Recommendations for

Grouting Machinery

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THE GROUTING of machine base plates and bearing plates, and of anchoring/alignment equipment to a foundation are low-cost approaches that provide a high quality machine-to-foundation connection. A successful installation depends on: proper grout selection, based on application; foundation preparation; forming method employed; and careful attention to the actual application of the grouting material.

Grout Selection—Selecting a grouting material for a particular application should include an evaluation of these factors:

1. Cost—Compare the cost of mixed grout, ready for placement. Yields can vary considerably from one manufacturer to another, and dry powder to price comparisons are misleading, as the amount of mixing water required will also vary.
2. Strengths—Applied loads should be evaluated carefully to ensure that the bearing capacity of the grout is not exceeded. Compressive strengths reported by manufacturers are based on tests run under lab conditions; actual field-cured values for cementitious grouts will be approximately 80 percent of the lab result.
3. Ease of handling and placement—The following factors are important:
   A. Flowability. The ease with which the material enters small cavities and travels under larger base plates is usually measured either by the ASTM-C230 test or Corps of Engineers Spec CRD-588-76 flow cone test. For the ASTM-C230 test, the results are expressed as a dimensionless number ranging from 100 to 150, with 150 the most flowable. The Corps of Engineers' results range from 30 seconds to 10 seconds, with 10 seconds the most flowable.
   B. Tendency to separate when mixed or handled excessively. In some materials that use metallic additives or have aggregates of widely varying sizes, the aggregates tend to separate if the material is overmixed or handled excessively.
   C. Ability to be pumped or vibrated, particularly on larger installations. Again, separation is the problem. The ability to be vibrated or pumped is a prime concern when grouting cavities are small, when placement is difficult, or when grout must be flowed long distances.
   D. Expansion or nonshrink properties. The main objective is to select a material that will expand enough to assure full bearing contact with machine base and foundation (a few tenths to 1 percent or so is normal). When large grout-to-machine contact areas are encountered, a grout with a controlled internal pressure development should be selected to prevent the grout's expansion from disturbing alignment. The actual expansion of a grout is typically measured by either the Schmid

GROUTING ADVANTAGES

1. Foundation forming and finishing tolerances may be relaxed. Because grout provides the final link between the machine and the foundation, the foundation is usually finished 1½ to 3 in. below the desired machine base level. A thicker or thinner grout pad can be used, as the specific situation requires, to compensate for the variances encountered in actual foundation construction, eliminating the need for precision foundation work.
2. Grouting provides a rigid machine-to-foundation connection. As the grout is placed into the cavity, in the plastic or fluid state, it conforms precisely to the machine base and to the foundation, providing a 100 percent bearing contact between foundation and grout pad, and grout pad and machine base.
3. Anchoring/alignment equipment can be positioned within a precast or core-drilled grouting cavity at the time of machine installation. As the foundation is constructed, grouting cavities are created by precasting or core drilling (while the foundation is green) at the approximate location of each support or anchor point.

   When the foundation has cured sufficiently to support machine loads, the machine is moved into position on the foundation and supported by temporary blocks. The anchoring/alignment equipment is then assembled to the machine base with the anchor bolt and base of the alignment device (if one is being used) projecting into the grouting cavity. Grout is then placed into the cavity and allowed to cure, completing the machine-to-foundation connection. This approach eliminates the requirement for time-consuming, precise presetting of anchor bolts or alignment equipment, significantly lowering the cost of more complex installations.
4. Existing foundations may be easily adapted to new equipment. Core drilling an existing foundation to accept new anchoring/alignment equipment, which is in turn grouted into permanent position, eliminates the need for removing and replacing an otherwise sound foundation if the equipment it supports is being relocated or replaced. When properly installed, these anchors exhibit holding power equal to or better than that of anchors set into the foundation as it was constructed.

or ASTM-C827-78 early volume change method; the result is expressed as a percentage.

E. Maintenance requirements. What will be required to keep the grout functional in the environment into which it will be placed is the main concern. For example, a grout that is to be used in an oily environment should be a relatively impermeable type. A grout with a porous structure will require a paint coat to prevent penetration by oils and other chemicals.

Other special considerations include ability to withstand thermal cycling and high temperatures, ability to resist acids, and susceptibility to spalling under freeze-thaw cycling.

Materials in use today range from slightly modified sand and cement mixtures to chemically sophisticated epoxy materials with strengths five to six times that of standard concretes.

Cementitious Grouting Materials—The simplest grouting material consists of sand and cement mixed at approximately a 50-50 ratio. Simple sand and cement mixtures shrink on curing, usually from 2 to 3 percent, making their use in high load or precision applications questionable. Cementitious grouts in use today have been modified to expand rather than shrink on curing.

There are several basic expansion mechanisms in use today. One involves the addition of iron filings to the sand-cement mixture. The filings expand slightly when water is added to the mixture, causing the desired expansion.

Other systems include the use of carbon particles (evolved gas causes expansion) and the use of chemically compensated "Type K" cements (which promote growth within the cement paste).

Epoxy Grouting Materials—The epoxy grouts consist typically of a base resin and hardener that are mixed at the jobsite immediately before placement. (Some systems may also require the addition of a filler at this point.) An advantage of epoxy materials is the ability to withstand significantly higher shock loads than cementitious materials. Epoxies also can be used in much thinner cross sections than cementitious materials; this feature may be desirable in certain applications.

The epoxy grouts typically exhibit slight shrinkage on curing but usually the thinner section used (and extremely small amount of overall shrinkage encountered) minimizes the problem.

When the application is unusually severe from a shock loading standpoint or is to be used in a very thin section requiring high flowability, high strength, and rapid cure rate, an epoxy grout should usually be chosen rather than a cementitious one. Setting anchor bolts is an application particularly well suited to the epoxy material because a relatively small quantity is used and the short cure time is an advantage. Epoxy grouts are widely used for applications such as installing large engines, compressor units, crushers and shredders, and other equipment imparting large dynamic loads to their foundations.

Foundation Preparation—The concrete surfaces to which the grout will be applied must be carefully cleaned, leaving the surface free from all foreign material, grease, oil, etc. If an old foundation is being reused, be sure that the upper surfaces are sound. If unsound concrete is encountered, it will be necessary to chip back to sound concrete. The objective is to place grout against sound, clean concrete only.

Forming Recommendations—In preparing forms for retaining fluid grout, keep in mind that the most effective means of achieving a good machine base-to-grout contact is to place the material from one side only. The material should flow under the machine being grouted, and, while it is flowing, contact between the upper surface of the advancing grout and the machine base should be maintained. This approach will ensure that no air becomes trapped between the grout and machine base, Fig. 1.

It is important to maintain clearances between the machine base, foundation, and forms. Adequate clearance should be provided between the form and base plate on the pour side to permit material to be introduced rapidly enough to maintain grout base contact. Use of a sheet metal or wooden chute may prove helpful in introducing the mixed grout into the form. The forms should also be high enough to permit the fluid grout to be brought up the side of the machine base about ½ in. to make sure that full bearing contact is realized. Sufficient grout must be available so that the entire cavity is filled in a single, continuous pour.

DO'S AND DON'TS

For Cementitious Grouts

- Don't exceed recommended water levels in an attempt to achieve greater flowability. Using more water than specified by the manufacturer may result in segregation of the material or may interfere with the nonshrink mechanism.
- Don't overmix or undermix. Refer to the grout manufacturer's minimum and maximum mixing time recommendation. Overmixing may cause segregation in metallic-type materials and unnecessary air entrainment in other materials. Undermixing may not accomplish adequate blending of dry ingredients and may prevent proper wetting of materials which could result in the grout's "false setting" and other problems.
- Don't use curing compounds or bonding agents unless specifically approved by the grout manufacturer.
- Do wet the foundation thoroughly. Otherwise, water will be drawn from the newly placed grout too quickly, interfering with proper curing.
- Do use clean mixing water. Chemical contaminants may interfere with the proper expansion of the material.
- Do read the individual manufacturer's instructions, especially when placing grout at temperatures below 40 F (5 C) and above 90 F (35 C) as the requirement for special measures varies considerably.

For Epoxy Grouts

- Don't place epoxy grouts when water is present (once cured, water is no problem).
- Do be sure the foundation is clean and free from oil or grease.
- Do design for thin sections, avoiding large pours.
- Do familiarize jobsite personnel with the manufacturer's recommended handling and safety precautions.

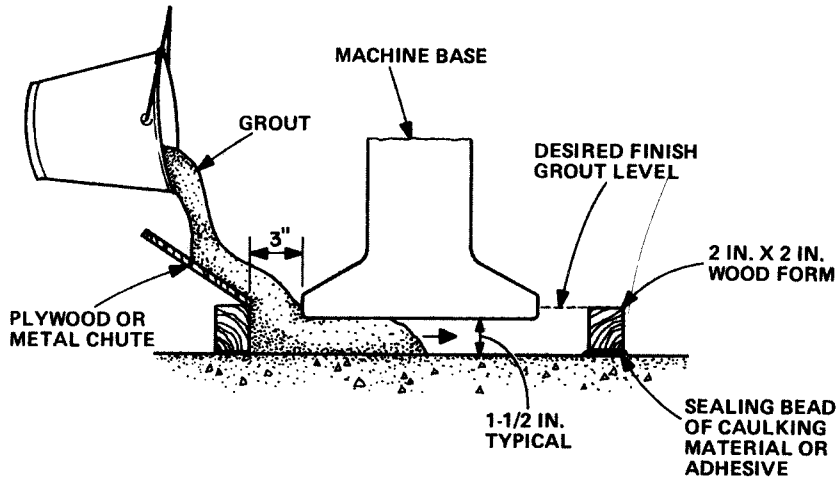

Fig. 1. The grouting material should be placed from one side only to achieve good machine base-to-grout contact. This approach ensures that no air is trapped between the grout and machine base.

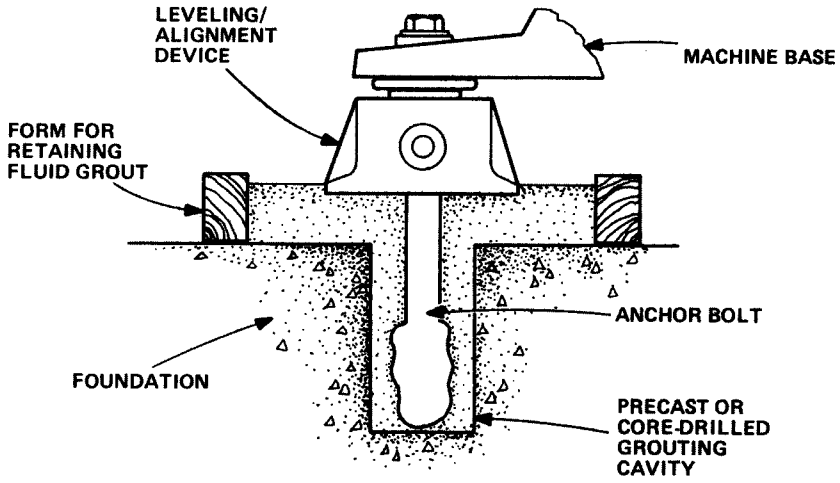

Fig. 2. This application, recommended when leveling/alignment equipment is grouted, simultaneously providing a bearing pad and anchor bolt.

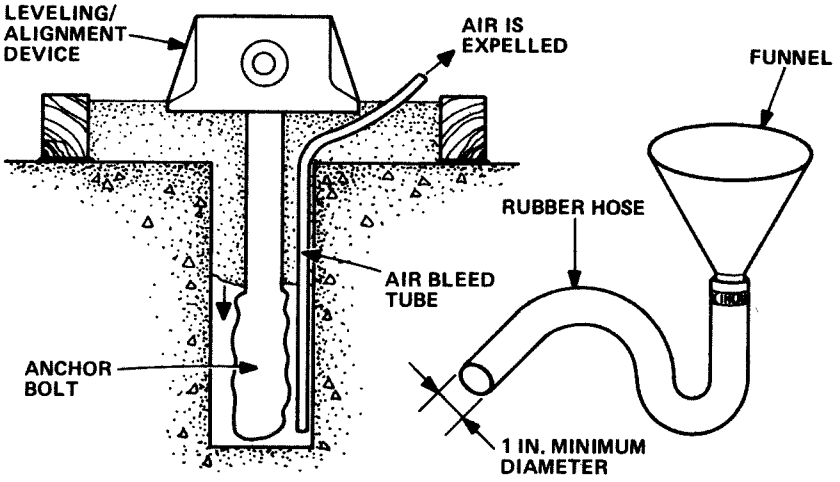

Fig. 3. If the anchor bolt cavity is very deep, an air bleed tube might be advisable. It should be withdrawn after the cavity is filled. An alternate approach is to use a funnel and hose. A highly flowable grout is required, and the tip of the hose should be withdrawn slowly as grout level rises.

The form should be carefully designed and constructed to prevent leakage because modern grouts are much more flowable than concrete. It is recommended that caulk or a construction adhesive be used to seal the individual form components to each other and to seal the completed form to the foundation. Epoxy grouts, which are extremely flowable, require extra attention to the sealing to prevent possible form leaks.

Application—It is desirable, in some cases, to grout anchoring/alignment equipment in place, pouring a bearing pad and setting an anchor bolt simultaneously, Fig. 2. The anchor bolt cavity must be completely filled with grout. A filled cavity can be at-

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"The time spent in thoroughly planning the grouting installation will pay off in fewer problems in the machine's performance."

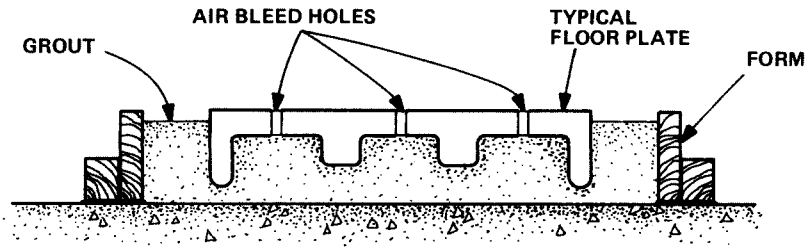

Fig. 4. Air bleed holes should be provided when blind cavities are grouted. The holes also provide visual assurance that all cavities are filled.

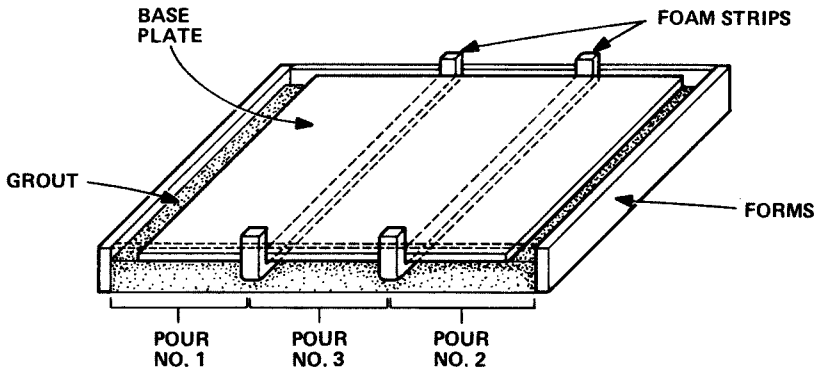

Fig. 5. When large areas are grouted, the pour should be divided into sections. Sections 1 and 2 should be poured and allowed to set before the center section is poured.

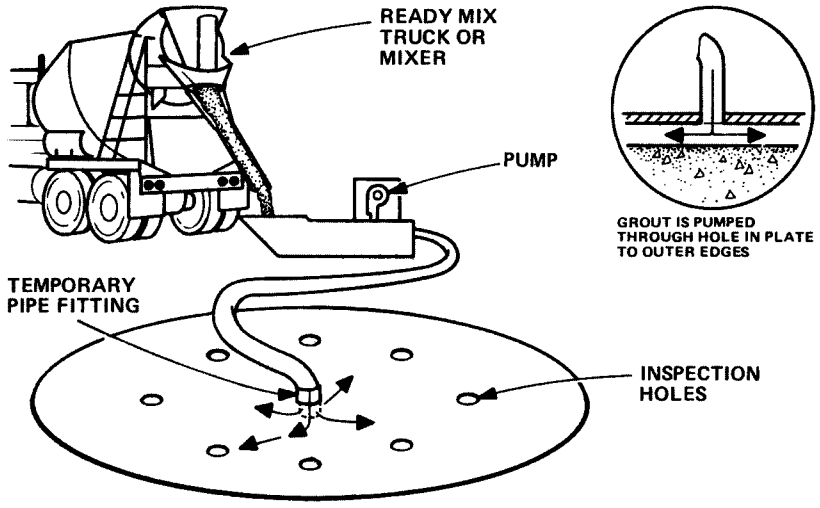

Fig. 6. For large pours, a ready-mix truck and concrete pump are recommended.

tained by pouring the grout slowly at first to make sure no air is trapped. For unusually deep holes, it may be advisable to use an air bleed tube that is withdrawn when the cavity is full, Fig. 3.

An alternate approach is the funnel and hose method. A highly flowable grout is required for this approach, and the tip of the hose should be inserted into the anchor bolt cavity and withdrawn slowly as the grout level rises.

Air bleed holes should be provided when blind cavities are grouted, Fig. 4. The air bleed holes serve a second function of providing visual assurance that all cavities are filled.

When working with a larger pour, it may be advisable to break the pour into sections for more convenient handling by using polyethylene foam strips, Fig. 5. The outside cavities are filled first, and the grout is allowed to set before the foam strips are removed. The remaining center cavity is filled last.

Many of the currently available grouting materials can be pumped with a standard concrete pump. This approach is frequently used when extremely large pours are required. The main problem is mixing the necessary amount of material quickly enough to permit a single continuous pour. A standard ready-mix truck and concrete pump work well, Fig. 6.

A first-quality grouting installation is the key to successful machine installation. The time spent in thoroughly planning the installation will pay off in fewer problems in the machine's performance.

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