PREVENTING MACHINE INSTALLATION PROBLEMS

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Preventing Machine Installation Problems

Optimum machine performance depends on proper installation, anchoring methods, and isolation techniques. A number of ways of satisfying these criteria are discussed by this expert

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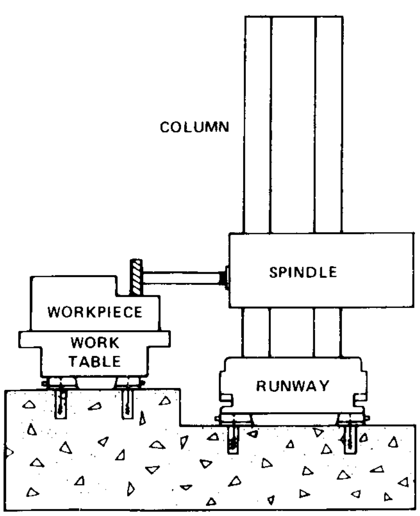
PERFORMANCE, repeatability, and precision designed into today's sophisticated machine tools cannot be delivered without proper installation in a manner designed specifically to meet the machine's requirements. While this seems obvious, there are many instances where the key reason for excessive maintenance or scrap was due to an installation that did not provide adequate support or isolation against shock and vibration. Other costly production problems which can be prevented or corrected with proper installation include short machine life, reduced productivity, and frequent realignment.

Since only about 1% of a machine's total value is generally required for proper installation, it is poor economy not to give due care and consideration to all facets of machine installation. A thoroughly engineered foundation and installation help assure that any machine tool will operate at its optimum performance potential, provide maximum productivity, and give an appropriate return on investment.



1. FOUNDATION IS CRITICAL for this floor-type horizontal boring mill since it is the only connection between machine and workpiece.

Types of Machines. From an installation standpoint, machine tools can be divided into those that are support-critical and those that are not. The foundation is a primary factor in achieving optimum performance with support-critical machines. For example, in a typical floor-type horizontal boring mill installation, *Figure* 1, the only connection between the machine and the workpiece is the foundation.

Basic characteristics of support-critical machine tools are:

▶ An anchoring/alignment system provided by the machine tool builder.

▶ Machine setup procedures which specify in-place alignment criteria.

▶ A machine comprised of several nonconnected segments and large moving masses.

▶ Machines designed for producing large workpieces. When workpiece size or configuration prohibit the construction of a completely self-supporting machine, the foundation must become an integral component of the machine's structure.

Machines that are nonsupport-critical, such as a toolroom-type milling machine, do not require external support to maintain critical alignments. Such machines may require only anchoring for stability, or merely a unit mount which combines leveling capability with vibration isolation. These machines generally include toolroom equipment, small lathes (under 48″ — 1219 mm between centers), small grinding machines for short workpieces, and various types of process equipment.

Determining whether shock and vibration isolation is a primary requisite for proper machine tool installation requires analyzing the machine, its task, and the environment in which it will operate. For example, if very precise machining is being done, irregularities caused by external shocks or vibrations are easily detectable and often disastrous. Conversely, a large milling machine for roughing operations would not be sensitive to, or critically affected by, the same magnitude of shocks or vibrations.

Sources of Shock and Vibration. Shock and vibration sources can originate from nearby manufacturing operations or other sources in the plant environment. Typical shock/vibration sources emanating from nearby operations include forging hammers, heavy presses, in-plant traffic and crane movements, and machine tools in the vicinity that are taking heavy or interrupted cuts. Sources from the nonmanufacturing environment include railroad and highway traffic. Another often-overlooked source of vibration problems is resonance of the building floor. When mechanically excited by extraneous sources, building floors may resonate at a natural frequency, which can cause considerable difficulty if not dealt with.

Isolating a support-critical machine means isolating the entire foundation as well as the machine, since they are a single unit. Nonsupport-critical machines, however, can be isolated successfully by a unit mount. A combination anchoring/isolation arrangement that provides isolation pads and an anchor bolt in a "bolt-through" connection is good for machines such as top-heavy presses that require substantial restraint.

Foundation Configuration. Since the foundation is an integral part of the machine structure, it is extremely important to design the foundation to be stiff enough to provide the required machine support; the basic foundation geometry is critical. For example, a few extra inches of thickness can make a large difference in the overall stiffness of a particular foundation.

Foundations must also be designed so that they react uniformly to dynamic loads no matter where they occur. Local soil conditions must be taken into account to assure stability of the foundation.

Foundation Connections. Once an adequate foundation has been established, the next task is to secure the machine to the foundation, making the machine structure and foundation integral. To achieve this, a connection of adequate rigidity must be provided. For most machine tools, a means of adjusting the relationship of the machine base to the foundation is also a prime requirement. The following approaches may be considered.

Anchor bolts and shims, *Figure* 2, offer a moderately rigid connection between machine and foundation. This approach, however, may not be adequate for high precision machinery because the large number of interfaces under load compromise the rigidity. Another drawback to this method is that precise alignments are often difficult to achieve.

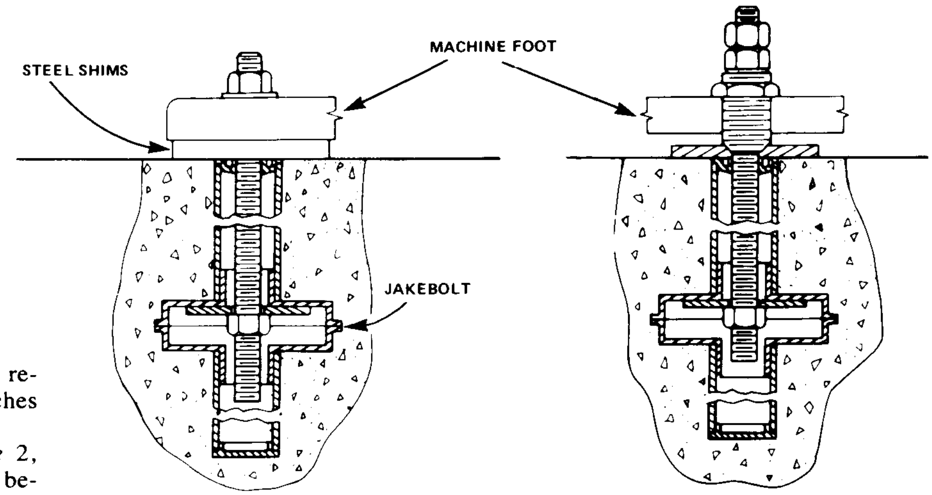
Leveling screws, *Figure* 3, permit faster adjustment than the shimming method. However, more frequent realignments are generally necessary. Also, precise alignments are difficult.

Anchor bolts in grout, *Figure* 4, provide a strong, continuous, and rigid support between a machine and its foundation. Grouting assures that the voids between the machine base and foundation surface are completely filled with a load-bearing material. A nonshrinking grout should be used to assure that critical alignments are maintained and maximum rigidity achieved.

Leveling wedges, *Figure* 5, provide a firmer and stiffer support than either the shim pack or leveling screw. The most basic leveling wedge is a simple two-piece device which permits vertical adjustments by moving one wedge against the other with an adjusting screw. A more effective technique is to employ a three-piece wedge, with the third (upper) wedge member remaining stationary. With this design, horizontal motion is not transmitted to the machine as vertical adjustments are being made.

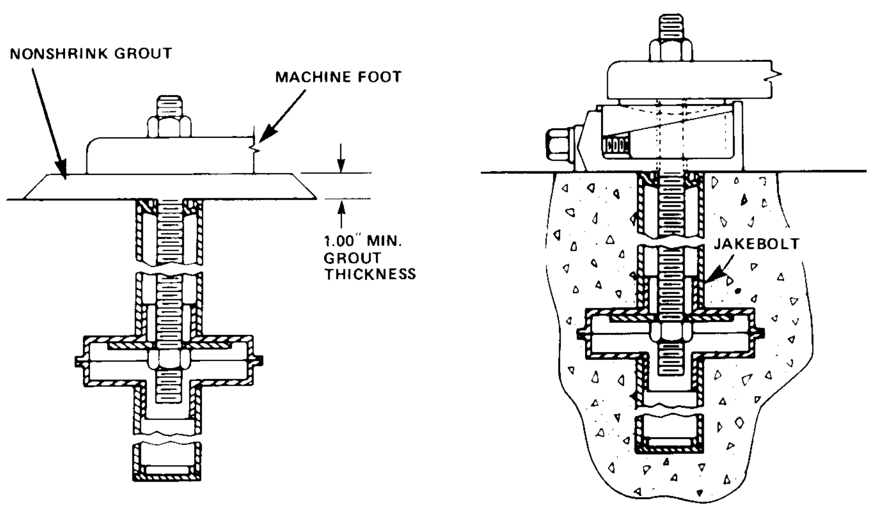
Mount systems are available which combine a three-piece wedge with a spherical seat arrangement in the upper wedge. This compensates for misalignment between the floor surface and the base of the machine. The system provides rigid support, easy adjustment, and a cost effective means of installing precision machinery.

Isolating the Machine. Total isolation of a support-critical machine first requires isolating its foundation, since the foundation and machine are a common unit. Excellent results have been



2. ANCHOR BOLTS and shims offer a moderately rigid connection between machine and foundation, but may not be adequate for precision machines.

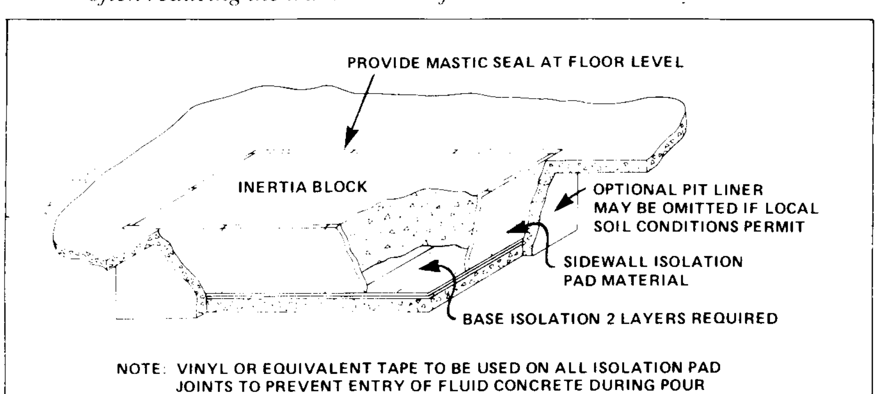
3. LEVELING SCREWS permit faster adjustment than shimming method (Figure 2), but may require more frequent realignment.



4. BOLTS IN GROUT provide a strong, continuous, and rigid support between machine tools and their foundations.

5. LEVELING WEDGES, with adjusting screw, provide a firmer and stiffer support than shim packs (Figure 2) or leveling screws (Figure 3).

6. ISOLATED INERTIA BLOCK gives excellent results, often reducing the transmission of shock and vibration by as much as 90%.



achieved with the isolated inertia block method, *Figure* 6. The transmission of shock and vibration can often be reduced by as much as 90% in this way, leading to natural frequencies as low as 7 to 8 Hz. Basically, this method suspends the machine/foundation system on a deflectable element which has the ability to absorb energy and drastically limit its transmission. Foundation isolation pads are specifically engineered today for this application, and have been well received by the machine tool industry.

Isolation materials are installed during the early phases of foundation construction, and require only standard construction practices. Typically, an excavation is made to the size and shape of the desired inertia block. The pad material is then placed against the sidewalls, and the foundation poured inside the barrier. In some soil conditions, it may be necessary to provide a foundation pit liner, which usually consists of a few inches of concrete.

A similar isolated inertia block approach is also effective when applied to source machines such as presses, chip crushers, and other equipment which normally generate troublesome shocks and vibrations. In these applications, the foundation isolation materials serve to prevent the transmission of shock from the block to surrounding areas — functioning exactly opposite to that of the typical machine tool installation.

Installing Machines Which Are Not Support Critical. While many machines do not require substantial support from their foundations, they may have to meet several different installation requirements. For example, it may be necessary to prevent the machine from "walking" during normal operations. Also, for certain machine configurations, an anchoring restraint might be required to eliminate safety hazards. Leveling may also be a consideration, particularly if floor conditions are less than ideal.

Where anchoring is not required, a freestanding mount combining vibration isolation and leveling capability is recommended. Such mounts, with specially treated bearing pad surfaces to prevent walking, are now commercially available. They are especially effective for injection molding machines and presses. For machines that do not require leveling, pads provide efficient, low-cost vibration isolation, and also prevent walking.

For installations where vibration isolation and anchoring are required, pads can be used in a bolt-through configuration. This assures a high degree of shock/vibration isolation, while providing the positive restraint of an anchor bolt. ■

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