

OVERVIEW OF MECHANICAL DIE FASTENING

The primary purpose of any die clamping system is to retain the die in the press in a safe and secure manner. A good clamp must be strong and quickly applied. It must resist breaking or loosening when subjected to repeated shock loading. The use of high quality fasteners provides the best overall safety and economy.

Many die clamps use threaded fasteners. The clamping system may be as simple as a T-bolt, nut, and special heavy washer. This is very simple and effective if U-shaped cutouts having a constant tie-down height are provided in the die.

Hydraulically powered clamps may be cost-effective when many die changes are performed daily. Automatic die changes on large tandem lines and transfer presses require pneumatic or hydraulically actuated clamps. However, they are not a cure-all for reducing setup time when manually setting dies.

Safe Fastener Standards

A basic responsibility of pressroom management is to provide a safe workplace. The number, size, and location of fasteners should be specified in the design of the die. Every company having pressworking operations should have die design standards covering each class of work performed. Standards, including diesetting procedures should be periodically updated based on experience and sound engineering principles.

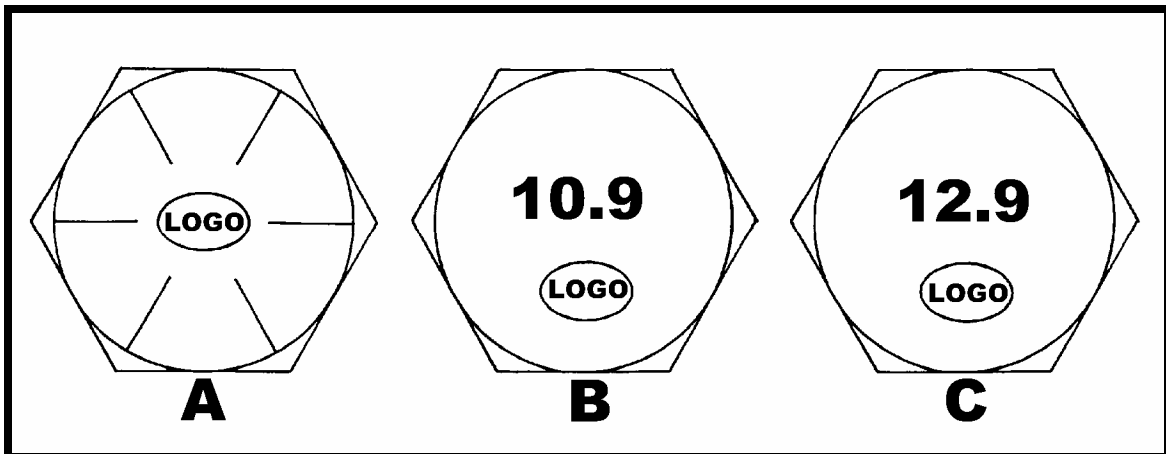


Figure 1. The heads of bolts often specified for diesetting have distinctive head markings. SAE-ASTM grade eight bolts (A) are identified by six markings. The metric fasteners are ISO 10.9 (B) or ISO 12.9 (C) property class bolts. All SAE-ASTM and ISO fasteners meeting these specifications are identified with the manufacturer's logo or identification.

The clamping examples discussed and illustrated in this paper are not suitable for all classes of work. It is to be noted that clamping practices suitable for clamping workpieces in machine tools are not necessarily suitable for die fastening. Presswork involves dynamic forces and often shock loading.

Safe pressworking depends on the use of a sufficient quantity of clamps to securely hold the die in the press. The attachment of the die buildup including parallels and sub-plates also requires an adequate size and number of high-grade fasteners to insure against failure.

Some classes of work may require fastener safety factors several hundred times the static weight of the die and buildup alone. Note that a safety factor of as much as 300 not 300% is stated. A safety factor of 300 is 30,000% of the static load. High-speed work involving rapid cyclical loading is an example of an application requiring large safety factors. The shock and impact loads occurring in slow operations can also be quite severe. Typical causes are snap-through energy release in heavy punching operations as well as heavy cam and pad return impact.

Recommended Fasteners

It is highly recommended that only SAE grade eight or equivalent fasteners are used for diesetting applications. These bolts are made of heat-treated alloy-steel having a minimum yield-strength of 130 KSI (896 mPa). An ASTM equivalent is specification designation number A354, grade BD threaded fastener. Both of these fasteners are identified by six markings on the head illustrated in Figure 1 (A).

It is worth noting that all specification-grade fasteners made in the United States have a manufacturer's mark or logo in addition to the grade marking. If there is no manufacturer's identification, the bolt may be imported.

Some imported bolts have failed to meet specifications. Diesetting fastener safety is too critical to leave fastener safety to chance. Require the seller to properly identify all fasteners and supply certified test results.¹

Metric Diesetting Fasteners

Many metric die standards specify ISO 10.9 or 12.9 property class bolts for diesetting. These have yield and tensile strengths similar as the recommended SAE and ASTM fasteners. Metric fasteners have the property class numerical designator and maker's identification stamped on the head as illustrated in Figures 1 (B) and (C).

Avoiding Unsafe Fasteners and Fastening Methods

¹ J. E. Shingley and C. R. Mischke, Mechanical Engineering Design, Fifth Edition, McGraw-Hill, New York, 1989. The problem of deliberately misidentified fasteners being marketed has resulted in federal fastener safety legislation in The United States. Some misidentified fasteners are probably still in use. In cases where there is doubt concerning a fastener's rating, it is good economy to discard it and use only fasteners having manufacturer's certification. At least one automotive manufacturer independently tests new grade eighth fasteners, and finds random samples of specification grade fasteners to fail prematurely.

Applicable safety rules including those of some government regulatory agencies, may simply state that the die to be securely fastened to the bolster and slide. This simple requirement leaves a lot to the imagination.

Management has a duty to provide a safe workplace. In pressworking, an important part of this duty is to determine what is required to safely retain the die, and train the employees in how to set each die securely.

When threaded fasteners are used, specifying a sufficient size and quantity of heat-treated alloy-steel bolts is highly recommended. Avoiding the use of plain carbon-steel or soft bolts actually saves money. High-grade bolts last much longer. The heads do not round off, nor do the threads stretch and wear out rapidly. Rapid wear, stretching, and thread damages are frequent problems with inexpensive fasteners.

Avoid the Use of All-Thread Rod

Commercial all-thread rod should not be used. There is no simple way to know that it has the required mechanical strength to securely set the die. Some threaded rod is represented to be grade eight or equivalent material. However, since there is no easy way to mark identification on the rod, the use of such material is not advised.

Never Weld Diesetting Fasteners

Fabricating special threaded fasteners for diesetting and die handling by welding should be strictly forbidden. The properties of the weld itself, and that of the heat-affected zone are difficult to determine. There is an unacceptable likelihood of failure in service.

The writer is aware that many light duty pressworking applications do use all thread rod and nuts welded to the rod to produce low cost fasteners quickly. Here extreme caution should be observed and a metallurgical engineers judgement used to approve the application

Correct Tightening of Diesetting Fasteners

High-strength fasteners for bolting structural members are typically tightened to a one-time value 70% of yield strength to develop the proper holding force. Some fasteners tightened to a large percentage of their yield strength will fail with repeated reuse. The correct value of torque for a threaded diesetting fastener should be determined based on the engineering data for the fastener, and the actual application.

Diesetting fasteners must withstand the cyclical loading from both the dynamic action of the press and re-tightening with re-use. The die clamping system should incorporate redundant fasteners. Analyze and correct the root cause should any one fastener fail. Many factors affect the endurance limit and fatigue strength of mechanical systems. Consult standard engineering references should establish safe fastening standards for each class of work, and to analyze any failures that may occur. ²

2 B. Tapley "Eshbach's Handbook of Engineering Fundamentals", Fourth Edition, John Wiley & Sons, Inc., New York, 1990. Section 4.8, which treats the mechanics of deformable bodies including theories of

Threaded Fastener Styles

There are two systems in widespread use for bolting dies in presses having T-slots. The preferred method is the use of a T-slot bolt shown in Figure 2. A popular, but less desirable method shown in Figure 3 is to use a bolt and a T-slot nut.

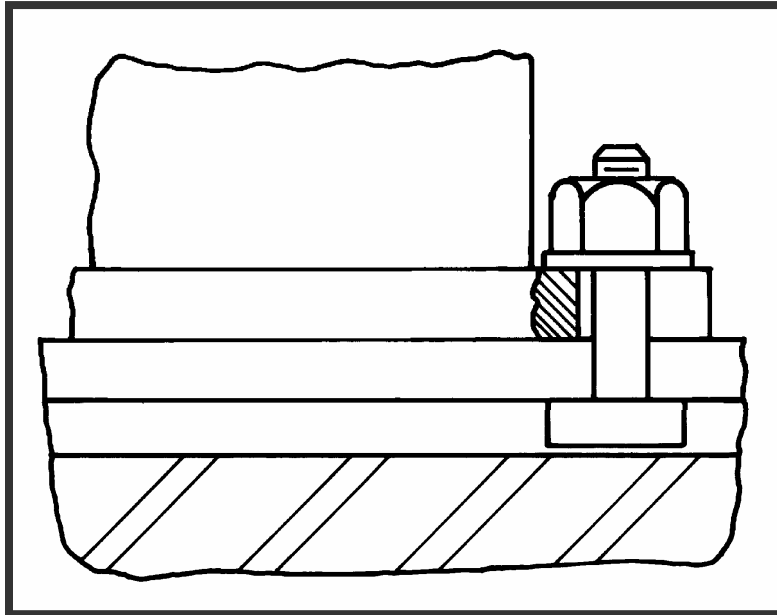


Figure 2. A high-strength alloy-steel T-slot bolt and nut permits the use of a large strong fastener, and visual inspection for proper thread engagement. *Smith & Associates*

One advantage of the T-slot bolt is that a larger fastener can be used than is the case with the hex-head bolt and a T-slot nut system. A 1.000-inch (25.4 mm) diameter T-slot bolt has approximately twice the strength of a comparable 0.750-inch (19.05 mm) hex-head bolt and T-slot nut.

Disadvantages of T-Slot Nuts

T-Slot nuts are popular in machine tool work. Their use in pressworking should be discouraged. They are conditionally acceptable only for light duty work. Disadvantages in addition to smaller diameters for a given slot size include:

1. Thread engagement cannot be visually inspected.
2. The screw may bottom out on the T-slot bottom if too long.
3. The nut is usually not made of grade eight or equivalent material.

strength and failure is a good reference for those wishing to understand some current theories of the limits of fasteners subjected to cyclical loading.

Nut Safety Considerations

To avoid stress concentration, approximately one and one-half threads should extend beyond the end of the nut. Some diesetting standards require a minimum of three full threads. This condition is easily determined by visual inspection with the T-slot bolt system. Once in place, there is no easy way to determine the thread engagement in a T-slot nut. In addition, there is a danger that the screw may interfere with the bottom of the T-slot before the screw is completely tightened.

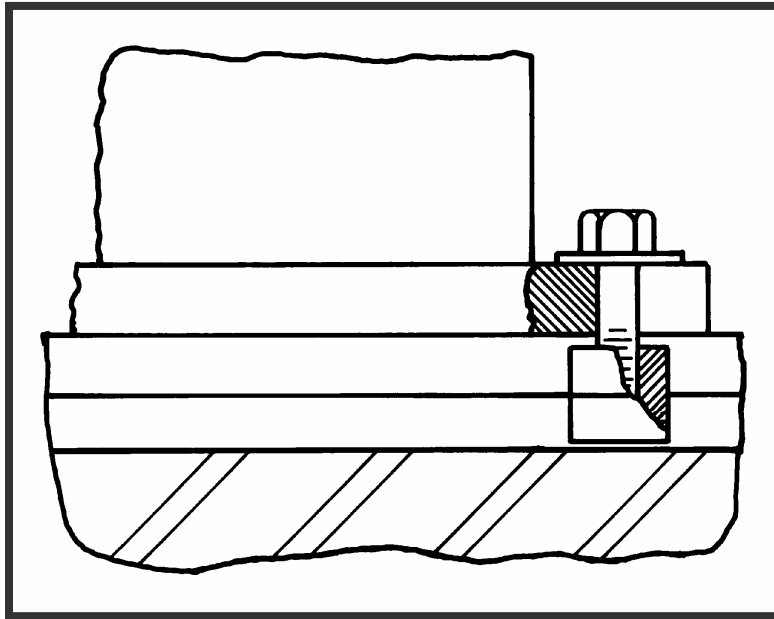


Figure 3. The use of a T-slot nut requires the use of a smaller hex-head bolt, and does not permit visual inspection of thread engagement. *Smith & Associates*

The nuts used for diesetting applications should be made of the same high-grade heat-treated material as the bolts. The height of the nut should be great enough to permit a length of thread engagement at least one and one-half times the thread diameter.

Diesetting Wrenches

Only proper heavy-duty wrenches designed for diesetting should be used. Lightweight automotive and adjustable wrenches are not suitable. Heavy-duty ratchet wrenches are suitable if they are of very robust construction. Special heavy forged diesetting wrenches are available that have captive tubular handles. Pipe extensions or wrenches fabricated by welding should not be used.

Air Powered Wrenches

Pneumatic impact wrenches are a good way to speed up diesetting and reduce fatigue. Special impact wrench sockets are required. Regular automotive socket wrenches are apt to split under impact.

A means to insure that proper torque values are reached is needed. Diesetters should check the final tightening with a torque wrench from time to time to be sure that the tool is operating properly. In critical applications final hand tightening with a torque wrench is advisable.

Standardization of Clamping Height

Standardized clamping heights, together with positive location methods are the key to quick repeatable die changes. Considerable savings in changeover time and die fastener inventory can be achieved by adopting standardized clamping height for all dies. This is true without regard as to whether the die is fastened with straps and setup blocks or hydraulic clamps.

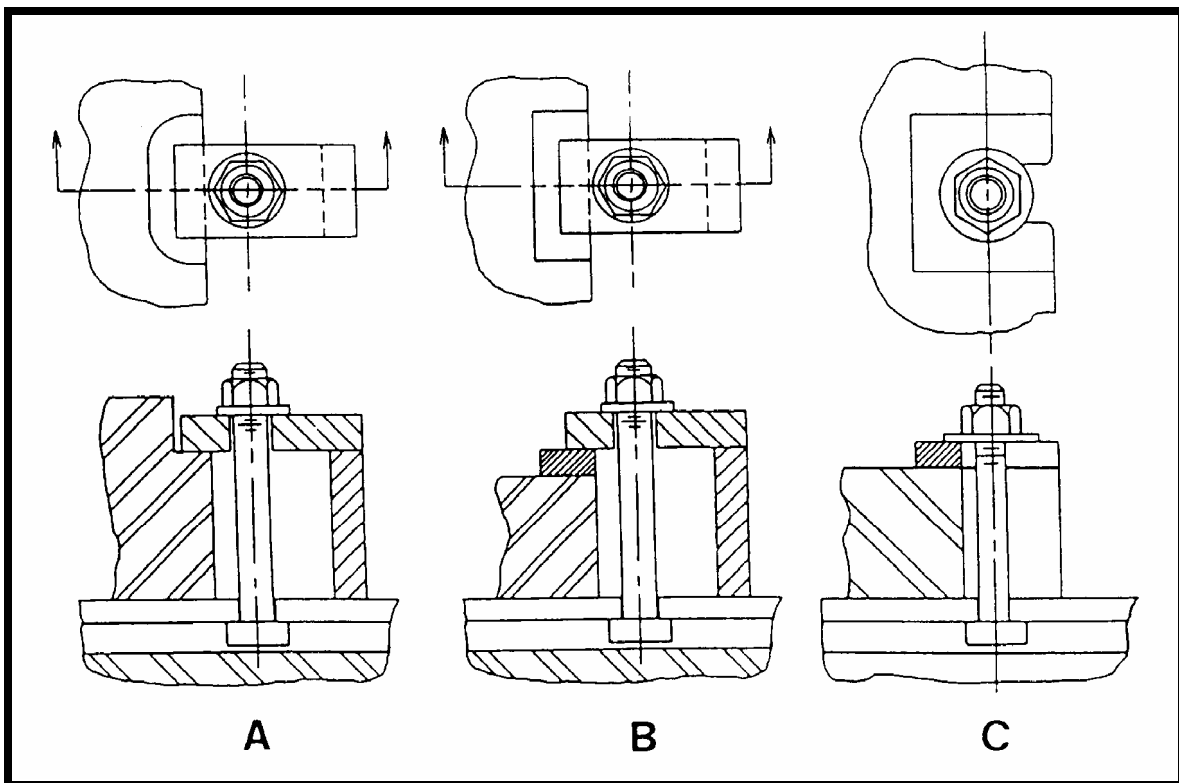


Figure 4. Example of three simple ways to adapt dies to a constant clamp height. Pockets (A) milled to provide a constant clamp height. Spacers (B) attached to the edge of the die shoe. A horseshoe-shaped spacer attached to the die (C). *Smith & Associates*

In cases where more than one tie-down height is required, a system of uniform increments of clamping heights should be used. For example, the distance from the clamping surface to the ram and bolster can be standardized in one inch or one centimeter steps.

Figure 4 illustrates three simple methods of correcting differing die shoe or sub-plate thicknesses to a constant clamp height. In the case of a shoe or sub-plate that is too thick (A), small pockets can be milled to provide a common clamping height. If it is too thick (B), the correct thickness spacers are attached to the edge of the die shoe or sub-plate to provide the correct dimension. In some cases, tack welds can be used, but screws are preferable to avoid warping the shoe. Where T-slot bolts and washers are used (C), differing heights can be corrected by milling, or attaching a horseshoe-shaped spacer as shown.

Matching the Fastening Method to the Job

Stamping dies vary in weight from under a pound (less than a half-kilogram) to over 100 tons (100 T). Simple toe clamps are often sufficient for lightweight dies. However, for setting very large and heavy dies, T-slot bolts are frequently required.

An exception might be provided in diesetting rules for setting a large die with toe clamps. This provision is normally for running small quantities of initial production material or die tryout work. In such cases, the usual requirement is to obtain competent engineering management approval as to exactly how the toe clamping is to be accomplished.

The many factors that pressroom personnel must deal with to insure a safe working environment may require safety procedures that inspectors from regulatory agencies might not be aware of. The die design and engineering department must specify the requirements for safe diesetting, as well as safe part loading and unloading when the process for a new stamping is approved.

Adopting safe methods requires much more than conducting safety training for pressroom personnel. Management must:

1. Supply the correct fasteners and clamping devices.
2. Provide proper storage for all needed equipment.
3. Scrap all inferior diesetting fasteners.
4. Provide hands-on training in proper methods.
5. Plan and achieve the goal of clamping standardization.

Of course, it is necessary to follow government and insurance regulations. However, safe pressworking requires the application of sound engineering principles to analyze and avoid potential problems involving fastener failures.

It is unreasonable for management to assume that die designers, diemakers, and diesetters will automatically design, build and fasten dies in a safe and secure manner. Here, die design standards based on sound engineering data for the type of work involved must be determined and used without fail.

Methods of Securing Dies with Threaded Fasteners

Several of the following figures illustrate examples of commonly used die clamping methods. Depending on shop rules, shock loading, and changes in regulations, not all of these methods may be suitable for a given application.

The use of spacer or setup blocks to provide support for a strap clamp may be an acceptable practice depending upon die weight and engineering data. The use of a single spacer block equal to the standard clamping height is conditionally permissible. Supervised die tryout work is an exception. However, most large dies are not set with straps and spacers. This method, often termed bridge clamping is suitable for light duty work not involving shock or impact loads and die tryout work with engineering approval.

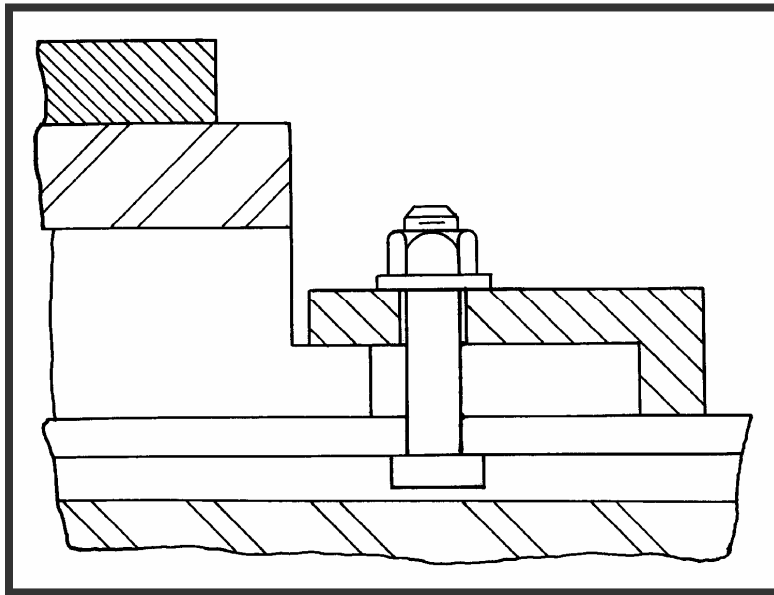


Figure 5. Clamping to a standard height ledge on a parallel permanently attached to the die shoe. *Smith & Associates*

Constant Height Clamping Ledges

A basic requirement for most rapid clamping system is a constant clamp height. This can be as simple as providing a protruding ledge on a parallel attached to the die shoe (Figure 5). A recessed ledge (Figure 6) is less subject to damage during die handling operations. The attachment of the parallel to the die shoe must be at least as strong as the clamping system to provide for emergency stripping loads in case of a die mishit.

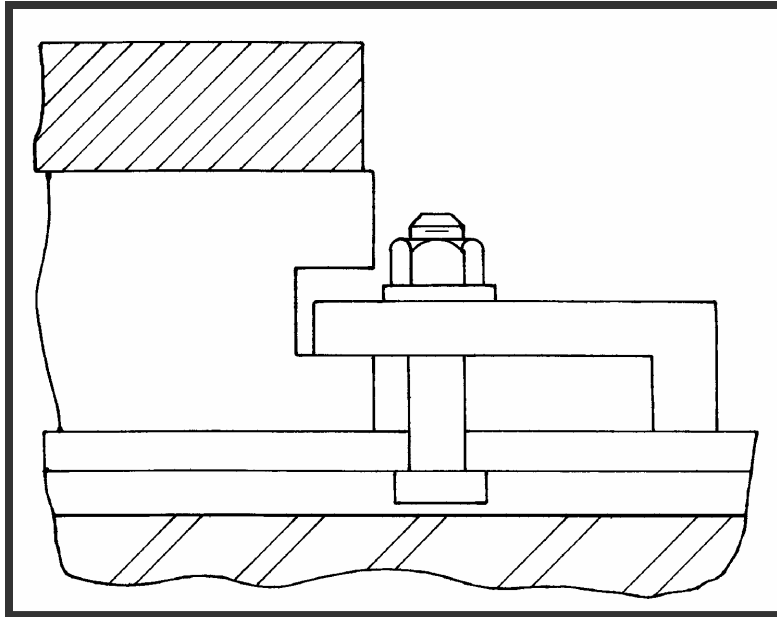


Figure 6. A recessed parallel clamping ledge is less apt to be damaged than the exposed style illustrated in Figure (4). *Smith & Associates*

Forged Steel Clamps

A number of styles of forged steel clamps are commercially available from diemaking supply houses. The offset type clamp illustrated in Figure 7 engages a drilled hole in the die shoe. The offset design has a short profile to permit ease of scrap shedding. Figure 8 illustrates a straight type clamp.

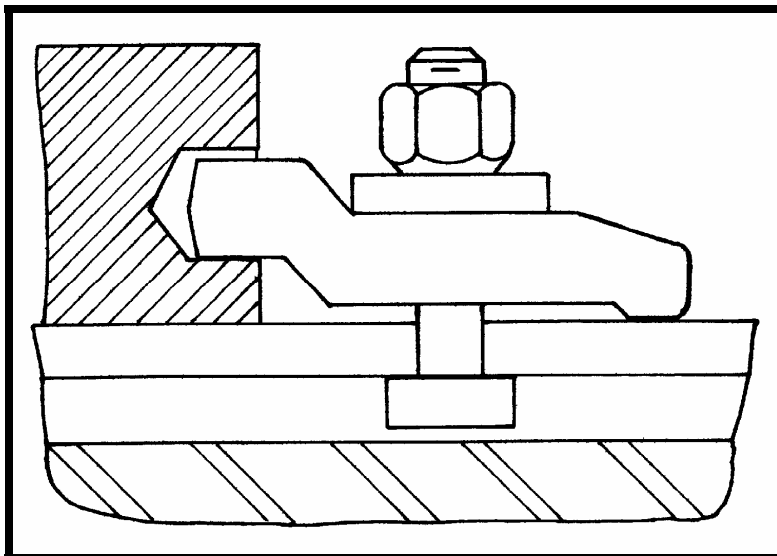


Figure 7. A commercially available forged-steel offset clamp designed to engage a drilled hole in the die shoe. *Smith & Associates*

An advantage of the clamps illustrated in Figures 7 and 8 is that the hole is easy to drill on location using a light-duty radial-arm drill press. Horizontal milling machines are ideal for cutting clamping flats in parallels efficiently. Shops lacking such mills usually have a suitable drill press for drilling the tie-down holes.

Figure 9 shows a forged gooseneck clamp that engages a ledge on a die shoe or parallel. All of the forged commercially available clamps shown use swivel washers, and either swivel head capscrews, or swivel nuts.

Use of Springs with Die Clamps

An obvious improvement to speed up diesetting is to place a spring on the bolt to hold the toe-clamp in the up position. This works reasonably well with toe clamps of the type illustrated in Figures 5 and 6.

A washer may be needed under the spring to keep it from catching in the T-slot. A second washer may be needed on top of the spring if a long U-shaped bridge clamp is used. Figures 10 and 11 show an alternative the use of a spring to support the clamp.

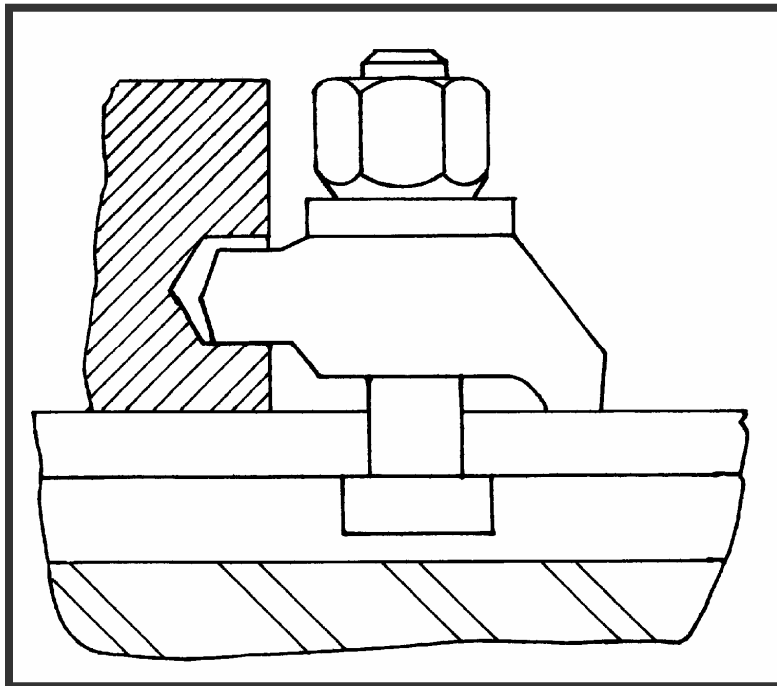


Figure 8. A straight type forged steel clamp. The clamp has a round projection that engages a drilled hole in the die shoe. The opposite end is designed to span a T-slot to eliminate the need for a setup block. *Smith & Associates*

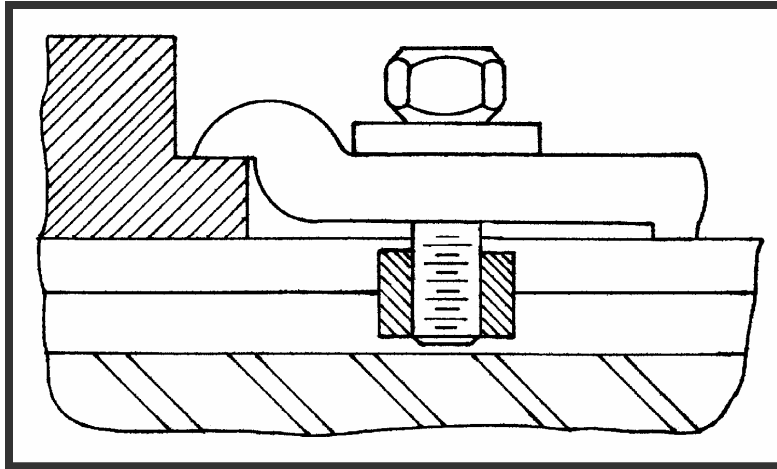


Figure 9. Example of a forged steel gooseneck clamp. *Smith & Associates*

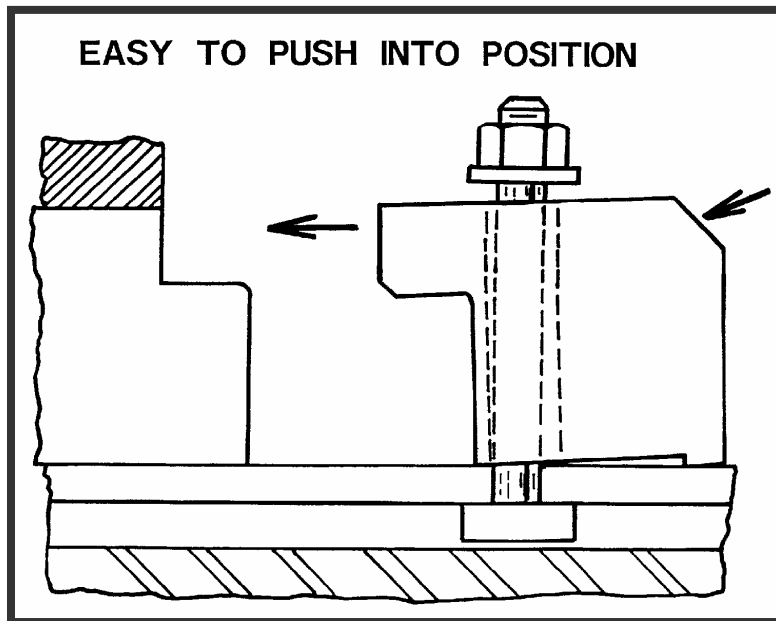


Figure 10. This small one-piece “Danny Morgan” toe clamp is easily shoved into position. *Smith & Associates*

Homemade One-piece Clamp

The clamp illustrated in Figure 10 rests near the correct clamping height before it is slid onto the die-clamping ledge. This style clamp was developed in a high-speed pressroom in which circuit breaker parts are stamped. Danny Morgan of Siemens (retired) is considered to have lead a quick die change team develop this clamp. Before this improvement, an inconvenient bolt and spring design was used to position the clamp. This design has been widely duplicated. It is published in the SME reference publication, “Fundamentals of Pressworking” as well as training course manuals by the writer.

The simplified design has a lead on the portion of the clamp that engages the die-clamping ledge. The palm of the hand is placed on the large chamfer at the rear of the clamp. It is simply pushed into place. Figure 11 illustrates the clamp in position. This clamp is used in light duty applications, and is not recommended for heavy work. The clamp can be machined from SAE 1018 steel and gas carburized for wear resistance. Danny Morgan is the owner of Morgan Tool and Die in Bellfontaine, Ohio.

A consideration in the use of this design is that there is a stress concentration where the edge of the clamp attaches to the body. The radius at this point should be made as generous as possible. If substantial clamping forces are anticipated, the clamp should be made of alloy steel and heat-treated for maximum toughness.

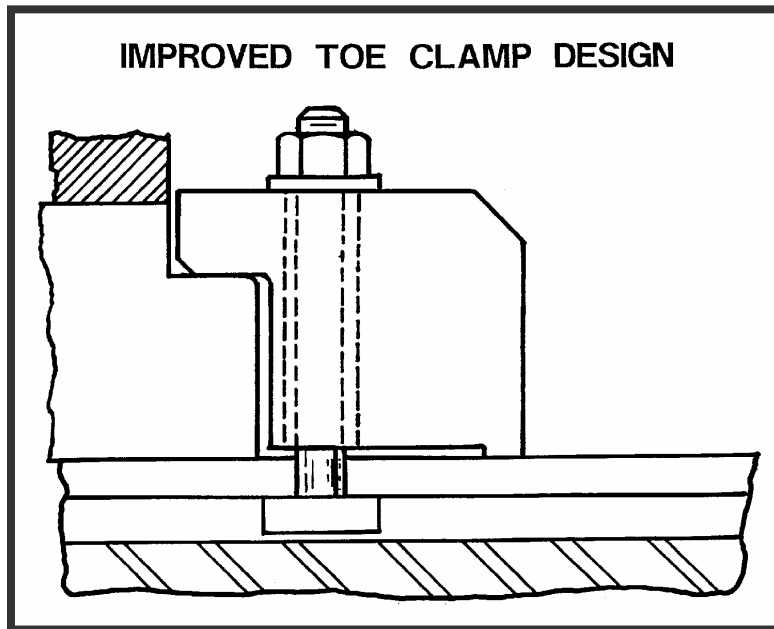


Figure 11. The clamp illustrated in Figure 10 in position. A limiting factor is the allowable stress concentration at the radius under the clamping lip. *Smith & Associates*

Benefits of Good Clamping Practices

Good clamping methods help insure consistent setups, which in turn reduces stamping process variability. Poor clamping methods can result in product inconsistency as well as endangering personnel and equipment. Proper die fastening methods with attention given to safety is a necessity.

Proper Threaded Fastener Storage

The threads should be protected from damage. Racks near the press or on a die cart should be designed to store the bolts by hanging them by the heads. This will help protect the threads from the damage that might occur if they were stored in a bin. Every pressroom should be equipped with good clamping equipment so that the diesetters will not resort to unsafe fastening methods to get their job done.

Turns Needed for Mechanical Clamps

Once a diesetting bolt is snugged up by hand, only a fraction of a turn to one and one-half turns are needed to tighten the fastener to the proper torque value. The exact amount is determined by several factors including the thread pitch and length of the bolt. Any bow in the die shoe or sub-plate must also be drawn-up. If spring washers are used, they must be compressed until all clearance is drawn-up. This may require several turns.

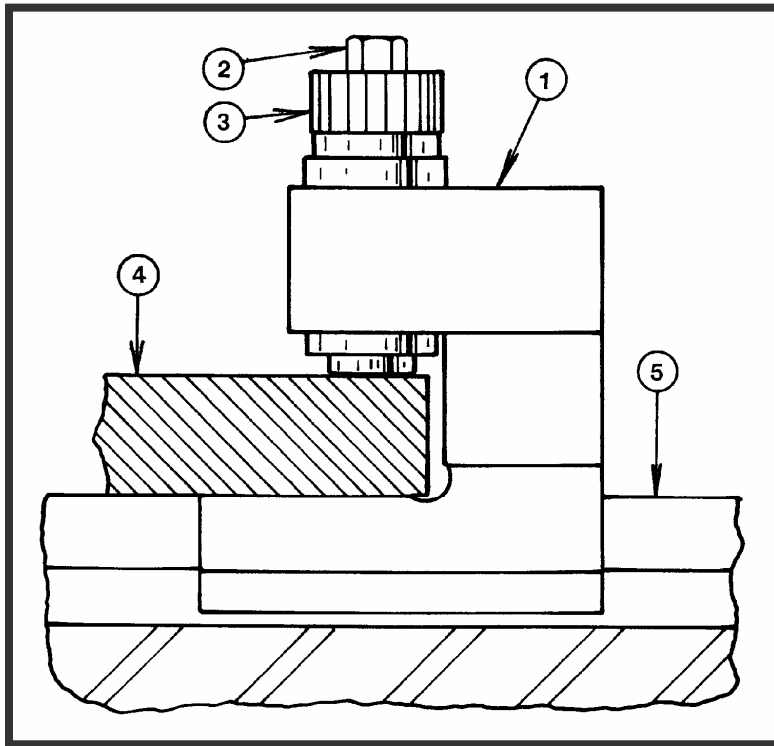


Figure 12. An example of a mechanical half-turn die clamp employing a toggle locking mechanism. *Optima USA*

Special Commercially Available Mechanical Clamps

There are several types of rapidly applied mechanical fasteners in widespread uses that are superior to hydraulic clamps in light duty applications. One example is the Optima™ mechanical toggle clamp shown in Figure 12.

The Optima™ Half Turn Clamp

Figure 12 illustrates an Optima™ brand half-turn clamp. The clamp body (1) is slid into place in the bolster T-slot (5) and engages the die shoe or sub-plate as shown in (4). A serrated knob (3) is hand-tightened until the plunger contacts the plate to be clamped. Finally, the over center toggle mechanism is activated by turning the small screw (2) approximately one-half turn. Since the toggle mechanism provides substantial mechanical advantage, relatively little force is required.

The total movement of the toggle is approximately 0.008-inch (0.2 mm). This is sufficient to properly tension the clamp if the clamp and plate are in intimate contact with

the bolster. In cases where the plate is warped, the serrated nut must be pre-tightened with a special spanner wrench. If this extra effort is required, the advantage of the clamp for quick die change is lessened. Development of new designs of the type of clamp is expected to result in greater clamping forces and clamping plunger travel.

Self-Positioning Hold down or Swivel Clamps

Figures 14 and 15 show a swivel clamp that is designed to accommodate different heights without the need for a setup block. These clamps are made by several manufacturers. They are only recommended for light-duty short run work. Because of their shape, they are called banana clamps in some shops. Like any machine tool clamp, they are recommended only for light-duty work subject to competent engineering approval.³

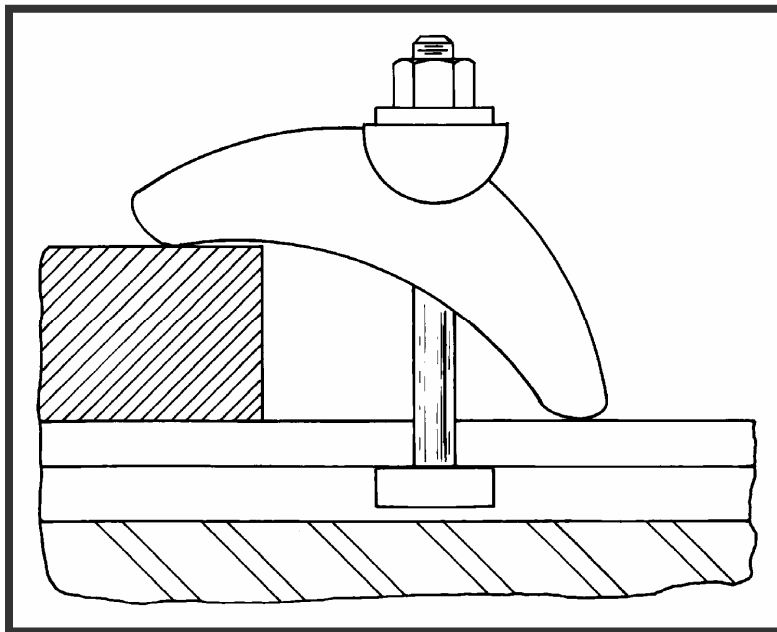


Figure 14. An example of a self-positioning hold down or swivel clamp. These clamps are widely used in machine tool setups because they accommodate a wide range of clamping heights. They are recommended only for short run light-duty presswork subject to competent in-plant engineering approval.

³ D. Smith, Quick Die Change Video Course, tape two, session eight has animated footage of how the swivel or "banana" clamp works. The case study is from W. C. McCurdy Company, Troy, Michigan. This company is now a unit of Masco Stamping Technologies, Inc. The workbook has a description of the clamp on pages 107 to 108. The same description is in the Facilitators Guide on page 136. A second video case study, tape five session 22, shows a different brand of swivel clamp used for short run production. This case study is from Webster Industries, Tiffin, Ohio. The workbook has a description of the Webster application on page 238. The same description is in the Facilitator's Guide on page 278. The video training series, is copyrighted material available from The Society of Manufacturing Engineers, Dearborn, Michigan, © 1992.

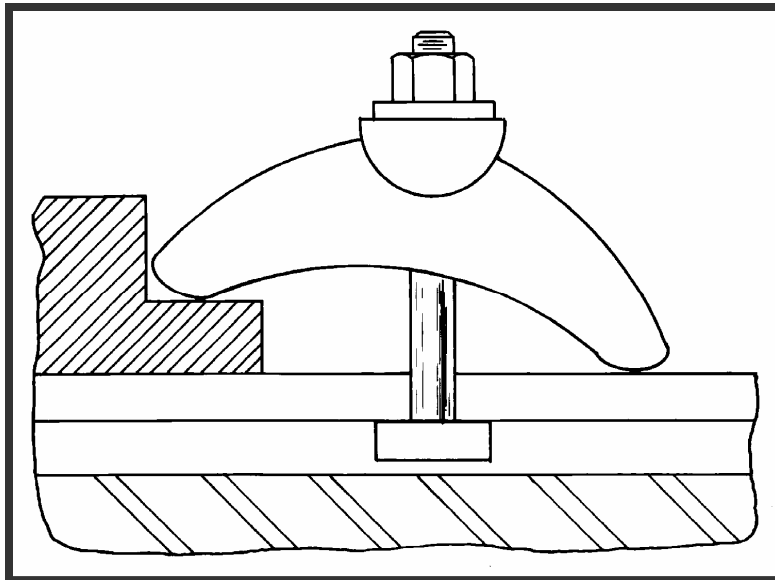


Figure 15. Another view of the self-positioning hold down or swivel clamp illustrated in Figure 14. The design accommodates different heights without the need for a setup block. These clamps are made by several manufacturers. They are only recommended for light-duty short run work subject to competent in-plant engineering approval.

Clamping Design Improvement Case Study

The operation in our case study uses a number of combinations of dies to produce different styles of parts. The die positions are accurately controlled by round bolster locating pins. Producing many different styles of parts having different patterns of holes and other features is accomplished by changing die details, on one or both of the dies.

The tooling is capable of producing a great variety of product styles with a modest investment in tooling. If an individual die were used for each product style, the tooling cost and die storage space requirements would be several times greater than the split die system.

However, the designer has overlooked a basic problem that the diesetter will have in changing over the dies. The inside T-slot bolts cannot be inserted once the dies are in position. By overlooking this factor, the designer has created a difficult task for the diesetter. The problem is illustrated in figure 16.

Two Simple Solutions

Figure 17 shows two simple solutions to the problem of inside bolt placement illustrated in Figure 16. Both the upper and lower dies can be retained by simple one-piece toe clamps and T-bolts. An alternative is to use hydraulic ledge clamps that are actuated after being slid into place.

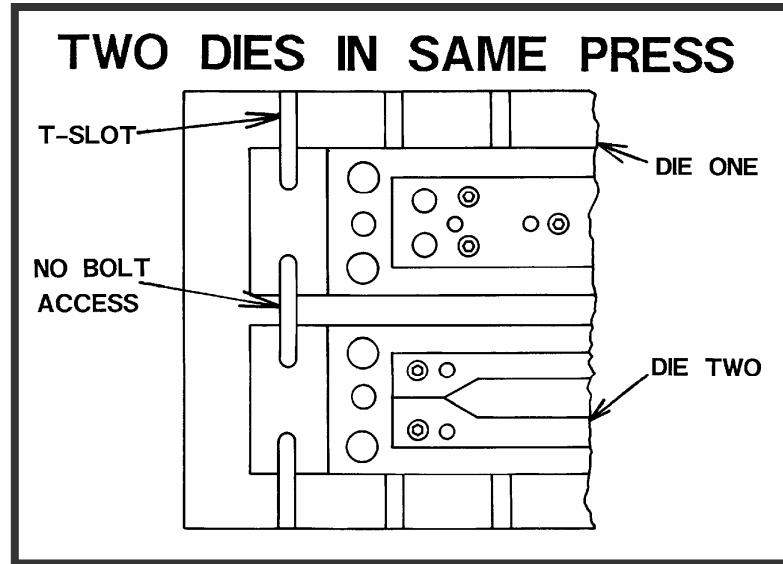


Figure 16. Two dies set in the same press results in a problem placing T-slot bolts to clamp the inner die edges. *Smith & Associates*

The toe clamps used with T-slot bolts are simple and low in cost. The hydraulic ledge clamps may be more cost-effective if many die changes are performed each shift -- especially if the access to tighten the conventional bolts is limited by the size of the die and or press opening.

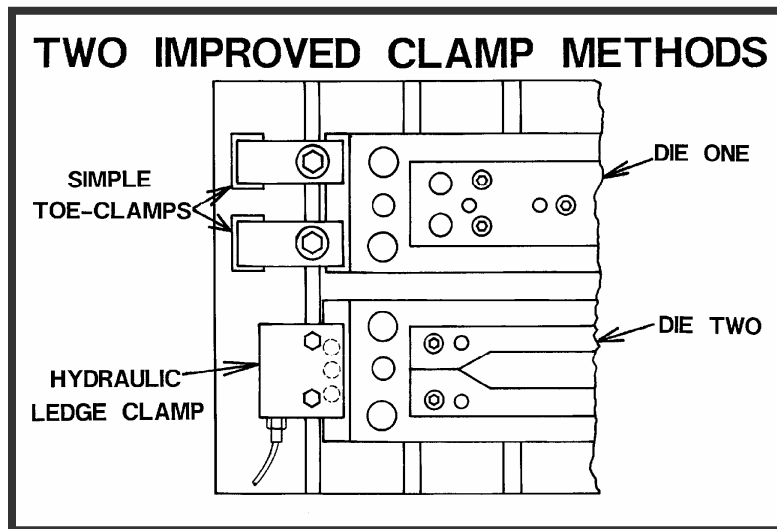


Figure 17. Two ways of solving the problem of inside bolt placement shown in Figure 16. Both the upper and lower dies can be retained by either simple one-piece toe clamps or T-bolts. Another choice for frequent changeovers is the use of hydraulic ledge clamps that are actuated when in position. *Smith & Associates*

Shanley Partial Turn Quick Die Change Clamp Assembly⁴

Figure 18 illustrates a partial turn bolt assembly having a captive nut. It is available in several sizes and load ratings from a number of fastener marketers. Like any safety critical fastener, the seller should be asked to supply information concerning its compliance with the fastener safety act and suitability for your specific application.

Avoid a False Sense of Security

Relying solely on good ratings by insurance inspectors and government enforcement officers can create a false sense of safety security. Bad methods and individual poor habits quickly grow into everyday unsafe practices. Visiting inspectors often lack the time and knowledge to spot these problems.

Safe pressworking involves many disciplines. The die designer and process engineer must apply accurate pressworking formulas when determining press requirements.

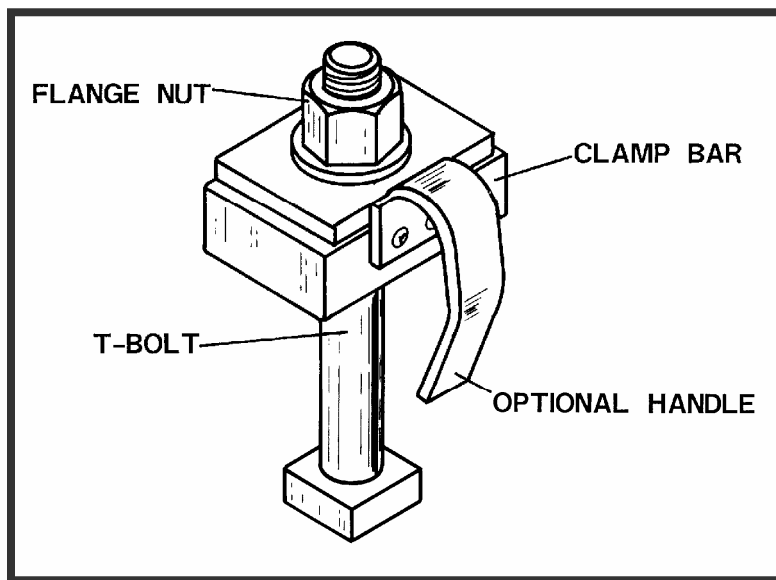


Figure 18. An example of a commercially available partial turn die-bolting assembly having a captive nut. This unique design is considered to be manufactured by Shanley Enterprises and covered by a United States patent.

A Die Fastener Failure Case Study

⁴ This clamp is considered to be covered by a United States patent and manufactured by Shanley Enterprises - 9088 Highland Drive - Grosse Ile, Michigan. It is considered available through fastener dealers who should be consulted for suitability for a specific application.

When large stamping die pads stop on the pad keepers, all of the inertia of motion of the pad is suddenly dissipated, resulting in severe shock and noise. The result is rapid keeper wear as well as broken die shoes. In extreme problem cases, the bolts used to fasten the upper die to the press slide fail, permitting the upper shoe to become detached from the press. This case study shows how to solve the problem with automotive pull-rod shock absorbers.

When the pad is suddenly lifted by the pad keepers on the press upstroke, the sudden acceleration of the pad resting on the lower die results in severe shock and noise. In addition, the following failures are likely to occur:

1. The bolts used to fasten the upper die to the press ram may fracture and fail.
2. Rapid keeper wear is likely to occur.
3. The upper die shoe may be broken.

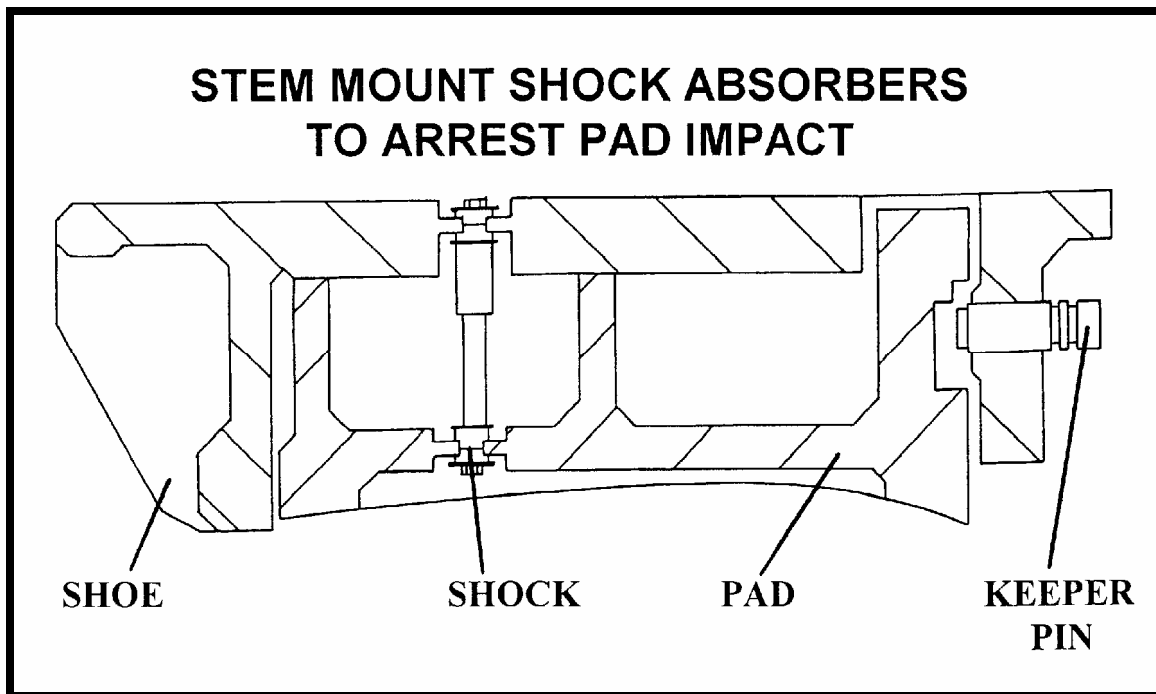


Figure 19. A frequent cause of upper die attaching bolts failure is upper die pad impact of the pad keepers. The use of heavy-duty automotive shock absorbers is an effective way to deal with the problem in large automotive dies. *Smith & Associates*

Broken Die Attachment Bolts

The tandem line fourth operation of the Ford Ranger truck 7-foot (2.13 m) body-side flange die is the subject of this case study which occurred in 1987 at the Ford

Woodhaven, Michigan Stamping Plant The die was attached to the ram with 15 one inch (25.4 mm) grade 8 bolts. Typically, eight would be required if shock were not a problem. The impact problem was quite serious—as many as 12 of the 15 bolts failed due to fatigue fracture on several occasions.

Initial Engineering Considerations

The die pad weight was 6,520 pounds. The pad travel measured 6-inches (152.4 mm). The plan adopted was to install sufficient automotive type shock absorbers to lift the pad on the press upstroke before keeper pin contact with the pad occurred. A 50% safety factor was decided upon in order to insure that the shock absorbers would still pick the pad up should they become worn.

Mounting Design Considerations

Two basic mounting methods were devised. Angle iron mounting brackets for the round end loop style mounts (Figure 19) and counterbored stepped holes for the stud mount styles (Figure 3). In a die large enough to have a serious pad impact problem, there usually will be enough room to accommodate the required shock absorbers.

For this application, Monroe Magnum series 70-shock part number 74408 was chosen. These shock absorbers are designed as an OEM product for General Motors city buses. Each shock was determined to have a lifting capacity or resistance to extension of 1600 pounds (725.76 Kg) the press ram velocity several inches into the upstroke. A 50% safety factor for a 6,520-pound (2957-kg) pad requires a control force in extension of 9,780 pounds (4436 kg). Six shock absorbers were specified.

Shock Absorber Case Study Results

After the modification, there were no problems of any kind with the shock absorbers. The replacement cost of the shock absorbers was \$31.00 each. The Monroe Auto Equipment division of Tenneco Automotive provided without cost the shock absorbers used in this application.

During the modification, the nitrogen pressure system supplying pad pressure was eliminated. The weight of the pad together with the compression force of the shock absorbers provided sufficient holding pressure.

Quality Improvement and Reduction of Die Maintenance

Pad keepers and keeper slots seldom wear evenly. Uneven wear results in the pad hanging out of level. Upon die closure, the pad tends to move the panel out of location resulting in uneven flanges, hard marks and distortion.

The use of shock absorbers permits the pad to come to a gentle rest on the keepers resulting in very little keeper wear. By preventing keeper wear, a great deal of needless die respotting and flange steel shimming in order to maintain correct checking-fixturing fit can be avoided. Heat buildup and the maximum speed of operation are limiting factors in applying this shock abatement system. Engineering the shock absorber application must

be done in conjunction with the shock manufacturer to assure a safe effective system. Aftermarket shock absorbers may not have the same specifications as the OEM product—check with the manufacturer’s engineering department to verify suitability for a given application.⁵

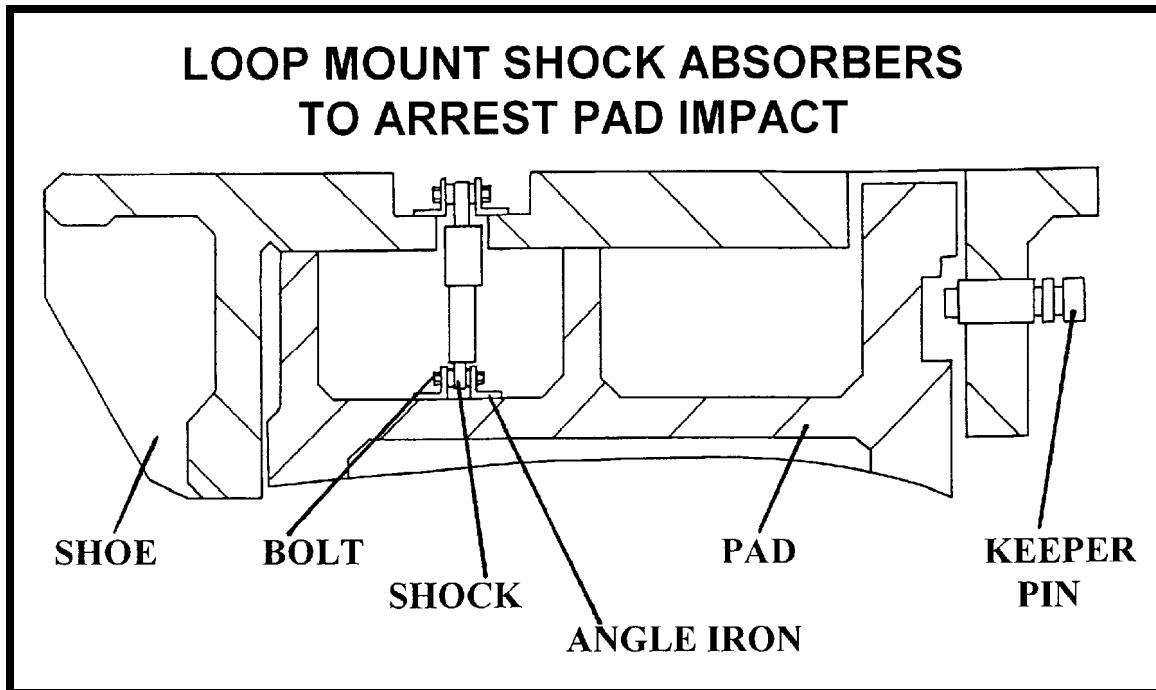


Figure 20. An example of an alternative method for installing shock absorbers to control pad impact problems. Note the cautionary information in footnote 5. In addition, this type of shock abatement system is recommended for slow speed stamping applications. Heat buildup must be calculated using simple engineering formulas.

⁵ D. Smith, "How to Solve Die Impact and Noise Problems with Automotive Pull Rod Shock Absorbers", SME Technical Paper MF91-259, Society of Manufacturing Engineers, Dearborn, Michigan, 1990. This paper provides the basic information for using automotive pull-rod shock absorbers to control upper die pad keeper impact problems on the press upstroke. Anyone attempting to use this information is advised to contact the specialty product-engineering department of The Monroe Auto Equipment Company, Monroe, Michigan. Aftermarket shock absorbers may not have the same valving characteristics as OEM products. The work by the author is the basis for Ford Motor Company die standard W-DX14-50M. Upper pad impact problems are considered a root cause of die fastener failures. In some cases, this is considered to have resulted in amputations and pressroom fatalities. Severe pad impact is especially a problem with large automotive deep flange and redraw dies.

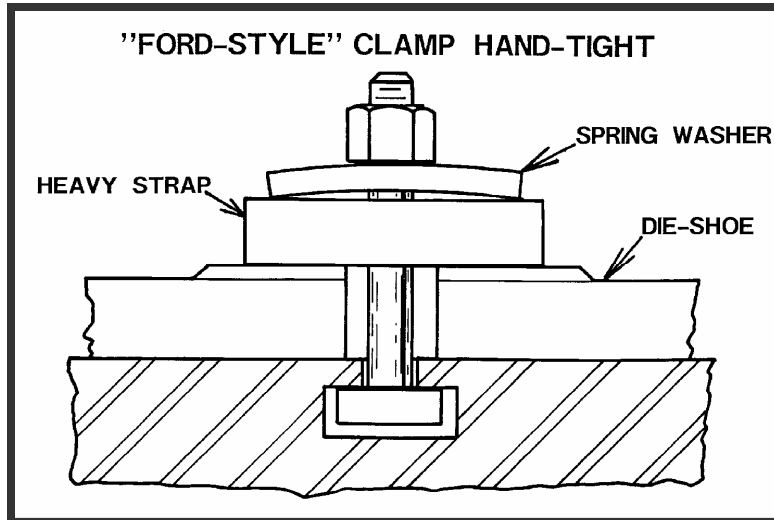


Figure 22. A T-slot bolt, large carburized steel strap and heavy-duty spring washer in place after hand tightening. The bolting assembly (B) illustrated in (A) after it is properly tightened. *Ford Motor Company*

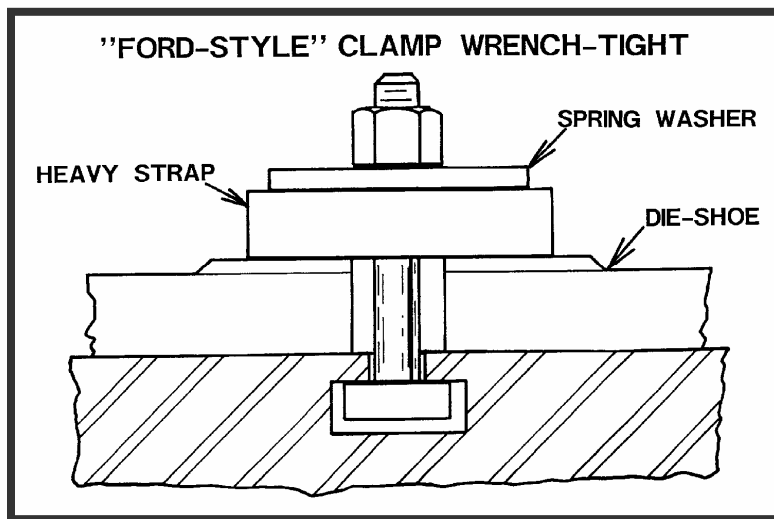


Figure 23. A T-slot bolt, large carburized steel strap and heavy-duty spring washer in place after it is properly tightened. *Ford Motor Company*

Spring Washers

For decades, Ford Motor Company, and other manufacturers engaged in heavy stamping, have had excellent standardized die fastening methods. Features include U-shaped cutouts in the die shoes, and uniform clamping heights. Grade eight or equivalent T-slot bolts and nuts are used. The U-shaped slots are bridged with thick carburized steel plates.

Figure 22 illustrates a T-slot bolt, carburized steel strap and heavy spring washer in place after hand tightening. The large square spring washer serves several purposes. First, it helps prevent the nut from working loose under high impact loads. The pressure of the nut is distributed over a large area by the heavy strap.

The spring washer also serves as a visual indicator. Should the bolt loosen in service, a gap will be visible under the washer. Figure 23 illustrates the bolting assembly after it is properly tightened.⁶

Example of Die Plate Fastening Improvement

T-slot bolts used in conjunction with constant-height clamping slots or ledges are an essential part of most simple quick die changing systems. To be used effectively, the T-slot bolt, together with either a nut or washer or a toe clamp, must be slid into place quickly and tightened rapidly.

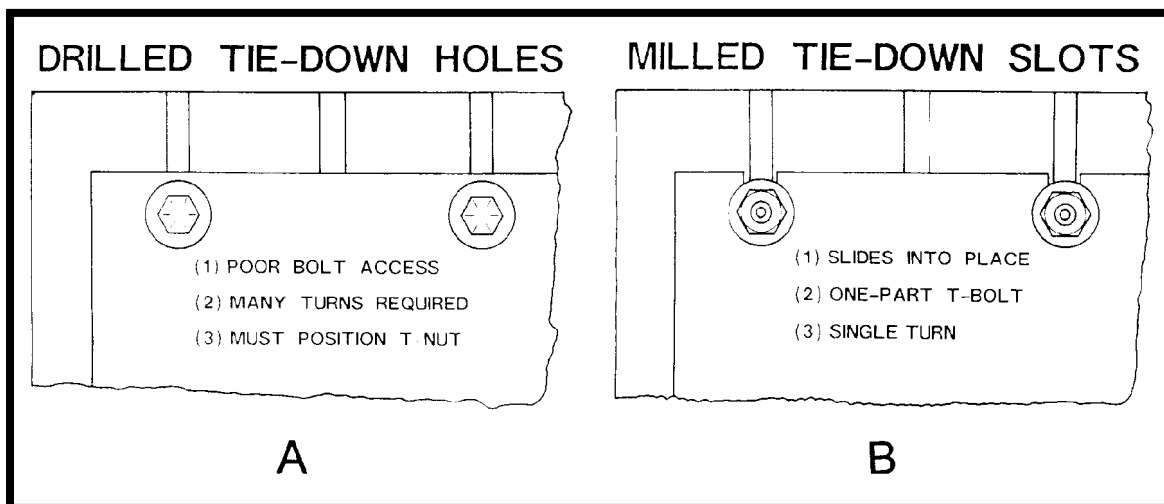


Figure 24. A die shoe or sub-plate having drilled tie-down holes (A) usually must be fastened to the ram or bolster with cap screws and T-slot nuts. T-slot bolts are preferable. Milling tie-down slots for T-slot bolts (B) permits the use of a strong fastener that can be tightened with a fraction of a turn.

⁶ Ford Motor Company, "Die Design Standards for North American Operations", Body and Assembly Division, Dearborn, Michigan. Standardized diesetting fasteners are generally used in the automotive industry. The grade eight fasteners used are Danly Gold-Bond brand. The plates used to bridge the U-shaped cutout and special spring washer is made to Ford specifications and available from Jolico Industries, Utica, Michigan.

Some dies, such as the example shown in Figure 24 (A), may have drilled holes rather than tie-down slots. T-slot bolts cannot be put in place easily. T-slot nuts and cap screws, which are not advised for heavy-duty diesetting, must be used.

If T-slot bolts are required, they must be in place before the die is set. When setting the die, getting the T-slot bolts to line up with the holes in the lower die can be time consuming and often dangerous. The diesetter may be exposed to hazardous trial-and-error work in positioning the bolts.

Aligning T-slot bolts placed in the ram with drilled holes in the upper die can result in mechanical interference when inching the press closed. A diesetter may attempt to place his or her hand between the ram and the upper die to align the bolts as the press is being inched. This is an extremely unsafe practice.

Avoid Bolting through Drilled Holes

T-slot bolts are much stronger than a T-slot nut and hex head capscrews. Figure 24 (B) illustrates the advantage of using U-shaped cutouts in the die shoe or sub-plate for attaching the die to both the bolster and press ram.

Providing a constant clamping height can permit the same T-slot bolts to be used with many dies. An added advantage is that only a fraction of a turn is required to tighten the fastener.

Die Tryout Practice

One reason that drilled holes are provided rather than U-shaped cutouts is that the holes can be drilled quickly in order to try-out the die. Before the die tryout process is completed, U-shaped cutouts should be provided by milling a tie-down slot from the edge of the plate to the drilled hole. This is advised before the die is approved for normal production. Providing tie down slots in standard locations during die construction is the best way to insure ease of diesetting during die tryout and initial production work.

Mill Slots Rather than Use a Cutting Torch

Oxyfuel cutting (OFC) of tie-down slots in finished dies is not advisable. The process generates large amounts of heat, which will almost certainly warp the plate. The best solution is to specify the location of the slots in the die design. They can be flame-cut at little or no added cost when the die is built. Good quality die shoes and sub-plates are normalized to relieve stresses created by flame cutting and any welding required for fabrication. Normalizing must be done before machining.

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