

CHAPTER 4
UNTENSIONED REINFORCEMENT ELEMENTS

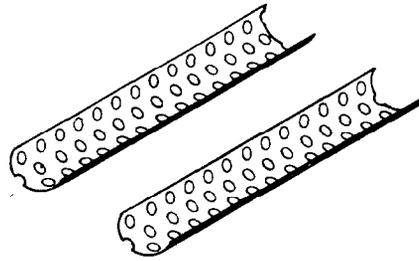
4-1. General. Although the installation of tensioned fully grouted elements is preferred for rock reinforcement, some conditions may make desirable the installation of fully grouted untensioned elements (commonly referred to as rock anchors, anchor bars, or rock dowels). Once installed, stress is developed passively in the element as rock movements take place. Anchoring through and behind burden (recessed rock anchor) prior to removal by later blasting is a desirable application because rock movements are immediately controlled to maintain stability upon exposure of the final excavation line. Additional tensioned reinforcement can then be installed. Installation of grouted untensioned elements also becomes necessary when it is difficult to achieve anchorage for tensioning in soft or highly fractured rock. Other uses are for economically reinforcing areas that are essentially stable (downward installations or as supplemental reinforcement to existing reinforcement or shotcrete, for example) or for anchoring structures to rock.

4-2. Types and Installation Methods.

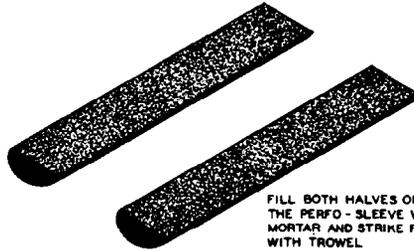
a. Except that embedment is initially made full length, commonly used types are identical to those shown in figures 3-6, 3-7, and 3-8. Additional details are shown in figures 4-1 and 4-2. Installation techniques and grouting materials, except for obvious differences, are likewise identical to those described in chapter 3 for forming grouted end anchorages or for full-length element grouting. Untensioned elements of all types may be installed without hardware at the face as shown in figures 4-1 and 4-2a or with hardware as shown in figure 4-2b, depending on the application. Nuts tightened against bearing plates are important for providing restraint and to prevent loosening of surface rock. Threaded bar ends are also needed for fastening chain link fabric or other surface treatment, when used. Where surface rock is highly fractured but temporarily stable, unthreaded bars could be installed followed by a shotcreted surface treatment. On the other hand, shotcrete might be used to provide initial support and reinforcement installed through the shotcrete. In this case, bearing plates could be installed at the surface to increase the support capability of the shotcrete.

b. Figure 4-2a shows a typical recessed installation. Once this type is driven to the existing excavation line, an additional bar equipped with a driving dolly is used for pushing the bar to the final line. Some contractors prefer to drill the hole through the burden oversize by approximately one-half inch or more. This reduces the

INSTALLATION

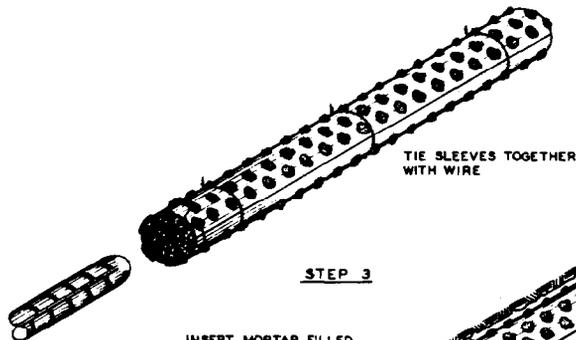


STEP 1



FILL BOTH HALVES OF THE PERFO - SLEEVE WITH MORTAR AND STRIKE FLUSH WITH TROWEL

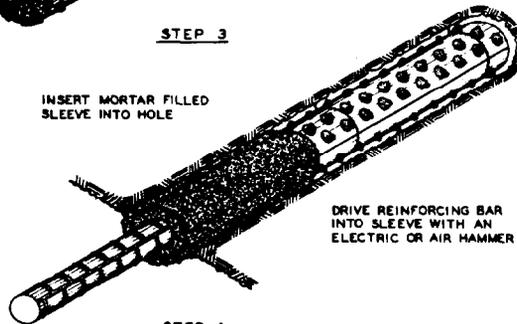
STEP 2



TIE SLEEVES TOGETHER WITH WIRE

STEP 3

INSERT MORTAR FILLED SLEEVE INTO HOLE

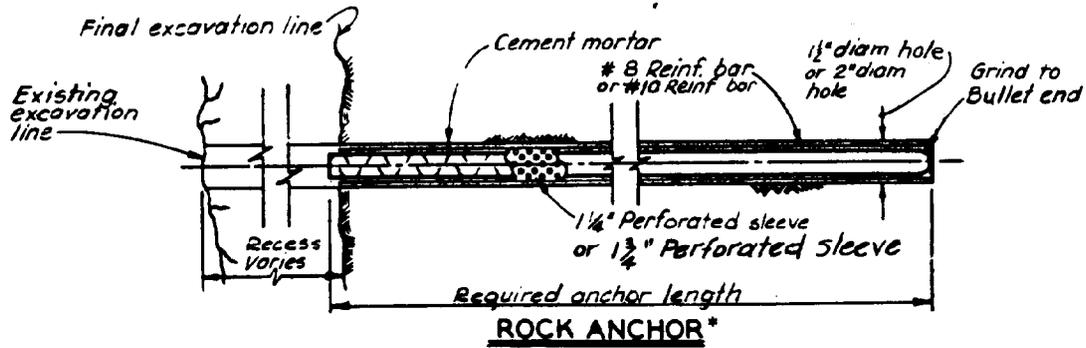


DRIVE REINFORCING BAR INTO SLEEVE WITH AN ELECTRIC OR AIR HAMMER

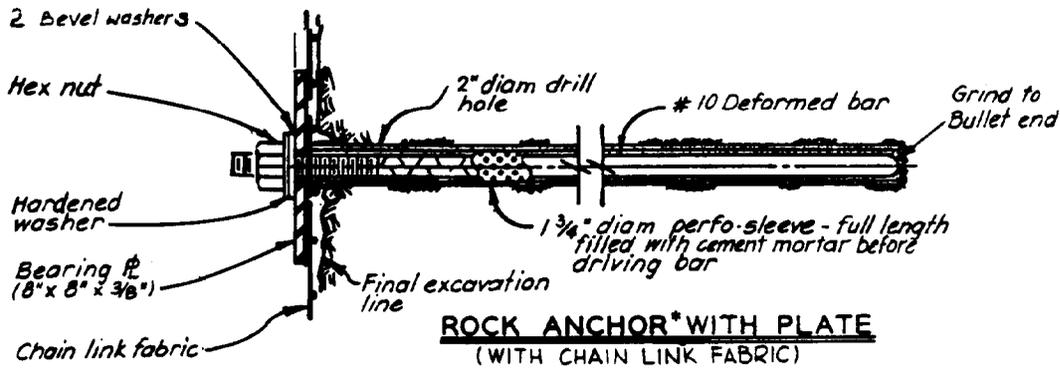
STEP 4

ROCK ANCHOR

Figure 4-1. Rock anchor, perforated sleeve and mortar type.



a. Without plate.



* ON LONG ANCHORS, CENTER LUGS SHOULD BE WELDED TO THE BAR SO THAT THEY WILL CENTER THE BAR AND ALLOW GROUT TO FLOW COMPLETELY AROUND THE ANCHOR BAR.

b. With plate.

Figure 4-2. Typical recessed installations, with and without plate.

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possiblility of bars binding in the hole and prevents bonding of the bar to the burden rock in the event a bar does bind and cannot be fully driven.

c. Although not shown, untensioned elements can be installed through grout placed by gravity in down-holes. Also, it may be convenient at times to inject grout through untensioned hollow-core rock bolts when the mechanical anchor does not hold because of the existence of poor rock. Other methods, more common in Europe, involve the use of compressed air to force plastic portland cement mortar into the drill hole. The element is then inserted to force excess mortar to flow out the hole. One variation of this method is commonly referred to as the SN method because it was used to reinforce rock on the Stor-Norrfor underground powerhouse in Sweden.

4-3. Sample Specification. A sample specification based on experience with fully grouted untensioned elements during excavation at the NORAD Cheyenne Mountain Complex is included as Appendix D. The sample may be used as a guide and revised to include other types described in this manual and to fit conditions at other projects.