

Cutting force

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The Cutting force is the force which has to act on the on the stock material in order to cut out the blanker slug. This determines the capacity of the press to be used for particular tool. The first step in establishing the cutting force is to determine the cut length area. The area to be cut is found by multiplying the length of cut by stock thickness.

Formula for calculating the cutting force:

$$\text{Cutting force} = L \times S \times T \text{ max}$$

L = Length of periphery to be cut in 'mm'.

S = Sheet thickness in 'mm'

T max = Shear strength in N/mm^2

Generally for calculation purposes Shear strength is considered as 80% of tensile strength.

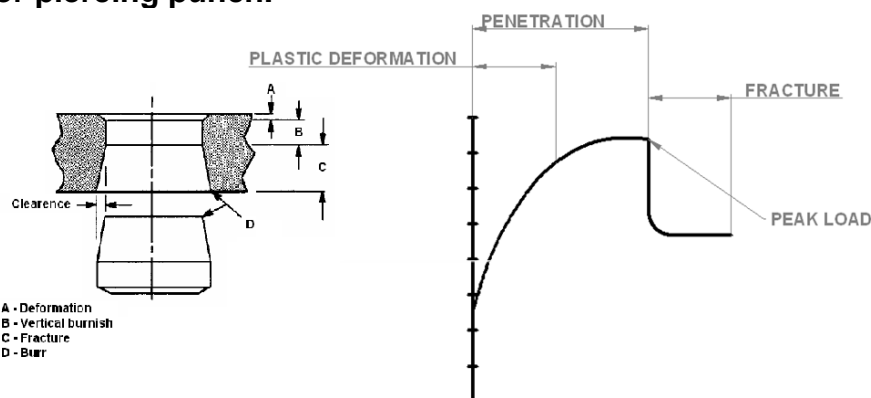
Shear and tensile strengths for most materials are not the same. Shear strength for:

Aluminum is approximately 50% of its tensile strength

Cold roll steel is approximately 80% of its tensile strength

Stainless steel is approximately 90% of its tensile strength

The bellow fig. represents the typical load curve of cutting force of blanking or piercing punch.



The three critical stages of shearing action are related to cutting force. The figure represents the typical load curve of cutting force of blanking or piercing punch. Resistance begins when the punch contacts the stock material. The load builds up rapidly during the plastic deformation stage and continues to increase while penetration is taking place. The accumulated load is suddenly released when fracture occurs. If proper cutting clearance condition exists between the punch and the die the fracture will occur when the cutting force equals the shear strength of the material.

The curve levels off near the bottom. This last portion of the load curve represents the frictional resistance as the punch travels through the stock material and also the resistance of the blank passing through the die.

Formula to calculate the press force

$$\text{Press force} = \text{Cutting force} + \text{Stripping force}$$

so

$$\text{Stripping force} = 10\% \text{ to } 20\% \text{ of cutting force}$$

The below given table gives the shear strength ($T_{\max} = 0.2$ for tensile strength σ_{\max}) of several materials.

Material	T max in N/mm ²
Steel with 0.1% carbon	240 - 300
Steel with 0.2% carbon content (deep draw steel)	320 - 400
Steel with 0.3% carbon	360 - 420
Steel with 0.4% carbon	450 - 560
Steel with 0.6% carbon	550 - 700
Steel with 0.9% carbon	700 - 900
Silicon steel	450 - 550
Stainless steel	350 - 450
Copper	200 - 400
Brass	350 - 400
Bronze	360 - 450
German silver (2 - 20% Ni, 45 - 75% Cu)	300 - 20
Tin	30 - 40
Zinc	100 - 120
Lead	20 - 30
Aluminium 99% pure	20 - 120
Aluminium manganese alloy	150 - 320
Aluminium silicon alloy	120 - 250
Paper & card board	20 - 50
Hard board	70 - 90
Laminated paper or rosin impregnated paper	100 - 140
Laminated fabrics	90 - 120
Mica	50 - 20
Plywood	20 - 40
Leather	7
Soft rubber	7
Hard rubber	20 - 60
Celluloid	40 - 60

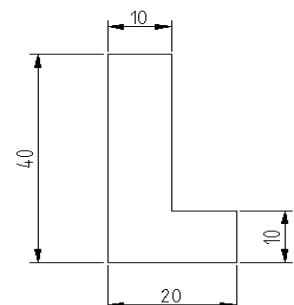
Solved problems

Calculate the press force required to produce the following component. Sheet thickness 2mm. Material is brass.

Given

Material – Brass

Sheet thickness – 2mm



Solution

Cutting force = $L \times S \times T_{\max}$

$$= 126 \times 2 \times 400$$

$$= 100800 \text{ N}$$

$$= 100.8 \text{ KN}$$

Press force = Cutting force + Stripping force

$$= 100800 + 20\% \ 100800$$

$$= 120960 \text{ N}$$

$$= 120.960 \text{ KN.}$$

Method of reducing Cutting force

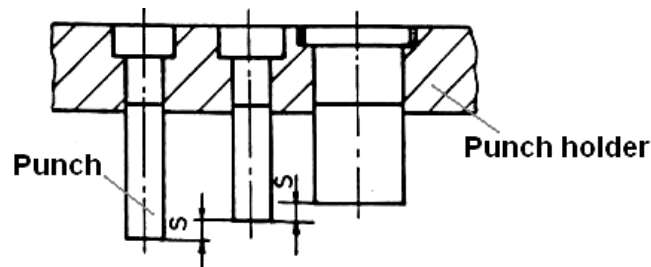
It sometimes becomes necessary to reduce the cutting force to prevent press over loading.

1. Stepped punches to be used.
2. Grinding the face of the punch or die to a small shear angle.

1. Stepped punches

The method of reducing cutting forces is to step punch length. Punches or group of punches progressively become shorter by about one stock material thickness. This will result in distribution of force during the blanking or piercing action on the punches interns reducing in total force.

During shearing action lengthier punches will take cutting action at first time and once the sheet is pierced for a sheet thickness, other shorter punches will enter the sheet to get the required holes. This type is mainly used in piercing of more number of holes on the component.



2. Grinding the face of the punch or die to a small shear angle.

A second method is to grind the face of the punch or die to a small shear angle with the horizontal. This has the effect of reducing the contact area while shearing at one time. Providing shear also reduces the shock to the press and smoothens out the cutting operation. The shear angle chosen should provide a change in punch from 1 to 1.5 sheet thickness.

Various types of shear angle are shown in the figure. Double shear angle is preferred force acting on the punch. Double shear angle on punches should be concave to prevent the stretching of the material before it is cut. Shear angle may be applied either to the punch face or to the die face, depending on whether the operation is blanking or piercing because shear will distort the work material.

The shear angle for blanking operation will be on the die member, while, as the piercing operation the shear angle will be given on the punch member.

