Epoxy Grout Installation Techniques For Skid Mounted Equipment

Revised September 03

By

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The purpose of this paper is to provide the Engineer, Operator, and Installer with field proven installation techniques for grouting of skid mounted equipment. These techniques are based on our company's 46-year history of designing repairs for all types of critical alignment equipment.

Proper foundation and structural design for the skid are not covered in this paper. The influence they have on the installation is very important and is where you must begin when planning the job.

Concrete Foundation Design

Concrete raw materials vary across the country so it is not possible to use common mix design. The design and placement should be per ACI standards. The installer, who is typically involved with the concrete placement as well as the epoxy grout, should know the physical properties of the concrete used. Standard Portland based concrete takes twenty-eight days to cure. Testing of physical properties should be done per ASTM guidelines to ensure the foundation is properly cured and ready for grouting. It is very important to know what you have to work with regarding the physical properties of the concrete. If there is a problem with the concrete, such as low tensile or compressive strength, it can be addressed much easier and more cost effectively before grouting.

Anchor bolt design and installation is also important considerations. Most blocks are relatively shallow and free stretch of anchor bolts is sacrificed for impediment depth. This can be solved by going with a two-piece bolt. The bottom is in the concrete block and has a coupling set just below grade. The skid beam is reinforced and holes drilled so the top piece of the anchor bolt can project through the top of the skid beam. This provides embedment and free stretch. Adjustable canister anchor bolts can help prevent bolt binding from misalignment at installation, particularly if an accurate template is not used. Illustrations of how to provide free stretch and a canister type anchor bolt design are on the next two pages.

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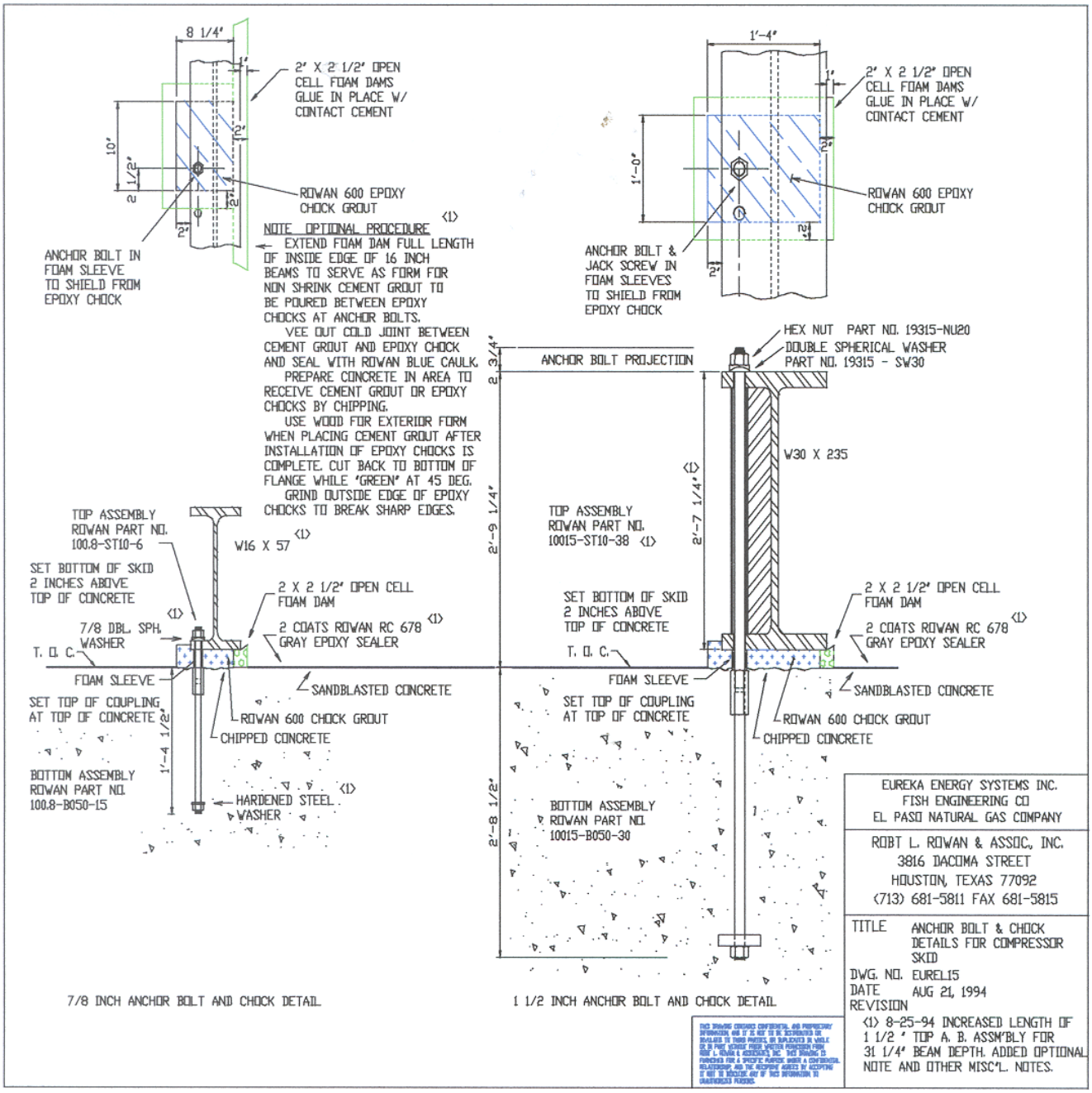

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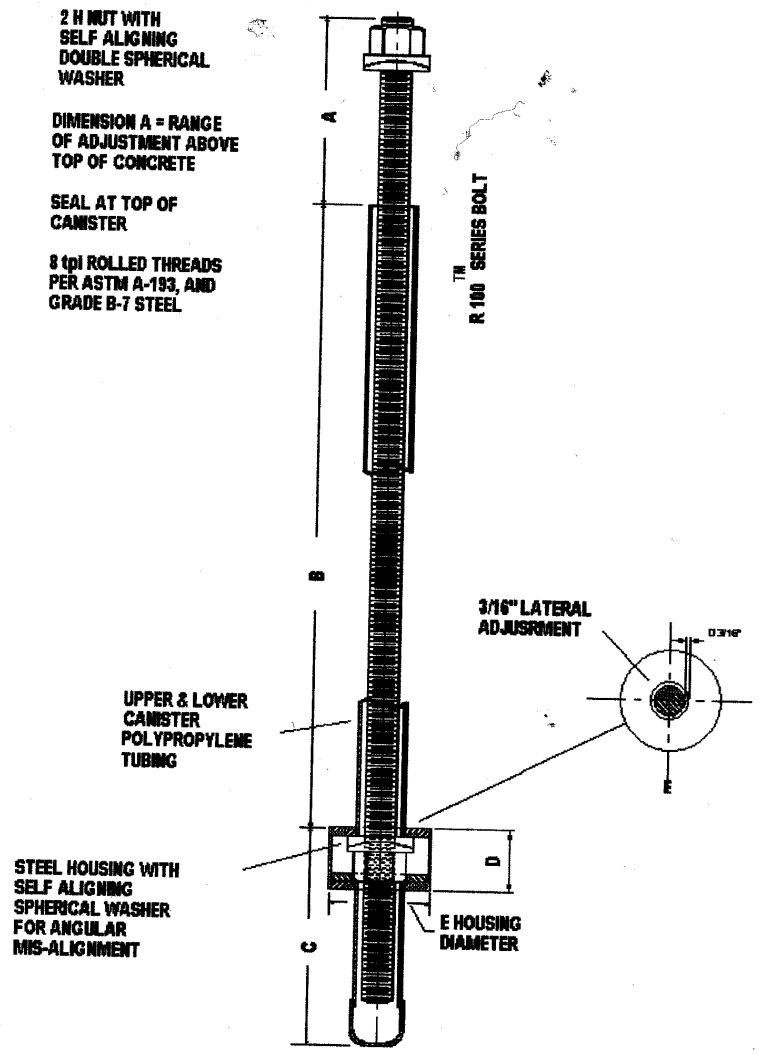

STANDARD DIMENSIONS FOR ROWAN R-100/CANISTER ANCHOR BOLT

SIZE	1"	1 1/4"	1 1/2"	1 3/4"	2"
A	0 - 6"	0 - 7"	0 - 9"	0 - 12"	0 - 16"
B	18"	30"	42"	54"	66"
C	10"	11"	13"	17"	21"
D	3"	3"	3"	4"	4"
E	5"	5"	6"	6"	6"
CAPACITY*	60,000	84,000	125,000	174,000	232,000

*BASED ON GRADE B-7 PUBLISHED DATA AND USING 80% OF 105,000 PSI YIELD STRENGTH (125,000 PSI TENSILE STRENGTH) IN POUNDS. ACTUAL PULLOUT STRENGTH MAY VARY DEPENDING ON THE QUALITY OF CONCRETE AND THE STEEL REINFORCING.

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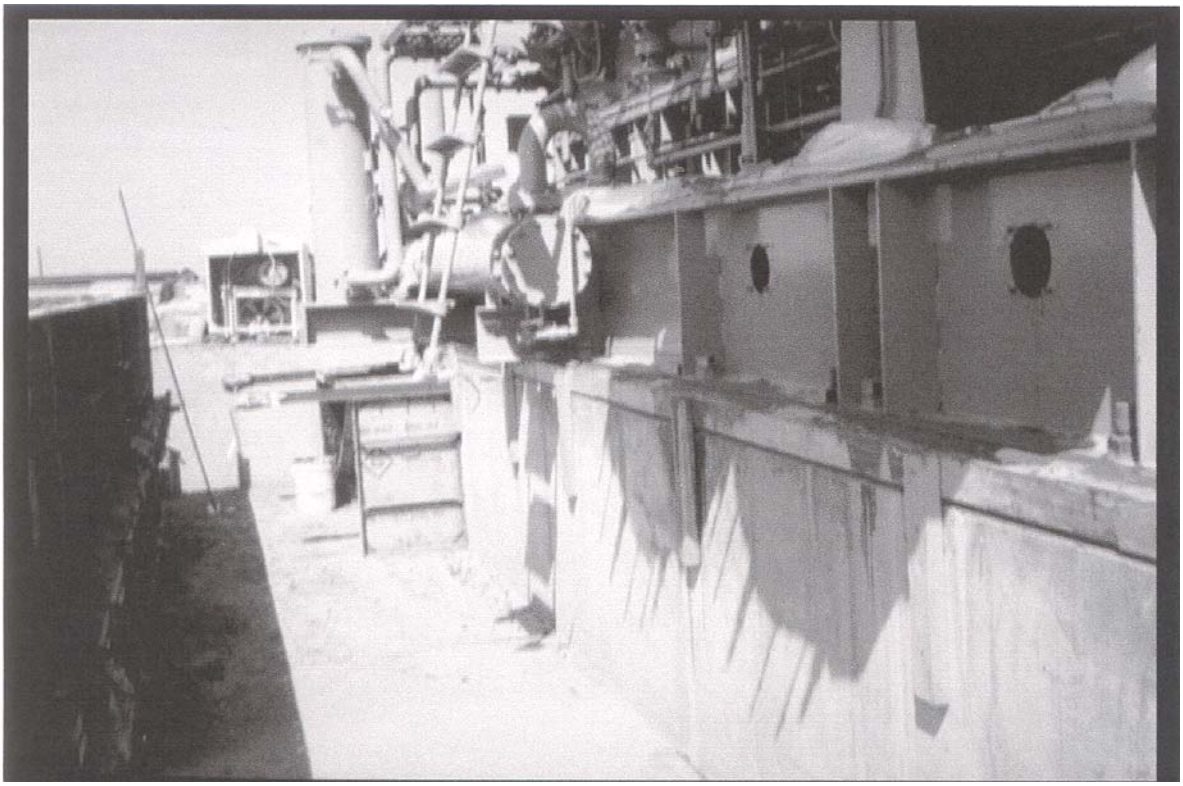
Skid Design

The structural steel design is determined by the manufacturer or packager. How the skid is designed determines the type of grout installation. Some skids are rigid and strong enough to be supported only at the anchor bolt locations on epoxy chocks (typically 10" Long x 12" Wide x 2" Deep). Others require the whole length of the longitudinal I beams to be grouted, but not the transverse I beams. Most commonly, both the longitudinal and transverse I beams will have to be grouted and at times, the inside cavity beneath the floor plate is also filled with either epoxy or cementitious grout. This is typically done to add mass for vibration reasons.

Access holes for grouting should be provided in the skid floor plate by the OEM or packager. **The end user should specify these when purchasing.** Access holes are very important when trying to flow any type of grout 10' to 12' across and 20' to 30' down the length of the foundation. The grout depth should be 2" minimum after chipping to provide adequate flow. Access holes also allow you to pour from the middle, cutting the flow distance in half. They also provide inspection points to ensure all of the I beams are fully supported. Be sure there are no blind or restricted flow areas in the skid design. One way a packager provided grout placement holes through the neutral axis of the beams can be seen in the following photograph.



What happens if the grouting operation is not done correctly? Unsupported beams that can cause high vibration and machine misalignment can result. The following photograph shows poor grout placement.

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While most skids are designed to only be supported by grout under the skid beams, occasionally the inside cavity of a skid will also need to be filled to provide mass. The inside cavity of the skid can be filled with either epoxy grout, cement grout, or concrete. Epoxy grouts are more expensive, but perform better than cementitious grouts or concrete. Epoxy grouts are also resistant to most chemical attacks that cement based products cannot handle. Cement based products shrink as the hydrate or cure. This can continue for a year or longer after installation. The shrinkage causes the cementitious grout or concrete to pull away from the inside of the skid. This causes or contributes to mass related vibration problems. This problem can easily be fixed by injecting an epoxy injection grout into the gap between the cement-based product and the skid beams. Mechanical locks can be welded to the inside cavity area to help prevent this problem. Filling the inside cavity area with epoxy grout is a more expensive method, but it is typically better performing and maintenance free. Cement based products are more economical and have limitations, but have been used successfully for years. Some premium cementitious grouts have built in expansive mechanisms to help offset shrinkage.

Skid Leveling

Jackscrews or some leveling system will be supplied by the OEM or packager. Jackscrews must be wrapped with tape or foam to prevent casting threads in the grout. Jackscrews must be removed after the grout has cured or they can cause cracks in the grout and concrete. As the skid and equipment grow thermally, the stresses they exert on the grout and concrete, if the jackscrews are left in place, can cause cracks. Jackscrew landing plates should be made from round stock, sufficiently hard to prevent deformation, and all of the sharp edges should be beveled or radiused. If wedges are used, then it is best to form around them for the epoxy grout pour. They must also be removed, so they should be waxed or protected from bonding with the grout if you cannot form around them.

Be careful not to cast any 90˚ corners (inside or outside corners) in the epoxy grout. Outside corners are blunted by adding a chamfer to the inside corner of the form. Inside corners are rounded by adding a piece of PVC pipe cut in quarters down its length to the outside corner of the form.

The skid bottom in contact with the epoxy grout should be sandblasted to a NACE 1 white metal for the best bond to epoxy grout. If the bottom is primed, then the primer should be removed for the best bond. The grout bond is only as good as, what it sticks to. A weak primer bond equals a weak grout bond. The skid can easily be blasted in the yard prior to installation. There is no problem bonding through a light film of rust. If the primer is compatible and is to be left on the skid bottom, then is must be abraded and the glossy top surface removed. The surface should then be solvent wiped with an evaporative solvent that leaves no residue behind which could act as a bond breaker.

Advance Preparation For Grouting

Shelter for the foundation from rain and excessively hot or cold temperatures must be provided. Typically, this is also required for alignment purposes.

Both the foundation and the material may need to be heated or cooled prior to grouting. Optimum temperature is 70˚F. It can take several days to achieve temperature equilibrium, so start early. Removing product from their pallets can speed the material conditioning but the foundation will take several days to condition, depending on the environment.

The concrete must be thoroughly cured and dry prior to chipping. For new blocks, a 15-pound chipping gun with chisel point provides the best profile for bonding to the concrete. This also removes all laitance or fine particles that rise to the top of the concrete during cure. This weak layer must be removed (approximately ½" to 1") to expose broken aggregate. The rocks should fracture instead of popping out of the cement paste. Do not use a heavy chipping gun as this causes excessive micro-fractures below the surface of the concrete. Do not use a bush head, as this will not properly remove the laitance layer, does not create a good bonding profile, and it compacts and crushes the top surface.

The edges of the concrete block, should be chamfered or radiused approximately 30˚. Rebar wickets or dowels can also be added to provide mechanical locks between the epoxy grout and concrete. Both of these techniques will help prevent edge lifting or a horizontal crack at the grout concrete interface.

Expansion joints for epoxy grout should be installed in advance (after chipping) if a crane is used to lower the equipment in place. If jacks and rollers are used, then the joints should be added prior to lowering the equipment with the jacks. The following photograph shows expansion joint foam that has been glued to the top of the concrete. As the skid is lowered to its final level position, typically 2 inches above the chipped concrete, the foam will be compressed under the skid beams.

Access for mixing and placing of materials must also be considered in advance. The materials must be close to the mixer on the day of the pour. How the material is to be placed either, by bucket, wheelbarrow or directly from the mixer, must also be considered. Ramps over piping or scaffolding for an elevated block may be needed. The average unit of epoxy grout weighs approximately 230 pounds, so providing unencumbered access makes the job much easier. If a scaffold is required, it is best to incorporate a mixing area. The materials will still need to be lifted onto the deck, but once mixed it can then be easily transported by wheelbarrow or bucket.

Proper ventilation, if environmental conditions require a full enclosure, must be provided during mixing and placing.

Any back up mixers or other back up equipment that is critical to the job success, should be provided and accessible. Doing a job with only one mixer can have a huge downside if it breaks.

Decide on the crew size necessary for a successful job. Too few people can cause confusion and exhaustion and will cause problems that affect the success of the job.

How to Place Epoxy Grout When the Skid has No Grout Access Holes

The warning often seen during televisions commercials that "only trained professionals" should attempt what is being demonstrated, also applies to skid grouting. Trained supervisors are available and well worth whatever extra it costs. Moving epoxy grout horizontally 12 feet over rough concrete that is two inches below the bottom of the skid is a difficult task. In years past when cement based grouts were used (usually unsuccessfully) for skid grouting, chains and steel banding were used to move the grout from one side to the other. Epoxy grouts do not move much with chains, and a new technique has developed where the grout is pulled from one side over to the other. Briefly the major steps are as follows:

- A head box is added to the wood forms on the side where the grouting starts.
- On the opposite side a 1 inch hole is drilled horizontally through the wood form
- A pulling tool head is placed inside the wood form and a piece of ¾" conduit, 3 feet longer than the skid is wide is screwed into the tool.
- Grout is poured into the head box and the pulling tool is pushed horizontally over to the other side until it is under the head box. As the tool is retracted, two blades or wings deploy to form a "tee". Pulling the tool away from the head box moves grout from one side over to the other. As the tool is pushed back again towards the head box, the wings retract so as not to move grout back from where it came!

Each compartment between the transverse expansion joints are filled completely before plugging the hole in the wood form for the pulling rod, and moving over to the next area/compartment to be grouted.

A series of picture showing how this unique grout placing is carried out follows.

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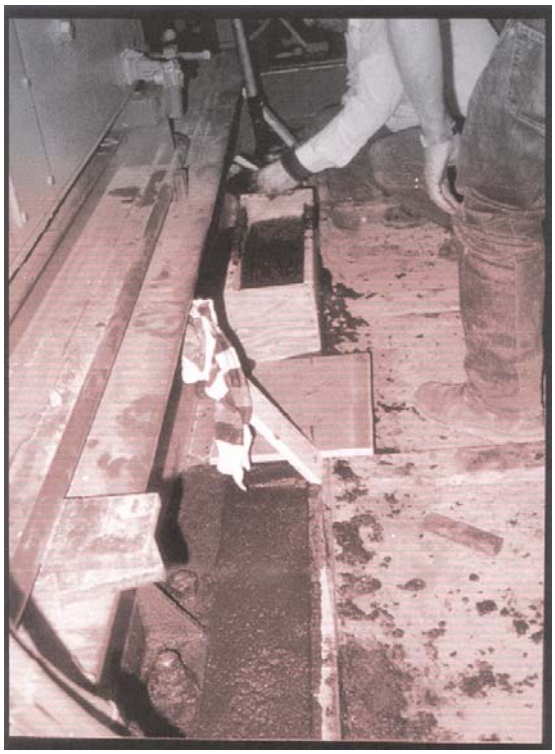

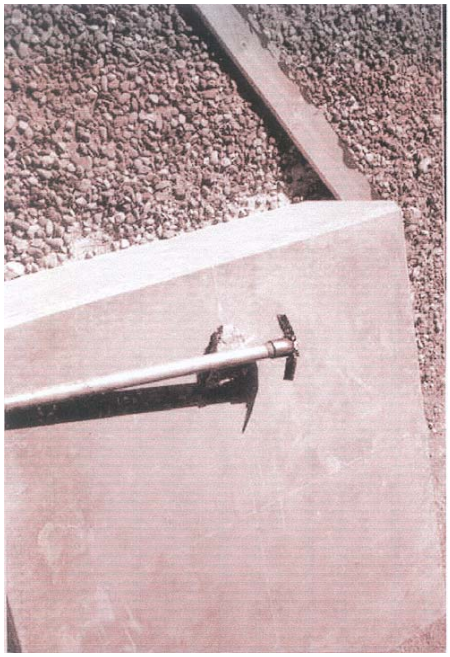

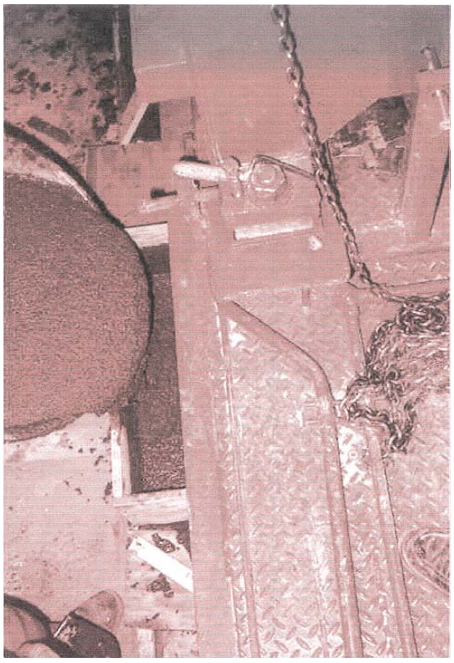

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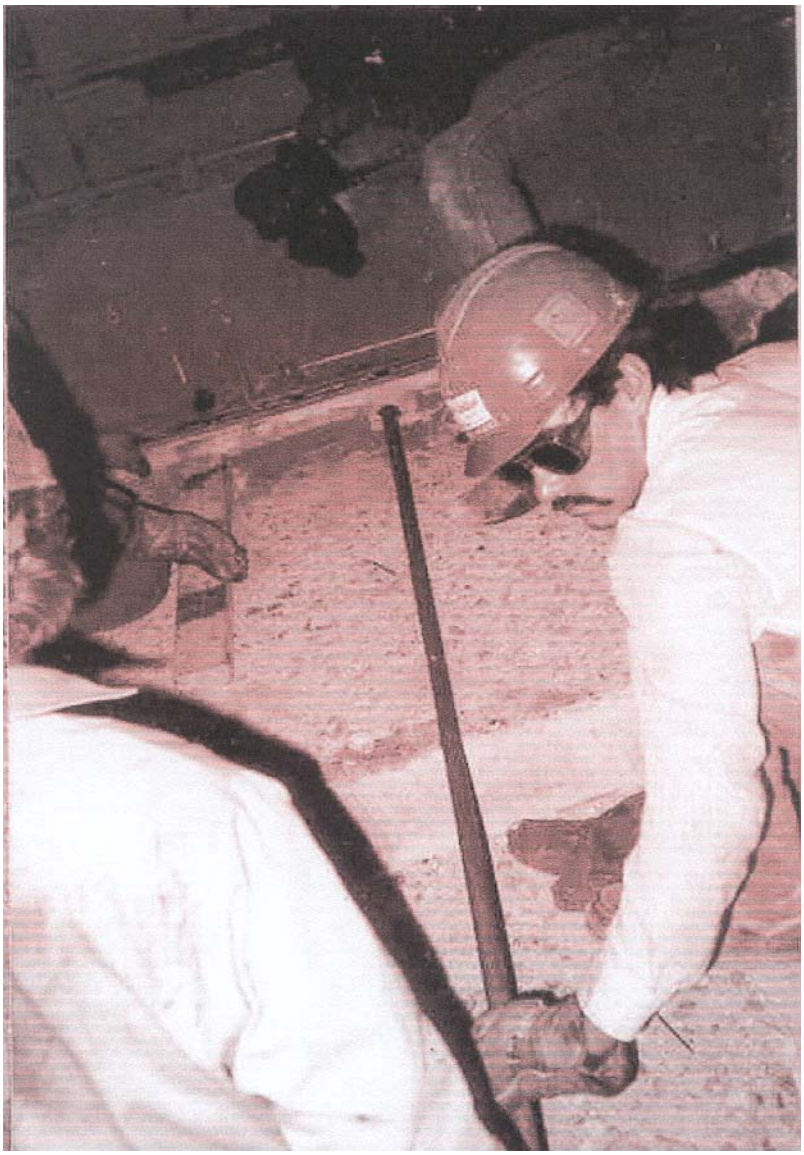

Prejob Meeting

A prejob meeting with the contractor, operator, and supplier representative should be held to cover everything from safety to job assignment. You must have everyone on the same page, as it is very hectic and fast paced once the job starts. Inform the crew what to do if a mixer goes down or there is a leak in the forms. They should know what to do in case of any foreseeable potential problem.

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It is best to begin with an overall description of the job. Describe what we are trying to accomplish and its importance. Grouting is a non-stop operation. There are no breaks during the job. If someone has a problem, they need to know who to tell immediately as well as who can replace or back them up as needed.

Safety regarding mixing, transporting and placing should be covered. The epoxy grouts are hazardous and very heavy so proper lifting techniques as well as dust masks, eye and hand protection per manufacturers recommendations should be covered. A bucket of soapy water should be close by so the crew can clean up as needed during the job. Proper ventilation of the mixing area should also be covered.

Assign jobs to the individuals in the crew and decide who is a back up in case of a problem. Specific jobs, such as mixing liquid and hardener, opening materials, mixing the liquid/hardener and aggregate, transporting, and placing of the material should be assigned. When assigning jobs, cover the particular responsibilities for that job. Make sure everyone knows what the other is doing and how the jobs inter-relate.

What to do in case of a leak, injury or equipment malfunction should also be covered. The crew should know who to tell, what to do, and where to find it, before the jobs starts.

Proper usage of any special tools such as head boxes, grout-pulling tools, or porta packs for bracing forms should be covered as well before the job starts.

Any inspection points should be decided in advance and the crew alerted as to whom to notify at critical points in the job.

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