Calculation of Perforating Pressure

The formula for the tonnage required to perforate a given material, using flat faced punches and dies is:

$$P = \frac{LTS}{2000}$$

P = Punching load in tons
L = Length of cut in inches. Use the circumference (πD) for round holes and the perimeter for holes of other shapes.
T = Thickness of material in inches
S = Ultimate shear of material in pounds per square inch

EXAMPLE:
Material-AISI 1020 Cold Rolled Steel, .030 thick Punch or Hole Diameter .375

$$P = \frac{LTS}{2000} = \frac{1.1781 \times .030 \times 52{,}000}{2000} = \frac{.9189 \text{ or}}{1 \text{ ton}}$$

L = 1.1781 from Decimal Equivalent Chart
S = 52,000 P.S.I. from Shear Strength Table

To determine whether a punch or a die button will "sink" into the die plates, calculate the force per unit area by the formula

$$\mathbf{Sc:} \frac{2000}{As} \text{ where:}$$

Sc = Compressing Stress, in pounds/square in
P = Perforating load, in tons
A = Surface area, in square inches
Punches - Head Type...Use head area (Ball-Lock type are normally used with hardened backing plate)
Die Buttons-Head Type...Use head area minus slug hole area
Headless...Use body area minus slug hole area. If the Calculated Compressive Stress **(Sc)** is greater than 20,000 P.S.I. select a larger Punch Shank or Body Dia. or use a hardened backing plate. This rule applies for both all-steel and semi-steel die set punch plates.

EXAMPLE:
Punching Load (P) = .9189 tons
Punch Data: Point Dia. .375
Shank Dia. .500
Head Dia. .625
Die Button Data: Body Dia. .875
Slug Hole Dia. 17/32
(See Dec. equiv. Chart for areas)

$$Sc = \frac{2000P}{A} \quad \frac{2000 \times .9189}{.3068} = 5990 \text{ P.S.I.}$$

Since Sc is less than 20,000 P.S.I. the punch head will not "sink" into the die set plate.

$$Sc = \frac{2000P}{A} \quad \frac{2000 \times .9189}{(.60132-.22166)} = 4841 \text{ P.S.I.}$$

Sc is less than 20,000 P.S.I. and the die button will not "sink."

Shear Strength Chart

Material Description	Hardness	Ultimate Tensile P.S.I.	Ultimate Shear P.S.I.
STEELS			
Low Carbon, H.R. Sheet ASTM A-415	Rb 70	60,000	50,000
Low Carbon, C.R. Sheet Special Killed Drawing Quality	Rb 50	50,000	40,000
Low Carbon, C.R. Sheet			
(Soft)	Rb 46-50	53,000	42,000
(1/4 Hard)	Rb 60-75	60,000	45,000
(1/2 Hard)	Rb 70-85	72,000	50,000
(Hard)	Rb 80-95	92,000	61,000
.40-.50% Carbon Steel H.R. Sheet	BHN200	100,000	80,000
SAE 1074 C.R.Annealed Spring Steel	Rb 90	95,000	75,000
SAE 1095 C.R.Annealed Spring Steel	Rb 95	100,000	80,000
SAE 1074 or 1095 Spring Steel Hardened to Spring Temper	Rc 45-50	260,000	200,000
Abrasion-Resisting	BHN200/245	120,000	100,000
Cor-Ten Steel	BHN140	70,000	50,000
Tri-Ten Steel	BHN120	60,000	50,000
T-1 Steel (Types A&B) 100,000 P.S.I. Y.S.	BHN260	130,000	105,000
STAINLESS STEEL			
202-Annelaed	Rb 95	110,000	90,000
302, 303, 304-Annealed	Rb85	95,000	75,000
310-Annealed	Rb90	105,000	90,000
316, 321, 430-Annealed	Rb 90	95,000	75,000
410-Annealed	Rb85	85,000	75,000

* 500Kg Load 10mm Ball

Material Description	Hardness	Ultimate Tensile P.S.I.	Ultimate Shear P.S.I.
ALUMINUM BASE*			
ALLOY-TEMPER			
1100-0	BHN23	13,000	9,000
-H14	BHN32	18,000	11,000
2024-0	BHN47	27,000	18,000
-T3	BHN120	70,000	41,000
3003-0	BHN28	16,000	11,000
-H14	BHN40	22,000	14,000
-H16	BHN47	26,000	15,000
3105-H25	BHN47	26,000	16,000
5005-H34	BHN41	23,000	14,000
5052-0	BHN47	28,000	18,000
5052-H32	BHN60	33,000	20,000
6061-0	BHN30	18,000	12,000
-T6	BHN95	45,000	30,000
7075-0	BHN60	33,000	22,000
-T6	BHN150	83,000	48,000
COPPER BASE			
**ALLOY-TEMPER		110,000	90,000
110-Electric Tough		95,000	75,000
Pitch Cooper		105,000	90,000
- .050mm G.S.	Rb40	95,000	75,000
- 1/2 Hard	Rb40	85,000	75,000
- Hard	Rb50		
220 Comm Bronze, 90%			
- 1/2 Hard	Rb58		
320 Red Brass, 85%			
- 1/4 Hard	Rb55		
260 Cartridge Brass, 70%			
- .035mm G.S.	Rf68		
- 1/2 Hard	Rb70		
- Spring	Rb91		
280 Muntz Metal			
- 1/8 Hard	Rb55		
342-A High Leaded Brass			
- 1/2 Hard	Rb70		
675 Manganese Bronze, A			
- Soft Anneal	Rb65		

** Copper Development Association No.

Decimal Equivalents Chart

DECIMAL EQUIVALENTS CIRCLES...CIRCUMFERENCES AND AREAS							
Dia. in.	Decimal Equiv.	Circum. in.	Area Sq. in.	Dia. in.	Decimal Equiv.	Circum. in.	Area Sq. in.
1/64	.015625	.0491	.00019	37/64	.578152	1.8163	.26248
1/32	.03125	.0982	.00077	19/32	.59375	1.8653	.27688
3/64	.046875	.1473	.00173	39/64	.609375	1.9145	.29164
1/16	.0625	.1963	.00307	5/8	.625	1.9635	.30680
5/64	.071825	.2455	.00479	41/64	.640625	2.0127	.32232
3/32	.09375	.2945	.00690	21/32	.65625	2.0617	.33824
7/64	.109375	.3436	.00940	43/64	.671875	2.1108	.35453
1/8	.125	.3927	.01228	11/16	.6875	2.1598	.37122
9/64	.140625	.4418	.01553	45/64	.703125	2.2090	.38828
5/32	.15625	.4909	.01916	23/32	.71875	2.2580	.40574
11/64	.171875	.5400	.02321	47/64	.734375	2.3072	.42356
3/16	.1875	.5890	.02761	3/4	.750	2.3562	.44179
13/64	.203125	.7381	.03241	49/64	.765625	2.4054	.46041
7/32	.21875	.6872	.03758	25/32	.78125	2.4544	.47937
15/64	.234375	.7363	.04314	51/64	.796875	2.5036	.49872
1/4	.250	.7854	.04909	13/16	.8125	2.5525	.51849
17/64	.265625	.8345	.05541	53/64	.828125	2.6017	.53862
9/32	.28125	.8836	.06213	27/32	.84375	2.6507	.55914
19/64	.296875	.9327	.06922	55/64	.859375	2.6999	.58003
5/16	.3125	.9817	.07670	7/8	.875	2.7489	.60132
21/64	.328125	1.0309	.08456	57/64	.890625	2.7981	.62298
11/32	.34375	1.0799	.09281	29/32	.90625	2.8471	.64504
23/64	.359375	1.1291	.10144	59/64	.921875	2.8693	.66746
3/8	.375	1.1781	.11045	15/16	.9375	2.9452	.69029
25/64	.390625	1.2273	.11985	61/64	.953125	2.9945	.71349
13/32	.40625	1.2763	.12962	31/32	.96875	3.0434	.73708
27/64	.421875	1.3254	.13979	63/64	.984375	3.0923	.76097
7/16	.4375	1.3744	.15033	1	1.000	3.1416	.7854
29/64	.453125	1.4236	.16126	1-3/32	1.09375	3.4362	.9396
15/32	.46875	1.4726	.17257	1-1/8	1.125	3.5343	.9940
31/64	.484375	.18427	.18427	1-1/4	1.250	3.9270	1.2272
1/2	.500	.19635	.19635	1-3/8	1.375	4.3197	1.4849
33/64	.515625	.20880	.20880	1-1/2	1.500	4.7125	1.7671
17/32	.53125	.22166	.22166	1-5/8	1.625	5.1051	2.0739
35/64	.546875	.23489	.23489	1-3/4	1.750	5.4978	2.4053
9/16	.5625	.24850	.24850				