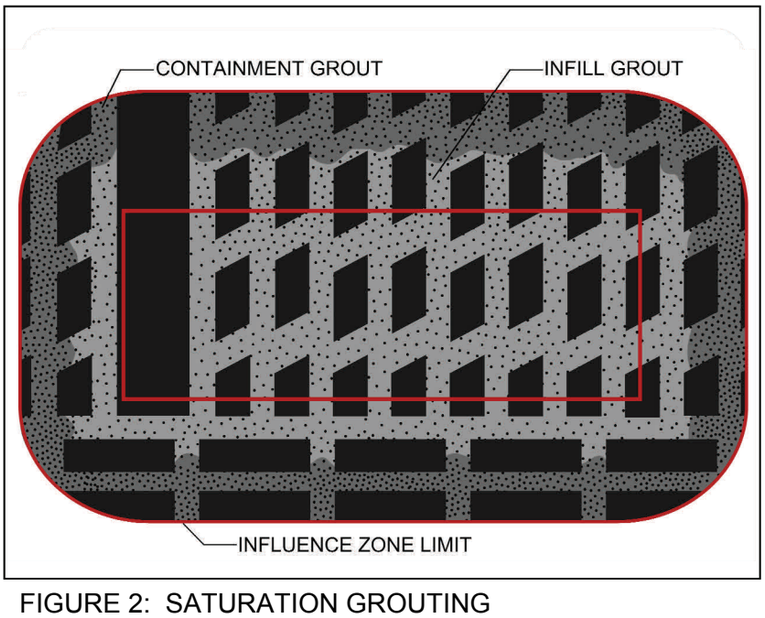

FIGURE 2: SATURATION GROUTING

COST FACTORS

In addition to the determination of the mine area which needs to be stabilized and the grouting methods discussed above, other key factors which can control the costs are the specification of the grout mixes (grout unit cost) and the injection hole spacing (drilling quantity), as well as the acceptable risk level. The specified area of grouting determines the overall quantity of grout and amount of drilling needed. This is directly related to the influence angle and the mine depth. In other words, the greater the mine depth, the greater volume of grout and drilling required for the protected structure. Saturation

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grouting which is the most common practice, requires that a containment grout barrier be created before infill grout can be placed. The most expensive grouting method is containment grouting which is most affected by the selection of the influence zone. Also the needed infill volume is correspondingly affected. Grouts used for containment, infill, or other purposes can be optimized by using materials and additives which provide cost effective mixes.

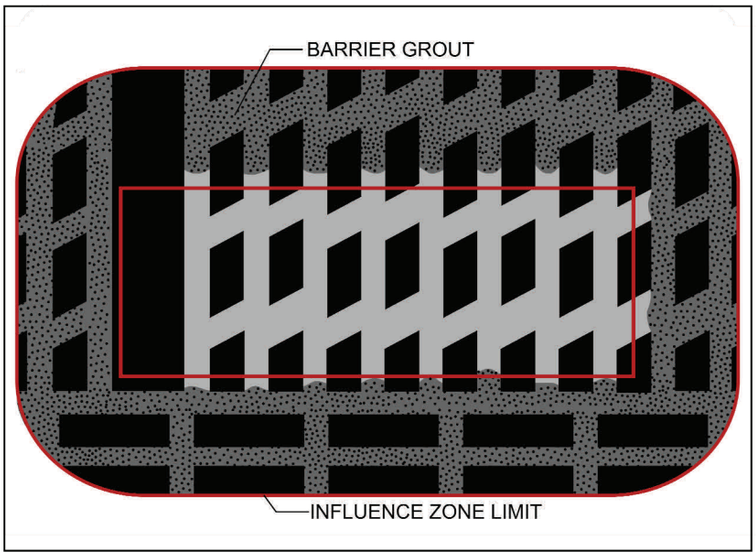

FIGURE 3: BARRIER GROUTING

COST CONTROL

The ultimate cost of mine subsidence concerns is related to risk. With experience and technical know-how, the mine grouting project will be best optimized to the needs and wants of the Owner. The most significant factor in this regard is the acceptance level of risk the Owner can tolerate. This assessment, which is most important in the Owner decision making process, should be sufficiently detailed, reliable and accurate, otherwise grouting specifications will not meet the Owner's intended level of protection for the structure. A good risk analysis will include accurate assessments of potential mine collapse mechanism(s) as well as the risk and potential magnitude of subsidence and associated damage without or with different stabilization approaches.

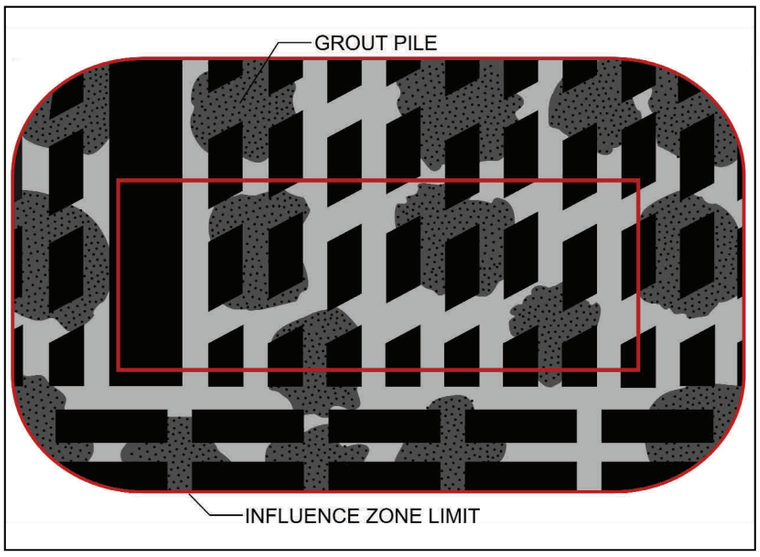

FIGURE 4: PILE GROUTING

SUMMARY

The cost for a mine grouting project is controlled by the acceptable risk the owner is willing to take. Armed with an accurate risk assessment of the site, a smart stabilization program can be tailored to address only the necessary mine support issue(s) while still adequately protecting the proposed structure. Conversely, an inaccurate assessment will lead the owner to expensive, unnecessary measures and potentially will not address the real problematic conditions.

Other Engineering UPDATES of Interest:

UPDATE 1: Successful Deep Mine Backfilling to Mitigate Subsidence

UPDATE 6: Subsidence Mitigation by Combining Foundation Treatment with Deep Mine Grouting

UPDATE 21: Mine Subsidence Damage During Construction of Medical Center and Remedial Measures Taken

ABOUT MEA: Marino Engineering Associates, Inc. focuses on engineering research, practice and expert evaluations and is licensed in 24 states in the U.S. Our projects primarily have an emphasis on Geotechnical Engineering, however, we also have significant experience in projects involving transportation, subsidence engineering, laboratory testing, training, and geophysical exploration. Gennaro G. Marino, Ph.D., P.E., D.GE is president and principal engineer of Marino Engineering Associates, Inc., and has been a licensed professional engineer since 1984. To obtain additional information on MEA, one can also visit our website at www.meacorporation.com.

FOR MORE INFORMATION: There is a significant amount of additional information that is available on the above subject. For more information, please contact Dr. Marino at the address listed below.

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