PRESS FOUNDATIONS AND MACHINE LEVELING

Achieving long trouble-free service from presses and dies starts with proper installation of the machine on a good foundation. A properly engineered foundation together with correct mounting and leveling of the press bed is an essential requirement for long trouble-free service. [1] [2]

Foundation Requirements

Machine sizes range from small bench presses that can be carried with one hand to multiple-slide transfer presses weighing over 1,500 tons (1361 metric tons). No one mounting method is correct for every application. Press mounting methods include:

1. Placing felt or rubber pads under the mounting feet.

2. Fastening the press to the floor with bolts grouted into the concrete.

3. Using shims and grout to take up any irregularities between the mounting slab and the press feet.

4. Attaching the press to a concrete slab or inertia block.

5. Providing a concrete foundation placed on bedrock.

6. Placing the press on adjustable resilient mounts.

7. Placing steel coil springs between the press feet and foundation—viscous dampers may be required to damp resonances at some press speeds with spring mounting.

Non-Critical Press Mounting

Some small gap-frame open back inclinable (OBI) and open back stationary (OBS) presses do not require a critical foundation alignment system. Many small presses can be placed on felt or rubber isolating pads. Presses that can be mounted in this way are termed *non-foundation critical*.

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[1] S. Young, Press Isolators: ***Their Function and Effectiveness***, Metal Stamping, The Precision Metalforming Association, Richmond Heights, Ohio, February © 1980.

[2] W. Whittaker, ***Preventing Machine Installation Problems***, Manufacturing Engineering, The Society of Manufacturing Engineers, Dearborn, Michigan, April © 1980.

A thick reinforced concrete floor over earth or rock of sufficient load bearing capacity is often sufficient. The resilient pads, shown in Figure 1, compensate for slight floor irregularities that might otherwise cause machine misalignment. The mounting pads also reduce vibration transmission to the floor and retard lateral press movement.

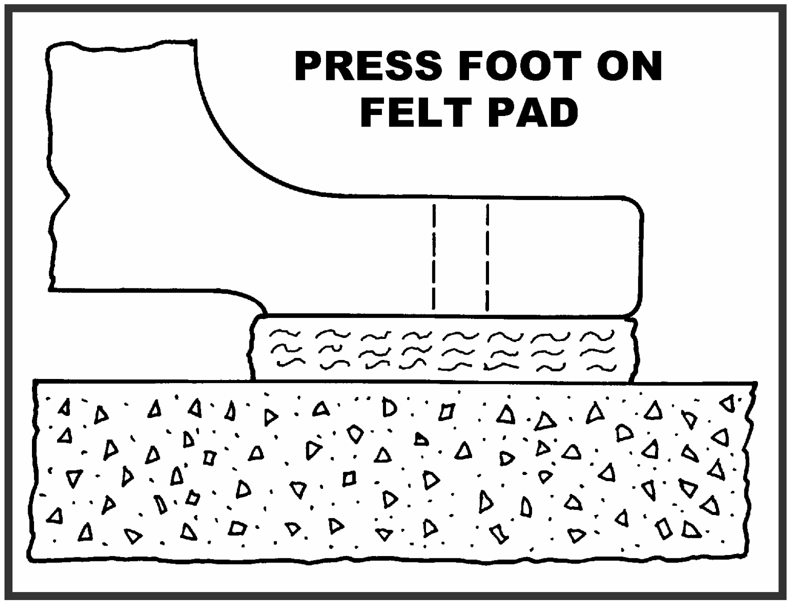

Figure 1. A press foot shown resting on a felt pad. *Smith & Associates*

Presses with Critical Mounting Requirements

Unlike most small OBS and OBI presses, large machines are *alignment-critical*. Any irregularities or unevenness in the mounting surfaces may have harmful effects. These may include:

1. The press may move from the location at which it is placed.
2. Damaging levels of vibration may occur because the uneven support increases the effect of the vibration.
3. Uneven support can result in the press bed being skewed.
4. Bed skewing results in misalignment of many critical press parts.
5. Press misalignment can result in die misalignment.
6. Part quality problems together with rapid press and die wear are typically the result.

Dead Weight Compared to Live or Dynamic Weight

The load on the foundation has two components. First, there is the total machine static weight or dead weight. The foundation should not be designed based on this factor alone. There is also the live weight that is generally assumed to be 1.5 times the static or dead weight of the machine.

A number of factors determine press foundation requirements. Presses subjected to snap-through loads from cutting operations have more critical foundation requirements than similar machines used for drawing or forming.

Presses having slides that are heavy in relationship to the total machine weight require careful engineering analysis when determining foundation requirements. This is especially true of high-speed presses. As the weight of the slide, stroke length and strokes per minute increase, the dynamic forces acting on the foundation also increase.

Many press manufacturers and engineers allow a safety factor of 1.5 times the dead weight of the press and heaviest die for the live weight factor when designing the foundation. This is a rule of thumb. An individual case-by-case engineering analysis may result in a different actual live weight figure. Of course, it is wise to over-design the foundation if there is any doubt as to the actual live weight. The amount of live weight is greater in the case of presses having heavy slides and upper dies operated with long stroke lengths and at higher speeds.

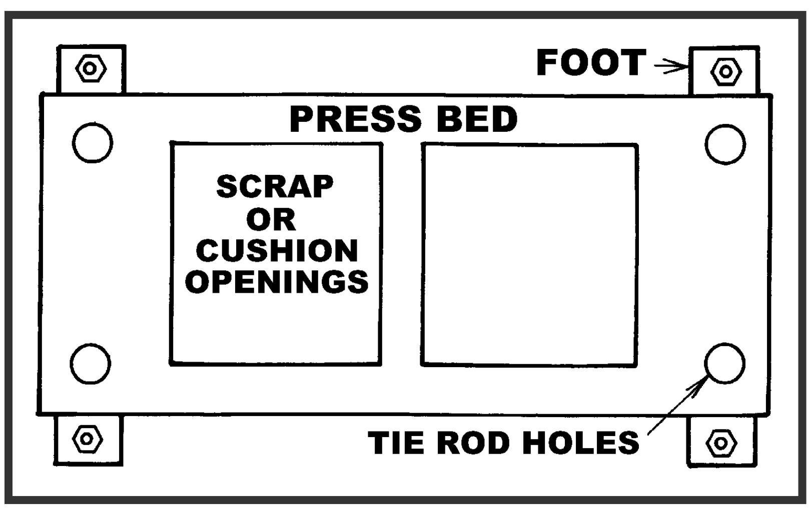

Figure 2. Plan view of a typical straight-side press bed. The main structure may be of either welded steel or cast iron construction. Holes for the tie rods are provided. Openings are provided for die cushions and/or the discharge of scrap. Mounting feet with holes are provided for supporting or anchoring the machine. *Smith & Associates*

Soil Conditions

If the press is placed on a reinforced concrete floor, the thickness and strength of the concrete are important factors. However, the soil condition under the concrete is a very important consideration. Well-drained undisturbed clay over sound bedrock can support heavy loads. Foundations placed on solid bedrock are ideal.

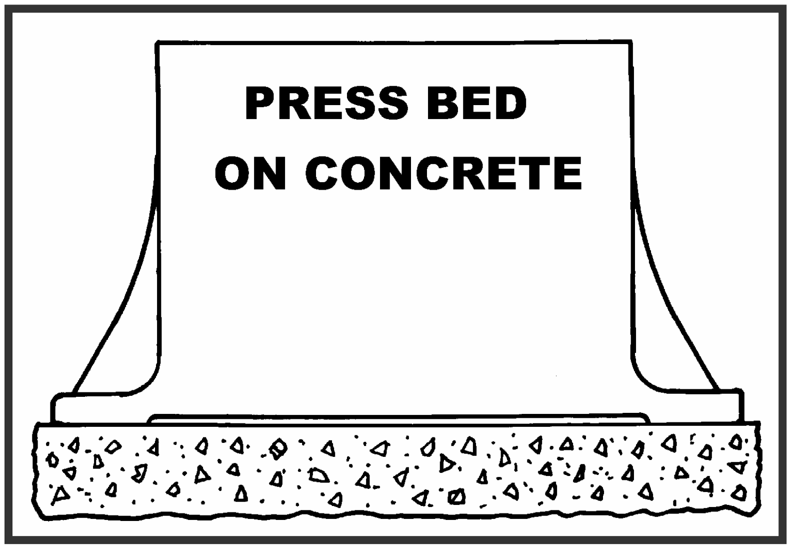

Figure 3. Press bed resting on a thick concrete slab. *Smith & Associates*

Building a pressroom over unstable fill or wet soil can require very costly measures to insure a proper press foundation. Seeking the advice of a structural engineer who specializes in designing foundations for heavy machinery can avoid costly errors.

The Slab or Inertia Block Foundation

Many types of press foundations can be found in use throughout the pressworking industry. Variables such as soil conditions, machine weight, and dynamic loading all should be considered when developing a final plan for a foundation design.

Press manufacturers may supply guidelines for foundation requirements. Because of the effect of stamping applications, the final responsibility for a proper installation is the duty of the machine user. One of the most popular foundations is a rectangular slab of reinforced concrete placed on soil at least as good as firm well-drained clay.

Typically, the slab is isolated from the surrounding concrete flooring by an inch (25.4-mm) of insulation board and the top of the joint sealed with an oil resistant sealing compound. For example, the Minster Machine Company provides copyrighted foundation design ideas for installing their E2 series presses. [3]

[3] Operators Manual No. 1125B for the Minster ® series E2 HeviStamper™ eccentric shaft straightside press, Copyright © 1971, 1978 by Minster Machine Company, Minster, Ohio 45865.

Reference 3 suggests that the slab should extend at least 18 inches (457.2 mm) beyond each of the press feet on all sides for Minster E2 presses. The reference suggests that less than ideal soil conditions may require a larger slab. Figure 4 illustrates a slab type of press foundation isolated from the surrounding concrete flooring.

The slab thickness (E) should provide a weight equal to or greater than that of the machine if soil conditions are ideal and press speeds are under 300 strokes per minute (SPM). If the press is to operate at speeds above 300 SPM and/or shock loads from blanking snap through energy release are expected, the weight should be increased to 1-1/2 to two times the press weight. If the soil conditions are not ideal, it may be necessary to increase the foundation dimensions in all directions.

The concrete must be of high quality and have a minimum compressive strength of 3,500-psi (24,129 kPa) after curing 28 days. If anchor bolts or other fasteners are to be used, they should be cast into the slab at locations that line up with the mounting holes in the press feet. The weight of the press must be distributed evenly on the slab foundation.

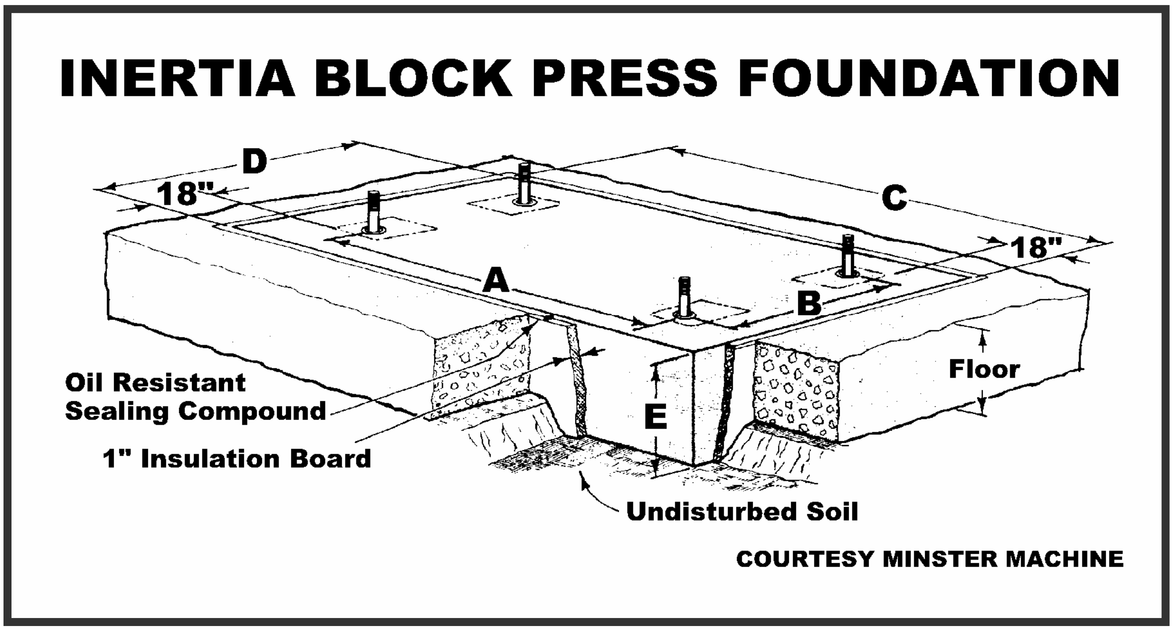

Figure 4. An illustration of an inertia slab type press foundation. It is important to place the slab on undisturbed soil at least as good as firm clay. Reinforcing rods are placed in the slab. See the text for additional design considerations critical to success.
Courtesy of the Minster Machine Company

Avoiding Uneven Support and Press Bed Skewing

Press beds should be level and must be free of skewing or twist if high-quality presswork is to be accomplished. The terms level and twist or skew are often confused. Level refers to a horizontal condition. A skew is a mechanical bed deformation.

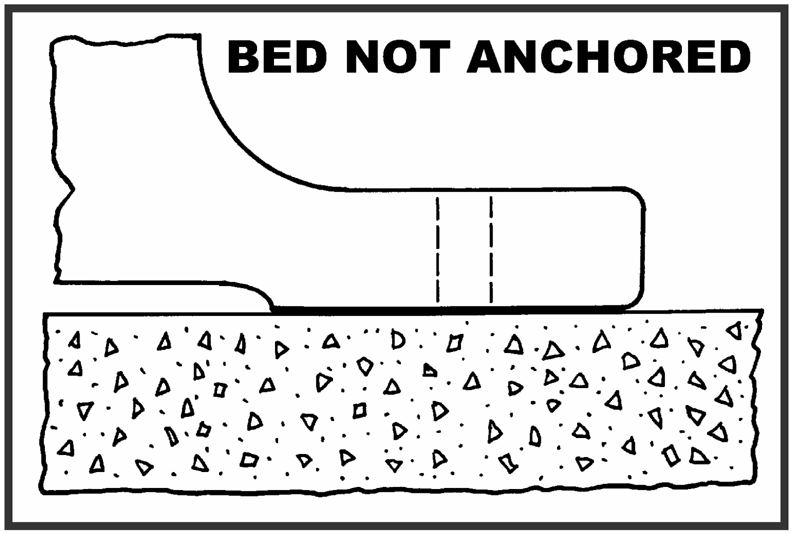

Figure 5. If press beds are not anchored to the floor, lateral movement or "walking" may occur. *Smith & Associates*

Placing the Press on the Foundation

Figure 3 illustrates an end-view of a straightside press bed resting on a thick concrete slab. Here, there is no provision made to anchor the press. Lateral motion or walking shown in Figure 5 of the press may occur. Another problem is that not all four mounting feet may rest solidly on the slab illustrated in Figure 6 resulting in one or two corners being unsupported.

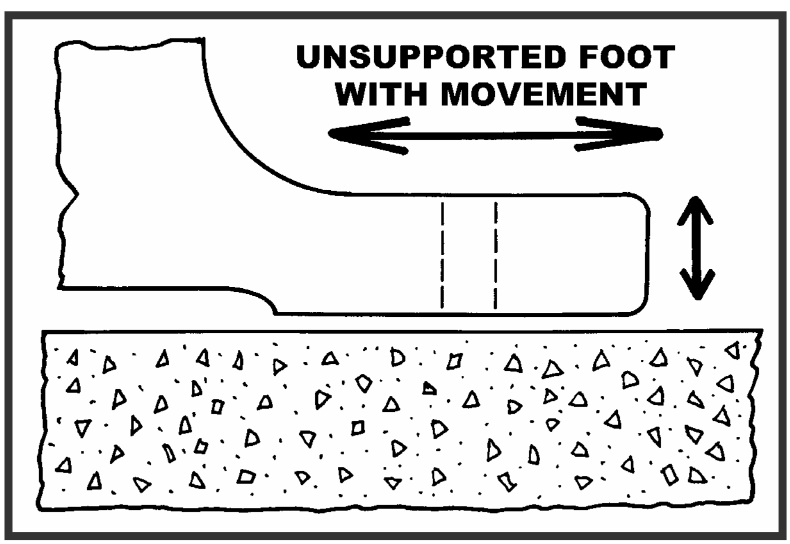

Figure 6. Placement of a straightside press on a concrete floor or foundation may result in a mounting foot being unsupported. *Smith & associates*

Resilient felt pads with an anti-slip coating often suffice for small presses. However, it is recommended that any press having critical alignment requirements be supported properly and anchored to the foundation securely. An approved alternative is to place the press on adjustable resilient elastomer, metal or pneumatic spring mounts. Accurate alignment of machines having critical leveling requirements is part of the installation procedure. However, periodic maintenance procedures including checking for any bed skewing is generally the responsibility of the user.

Measuring Equipment for Leveling Press Beds

The equipment required range in complexity from the simple precision machinist's level to vibration monitoring using accelerometers and waveform signature analysis. Electronic strain sensors are built into some adjustable resilient mounts to indicate which mounts to adjust and how much to adjust them for optimum level and support conditions.

For most work, the machinist's level is the most frequently used press bed-leveling tool employed to insure that the bed is free of skewing. The press manufacturer's specifications should be met or exceeded. A skew of no more than 0.0005 inch (0.0127 mm) per foot (304.8 mm) is often recommended for accurate straightside presswork.

Usually, this process is referred to as leveling the bed. However, removing any bed twist or skew is the goal to avoid misalignment of the parts of the machine. If the bed is skewed, the alignment error is transferred to other machine members and the die as well. The clearance in machine parts such as gibbing, gears, and bearings will be changed. This may result in binding of machine parts and die misalignment. The result is often accelerated press and die wear as well as quality problems with the stampings.

The Machinist's Level

Figure 7 illustrates a precision machinist's level. A machinist's level is much more precise than a carpenter's level and can easily be calibrated in the field. The basic accuracy of the level is ten seconds of an arc per division.

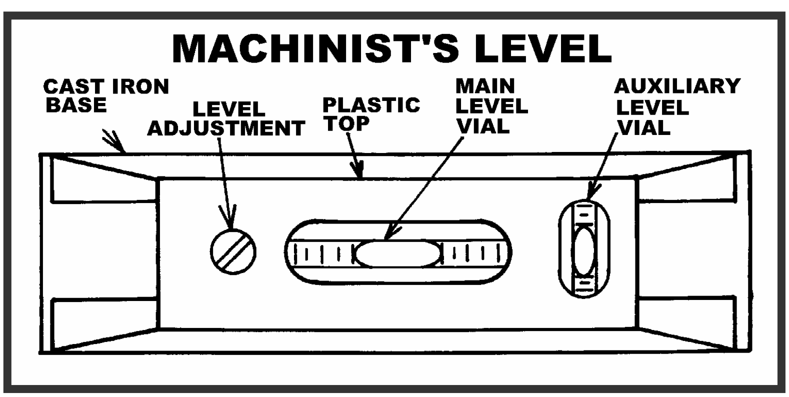

Figure 7. The essential features of a precision machinist's level used for press bed leveling. The function of the details and adjustment procedure is explained in the text. *Smith & Associates*

The base is made of iron alloy, which has been carefully processed for stability and scraped flat. The top cover of the level is made of a plastic insulating material to minimize body heat transfer to the iron base during handling. The main level vial is precisely ground and graduated in divisions of 0.0005-inch per foot, or 0.042-mm per meter. An auxiliary vial shows lateral position and assists in horizontal setting of the machine bed.

Calibrating the Level

Placing the level on a level surface plate or coordinate measuring machine table will serve to test both the level and surface for true level adjustment. First, place the level on the test surface and note the position of the bubble. If it is in the center, turn the level end-for-end. If the bubble remains exactly in the center, the level is correctly adjusted, and the test surface is level as well.

If the bubble is found to move in the same direction an equal amount when turned, the level is correctly adjusted, but the test surface is out of level the amount indicated by the machinist's level. Should the bubble not move equal amounts, the cover screw can be removed to gain access to the adjustment screw.

The screw is turned a slight amount and the level turned the level end-for-end while observing the result. When the bubble offset is equal when turned, the level is correctly adjusted. The test surface can then be leveled, and the machinist's level double-checked for exact adjustment.

Testing and Adjusting the Press Bed

Figure 8 illustrates a machinist's level placed on a skewed straight-side press bed. The level at the bottom of the figure indicates a level condition while the one placed on the other side of the bed is out-of-level indicating a skewed condition. Figure 9 is a close-up view of the second level.

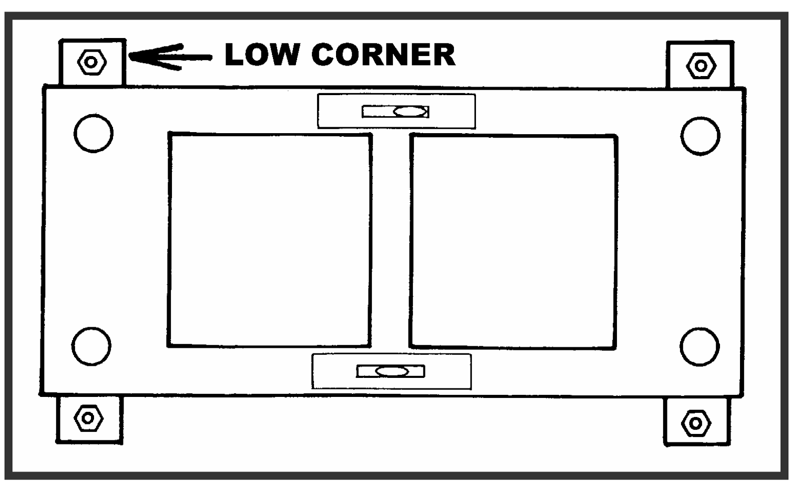

Figure 8. The level at the bottom (front) indicates that the bed is level left to right while the one at top (rear) is out of level indicating a skewed press bed condition.
Smith & Associates

Correcting a Skewed Press Bed

If the press is solidly mounted to its foundation, shims may be used to correct a skewed condition. The object is to remove any skew observed in either side of the press bed. The bed should be free from skew with equal weight resting on each support. The purpose of the shims is to correct any unevenness in the foundation. Figure 10 illustrates the press bed after the skew is corrected by shimming the low corner.

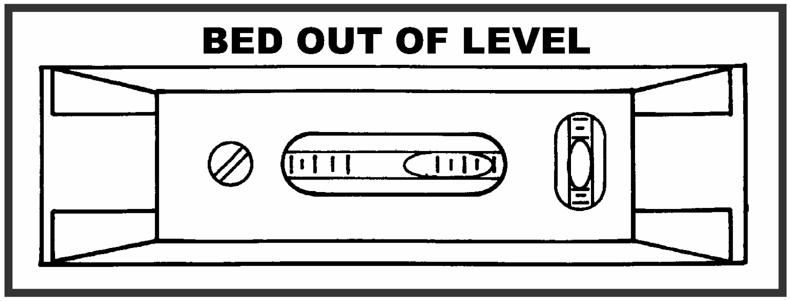

Figure 9. A close-up view of the top of the level illustrated in figure 8. To correct the skew, shims must be added under the press support. *Smith & Associates*

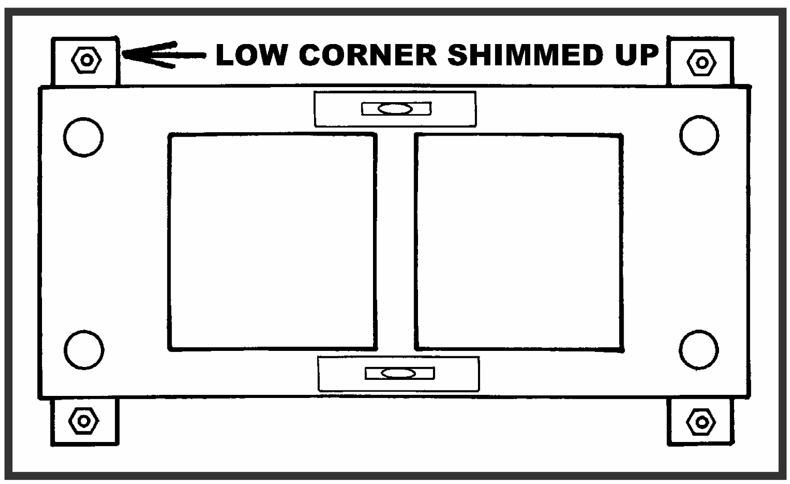

Figure 10. The press bed is level on both sides after the skew is corrected. *Smith & Associates*

Large Uncorrectable skews

Some press beds may have a skew that cannot be removed by shimming. The amount of inaccuracy should not exceed manufacturer's recommendations. For presses intended for close work, the skew should not exceed 0.0005-inch per foot (0.04 mm per meter).

Large skews that cannot be corrected may result from inaccurate machining, damage due to severe overloading and stresses created during the fabrication process if the press is made of welded steel plate. New welded press components as well as major welded repairs require normalization to relieve any stresses prior to machining.

Over the years, the writer has observed many welded press modifications intended to reduce deflection or repair severe damage resulting in broken components. To perform this work correctly, the press should be dissembled and the welding carried out with careful pre and post heating followed by remachining to restore dimensional accuracy.

In the event that a large uncorrectable skew is found, the cause should be investigated. If the press is new, a machining error may have occurred.

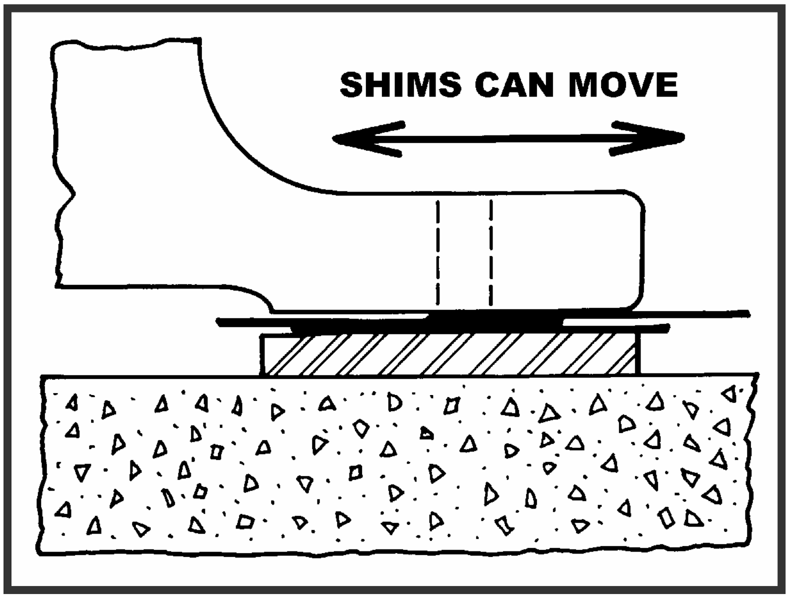

Figure 11. Steel shims placed under a press support point tend to shift out-of-position. *Smith & Associates*

The accuracy of machine alignment and acceptable deflections should be specified and contractually agreed upon when the machine is ordered. If the press does not meet specifications, warranty service should be requested and payment withheld pending correction.

Placement and Retention of Leveling Shims

If steel shims are placed under a press foot, they will tend to shift out-of-place as illustrated in Figure 11. To prevent the, anchor bolts grouted into the floor (Figure 12) should be used to secure both the press and shims in place.

Leveling the Press with Grout

Grouting may be used alone to compensate for any irregularities in the press foundations. Temporary shims or jacks are used to support the machine until the grout cures. Forms are required to hold the grout in place. In most cases, at least 72 hours are required for the grout to cure prior to tightening the foundation bolts. Epoxy based bolt anchoring materials are also available and are excellent for this purpose.

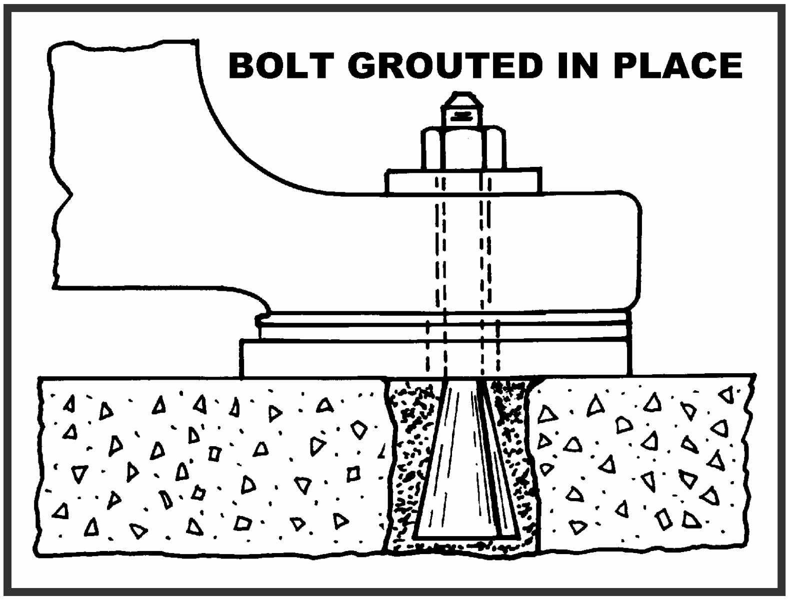

Figure 12. Securing the press to the foundation with bolts grouted in-place serves to anchor the press and hold the leveling shims in position. *Smith & Associates*

Extremely large presses having dedicated foundations may have large thick steel plates placed in the concrete to provide a firm level surface upon which to mount the press. This avoids extreme load concentrations on a small area of concrete and provides a smooth surface for the placement of leveling shims.

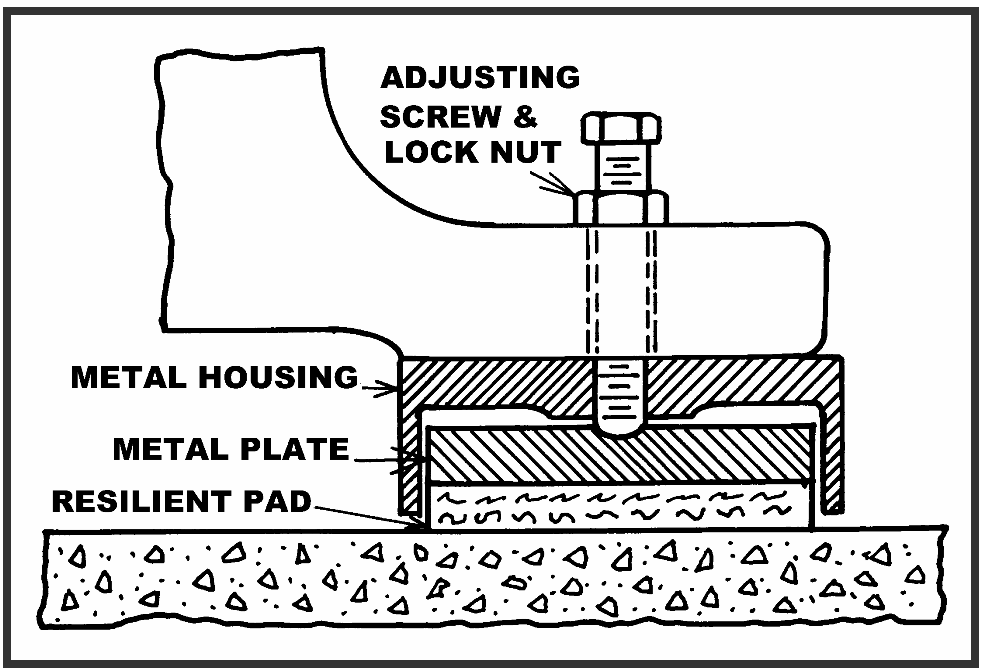

Figure 13. A sectional view through a resilient adjustable press-mounting device. *Smith & Associates*

Adjustable Resilient Mounting Devices

Figure 13 illustrates a section through press-mounting device housing under a press foot. The housing contains a resilient substance such as rubber or felt. A screw and lock nut transmit the press weight to metal plate, which spreads the load of the press foot over the resilient material, which rests on the press foundation.

Advantages of Adjustable Resilient Mounts

There are some important advantages to the use of resilient adjustable mounts for press installations. Deflection of the elastic material in the mounting device converts mechanical energy to heat. This serves to reduce the transmission of shock and vibration to the mounting surface. The adjustment screw permits rapid and precise leveling of machines weighing up to several hundred tons. Subsequent releveling due to foundation settling is fast and easy.

Features Available in Adjustable Resilient Mounts

Jacks and solid jacking points are required for conventional shim placement. Very heavy machines may also require jacks to support most of the press weight in order to permit the resilient leveling device screw to be adjusted. Hydraulic lift cylinders are built into some of the larger mounts. This feature permits the screw to be easily adjusted when leveling very large machines weighing 1,500 tons or more.

Another feature is strain gages attached to the leveling screw to measure the actual weight being supported with the use of an external readout device. These strain gages aid in adjusting the mounts to fine-tune the uniformity of support of the press feet.

The expense of leveling systems can often be justified by speeding up press installation. This is especially true in the case of very large machines. A potential disadvantage is that large presses installed on flat concrete flooring are raised high enough to require stands to permit the operator to reach the press controls. The change in height is also a problem in retrofitting existing tandem lines. Of course, new installations having press pits can easily have provision for the mount height provided for in the planning stage.

Other Considerations and Features of Resilient Mounting Systems

The resilient material used is typically molded neoprene rubber, although some use may be made of polyurethane and other elastomers. Another type of resilient mounting system makes use of steel coil springs. The mount must absorb energy. This requires planning in the design of a resilient mounting system to dissipate the heat generated.

In addition, coil spring mounts may incorporate hydraulic or viscous fluid dampers. Careful calculation of the amount of machine live weight and energy dissipation requirements of the damping system must be done in order to avoid heat and fatigue failures of such systems. Another factor is the effect of any unequal weight loading caused by press parts such as a large outboard flywheel. Both the static and live weight on each mounting point is taken into account when designing a trouble free resilient mounting system.

Tipping Safety for Open Back Inclinable (OBI) Presses

One of the most extensively used presses in the industry during the nineteenth and the latter half of the twentieth century. Figure 14 shows an older style of gap frame press with all guarding removed. This style of machine is known as open back inclinable or OBI press.

The press frame is secured in a cradle formed by the two separate sides of the press base. This permits the machine to be inclined backward. This is done to facilitate gravity loading as well as part and scrap discharge out of the *open back* of the press. [4]

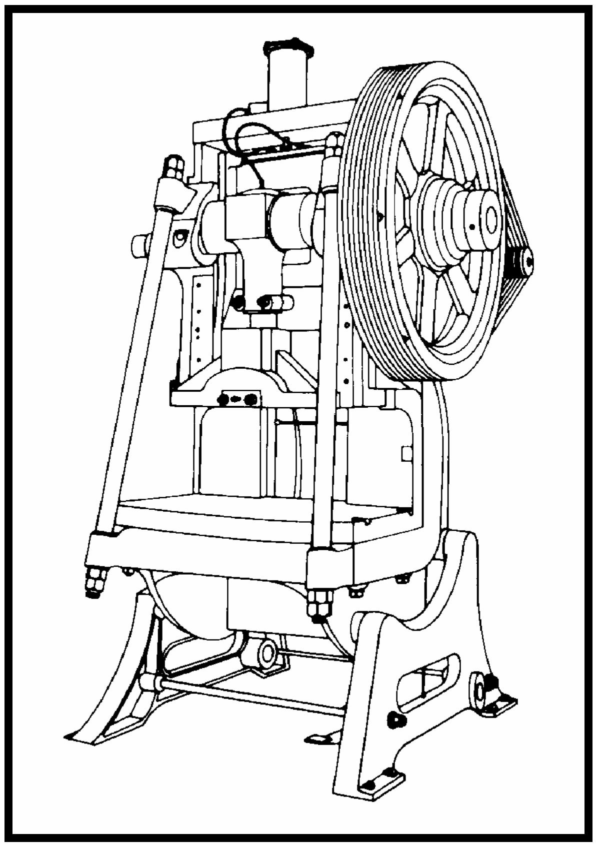

Figure 14. An older style open back inclinable (OBI) gap frame press with all guarding removed. Note that the use of the foot actuated full revolution clutch shown is no longer permissible for most applications.

[4] D. Reid, "Fundamentals of Tool Design", Third Edition, Chapter 7, "Design of Pressworking Tools", The Society of Manufacturing Engineers, Dearborn, Michigan, © 1991. The source art was taken from this publication.

Depending upon speed of operation and tooling accuracy OBI presses may not have critical foundation requirements. Felt pads and in some cases, anchor bolts may be placed under the feet to absorb vibration and compensate for minor mounting surface irregularities.

Some OBI presses can tip over backwards if inclined excessively. Here the press manufacturer's recommendations regarding the need for anchor bolts or other means to prevent tipping should be strictly followed. An alternative is to permanently and effectively disable the ability to incline the press.

A solution that is especially useful to reduce or lessen the tipping hazard is achieved by bolting the press feet securely to a heavy steel plate. The cradle then becomes a stronger more stable one-piece base. The use of a steel plate engineered to provide stability can be used in conjunction the type of adjustable resilient press mounting devices illustrated in Figure 13. The use of a steel plate has other advantages, which include increasing the press support and mass. The additional mass can be especially beneficial for high-speed operations.

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