# Foundation Repairs Increase Grout Life

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*Technology from the Leaders in Foundation Repair and Regrouting*

Some economic conditions in the oil industry encourage postponement of routine maintenance of operating equipment. As a result, machinery foundations fail at an increasing rate during these periods. The most serious type of failure is foundation cracking in a plane parallel to the crankshaft. These cracks may be caused by inadequate design or by operating conditions which exert excessive forces on the foundation. Unless these foundation cracks are repaired at the time of regrouting, grout life will be greatly reduced (usually to about 10% of its normal life).

Lateral dynamic forces are generated by compressor pistons and by some power pistons. Theoretically, if a machine were perfectly balanced, there would be no forces exerted on the foundation other than dead weight. Under such a condition, there would be no need for anchor bolts. In reality, a perfectly balanced reciprocating machine has never been built.

No experienced engineer would ever consider operating reciprocating equipment without anchor bolts.

After establishing the fact that unbalanced forces do exist on well designed and maintained equipment, consider what happens when maintenance is postponed. Take the ignition system, for example. Everyone knows what to expect from an automobile with the engine idling after one or two spark plugs have been disconnected. Imagine the same circumstances with a large industrial gas engine compressor running at 100% capacity. Next, suppose there are lubricating oil leaks which puddle on the foundation shoulder. If any movement exists between the machine and grout, oil will penetrate voids caused by the movement, and hydraulically fracture any remaining bond between the machine base and grout. As movement between the machine and grout increases, forces exerted on the foundation increase at an exponential rate, because of change in direction and impact.

At 330 rpm there are 475,200 cycles per day. Over twenty years the foundation sees the stresses of 3.4 billion cycles. Most reciprocating equipment is expected to last more than 20 years.

The tensile strength of concrete is only about 10 percent of its compressive strength. Because of this weakness in tension, reinforcing steel is embedded in concrete to carry the tensile loads. The placement of reinforcing steel should be with consideration as to the source and direction of the external forces

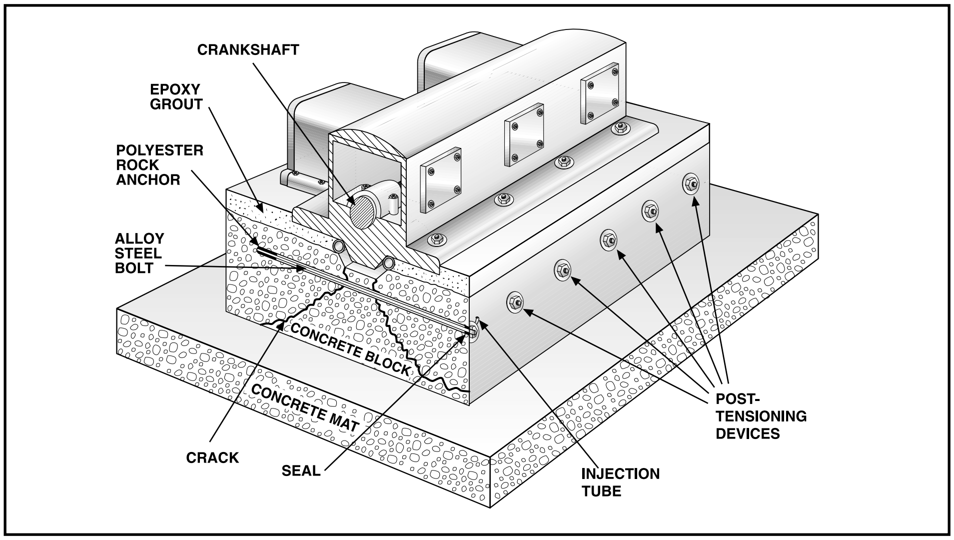


**Fig. 1:** Method of repairing compressor foundations that are cracked parallel to the crankshaft.

applied to the foundation. According to this reasoning, the preponderance of reinforcing steel in a reciprocating engine/compressor foundation should be placed in the upper portion of the block in a direction perpendicular to the crankshaft. Weighting the placement of steel in this location would reduce the tendency for cleavage-type failures that sometimes begin at the top of the foundation in the notch below the oil pan and extend through the block to the mat below.

The notch provided in the top of a foundation for the oil pan creates a perfect location for stress risers. A moment is created by lateral dynamic forces multiplied by the distance between the machine base and the transverse reinforcing steel in the foundation below. The possibility of a foundation cracking at this location increases as the depth of the notch increases. The further the distance between the horizontal forces and transverse reinforcing steel, the greater the moment.

Figure 1 illustrates a method of repairing such cracks by drilling horizontal holes spaced from one end of the foundation to the other end. This series of holes are placed at an elevation of just below the oil pan trough. A high tensile alloy steel bolt is inserted into each hole and anchored at the bottom of the hole. Next, a small diameter copper injection tube is placed in the annular space around the bolt, the end of the hole is then sealed and the nut tightened to an appropriate torque to draw the two segments of the block back together. An unfilled or liquid epoxy is injected into the annular space around the bolt. Air in the annular space around the bolt is pressed into the porous concrete as pressure builds. After the annular space has been filled, injection continues, and the crack is filled and sealed from the inside out.

This repair method places the concrete in compression, which would otherwise be in tension. The compressive condition must be overcome before a crack could possibly reoccur. As a result, the repaired foundation is much stronger than the original foundation. This technique is often used when the concrete in the foundation is of poor quality.

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