PT-50691

CINCINNATI®

PRESS BRAKE CAPACITIES

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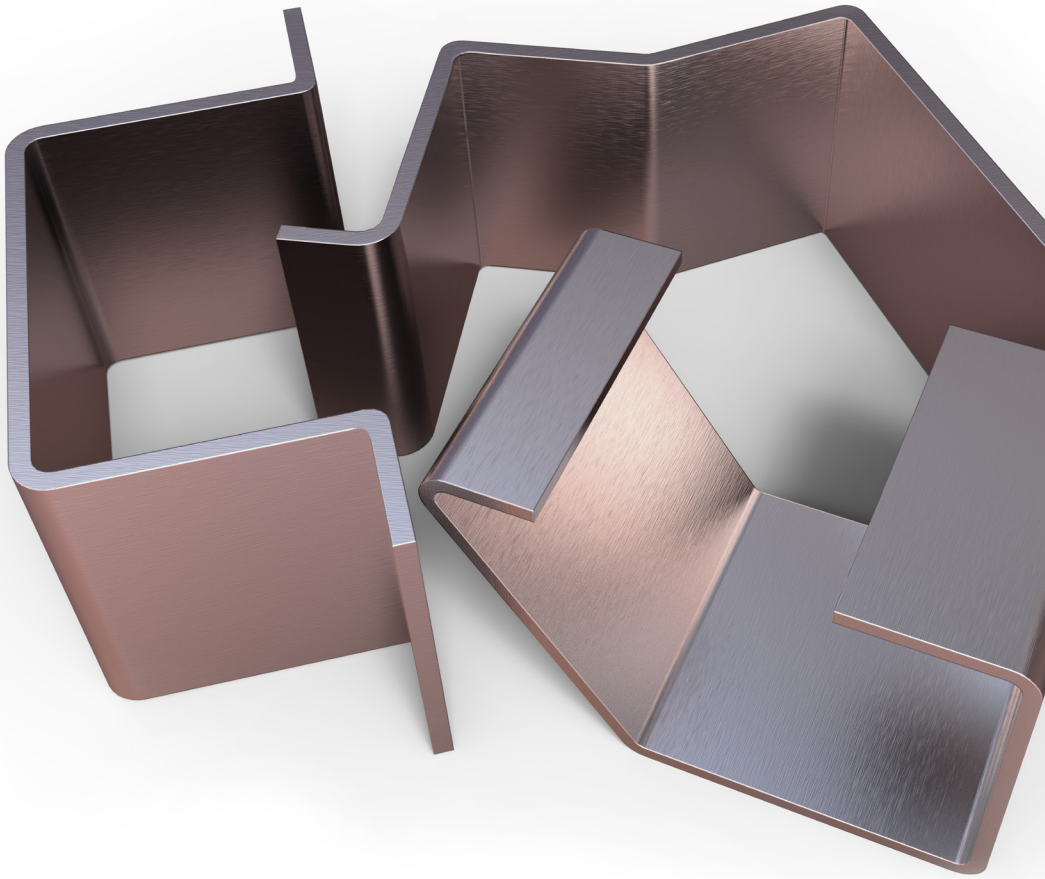
CONTENTS

SAFETY

Good safety practices and proper training of each press brake operator is mandatory. Comprehensive operator, maintenance and safety manuals provide instruction on proper procedures and safety methods and should be with the press brake at all times. Warning signs and a checklist of operator safety guidelines should be placed at strategic locations on the press brake.

Users are responsible for proper installation and continued use of point-of-operation safeguarding and other machine guards. This helps assure operator safety and compliance with OSHA requirements.

Each new CINCINNATI press brake displays a tag showing that it meets ANSI B11.3 construction requirements. A copy of the standard, which covers the proper care and use of press brakes, is included to help users with their safety programs. Refer to the Safety Manuals, Press Brake Safeguarding Bulletin PI-50686, ANSI B11.3 Safety Standards or consult Cincinnati Incorporated for further information.



BENDING ON A CINCINNATI PRESS BRAKE

PRESS BRAKE RATING

All CINCINNATI press brakes are rated for maximum bending pressure, or tonnage. Tonnage can then be converted into bending capacities through an understanding of basic factors affecting the formability of metal. Bending factors, or "rules of thumb," for press brake forming are based on using mild steel (60,000 psi maximum tensile strength). An explanation of these factors will help you understand the performance of your press brake and the mild steel air bend capacity charts presented in this booklet.

VEE DIE OPENING AND INSIDE RADIUS

The recommended vee die opening for mild steel up to 1/2" (.500") thick is eight times the metal thickness.

For thicker than 1/2" mild steel, it may be necessary to increase the vee die opening up to ten times the material thickness to minimize cracking of the material. To determine the vee opening for a simple 90° bend, multiply the metal thickness by eight. The answer is then rounded to the next higher 1/8" figure. For example: 14ga. (.075") x 8 = .600". This is rounded to a 5/8" vee opening.

The inside radius of a bend in mild steel is about 5/32" (.156") x the vee die opening regardless of the gauge of metal being formed. This figure was determined by measuring formed samples bent over various die openings. To illustrate: If a 1/8" (.125") sheet and a 1/4" (.250") plate are formed over a 2" vee die, each will have the same inside radius of approximately 5/16" (.312").

SPRINGBACK

Metal formed by an upper and lower die as shown in Figure 1 only has three points of contact. If metal is pushed into a lower die sufficiently to form a specific angle, when the force is released, the angle will open up due to springback. Normal springback for mild steel is 2° to 4°. If the material is hard, has a higher tensile strength, or a larger than normal inside radius, the springback will be greater.

AIR BENDING (FIGURE 1)

Air bending metal into a straight line angle is the most common form of press brake work. A top, or upper die, pushes the metal into a lower vee die. The metal only touches the point of contact of the upper die nose and the two edges of the lower vee die **(Figure 1)**. The material does not contact any other part of the tooling during the forming cycle.

Most "air bend" tools are manufactured so that the upper and lower dies have the same angle. This is done to minimize set-up time. In order to obtain a true 90° air bend, the tooling must be cut to allow sufficient springback to attain a 90° bend. In most cases, the angle cut on the dies will be between 30° to 85°. For air bending, the nose radius of the upper die should be equal to or slightly less than one metal thickness using simple fractions.

Note: If parts are to be formed with air bend dies on a press brake with computer control to determine ram reversal positions, the dies must be cut to an angle that will allow for all possible material springback.

BOTTOM BENDING

Bottom bending material with dies cut to approximately the finished angle (e.g. 88°,89° or 90°) will increase the forming tonnage. The reason for "true" bottoming and coining is to "set" the material in order to overcome springback and obtain better angular accuracy **(see Figures 3 and 4)**. Bottoming is often selected when forming boxes or panels. Minimizing the overbending keeps the final bends from hitting the previously formed flanges and causing distortion. Potentially smaller inside radii may also be achieved using the coining process. There are three different types of forming which are classified as "bottom" bending: bottoming with spring back, true bottoming and coining.

BOTTOMING WITH SPRINGBACK (FIGURE 2)

Bottoming with springback is not considered "true" bottoming. When metal is pushed into recommended tooling, it will form an inside radius that is equivalent to the 5/32 x vee die opening rule. Pressure is then built up at the bottom of the stoke causing the formed metal to "kink" in the inside radius area. This causes the legs of the formed metal to overbend enough to touch the corners of the upper die **(Figure 2)**. The force buildup will be about 1 1/2 to 2 1/2 times the tonnage required for air bending. When the forming pressure is released, the part may spring back to the desired angle. The angular consistency of this method is dependent on uniform material thickness. Normally, angular tolerances are similar to air bending.

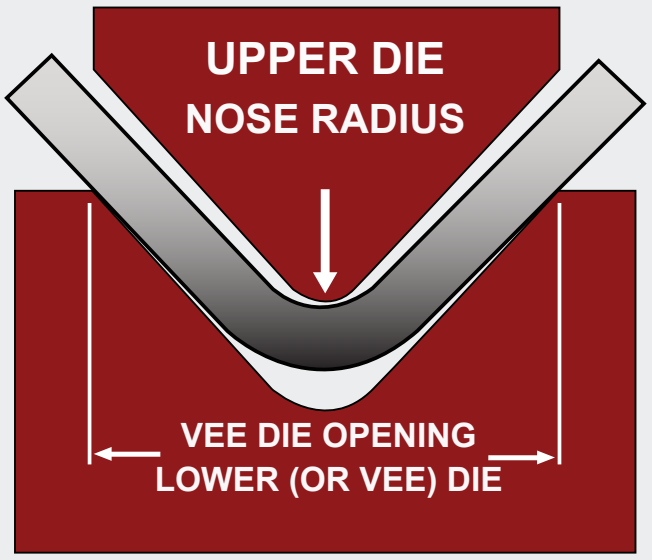


FIGURE 1 - AIR BENDING

FIGURE 2 - OVERBENDING DURING FORMING OPERATION

TRUE BOTTOMING (FIGURE 3)

When the upper die is made with a radius of one metal thickness (to the closest simple fraction), sufficient tonnage must be built up at the bottom of the stroke to "set" the metal and eliminate spring back. The required tonnage will range from three to five times the normal air bend tonnage.

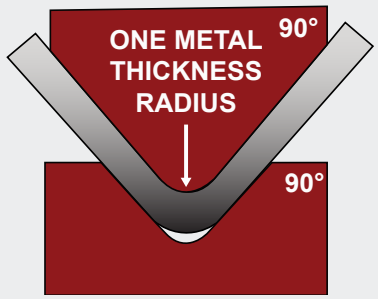


FIGURE 3 - BOTTOMING

COINING (FIGURE 4)

When the upper die is made with less than one metal thickness radius, the nose of the die will embed into the metal causing an apparent overbend condition. In order to push the upper die into the metal far enough to obtain the desired inside radius and bend angle, the required tonnage will be at least five times the air bend tonnage. If the desired inside radius is one-half the metal thickness or less, the forming load could approach ten times the tonnage shown on the air bend chart. When the top die embeds, or displaces metal, in order to obtain a sharper than one metal thickness inside radius, the term "coining" is applied.

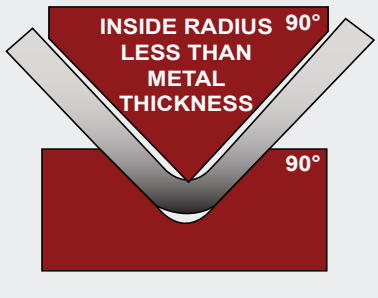


FIGURE 4 - COINING

CRACKING

When forming plate, "cracking" can be erratic. Small flanges can often be formed whereas making the same bend in the center of the sheet will cause failure. Differences will also be found when bending across the grain versus bending with the grain. Cracking is often minimized by increasing the nose radius of the upper die.

DIE SPACE (FIGURE 5)

Always total the height of the press brake dies and the height of the filler block (die holder) to make sure the tooling will fit into the available die space. For complete information on "die height selection," contact Cincinnati Incorporated.

DIE ALIGNMENT (FIGURE 6)

In order to obtain good accuracy in press brake forming, the tooling must be aligned so that the nose of the upper die is as central to the lower vee die as possible. With most press brakes, many bends could be made with an alignment accuracy of ±1/64" around the centerline of the vee opening.

Press brakes featuring computerized controls that allow the operator to input a specific bend angle depend on mathematical models to obtain good consistency. If the dies are not closely aligned to the tooling centerline, inaccuracies can occur. As a result, it is important to evaluate the available tooling with respect to the type of press brake being used in order to obtain the best possible forming angles. Vee dies with a 5/8" vee opening or less may require a ±.005" alignment to obtain good consistency.

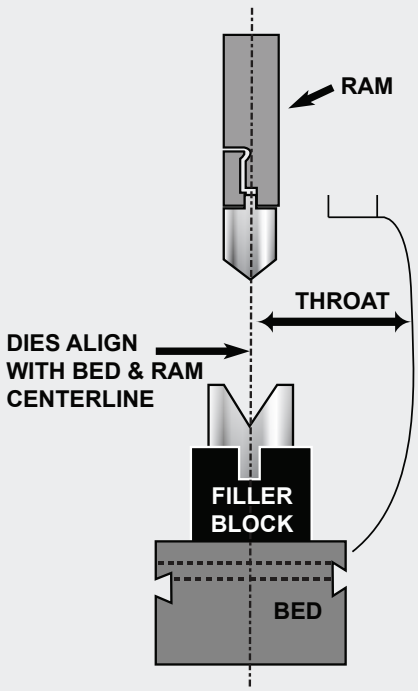


FIGURE 6 - DIE ALIGNMENT

BEND ALLOWANCE

In order to determine the proper blank size prior to forming a part on a press brake, a bend allowance for each bend must be determined. This information has been made available through many engineering textbooks, but the information provided is not consistent. If questions arise concerning a blank development for your part, CINCINNATI has available a bend allowance chart which may be helpful. Contact CINCINNATI at www.e-ci.com to obtain more information.

To obtain any brochures on CINCINNATI press brake models, die sets and accessories, please contact CINCINNATI at: (513) 367-7100, info@e-ci.com, www.e-ci.com

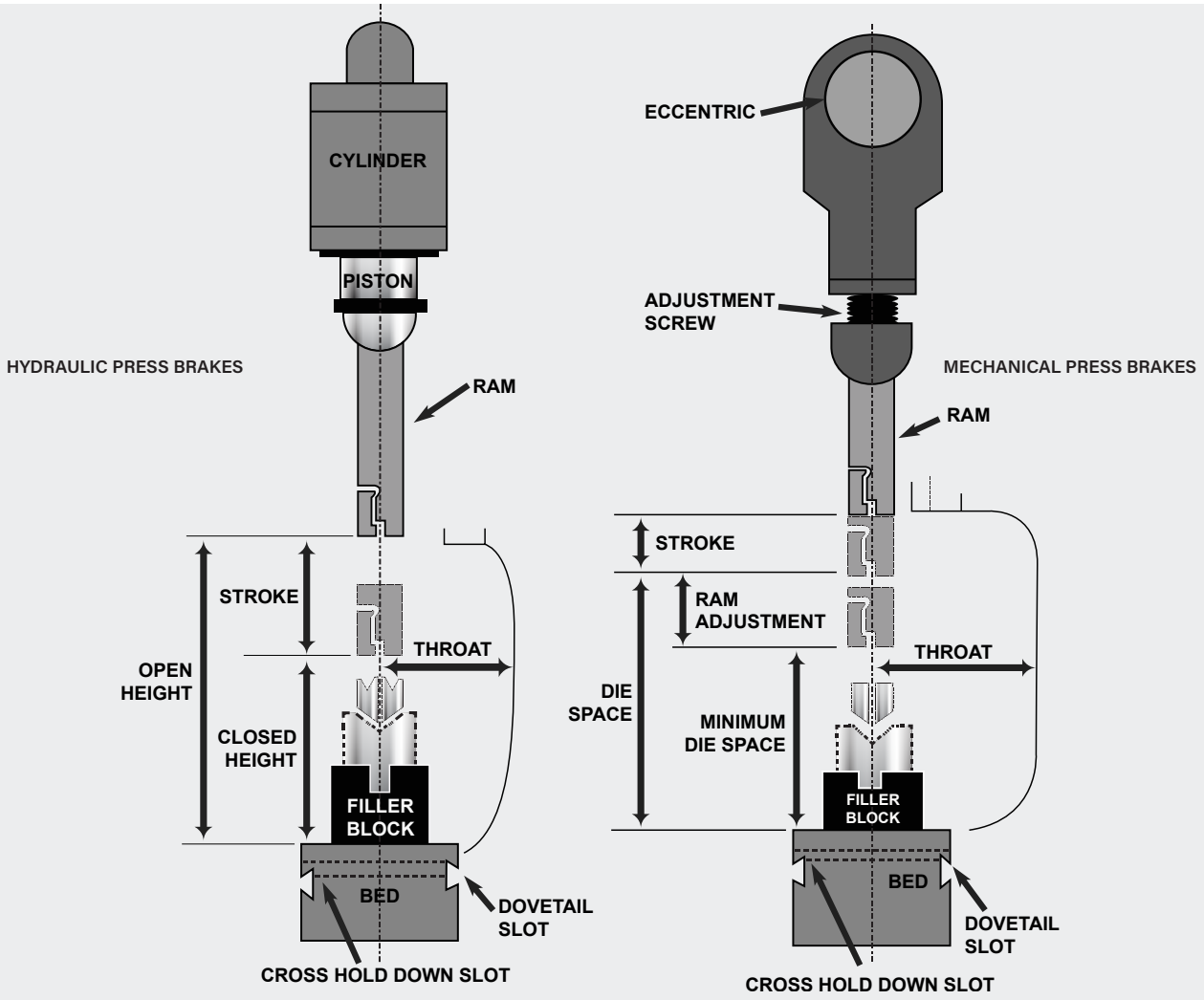


FIGURE 5 - DIE SPACE

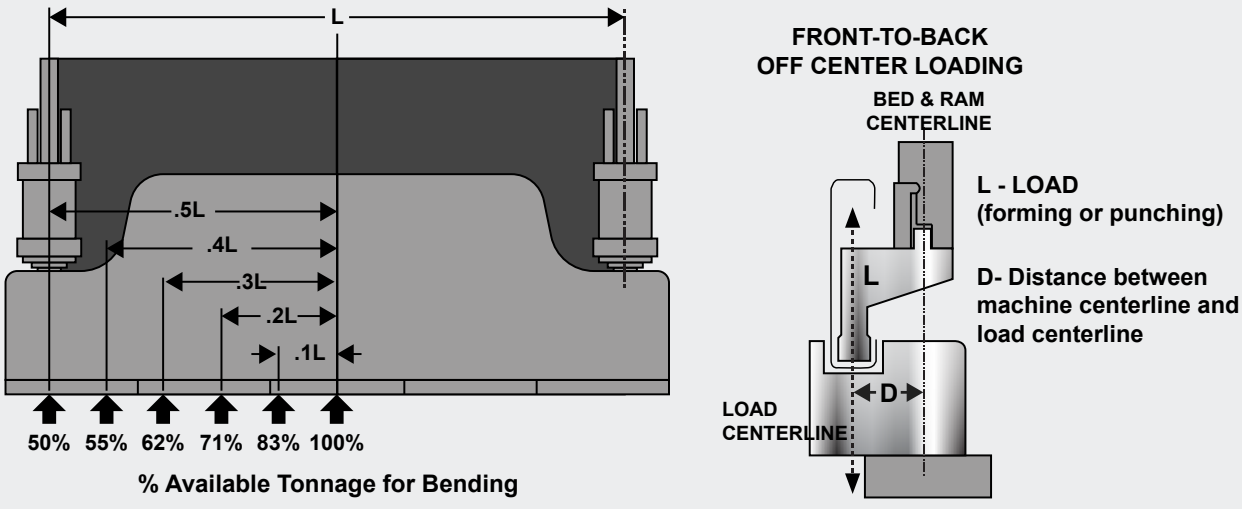


FIGURE 7 - OFF CENTER LOADING

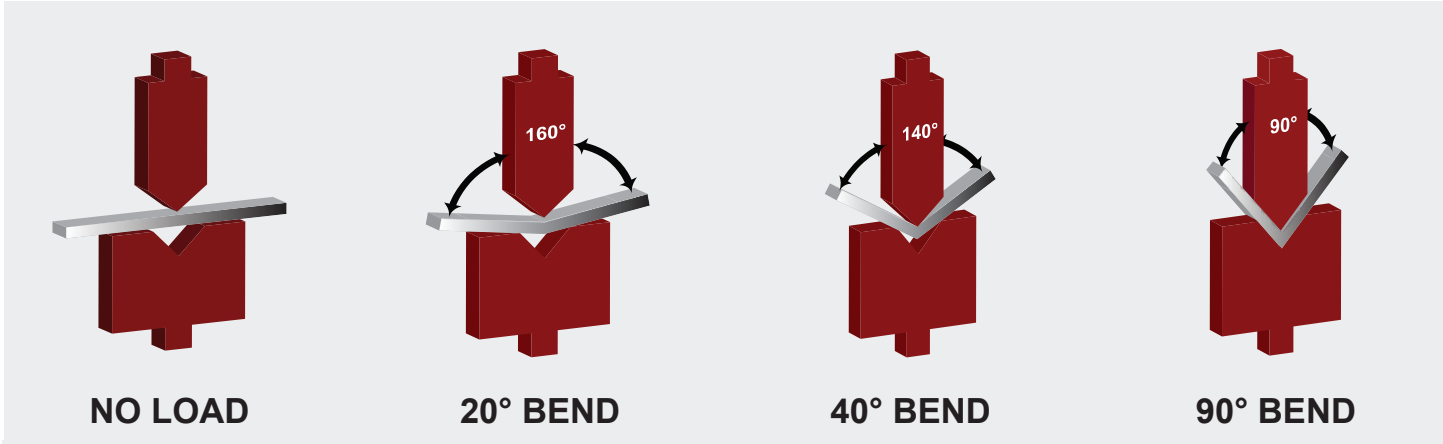
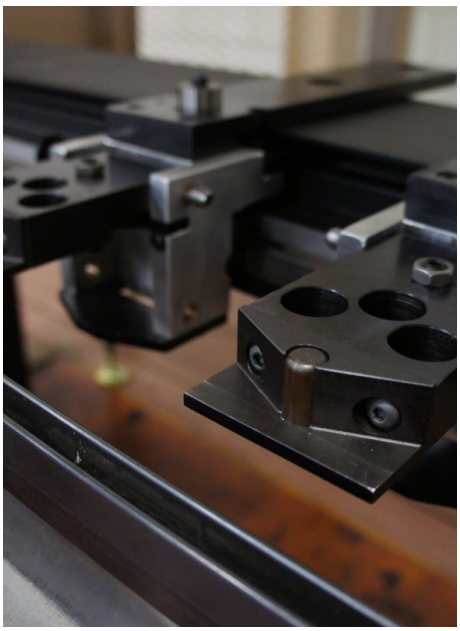


FIGURE 8 - TONNAGE BUILD-UP

ACTUAL TENSILE OR YIELD STRENGTHS

Many steels are suppled with tensile and yield strength identified as a "minimum value" with the "maximum" unspecified. Cincinnati Incorporated "Bending Factors" **(page 13)** allow an increase of 15,000 psi in steels using minimum figures. This allowance should work for over 90% of the steels available. In cases where breakage of the material is occurring or when the press brake will not make a bend even after the tonnage has been calculated to fall within the press brake capacity, the material should be tested to identify the actual tensile and yield strengths.



FORMING HIGH TENSILE STEELS

High tensile steels (70,000 psi or higher) do not react like mild steel. The material may form to the radius of the upper die. In this case, the nose radius of the die should conform to the steel manufacturer's recommendations. A larger vee opening may be required to obtain acceptable tonnages and angular accuracy. See" Bending Factors" chart **(page 13)** for typical recommendations.

Note: Stainless steels usually react similar to mild steel.

ANGULAR ACCURACY

Bending accuracy is limited by:

1. Press brake condition and repeatability
2. Operator ability
3. Condition of tooling
4. Quality of material

Assuming these four considerations are carefully reviewed, normal tolerances would be ±1 1/2° when forming up to 10' of 10 gauge or thinner sheet steel. If plate is being formed, add one degree to the tolerance. Bottoming operations will cut the air bend tolerance in half, but will increase the forming tonnage and could necessitate some shimming of the dies.

One half of the angular variation described above is due to normal material thickness variations found in commercial steel. The other half can be attributed to hard and soft spots in the metal, edge conditions, holes and notches, deflections in the machine or tooling and machine repeatability. CINCINNATI has available press brakes and options to improve the accuracy and consistency of many parts. Consult your local CINCINNATI sales representative for assistance.

BENDING FACTOR DETERMINATION

"Bending Factors" are obtained by relating the actual tensile and yield strengths of the steel being formed to those of mild steel. Consideration has been given in Cincinnati Incorporated's "Bending Factors" chart to allow for increasing the inside radius of the plate if required to eliminate cracking.

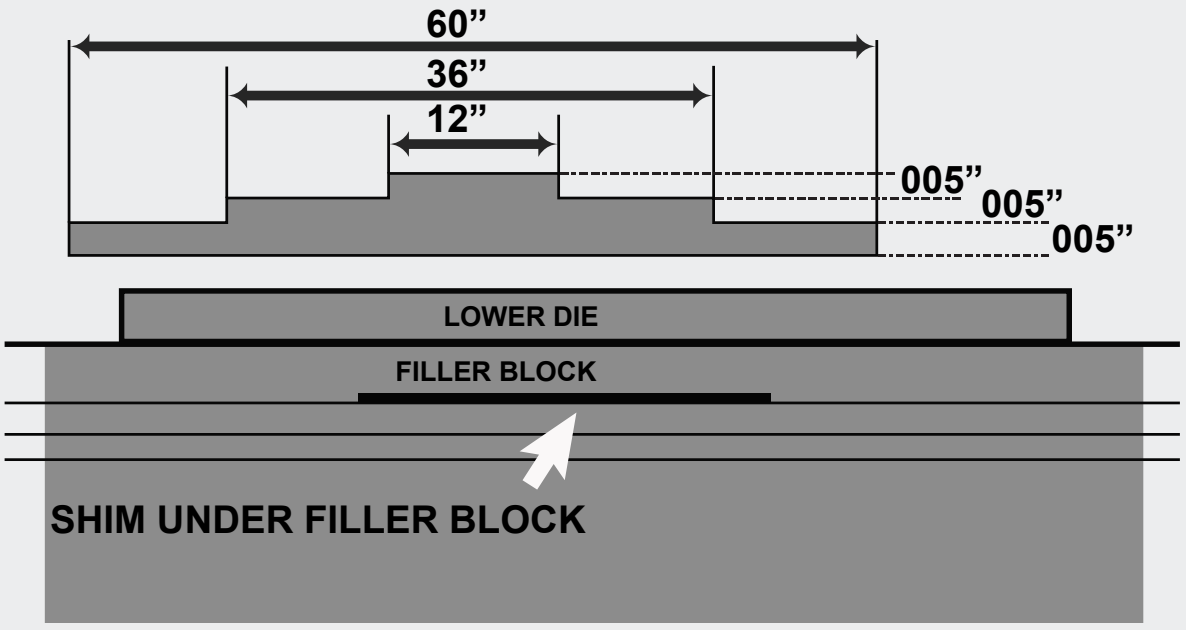


FIGURE 9 - TYPICAL SHIMMING CONFIGURATION

OFF CENTER LOADING
(FIGURE 7)

The Air Bend Capacity Chart **(see page 9)** is for centerline, symmetrical loads. Occasionally special forming or punching setups do not have their load centered on the bed and ram centerlines. Under these circumstances, care must be taken not to exceed the maximum eccentric (front-to-back) load capacity of the press brake. Similarly, when the load is not located at the machine centerline (left-to-right) only a portion of full rated capacity is available. Each housing is limited to one-half of the maximum rating. Contact Cincinnati Incorporated for specific information.

TONNAGE BUILD-UP
(FIGURE 8)

When making a 90° air bend, the load increases very rapidly, reaching 85% of maximum when the metal is bent 20° (10° per side). Maximum tonnage is reached when the metal is bent a total of 40°. The load drops off a few percent when the metal is bent to 90°.

SHIMMING (FIGURE 9)

To compensate for bed and ram deflection, as well as uneven wear on the press brake and tooling, shimming of the tooling may be required to obtain a uniform bend. All shimming should be done with a good quality steel (not brass) shim stock. In some cases, paper can be used. Keep all surfaces free from dirt or nicks since forming accuracy can be affected by poor work habits.

MARKING

General purpose vee dies sometimes cause marks on polished stainless, aluminum or painted stock. Marking can be minimized by:

1. Increasing the corner radius at the top of the vee die opening,
2. Polishing the entire vee die opening,
3. Hardening the corners of the larger lead-in radii.

In some cases, tape or die coverings can be used. Plastic coating on stainless steel may give inconsistent results in the reduction of die marks. Contact your CINCINNATI representative for additional information.

Note: Sectionalizing the lower die often results in objectionable marking.

GAGING

In order to obtain good consistency during the forming operation, the gaging sequence must be evaluated prior to parts being formed. The availability of CNC gaging, manually set front and back gaging or gages mounted to the lower die all must be reviewed to determine the best method.

Note: Remember that gaging determines the position of the bend. Angular accuracy is determined by the method of forming.

PRES BRAKE BENDING CAPACITY

AIR BEND CAPACITY CHART

The Air Bend Capacity Chart **(page 9)** lists the press brake bending capacities in linear feet of mild steel for different metal thicknesses when air bending only. The shaded area indicates the recommended vee die opening for each metal thickness. The nominal bending force in tons/foot (1 ton = 2000 lbs.) is listed in the third column. All capacities are listed for mild steel with a maximum tensile strength of 60,000 psi and a maximum yield strength of 40,000 psi. Nominal material variation allowances have been made for all capacity ratings. For materials other than mild steel, refer to the "Bending Factors" chart **(page 13)** for the proper formability factor.

BENDING FACTORS CHART

When material other than mild steel is to be formed, the required forming tonnage will probably change. The "Bending Factors" chart **(page 13)** offers a wide selection of ASTM numbers, their recommended upper die nose radii and vee die openings. The equivalent length of any special material which can be formed on a given press brake is calculated by dividing the mild steel capacity by the formability factor. This formability factor is shown in the far right hand column.

HOW TO USE THE CHARTS

1. Determine the maximum length of 1/4" (.250") mild steel a 5 Series press brake can air bend using the recommended vee die opening (8 x metal thickness).
   Step 1: Locate 0.250" thickness in the first column on the Air Bend Capacity Chart **(page 9)**.
   Step 2: Follow the recommended 2.00" vee die opening shaded line over to the intersecting vertical line for standard 5 Series mechanical press brake. Read maximum length of six feet. A 5 Series AC is listed at eight feet of bending capacity provided it is used at low speed.
2. Determine air bending capacity of a 230 ton hydraulic press brake when bending 1/4" (0.250") thick A242.
   Step 1: Refer to ASTM A242 on Bending Factors Chart **(page 13)** to determine recommended vee die opening for 1/4" plate. 12T = 12 x 0.250" = 3.00".
   Step 2: Determine the proper formability factor for A242 from the Bending Factors chart **(pages 13-16)** ---1.7.
   Step 3: Determine the bending capacity for a 230 ton hydraulic press brake when forming 0.250" mild steel over 3.00" vee die opening by using the Air Bend Capacity Chart **(page 9)**----21.7'.
   Step 4: Divide the maximum air bend capacity (Step 4) by the formability factor (Step 3) 21.7'/1.7 = 12.8 feet.
3. Select the proper size press brake to air bend 12' of 3/8" (0.375") thick A36 steel with a maximum yield strength of 45,000 psi.

   Step 1: Determine the nominal vee die opening for A36 from the Bending Factors Chart **(page 13)**-- 8T = 8 x 0.375" = 3.00".
   Step 2: Determine the formability factor for A36 (maximum yield strength of 45,000 psi) from the Bending Factors Chart **(page 13)**---1.3.
   Step 3: Determine the equivalent length of mild steel by multiplying the material length times the formability factor---12' x 1.3 = 15.6'.
   Step 4: Determine the smallest press brake that can be used from the Air Bend Capacity Chart **(pages 11-12)** by selecting the first press brake, mechanical or hydraulic, which exceeds 15.6' capacity for 0.375" thick material over a 3.00" vee die. A 21 Series mechanical (21.0') or 500 ton hydraulic (17.7') press brake will form this material.
4. Always check the tons per foot of force required to form mild steel with the available press brake tooling. This information can be used for designing tools and determining the unit pressure loading on the bed and ram, which must not exceed 15 tons/in.^{2} (1 ton = 2,000 lbs.).

Caution: The Air Bend Capacities Chart does not apply to non-standard stroke mechanical press brakes. Consult the factory on these applications.

MILD STEEL AIR BEND CAPACITY CHART

Mild Steel	Vee Die Opening Nominal Inches	Tons (2,000 lb) Per Foot	LINEAR FEET Hydraulic Press Brake Tonnage														
			60	90	135	175	230	300	350	400	500	600	750	1000	1250	1500	2000
(20 GA) 0.036	0.250	3.1	16.4	24.6	37.0	48.0	63.0	82.0	95.9	109.7	-	-	-	-	-	-	-
	0.312	2.3	22.2	33.3	49.9	64.7	85.0	110.8	-	-	-	-	-	-	-	-	-
	0.375	1.7	30.0	45.0	67.5	87.5	115.0	-	-	-	-	-	-	-	-	-	-
	0.438	1.4	36.4	54.6	81.9	106.2	-	-	-	-	-	-	-	-	-	-	-
	0.500	1.1	46.3	69.5	104.3	-	-	-	-	-	-	-	-	-	-	-	-
	0.625	0.9	56.7	85.0	-	-	-	-	-	-	-	-	-	-	-	-	-
(18 GA) 0.048	0.250	5.3	9.6	14.4	21.7	28.1	36.9	48.1	56.1	64.2	80.2	96.2	120.3	-	-	-	-
	0.312	4.0	12.7	19.1	28.7	37.2	48.9	63.8	74.4	85.0	106.3	-	-	-	-	-	-
	0.375	3.0	17.0	25.5	38.3	49.6	65.2	85.0	99.1	113.3	-	-	-	-	-	-	-
	0.438	2.5	20.4	30.6	45.9	59.5	78.2	102.0	-	-	-	-	-	-	-	-	-
	0.500	2.2	23.2	34.8	52.2	67.6	88.8	-	-	-	-	-	-	-	-	-	-
	0.625	1.7	30.0	45.0	67.5	87.5	115.0	-	-	-	-	-	-	-	-	-	-
	0.750	1.3	39.2	58.8	88.2	114.4	-	-	-	-	-	-	-	-	-	-	-
(16 GA) 0.060	0.375	5.6	9.1	13.7	20.5	26.6	34.9	45.5	53.1	60.7	75.9	91.1	113.8	-	-	-	-
	0.438	4.5	11.3	17.0	25.5	31.1	43.4	56.7	66.1	75.6	94.4	113.3	-	-	-	-	-
	0.500	3.8	13.4	20.1	30.2	39.1	51.4	67.1	78.3	89.5	111.8	-	-	-	-	-	-
	0.625	2.8	18.2	27.3	41.0	53.1	69.8	91.1	106.2	121.4	-	-	-	-	-	-	-
	0.750	2.2	23.2	34.8	52.2	67.6	88.8	115.9	-	-	-	-	-	-	-	-	-
	0.875	1.8	28.3	42.5	63.8	82.6	108.6	-	-	-	-	-	-	-	-	-	-
	1.000	1.5	34.0	51.0	76.5	99.2	-	-	-	-	-	-	-	-	-	-	-
(14 GA) 0.075	0.438	7.6	6.7	10.1	15.1	19.6	25.7	33.6	39.1	44.7	55.9	67.1	83.9	111.8	-	-	-
	0.500	6.3	8.1	12.1	18.2	23.6	31.0	40.5	47.2	54.0	67.5	81.0	101.2	-	-	-	-
	0.625	4.7	10.9	16.3	24.4	31.6	41.6	54.3	63.3	72.3	90.4	108.5	-	-	-	-	-
	0.750	3.5	14.6	21.9	32.8	42.5	55.9	72.9	85.0	97.1	121.4	-	-	-	-	-	-
	0.875	3.0	17.0	25.5	38.3	49.6	65.2	85.0	99.1	113.3	-	-	-	-	-	-	-
	1.000	2.5	20.4	30.6	45.9	59.5	78.2	102.0	-	-	-	-	-	-	-	-	-
	1.125	2.1	24.3	36.4	54.6	70.8	93.1	-	-	-	-	-	-	-	-	-	-
	1.250	1.8	28.3	42.5	63.8	82.6	108.6	-	-	-	-	-	-	-	-	-	-
(12 GA) 0.105	0.625	9.7	5.2	7.9	11.8	15.3	20.1	26.3	30.7	35.1	43.8	52.6	65.7	87.6	109.5	-	-
	0.750	8.0	6.4	9.6	14.3	18.6	24.4	31.9	37.2	42.5	53.1	63.8	79.7	106.3	-	-	-
	0.875	6.5	7.8	12.0	17.7	22.9	30.1	39.2	45.8	52.3	65.4	78.5	98.1	130.8	-	-	-
	1.000	5.6	9.1	13.7	20.5	26.6	34.9	45.5	53.1	60.7	75.9	91.1	113.8	-	-	-	-
	1.125	4.6	11.1	16.6	24.9	32.3	42.5	55.4	64.7	73.9	92.4	110.9	-	-	-	-	-
	1.250	4.1	12.5	18.7	28.0	36.3	47.7	62.2	72.6	82.9	103.7	-	-	-	-	-	-
	1.500	3.2	15.9	23.9	35.9	46.5	61.1	79.7	93.0	106.3	-	-	-	-	-	-	-
	2.000	2.3	22.1	33.2	49.9	64.7	85.0	110.8	-	-	-	-	-	-	-	-	-
(11 GA) 0.120	0.750	11.1	4.6	6.9	10.3	13.4	17.6	23.0	26.8	30.6	38.3	45.9	57.4	76.6	95.7	114.9	-
	0.875	9.0	5.6	8.5	12.8	16.5	21.7	28.3	33.0	37.8	47.2	56.7	70.8	94.4	118.0	-	-
	1.000	7.5	6.8	10.2	15.3	19.8	26.1	34.0	39.7	45.3	56.7	68.0	85.0	113.3	-	-	-
	1.125	6.3	8.1	12.1	18.2	23.6	31.0	40.5	47.2	54.0	67.5	81.0	101.2	-	-	-	-
	1.250	5.5	9.3	13.9	20.9	27.0	35.5	46.4	54.1	61.8	77.3	92.7	115.9	-	-	-	-
	1.500	4.4	11.6	17.4	26.1	33.8	44.4	58.0	67.6	77.3	96.6	115.9	-	-	-	-	-
	2.000	2.9	17.6	26.4	39.6	51.3	67.4	87.9	102.6	117.2	-	-	-	-	-	-	-
(10 GA) 0.135	0.875	11.9	4.3	6.4	9.6	12.5	16.4	21.4	25.0	28.6	35.7	42.9	53.6	71.4	89.3	107.1	-
	1.000	9.9	5.1	7.7	11.6	15.0	19.7	25.8	30.0	34.3	42.9	51.5	64.4	85.9	107.3	-	-
	1.125	8.5	6.0	9.0	13.5	17.5	23.0	30.0	35.0	40.0	50.0	60.0	75.0	100.0	-	-	-
	1.250	7.3	7.0	10.5	15.7	20.4	26.8	34.9	40.8	46.6	58.2	69.9	87.3	116.4	-	-	-
	1.500	5.8	8.8	13.2	19.8	25.6	33.7	44.0	51.3	58.6	73.3	87.9	109.9	-	-	-	-
	2.000	4.0	12.7	19.1	28.7	37.2	48.9	63.8	74.4	85.0	106.3	-	-	-	-	-	-
	2.500	3.1	16.5	24.7	37.0	48.0	63.0	82.2	95.9	109.7	-	-	-	-	-	-	-
0.188	1.125	16.4	3.1	4.7	7.0	9.1	11.7	15.5	18.1	20.7	25.9	31.1	38.9	51.8	64.8	77.7	103.7
	1.250	14.3	3.5	5.3	8.0	10.4	13.7	17.8	20.8	23.8	29.7	35.7	44.6	59.4	74.3	89.2	118.9
	1.500	11.2	4.5	6.8	10.3	13.3	17.4	22.8	25.5	30.4	37.9	45.5	56.9	75.9	94.9	113.8	-
	2.000	7.5	6.8	10.2	15.3	19.8	26.1	34.0	39.7	45.3	56.7	68.0	85.0	113.3	-	-	-
	2.500	5.7	8.9	13.4	20.1	26.1	34.3	44.7	52.2	59.6	74.6	89.5	111.8	-	-	-	-
	3.000	4.4	11.6	17.4	26.1	33.8	44.4	58.0	67.6	77.3	96.6	115.9	-	-	-	-	-
0.250	1.250	29.5	1.7	2.6	3.9	5.0	6.6	8.6	10.1	11.5	14.4	17.3	21.6	28.8	36.0	43.2	57.6
	1.500	22.7	2.2	3.4	5.1	6.6	8.6	11.2	13.1	15.0	18.7	22.5	28.1	37.4	46.8	56.2	74.9
	2.000	15.4	3.3	5.0	7.5	10.0	12.8	16.6	19.3	22.1	27.6	33.1	41.4	55.2	69.0	82.8	110.4
	2.500	11.4	4.4	6.7	10.1	13.0	17.1	22.4	26.1	29.8	37.3	44.7	55.9	74.6	93.2	111.8	-
	3.000	9.0	5.6	8.5	12.8	16.5	21.7	28.3	33.0	37.8	47.2	56.7	70.8	94.4	118.0	-	-
	3.500	7.4	6.9	10.3	15.5	20.1	26.4	34.4	40.2	45.9	57.4	68.9	86.1	114.9	-	-	-
	4.000	6.1	8.3	12.5	18.8	24.4	32.0	41.8	48.8	55.7	69.7	83.6	104.5	-	-	-	-

MILD STEEL AIR BEND CAPACITY CHART

Mild Steel	Vee Die Opening Nominal Inches	Tons (2,000 lbs) Per Foot	LINEAR FEET Hydraulic Press Brake Tonnage														
			60	90	135	175	230	300	350	400	500	600	750	1000	1250	1500	2000
0.313	1.50	39.8	-	-	2.9	3.7	4.9	6.4	7.5	8.5	10.7	12.8	16.0	21.4	26.7	32.0	42.7
	2.00	27.0	-	2.8	4.3	5.5	7.2	9.4	11.0	12.6	15.7	18.9	23.6	31.5	39.3	47.2	63.0
	2.50	19.7	-	3.9	5.8	7.6	9.9	12.9	15.1	17.3	21.6	25.9	32.4	43.1	53.9	64.7	86.3
	3.00	15.3	-	5.0	7.5	9.7	12.8	16.7	19.4	22.2	27.8	33.3	41.7	55.6	69.4	83.3	111.1
	3.50	12.7	-	6.0	9.0	11.7	15.4	20.1	23.4	26.8	33.5	40.2	50.2	66.9	83.7	100.4	-
	4.00	10.5	-	7.3	10.9	14.2	18.6	24.3	28.3	32.4	40.5	48.6	60.7	81.0	101.2	-	-
	5.00	7.7	-	9.9	14.9	19.3	25.4	33.1	38.6	44.1	55.2	66.2	82.8	110.4	-	-	-
0.375	2.00	42.3	-	-	2.7	3.5	4.6	6.0	7.0	8.0	10.0	12.1	15.1	20.1	25.1	30.1	40.2
	2.50	30.9	-	2.5	3.7	4.8	6.3	8.3	9.6	11.0	13.8	16.5	20.6	27.5	34.4	41.3	55.0
	3.00	24.0	-	3.2	4.8	6.3	8.3	10.0	12.4	14.2	17.7	21.3	26.6	35.4	44.3	53.1	70.8
	3.50	19.6	-	3.9	5.9	7.6	10.0	13.0	15.2	17.3	21.7	26.0	32.5	43.4	54.2	65.1	86.7
	4.00	16.3	-	4.7	7.0	9.1	12.0	15.6	18.3	20.9	26.1	31.3	39.1	52.1	65.2	78.2	104.3
	5.00	12.3	-	6.2	9.3	12.1	15.9	20.7	24.2	27.6	34.6	41.5	51.8	69.1	86.4	103.7	-
	6.00	9.5	-	8.0	12.0	15.6	20.6	26.8	31.3	35.8	44.7	53.7	67.1	89.5	111.8	-	-
0.438	2.50	45.8	-	-	2.5	3.2	4.3	5.6	6.5	7.4	9.3	11.1	13.9	18.6	23.2	27.8	37.1
	3.00	35.4	-	2.2	3.2	4.2	5.5	7.2	8.4	9.6	12.0	14.4	18.0	24.0	30.0	36.0	48.0
	3.50	28.6	-	2.7	4.0	5.2	6.8	8.9	10.4	11.9	14.9	17.8	22.3	29.7	37.2	44.6	59.4
	4.00	24.4	-	3.1	4.7	6.1	8.0	10.5	12.2	13.9	17.4	20.9	26.1	34.8	43.5	52.3	69.7
	5.00	17.3	-	4.4	6.6	8.6	11.3	14.7	17.2	19.7	24.6	29.5	36.8	49.1	61.4	73.7	98.3
	6.00	14.8	-	5.2	7.8	10.1	13.2	17.2	20.1	23.0	28.7	34.4	43.1	57.4	71.8	86.1	114.9
	7.00	11.2	-	6.8	10.2	13.3	17.4	22.8	26.6	30.4	37.9	45.5	56.9	75.9	94.9	113.8	-
0.500	3.50	39.7	-	-	2.9	3.7	4.9	6.4	7.5	8.6	10.7	12.8	16.1	21.4	26.8	32.1	42.8
	4.00	33.3	-	2.3	3.4	4.5	5.9	7.7	8.9	10.0	12.8	15.3	19.1	25.5	31.9	38.9	51.1
	5.00	24.6	-	3.1	4.7	6.1	8.0	10.4	12.0	13.8	17.3	20.7	25.9	34.6	43.2	51.8	69.1
	6.00	19.4	-	3.9	5.9	7.7	10.1	13.1	15.3	17.5	21.9	26.3	32.9	43.8	54.8	65.7	87.6
	7.00	15.9	-	4.8	7.2	9.4	12.3	16.0	18.7	21.4	26.7	32.1	40.1	53.5	66.8	80.2	106.9
	8.00	13.1	-	5.8	8.8	11.4	14.9	19.5	22.7	26.0	32.4	38.9	48.7	64.9	81.1	97.3	129.8
0.625	4.00	58.3	-	-	-	2.6	3.4	4.4	5.1	5.8	7.3	8.7	10.9	14.6	18.2	21.9	29.2
	5.00	43.1	-	-	2.7	3.5	4.5	5.9	6.9	7.9	9.9	11.3	14.8	19.7	24.7	29.6	39.4
	6.00	33.3	-	2.3	3.4	4.5	5.9	7.7	8.9	10.0	13.0	15.3	19.1	25.5	31.9	38.9	51.1
	7.00	27.4	-	2.8	4.2	5.4	7.1	9.3	10.9	12.4	15.5	18.6	23.3	31.0	38.8	46.5	62.0
	8.00	23.3	-	3.4	4.9	6.4	8.4	10.9	12.8	14.6	18.2	21.9	27.4	36.5	45.6	54.7	73.0
	10.00	16.9	-	4.5	6.8	8.8	11.5	15.1	17.6	20.1	25.1	30.2	37.7	50.3	62.9	75.4	100.6
0.750	6.00	53.5	-	-	2.1	2.8	3.7	4.8	5.6	6.4	7.9	9.5	11.9	15.9	19.9	23.8	31.8
	7.00	43.6	-	-	2.6	3.4	4.5	5.8	6.8	7.8	9.7	11.7	14.6	19.5	24.4	29.2	39.0
	8.00	36.5	-	2.1	3.1	4.1	5.4	7.0	8.5	9.3	11.6	14.0	17.5	23.3	29.1	34.9	46.6
	10.00	27.1	-	2.8	4.2	5.5	7.2	9.4	11.0	12.5	15.7	18.8	23.5	31.4	39.2	47.0	62.7
	12.00	21.0	-	-	-	7.1	9.3	12.1	14.2	16.2	20.2	24.3	30.4	40.5	50.6	60.7	80.9
0.875	7.00	64.6	-	-	-	2.3	3.0	3.9	4.6	5.3	6.6	7.9	9.9	13.2	16.4	19.7	26.3
	8.00	52.9	-	-	2.2	2.8	3.7	4.8	5.6	6.4	8.0	9.6	12.1	16.1	20.1	24.1	32.1
	10.00	39.7	-	-	2.9	3.7	4.9	6.4	7.5	8.6	10.7	12.8	16.1	21.4	26.8	32.1	42.8
	12.00	31.6	-	-	-	4.7	6.2	8.1	9.4	10.8	13.4	16.1	20.2	26.9	33.6	40.3	53.8
	14.00	25.2	-	-	-	-	-	10.1	-	13.5	16.9	20.2	25.3	33.7	42.2	50.6	67.5
1.000	7.00	91.2	-	-	-	-	2.1	2.8	3.3	3.7	4.7	5.6	7.0	9.3	11.7	14.0	18.6
	8.00	76.2	-	-	-	2.0	2.6	3.3	3.9	4.5	5.6	6.7	8.4	11.1	13.9	16.7	22.3
	10.00	56.3	-	-	2.0	2.6	3.5	4.5	5.3	6.0	7.5	9.1	11.0	15.0	18.9	22.6	30.2
	12.00	44.2	-	-	-	3.4	4.4	5.8	6.7	7.7	9.6	11.5	14.4	19.2	24.0	28.8	38.5
	14.00	35.2	-	-	-	-	-	7.2	-	9.7	12.1	14.5	18.1	24.1	30.2	36.2	48.3
	16.00	29.4	-	-	-	-	-	8.7	-	11.6	14.5	17.3	21.7	28.9	36.1	43.4	57.8
1.250	10.00	97.0	-	-	-	-	2.0	2.6	3.1	3.5	4.4	5.3	6.6	8.8	10.9	13.1	17.5
	12.00	75.5	-	-	-	2.0	2.6	3.4	3.9	4.5	5.6	6.8	8.4	11.3	14.1	16.9	22.5
	14.00	61.6	-	-	-	-	-	4.1	-	5.5	6.9	8.3	10.3	13.8	17.0	20.7	27.6
	16.00	51.1	-	-	-	-	-	5.0	-	6.7	8.3	10.0	12.5	16.6	20.8	24.9	33.3
	20.00	37.7	-	-	-	-	-	6.8	-	9.0	11.3	13.5	16.9	22.5	28.2	33.8	45.1
1.500	12.00	119.0	-	-	-	-	-	2.1	2.5	2.9	3.6	4.3	5.4	7.1	8.9	10.7	14.3
	14.00	97.3	-	-	-	-	-	2.6	-	3.5	4.4	5.2	6.6	8.7	10.9	13.1	17.5
	16.00	80.6	-	-	-	-	-	3.2	-	4.2	5.3	6.3	7.9	10.5	13.2	16.0	21.1
	20.00	59.5	-	-	-	-	-	4.3	-	5.7	7.1	8.6	10.7	14.3	17.9	21.4	28.6
	24.00	46.8	-	-	-	-	-	5.4	-	7.3	9.1	10.9	13.6	18.2	22.7	27.2	36.3
1.750	16.00	118.0	-	-	-	-	-	2.2	-	2.9	3.6	4.3	5.4	7.2	9.0	10.8	14.4
	20.00	87.5	-	-	-	-	-	2.9	-	3.9	4.9	5.8	7.3	9.7	12.1	14.6	19.4
	24.00	68.8	-	-	-	-	-	3.7	-	4.9	6.2	7.4	9.3	12.4	15.4	18.5	24.7
	30.00	50.7	-	-	-	-	-	5.0	-	6.7	8.4	10.0	12.6	16.8	21.0	25.1	33.5
2.000	16.00	165.0	-	-	-	-	-	-	-	2.1	2.6	3.1	3.9	5.2	6.4	7.7	10.3
	20.00	122.0	-	-	-	-	-	2.1	-	2.8	3.5	4.2	5.2	7.0	8.7	10.5	13.9
	24.00	96.0	-	-	-	-	-	2.7	-	3.5	4.4	5.3	6.6	8.9	11.1	13.3	17.7
	30.00	70.8	-	-	-	-	-	3.6	-	4.8	6.0	7.2	9.0	12.0	15.0	18.0	24.0

MILD STEEL AIR BEND CAPACITY CHART

Mild Steel	Vee Die Opening Nominal Inches	Tons (2,000lb) Per Foot	LINEAR FEET											
			Mechanical Press Brakes - Standard Stroke Only											
			5	5AC	9	9AC	12	12AC	13	13AC	21	34	36	50 *
			90/135	90/135	150/225	150/225	200/300	200/300	260/400	260/400	400/600	520/750	650/1000	1000/1500
	0.250	3.10	40.3	40.3	67.1	67.1	89.5	89.5	-	-	-	-	-	-
	0.312	2.30	54.3	54.3	90.5	90.5	-	-	-	-	-	-	-	-
(20 GA) 0.036	0.375	1.70	73.4	73.4	-	-	-	-	-	-	-	-	-	-
	0.438	1.40	89.1	89.1	-	-	-	-	-	-	-	-	-	-
	0.500	1.10	-	-	-	-	-	-	-	-	-	-	-	-
	0.625	0.09	-	-	-	-	-	-	-	-	-	-	-	-
	0.250	5.3	23.6	23.6	39.3	39.3	52.3	52.3	69.8	69.8	-	-	-	-
	0.312	4.0	31.2	31.2	52.0	52.0	69.4	69.4	92.5	92.5	-	-	-	-
(18 GA) 0.048	0.375	3.0	41.6	41.6	69.4	69.4	92.6	92.6	-	-	-	-	-	-
	0.438	2.5	50.0	50.0	83.3	83.3	-	-	-	-	-	-	-	-
	0.500	2.2	56.7	56.7	94.6	94.6	-	-	-	-	-	-	-	-
	0.625	1.7	73.4	73.4	-	-	-	-	-	-	-	-	-	-
	0.750	1.3	-	-	-	-	-	-	-	-	-	-	-	-
	0.375	5.6	22.3	22.3	37.2	37.2	49.6	49.6	66.1	66.1	99.1	-	-	-
	0.438	4.5	27.8	27.8	46.3	46.3	61.7	61.7	82.2	82.2	-	-	-	-
(16 GA) 0.060	0.500	3.8	32.0	32.0	54.8	54.8	73.0	73.0	-	-	-	-	-	-
	0.625	2.8	44.6	44.6	74.3	74.3	-	-	-	-	-	-	-	-
	0.750	2.2	56.7	56.7	94.6	94.6	-	-	-	-	-	-	-	-
	0.875	1.8	69.4	69.4	-	-	-	-	-	-	-	-	-	-
	1.000	1.5	83.3	83.3	-	-	-	-	-	-	-	-	-	-
	0.438	7.6	16.4	16.4	27.4	27.4	36.5	36.5	48.7	48.7	73.0	-	-	-
	0.500	6.3	19.8	19.8	33.0	33.0	44.0	44.0	58.7	58.7	88.1	-	-	-
	0.625	4.7	26.0	26.0	44.3	44.3	59.0	59.0	78.7	78.7	-	-	-	-
(14 GA) 0.075	0.750	3.5	35.7	35.7	59.5	59.5	79.3	79.3	-	-	-	-	-	-
	0.875	3.0	41.6	41.6	69.4	69.4	-	-	-	-	-	-	-	-
	1.000	2.5	50.0	50.0	83.3	83.3	-	-	-	-	-	-	-	-
	1.125	2.1	59.5	59.5	-	-	-	-	-	-	-	-	-	-
	1.250	1.8	69.4	69.4	-	-	-	-	-	-	-	-	-	-
	0.625	9.7	12.9	12.9	21.5	21.5	28.6	28.6	38.1	38.1	57.2	71.5	-	-
	0.750	8.0	15.6	15.6	26.0	26.0	34.7	34.7	46.3	46.3	69.4	-	-	-
	0.875	6.5	19.0	19.0	32.0	32.0	42.7	42.7	56.9	56.9	85.3	-	-	-
(12 GA) 0.105	1.000	5.6	22.3	22.3	37.2	37.2	49.6	49.6	66.1	66.1	-	-	-	-
	1.125	4.6	27.1	27.1	45.2	45.2	60.3	60.3	80.4	80.4	-	-	-	-
	1.250	4.1	30.5	30.5	50.8	50.8	67.7	67.7	-	-	-	-	-	-
	1.500	3.2	38.4	39.0	65.0	65.0	86.7	86.7	-	-	-	-	-	-
	2.000	2.3	40.2	53.5	90.4	90.4	-	-	-	-	-	-	-	-
	0.750	11.1	11.3	11.3	18.8	18.8	25.0	25.0	33.3	33.3	50.0	63.0	83.3	-
	0.875	9.0	13.9	13.9	23.1	23.1	30.8	30.8	41.1	41.1	61.7	77.1		-
	1.000	7.5	16.7	16.7	27.8	27.8	37.0	37.0	49.3	49.3	74.0	-	-	-
(11 GA) 0.120	1.125	6.3	19.8	19.8	33.0	33.0	44.0	44.0	58.7	58.7	88.1	-	-	-
	1.250	5.5	22.7	22.7	37.8	37.8	50.5	50.5	67.3	67.3	-	-	-	-
	1.500	4.4	27.9	28.4	47.3	47.3	63.1	63.1	84.1	84.1	-	-	-	-
	2.000	2.9	31.9	42.4	71.7	71.7	-	-	-	-	-	-	-	-
	0.875	11.9	10.5	10.5	17.5	17.5	23.3	23.3	31.1	31.1	46.6	58.3	77.7	-
	1.000	9.9	12.6	12.6	21.0	21.0	28.0	28.0	37.4	37.4	56.1	70.1	-	-
(10 GA) 0.135	1.125	8.5	14.0	14.0	25.0	25.0	32.0	32.0	43.5	43.5	65.3	-	-	-
	1.250	7.3	17.1	17.1	28.5	28.5	38.0	38.0	50.7	50.7	76.0	-	-	-
	1.500	5.8	21.2	21.5	35.9	35.9	47.8	47.8	63.8	63.8	-	-	-	-
	2.000	4.0	23.1	30.8	52.0	52.0	69.4	69.4	92.4	92.4	-	-	-	-
	2.500	3.1	25.3	31.8	57.0	57.0	88.8	88.8	-	-	-	-	-	-
	1.125	16.4	7.6	7.6	12.7	12.7	16.9	16.9	22.6	22.6	33.8	42.3	56.4	84.6
	1.250	14.3	8.7	8.7	14.6	14.6	19.4	19.4	25.9	25.9	38.8	48.5	64.7	-
0.188	1.500	11.2	11.0	12.0	19.0	19.0	25.0	25.0	34.0	34.0	49.6	61.9	82.6	-
	2.000	7.5	12.3	16.4	27.8	27.8	37.0	37.0	49.3	49.3	74.0	92.4	-	-
	2.500	5.7	13.8	17.3	31.0	31.0	48.3	48.3	62.3	62.3	-	-	-	-
	3.000	4.4	14.0	18.6	32.7	40.9	60.0	60.0	70.9	70.9	-	-	-	-
	1.250	29.5	4.2	4.2	7.1	7.1	9.4	9.4	12.5	12.5	18.8	23.5	31.3	47.0
	1.500	22.7	5.5	5.5	9.2	9.2	12.2	12.2	16.3	16.3	24.4	30.6	40.7	61.1
	2.000	15.4	6.0	8.0	13.0	14.0	18.0	18.0	24.0	24.0	36.0	45.0	60.0	90.1
0.250	2.500	11.4	6.5	8.6	15.5	15.5	24.2	24.2	31.0	31.0	46.6	60.9	81.0	-
	3.000	9.0	6.8	9.1	16.0	20.0	29.3	29.3	34.7	34.7	56.0	74.6	-	-
	3.500	7.4	7.1	9.5	16.7	20.8	31.1	31.1	40.5	40.5	58.4	-	-	-
	4.000	6.1	7.4	10.0	17.6	22.0	32.7	32.7	43.7	45.9	65.6	-	-	-

* Press Brake tonnage capacity at mid stroke and near bottom of stroke. Series 5AC, 9AC and 13AC tonnage capacity ratings listed are for low speed operation.

MILD STEEL AIR BEND CAPACITY CHART

Mild Steel	Vee Die Opening Nominal Inches	Tons (2,000 lb) Per Foot	LINEAR FEET											
			Mechanical Press Brake-Standard Stroke Only											
			5	5AC	9	9AC	12	12AC	13	13AC	21	34	36	50 *
			90/135	90/135	150/225	150/225	200/300	200/300	260/400	260/400	400/600	520/750	650/1000	1000/1500
	1.50	39.8	3.1	3.1	5.2	5.2	7.0	7.0	9.3	9.3	13.9	17.4	23.2	34.9
	2.00	27.0	3.4	4.6	7.7	7.7	10.3	10.3	13.7	13.7	20.6	25.7	34.3	51.4
	2.50	19.7	4.0	5.0	9.0	9.0	14.0	14.0	18.0	18.0	27.0	34.0	46.9	70.4
0.313	3.00	15.3	4.2	5.4	9.4	11.8	17.2	17.2	20.4	20.4	32.9	43.9	60.5	90.6
	3.50	12.7	4.4	5.5	9.7	12.1	18.5	18.5	23.6	23.6	35.0	50.8	68.1	-
	4.00	10.5	4.6	5.8	10.3	12.8	19.0	19.0	25.4	26.7	38.1	57.1	76.2	-
	5.00	7.7	-	-	-	-	25.2	25.2	27.6	34.6	44.8	72.8	-	-
	2.00	42.3	2.2	2.9	4.9	4.9	6.6	6.6	8.7	8.7	13.1	16.4	21.9	32.8
	2.50	30.9	2.4	3.2	5.7	5.7	8.9	8.9	11.4	11.4	17.2	22.4	29.9	44.9
	3.00	24.0	2.6	3.4	6.0	7.5	11.0	11.0	13.0	14.0	21.0	28.0	36.0	57.8
0.375	3.50	19.6	2.7	3.6	6.3	7.9	11.7	11.7	15.3	15.3	22.6	32.9	44.1	70.7
	4.00	16.3	2.8	3.8	6.6	8.3	12.3	12.3	16.4	17.2	24.5	36.8	49.0	85.1
	5.00	12.3	-	-	-	-	15.8	15.8	17.3	21.7	28.1	45.6	59.5	-
	6.00	9.5	-	-	-	-	-	-	-	-	-	-	67.6	-
	2.50	45.8	-	2.2	3.9	3.9	6.0	6.0	7.8	7.8	11.6	15.1	20.2	30.3
	3.00	35.4	-	2.3	4.1	5.1	7.5	7.5	8.8	8.8	14.2	19.0	26.1	39.2
	3.50	28.6	-	2.4	4.3	5.4	8.0	8.0	10.5	10.5	15.5	22.5	30.2	48.5
0.438	4.00	24.4	-	2.5	4.4	5.5	8.2	8.2	10.9	11.5	16.4	24.6	32.8	54.5
	5.00	17.3	-	-	-	-	11.2	11.2	12.3	15.4	20.0	32.4	42.3	69.6
	6.00	14.8	-	-	-	-	-	-	-	-	-	-	43.4	76.0
	7.00	11.2	-	-	-	-	-	-	-	-	-	-	-	-
	3.50	39.7	-	-	3.1	3.9	5.8	5.8	7.6	7.6	11.2	16.2	21.8	34.9
	4.00	33.3	-	-	3.2	4.1	6.0	6.0	8.0	8.4	12.0	18.0	24.0	39.9
0.500	5.00	24.6	-	-	-	-	8.0	8.0	8.6	10.8	14.0	20.0	29.7	49.0
	6.00	19.4	-	-	-	-	-	-	-	-	-	-	33.1	58.0
	7.00	15.9	-	-	-	-	-	-	-	-	-	-	-	63.2
	8.00	13.1	-	-	-	-	-	-	-	-	-	-	-	69.8
	4.00	58.3	-	-	-	2.3	3.4	3.4	4.6	4.8	6.9	10.3	13.7	22.8
	5.00	43.1	-	-	-	-	4.5	4.5	5.0	6.2	8.0	13.0	17.0	28.0
0.625	6.00	33.3	-	-	-	-	-	-	-	-	-	-	19.3	33.8
	7.00	27.4	-	-	-	-	-	-	-	-	-	-	-	36.7
	8.00	23.3	-	-	-	-	-	-	-	-	-	-	-	39.3
	10.00	16.9	-	-	-	-	-	-	-	-	-	-	-	-
	6.00	53.5	-	-	-	-	-	-	-	-	-	-	12.0	21.0
	7.00	43.6	-	-	-	-	-	-	-	-	-	-	-	24.9
0.750	8.00	36.5	-	-	-	-	-	-	-	-	-	-	-	26.0
	10.00	27.1	-	-	-	-	-	-	-	-	-	-	-	-
	12.00	21.0	-	-	-	-	-	-	-	-	-	-	-	-
	7.00	64.6	-	-	-	-	-	-	-	-	-	-	-	15.6
	8.00	52.9	-	-	-	-	-	-	-	-	-	-	-	17.3
0.875	10.00	39.7	-	-	-	-	-	-	-	-	-	-	-	-
	12.00	31.6	-	-	-	-	-	-	-	-	-	-	-	-
	14.00	25.2	-	-	-	-	-	-	-	-	-	-	-	-
	7.00	91.2	-	-	-	-	-	-	-	-	-	-	-	11.4
	8.00	76.2	-	-	-	-	-	-	-	-	-	-	-	12.0
1.000	10.00	56.3	-	-	-	-	-	-	-	-	-	-	-	-
	12.00	44.2	-	-	-	-	-	-	-	-	-	-	-	-
	14.00	35.2	-	-	-	-	-	-	-	-	-	-	-	-
	16.00	29.4	-	-	-	-	-	-	-	-	-	-	-	-
	10.00	97.0	-	-	-	-	-	-	-	-	-	-	-	-
	12.00	75.5	-	-	-	-	-	-	-	-	-	-	-	-
1.250	14.00	61.6	-	-	-	-	-	-	-	-	-	-	-	-
	16.00	51.1	-	-	-	-	-	-	-	-	-	-	-	-
	20.00	37.7	-	-	-	-	-	-	-	-	-	-	-	-
	12.00	119.0	-	-	-	-	-	-	-	-	-	-	-	-
	14.00	97.3	-	-	-	-	-	-	-	-	-	-	-	-
1.500	16.00	80.6	-	-	-	-	-	-	-	-	-	-	-	-
	20.00	59.5	-	-	-	-	-	-	-	-	-	-	-	-
	24.00	46.8	-	-	-	-	-	-	-	-	-	-	-	-
	16.00	118.0	-	-	-	-	-	-	-	-	-	-	-	-
1.750	20.00	87.5	-	-	-	-	-	-	-	-	-	-	-	-
	24.00	68.8	-	-	-	-	-	-	-	-	-	-	-	-
	30.00	50.7	-	-	-	-	-	-	-	-	-	-	-	-
	16.00	165.0	-	-	-	-	-	-	-	-	-	-	-	-
2.000	20.00	122.0	-	-	-	-	-	-	-	-	-	-	-	-
	24.00	96.0	-	-	-	-	-	-	-	-	-	-	-	-
	30.00	70.8	-	-	-	-	-	-	-	-	-	-	-	-

* Press Brake tonnage capacity at mid stroke and near bottom of stroke. Series 5AC, 9AC and 13AC tonnage capacity ratings listed are for low speed operation.

BENDING FACTORS CHART

ASTM SPECIFICATION			TENSILE STRENGTH K.S.I.	YIELD STRENGTH K.S.I.	MATERIAL THICKNESS INCHES	NOMINAL VEE DIE OPENING	NOMINAL UPPER DIE RADIUS	FORMABILITY FACTOR
NO.	TYPE	GRADE						
A-36	STRUCTURAL STEEL	-	58 - 60	36-51	0.180 - 0.500	8 T	1.0 T	1.3
					0.500 - 1.000	10 T	1.5 T	
				51-65	0.180 - 0.500	10 T	1.5 T	1.6
					0.500 - 1.000	12 T	2.0 T	
A-131	STRUCTURAL STEEL FOR SHIPS	ALL	58 - 71	34 MIN	0.180 - 0.500	8 T	1.0 T	1.2
					0.500 - 1.000	10 T	1.5 T	
A-242	HIGH-STRENGTH LOW-ALLOY STRUCTURAL STEEL	-	70 MIN	50 MIN	0.180 - 0.250	12 T	2.0 T	1.7
					0.250 - 0.500		3.0 T	
A-283	LOW & INTERMEDIATE TENSILE STRENGTH CARBON STEEL PLATES OF STRUCTURAL QUALITY	A	45 - 55	24 MIN	0.180 - 0.500	8 T	1.0 T	1.0
					0.500 - 1.000	10 T	1.5 T	
		B	50 - 60	27 MIN	0.180 - 0.500	8 T	1.0 T	1.0
					0.500 - 1.000	10 T	1.5 T	
		C	55 - 65	30 MIN	0.180 - 0.500	8 T	1.0 T	1.1
					0.500 - 1.000	10 T	1.5 T	
		D	60 - 72	33 MIN	0.180 - 0.500	8 T	1.0 T	1.2
					0.500 - 1.000	10 T	1.5 T	
A-285	LOW & INTERMEDIATE TENSILE STRENGTH CARBON STEEL PLATES FOR PRESSURE VESSEL	A	45 - 65	24 MIN	0.180 - 0.500	8 T	1.0 T	1.0
					0.500 - 1.000	10 T	1.5 T	
		B	50 - 70	27 MIN	0.180 - 0.500	8 T	1.0 T	1.1
					0.500 - 1.000	10 T	1.5 T	
		C	55 - 75	30 MIN	0.180 - 0.500	8 T	1.0 T	1.2
					0.500 - 1.000	10 T	1.5 T	
A-299	CARBON MANGANESE SILICON STEEL PLATE FOR PRESSURE VESSELS	-	75 - 95	42 MIN	0.180 - 1.00	12 T	1.5 T	1.5
A-514	HIGH-YIELD STRENGTH, QUENCHED AND TEMPERED ALLOY STEEL PLATE SUITABLE FOR WELDING	-	110 - 130	100 MIN	0.180 - 1.000	16 T	2.0 T	3.1
					OVER 1.000		3.0 T	
A-515	CARBON STEEL PLATES FOR INTERMEDIATE AND HIGHER TEMPERATURE SERVICE FOR PRESSURE VESSELS	55	55 - 75	30 MIN	0.180 - 0.500	8 T	1.0 T	1.2
					0.500 - 1.000	10 T	1.5 T	
		60	60 - 80	32 MIN	0.180 - 0.500	8 T	1.0 T	1.3
					0.500 - 1.000	10 T	1.5 T	
		65	65 - 85	35 MIN	0.180 - 0.500	10 T	1.5 T	1.45
					0.500 - 1.000	12 T	2.0 T	
		70	70 - 90	38 MIN	0.180 - 0.500	12 T	2.0 T	1.6
					0.500 - 1.000	14 T	2.0 T	
A-516	CARBON STEEL PLATES FOR MODERATE AND LOWER TEMPERATURE SERVICE FOR PRESSURE VESSELS	55	55 - 75	30 MIN	0.180 - 0.500	8 T	1.0 T	1.2
					0.500 - 1.000	10 T	1.5 T	
		60	60 - 80	32 MIN	0.180 - 0.500	8 T	1.0 T	1.3
					0.500 - 1.000	10 T	1.5 T	
		65	65 - 85	35 MIN	0.180 - 0.500	10 T	1.5 T	1.45
					0.500 - 1.000	12 T	2.0 T	
		70	70 - 90	38 MIN	0.180 - 0.500	12 T	2.0 T	1.6
					0.500 - 1.000	14 T		
A-517	HIGH STRENGTH, ALLOY STEEL QUENCHED AND TEMPERED PLATES FOR PRESSURE VESSEL	-	115 - 135	100 MIN	0.180 - 1.000	16 T	2.0 T	3.1
					OVER 1.000		3.0 T	
A-537	HEAT TREATED, CARBON MANGANESE-SILICON STEEL PLATE FOR PRESSURE VESSEL	CLASS I	70 - 90	50 MIN	0.180 - 1.250	14 T	3.0 T	1.9
					OVER 1.250	16 T	4.0 T	
		CLASS II	80 - 100	60 MIN	0.180 - 1.250	16 T	4.0 T	2.0
					OVER 1.250		5.0 T	
A-572	HIGH-STRENGTH LOW-ALLOY COLUMBIUM-VANADIUM STEELS OF STRUCTURAL QUALITY	42	60 MIN	42 MIN	0.180 - 0.250	10 T	1.5 T	1.4
					0.250 - 0.500	12 T	2.0 T	
		50	65 MIN	50 MIN	0.180 - 0.250	12 T	2.0 T	1.6
					0.250 - 0.500		2.5 T	
		60	75 MIN	60 MIN	0.180 - 0.250	14 T	3.0 T	1.8
					0.250 - 0.500		3.5 T	
		65	80 MIN	65 MIN	0.180 - 0.250	14 T	3.5 T	1.9
					0.250 - 0.500	16 T	4.0 T	
A-588	HIGH-STRENGTH LOW-ALLOY STRUCTURAL STEEL WITH 50,000 PSI MINIMUM YIELD POINT 4" THICK	ALL	70 MIN	50 MIN	0.180 - 0.250	10 T	2.0 T	1.7
					0.250 - 0.500	12 T	3.0 T	
A-606	STEEL SHEET AND STRIP, HOT ROLLED AND COLD ROLLED, HIGH -STRENGTH, LOW-ALLOY WITH IMPROVED CORROSION RESISTANCE	H.R.	70 MIN	50 MIN	0.000 - 0.062	8 T	1.0 T	1.7
					0.062 - 0.250	10 T	2.0 T	
					0.250 - 0.500	12 T	3.0 T	
		C.R. ANNEAL. NORM.	65 MIN	45 MIN	0.000 - 0.062	8 T	1.0 T	1.6
					OVER 0.062	10 T	2.0 T	
A-633	NORMALIZED HIGH-STRENGTH LOW-ALLOY STRUCTURAL STEEL	A-B	63 - 83	42 MIN	0.000 - 1.00	12 T	2.0 T	1.6
		C-D	70 - 90	50 MIN				1.7
		E	80 - 100	60 MIN				2.0
A-656	HOT-ROLLED STRUCTURAL STEEL, HIGH-STRENGTH LOW-ALLOY STEEL PLATE WITH IMPROVED FORMABILITY	50	60 MIN	50 MIN	0.000 - 0.250	8 T	1.0 T	1.5
					0.250 - 0.750	10 T	1.5 T	
		60	70 MIN	60 MIN	0.000 - 0.250	8 T	1.0 T	1.6
					0.250 - 0.750	10 T	1.5 T	
		70	80 MIN	70 MIN	0.000 - 0.250	8 T	1.0 T	1.8
					0.250 - 0.750	10 T	1.5 T	
		80	90 MIN	80 MIN	0.000 - 0.250	8 T	1.0 T	2.1
					0.250 - 0.750	10 T	1.5 T	

BENDING FACTORS CHART

The tensile and/or yield strength of many ASTM steels are specified as minimum values with no limit on the maximum. This chart is based on the actual tensile strength and/or yield strengths 15,000 PSI above the specified minimum values. Steel exceeding this value must be limited to thinner material than shown in the chart. The actual physical properties and chemical analysis of a steel may meet more than one specification and/or grade within a specification. In this case the capacities for the specification and/or grade with the highest mechanical properties must be used. The ASTM specifications listed are those in effect on January 1, 2000.

ASTM SPECIFICATION		TENSILE STRENGTH K.S.I.	YIELD STRENGTH K.S.I.	MATERIAL THICKNESS INCHES	NOMINAL VEE DIE OPENING	NOMINAL UPPER DIE RADIUS	FORMABILITY FACTOR
NO.	TYPE						
A1008 STEEL, SHEET, COLD ROLLED, CARBON STRUCTURAL, HIGH-STRENGTH LOW-ALLOY,AND HIGH-STRENGTH LOW-ALLOY WITH IMPROVED FORMABILITY	CS Type A,B & C	NOT SPECIFIED	20 - 40	ALL	8 T	1.0 T	1.0
	DS Type A & B	NOT SPECIFIED	22 - 35	ALL	8 T	1.0 T	1.0
	DDS	NOT SPECIFIED	17 - 29	ALL	8 T	1.0 T	1.0
	EDDS	NOT SPECIFIED	15 - 25	ALL	8 T	1.0 T	1.0
	SS: GRADE 25	42 MIN	25 MIN	ALL	8 T	1.0 T	1.0
	SS: GRADE 30	45 MIN	30 MIN	ALL	8 T	1.0 T	1.0
	SS: GRADE 33 TYPE 1 & 2	48 MIN	33 MIN	ALL	8 T	1.0 T	1.0
	SS: GRADE 40 TYPE 1 & 2	52 MIN	40 MIN	ALL	8 T	1.0 T	1.0
	SS: GRADE 80	82 MIN	80 MIN	-	-	-	-
	HSLAS: GRADE 45 CLASS 1	60 MIN	45 MIN	0.000 - 0.180	8 T	1.0 T	1.5
				0.180 - 0.230	10 T	1.5 T	
	HSLAS: GRADE 45 CLASS 2	55 MIN		0.000 - 0.180	8 T	1.0 T	1.5
				0.180 - 0.230	10 T	1.5 T	
	HSLAS: GRADE 50 CLASS 1	65 MIN	50 MIN	0.000 - 0.180	10 T	1.5 T	1.6
				0.180 - 0.230	12 T	2.0 T	
	HSLAS: GRADE 50 CLASS 2	60 MIN		0.000 - 0.180	10 T	1.5 T	1.6
				0.180 - 0.230	12 T	2.0 T	
	HSLAS: GRADE 55 CLASS 1	70 MIN	55 MIN	0.000 - 0.180	12 T	2.0 T	1.7
				0.180 - 0.230		2.5 T	
	HSLAS: GRADE 55 CLASS 2	65 MIN		0.000 - 0.180	12 T	2.0 T	1.7
				0.180 - 0.230		2.5 T	
	HSLAS: GRADE 60 CLASS 1	75 MIN	60 MIN	0.000 - 0.180	12 T	2.5 T	1.8
				0.180 - 0.230	14 T	3.0 T	
	HSLAS: GRADE 60 CLASS 2	70 MIN		0.000 - 0.180	12 T	2.5 T	1.8
				0.180 - 0.230	14 T	3.0 T	
	HSLAS: GRADE 65 CLASS 1	80 MIN	65 MIN	0.000 - 0.180	14 T	3.0 T	1.9
				0.180 - 0.230		3.5 T	
	HSLAS: GRADE 65 CLASS 2	75 MIN		0.000 - 0.180	14 T	3.0 T	1.9
				0.180 - 0.230		3.5 T	
	HSLAS: GRADE 70 CLASS 1	85 MIN	70 MIN	0.000 - 0.180	16 T	4.0 T	2.0
				0.180 - 0.230		5.0 T	
	HSLAS: GRADE 70 CLASS 2	80 MIN		0.000 - 0.180	16 T	4.0 T	2.0
				0.180 - 0.230		5.0 T	
	HSLAS-F: GRADE 50	60 MIN	50 MIN	0.000 - 0.230	10 T	1.5 T	1.5
	HSLAS-F: GRADE 60	70 MIN	60 MIN	0.000 - 0.180	8 T	1.5 T	1.6
				OVER 0.180	10 T	2.0 T	
	HSLAS-F: GRADE 70	80 MIN	70 MIN	0.000 - 0.180	10 T	2.0 T	1.8
				OVER 0.180		2.5 T	
	HSLAS-F: GRADE 80	90 MIN	80 MIN	0.000 - 0.180	10 T	2.0 T	2.0
				OVER 0.180	12 T	2.5 T	

Note:

1. The formability factors listed in the chart are based on a factor of 1.0 for mild steel with a tensile strength of 60,000 p.s.i. and a yield strength of 40,000 p.s.i.
2. The ASTM specifications listed are those in effect January 1, 2000.
3. High strength low alloy steel and stainless steel should not be formed at temperatures below 50°F (10°C).

BENDING FACTORS CHART (CONTINUED)

ASTM SPECIFICATION		TENSILE STRENGTH K.S.I.	YIELD STRENGTH K.S.I.	MATERIAL THICKNESS INCHES	NOMINAL VEE DIE OPENING	NOMINAL UPPER DIE RADIUS	FORMABILITY FACTOR
NO.	TYPE						
A1011 STEEL, SHEET & STRIP, HOT ROLLED, CARBON STRUCTURAL, HIGH-STRENGTH LOW-ALLOY, AND HIGH-STRENGTH LOW-ALLOY WITH IMPROVED FORMABILITY	CS Type A,B & C	NOT SPECIFIED	30 - 50	0.000 - 0.230	8 T	1.0 T	1.00
	DS Type A & B	NOT SPECIFIED	30 - 45	0.000 - 0.230	8 T	1.0 T	1.00
	SS: GRADE 30	49 MIN	30 MIN	0.000 - 0.230	8 T	1.0 T	1.10
	SS: GRADE 33	52 MIN	33 MIN	0.000 - 0.230	10 T	1.5 T	1.15
	SS: GRADE 36 TYPE 1	53 MIN	36 MIN	0.000 - 0.230	10 T	1.5 T	1.15
	SS: GRADE 36 TYPE 2	50 - 80	36 MIN	0.000 - 0.230	10 T	1.5 T	1.30
	SS: GRADE 40	55 MIN	40 MIN	0.000 - 0.230	12 T	2.0 T	1.25
	SS: GRADE 45	60 MIN	45 MIN	0.000 - 0.230	12 T	2.0 T	1.50
	SS: GRADE 50	65 MIN	50 MIN	0.000 - 0.230	12 T	2.5 T	1.60
	SS: GRADE 55	70 MIN	55 MIN	0.000 - 0.230	12 T	3.0 T	1.70
	HSLAS: GRADE 45 CLASS 1	60 MIN	45 MIN	0.000 - 0.180	8 T	1.0 T	1.50
				0.180 - 0.230	10 T	1.5 T	
	HSLAS: GRADE 45 CLASS 2	55 MIN		0.000 - 0.180	8 T	1.0 T	1.50
				0.180 - 0.230	10 T	1.5 T	
	HSLAS: GRADE 50 CLASS 1	65 MIN	50 MIN	0.000 - 0.180	10 T	1.5 T	1.60
				0.180 - 0.230	12 T	2.0 T	
	HSLAS: GRADE 50 CLASS 2	60 MIN		0.000 - 0.180	10 T	1.5 T	1.60
				0.180 - 0.230	12 T	2.0 T	
	HSLAS: GRADE 55 CLASS 1	70 MIN	55 MIN	0.000 - 0.180	12 T	2.0 T	1.70
				0.180 - 0.230		2.5 T	
	HSLAS: GRADE 55 CLASS 2	65 MIN		0.000 - 0.180	12 T	2.0 T	1.70
				0.180 - 0.230		2.5 T	
	HSLAS: GRADE 60 CLASS 1	75 MIN	60 MIN	0.000 - 0.180	12 T	2.5 T	1.80
				0.180 - 0.230	14 T	3.0 T	
	HSLAS: GRADE 60 CLASS 2	70 MIN		0.000 - 0.180	12 T	2.5 T	1.80
				0.180 - 0.230	14 T	3.0 T	
	HSLAS: GRADE 65 CLASS 1	80 MIN	65 MIN	0.000 - 0.180	14 T	3.0 T	1.90
				0.180 - 0.230		3.5 T	
	HSLAS: GRADE 65 CLASS 2	75 MIN		0.000 - 0.180	14 T	3.0 T	1.90
				0.180 - 0.230		3.5 T	
	HSLAS: GRADE 70 CLASS 1	85 MIN	70 MIN	0.000 - 0.180	16 T	4.0 T	2.00
				0.180 - 0.230		5.0 T	
	HSLAS: GRADE 70 CLASS 2	80 MIN		0.000 - 0.180	16 T	4.0 T	2.00
				0.180 - 0.230		5.0 T	
	HSLAS-F: GRADE 50	60 MIN	50 MIN	0.000 - 0.230	10 T	1.5 T	1.50
	HSLAS-F: GRADE 60	70 MIN	60 MIN	0.000 - 0.180	8 T	1.5 T	1.60
				OVER 0.180	10 T	2.0 T	
	HSLAS-F: GRADE 70	80 MIN	70 MIN	0.000 - 0.180	10 T	2.0 T	1.80
				OVER 0.180		2.5 T	
	HSLAS-F: GRADE 80	90 MIN	80 MIN	0.000 - 0.180	10 T	2.0 T	2.00
				OVER 0.180	12 T	2.5 T	
STAINLESS STEEL	302, 304, 304L,316, & 316L	80 - 90	30 - 40	0.000 - 0.500	8 T	1.0 T	1.30
				0.500 -1.000	10 T	1.5 T	
ALUMINUM	3004 - H34	35 TYP	21 TYP	0.000 - 0.125	8 T	1.0 T	0.60
				0.125 - 0.188	10 T	1.5 - 3.0 T	
	5052 - H32	33 TYP	28 TYP	0.000 - 0.031	8 T	1.0 T	0.70
				0.031 - 0.062	10 T	2.0 T	
	6061 - T6	42 TYP	37 TYP	0.000 - 0.031	8 T	1.0 T	0.80
				0.031 - 0.062	10 T	2.0 T	

BENDING FACTORS CHART (CONTINUED)

In Jan of 2000 new ASTM Specifications A1008 & A1011 replaced several old ASTM Specifications. The chart shown here is a cross reference between the old and the new specifications.

ASTM SPECIFICATION			
NO.	GRADE	PREVIOUS SPEC	
A1008 COLD ROLLED SHEET	CS TYPE A	-	CS = COMMERCIAL STEEL
	CS TYPE B	A-366	DS= DRAWING STEEL
	CS TYPE C	-	DDS= DEEP DRAWING STEEL
	DS TYPE A	-	EDDS= EXTRA DEEP DRAWING STEEL
	DS TYPE B	A-620	SS= STRUCTURAL STEEL
	DDS	A-963	HSLAS = HIGH-STRENGTH LOW-ALLOY STEEL
	EDDS	A-969	HSLAS-F = HIGH-STRENGTH LOW-ALLOY STEEL WITH IMPROVED FORMABILITY
	SS: GRADE 25	A-611 GR A	
	SS: GRADE 30	A-611 GR B	
	SS: GRADE 33 TYPE 1	A-611 GR C TYPE 1	
	SS: GRADE 33 TYPE 2	A-611 GR C TYPE 2	
	SS: GRADE 40 TYPE 1	A-611 GR D TYPE 1	
	SS: GRADE 40 TYPE 2	A-611 GR D TYPE 2	
	SS: GRADE 80	A-611 GR E	
	HSLAS: GRADE 45 CLASS 1	A-607 GR 45 CLASS 1	
	HSLAS: GRADE 45 CLASS 2	A-607 GR 45 CLASS 2	
	HSLAS: GRADE 50 CLASS 1	A-607 GR 50 CLASS 1	
	HSLAS: GRADE 50 CLASS 2	A-607 GR 50 CLASS 2	
	HSLAS: GRADE 55 CLASS 1	A-607 GR 55 CLASS 1	
	HSLAS: GRADE 55 CLASS 2	A-607 GR 55 CLASS 2	
	HSLAS: GRADE 60 CLASS 1	A-607 GR 60 CLASS 1	
	HSLAS: GRADE 60 CLASS 2	A-607 GR 60 CLASS 2	
	HSLAS: GRADE 65 CLASS 1	A-607 GR 65 CLASS 1	
	HSLAS: GRADE 65 CLASS 2	A-607 GR 65 CLASS 2	
	HSLAS: GRADE 70 CLASS 1	A-607 GR 70 CLASS 1	
	HSLAS: GRADE 70 CLASS 2	A-607 GR 70 CLASS 2	
	HSLAS-F: GRADE 50	A-715 GR 50	
	HSLAS-F: GRADE 60	A-715 GR 60	
	HSLAS-F: GRADE 70	A-715 GR 70	
	HSLAS-F: GRADE 80	A-715 GR 80	
A1011 HOT ROLLED SHEET	CS TYPE A	-	
	CS TYPE B	A-569	
	CS TYPE C	-	
	DS TYPE A	-	
	DS TYPE B	A-622	
	SS GRADE 30	A-570 GR 30	
	SS GRADE 33	A-570 GR 33	
	SS: GRADE 36 TYPE 1	A-570 GR 36	
	SS: GRADE 36 TYPE 2	-	
	SS: GRADE 40	A-570 GR 40	
	SS: GRADE 45	A-570 GR 45	
	SS: GRADE 50	A-570 GR 50	
	SS: GRADE 55	A-570 GR 55	
	HSLAS: GRADE 45 CLASS 1	A-607 GR 45 CLASS 1	
	HSLAS: GRADE 45 CLASS 2	A-607 GR 45 CLASS 2	
	HSLAS: GRADE 50 CLASS 1	A-607 GR 50 CLASS 1	
	HSLAS: GRADE 50 CLASS 2	A-607 GR 50 CLASS 2	
	HSLAS: GRADE 55 CLASS 1	A-607 GR 55 CLASS 1	
	HSLAS: GRADE 55 CLASS 2	A-607 GR 55 CLASS 2	
	HSLAS: GRADE 60 CLASS 1	A-607 GR 60 CLASS 1	
	HSLAS: GRADE 60 CLASS 2	A-607 GR 60 CLASS 2	
	HSLAS: GRADE 65 CLASS 1	A-607 GR 65 CLASS 1	
	HSLAS: GRADE 65 CLASS 2	A-607 GR 65 CLASS 2	
	HSLAS: GRADE 70 CLASS 1	A-607 GR 70 CLASS 1	
	HSLAS: GRADE 70 CLASS 2	A-607 GR 70 CLASS 2	
	HSLAS-F: GRADE 50	A-715 GR 50	
	HSLAS-F: GRADE 60	A-715 GR 60	
	HSLAS-F: GRADE 70	A-715 GR 70	
	HSLAS-F: GRADE 80	A-715 GR 80	

PUNCHING ON A PRESS BRAKE

Thickness		PUNCHING - TONS REQUIRED PER HOLE FOR ONE LEVEL PUNCHING														
		Hole Diameter														
Gauge	Inch	0.125	0.188	0.250	0.312	0.375	0.438	0.500	0.562	0.625	0.688	0.750	0.812	0.875	0.938	1.000
20	0.036	0.35	0.53	0.71	0.88	1.10	1.20	1.40	1.60	1.80	1.90	2.10	2.30	2.50	2.70	2.80
18	0.048	0.47	0.71	0.94	1.20	1.40	1.70	1.90	2.10	2.40	2.60	2.80	3.10	3.30	3.50	3.80
16	0.060	0.59	0.89	1.20	1.50	1.80	2.10	2.40	2.70	2.90	3.20	3.50	3.80	4.10	4.40	4.70
14	0.075	0.74	1.10	1.50	1.90	2.20	2.60	2.90	3.30	3.70	4.10	4.40	4.80	5.20	5.50	5.90
12	0.105	1.00	1.60	2.10	2.60	3.10	3.60	4.10	4.70	5.20	5.70	6.20	6.70	7.20	7.70	8.30
11	0.120	1.20	1.80	2.40	3.00	3.50	4.10	4.70	5.30	5.90	6.50	7.10	7.70	8.30	8.80	9.40
10	0.135	-	2.00	2.70	3.30	4.00	4.60	5.30	6.00	6.60	7.30	8.00	8.60	9.30	10.00	10.60
-	0.188	-	2.80	3.70	4.60	5.50	6.50	7.40	8.30	9.20	10.20	11.10	12.00	12.90	13.80	14.80
-	0.250	-	-	4.90	6.20	7.40	8.60	9.80	11.00	12.30	13.50	14.80	16.00	17.20	18.50	19.70
-	0.375	-	-	-	-	11.10	13.00	14.80	16.60	18.50	20.30	22.10	24.00	25.80	27.70	29.50
-	0.500	-	-	-	-	-	17.20	19.70	22.10	24.60	27.10	29.50	32.00	34.40	36.90	39.40
-	0.625	-	-	-	-	-	-	-	-	30.80	33.80	36.90	40.00	43.00	46.10	49.20
-	0.750	-	-	-	-	-	-	-	-	-	-	44.30	48.00	51.70	55.40	59.00

Punching mild steel plate-shear strength of 50,000 pounds per square inch. One ton = 2,000 pounds.

GENERAL

For many years it has been common practice to use a press brake for occasional punching jobs. The Punching Tonnage Chart shown above indicates the load required to punch round holes in ordinary mild steel. The tonnage is calculated by multiplying the area being sheared times the shear strength of the material. For example, the load required to punch a 2" diameter hole in 1/4" (.250") mild steel plate:

Diameter x π	the circumference of the circle
Thickness x circumference	the area of material being sheared
Use 50,000 psi (25tons/inch^2) for mild steel	
Punching load	2" x π x 0.250 x 25 tons/inch^2 = 39.25 tons

The shear strength of steel can vary between 75% to 80% of the actual tensile strength of the material. To determine the load, it is best to use 80% of the actual tensile strength of the material. If a material has a 70,000 psi minimum tensile, it is best to add 15,000 psi to obtain the probable range of tensile strengths.

CLEARANCE (FIGURE 10)

There must be clearance between the punch and die just as a shear has clearance between the upper and lower knives. The punch determines the hole size and should be made to the exact diameter that is required. The die bottom contains the hole diameter plus the necessary clearance. For best results on mild steel, the clearance between the punch and die at all points should be from 5% to 7% of the metal thickness. In other words, the die should be 10% to 14% of the metal thickness larger than the punch. The clearance could be different for various types of material.

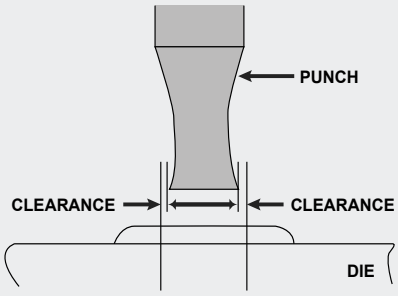


FIGURE 10 - CLEARANCE BETWEEN PUNCH AND DIE

LIMITATIONS OF THE PRESS BRAKE

Since punching consists of a shock load (rapid build up of force followed by an immediate release of the load as the material fractures) Cincinnati Incorporated recommends only using a punching load up to 2/3 of the maximum rating of the press brake when punching mild steel. This "punching" rating will normally allow sufficient safety to minimize abnormal machine maintenance.

Punching higher tensile (70,000 psi or higher) materials will require added considerations. The amount of penetration to punch a hole in high tensile steel is much less than the penetration in mild steel (e.g. mild steel = penetration of 1/3 metal thickness; higher tensile = penetration of only 15% of metal thickness). The buildup and release of the load is more rapid and has a greater shock effect on the press brake. Cincinnati Incorporated recommends limiting tonnage buildup to 1/2 of the maximum press brake capacity when high tensile steel is being punched. In punching applications where die sets are used or where special machine features (e.g. wide bed, deep throat, etc.) are required consult Cincinnati Incorporated Engineering for an evaluation of the part involved.

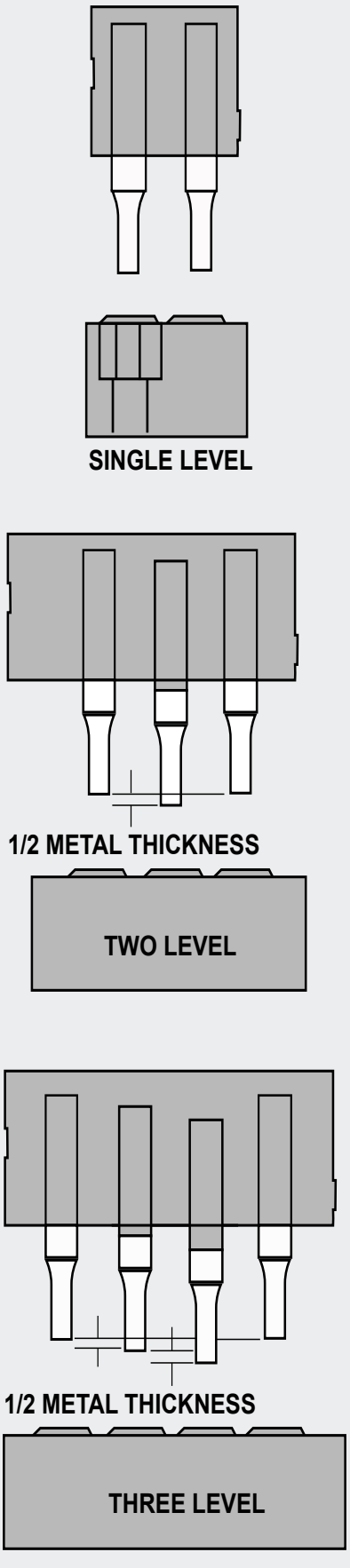


FIGURE 11 - STEPPING OF PUNCHES

STEPPING OF PUNCHES

(FIGURE 11)

It has been found that if the number of holes to be punched results in the recommended punching rating of the press brake being exceeded, punches in the die set can be "stepped." If punches hit the metal at two levels, approximately 1/2 metal thickness apart, a maximum punching load can be built up, released, and a second load built up and released in the same stroke without damage to the press brake.

Stepping of the punches can be accomplished by making the punches different lengths, shimming under the punches, or making steps in the die set. The punching load must continue to be symmetrical.

STRIPPING THE METAL FROM THE PUNCHES

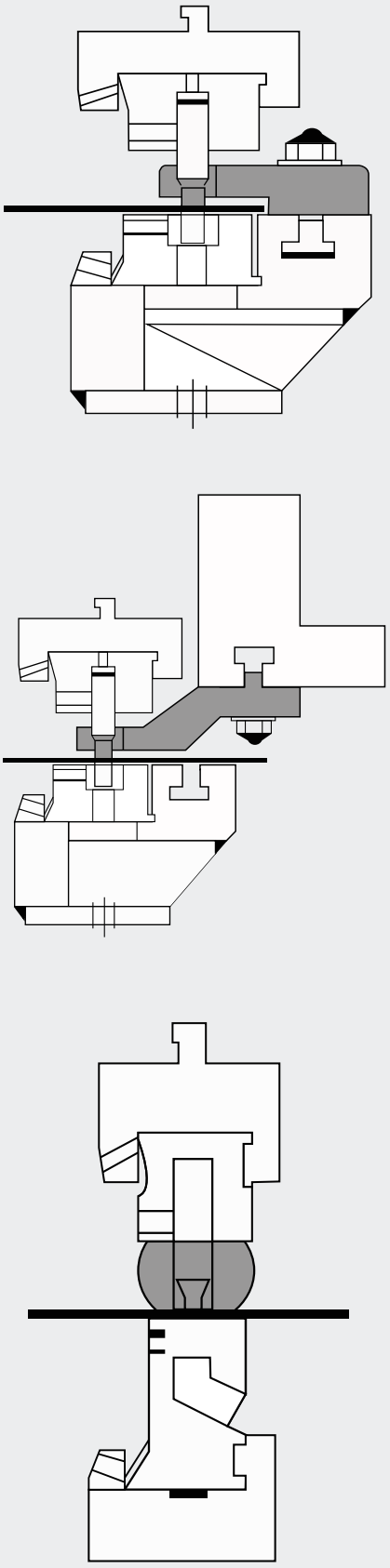
(FIGURE 12)

It is normal for sheet metal being punched to stick tightly to the punch as it moves upward after the hole is punched.

Note: The punch must move downward through the metal to ensure the slug is pushed through the hole. Springs, metal hooks, polyurethane or rubber are normally used to strip the metal off the punch. This force takes from 2% to 5% of the punching force.

The maximum stripping load of a press brake is limited to 10% of the punching capacity. Normally this is not a problem unless "stepping" is used. Then, all of the holes being punched in one stroke are stripped from the punches during the upstroke of the press brake. The stripping load will be a percentage of the entire punching load.

FIGURE 12
STRIPPING METAL FROM THE PUNCHES
TYPICAL PUNCHING UNITS WITH STRIPPERS SHOWN SHADED



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