

THE 4 PILLARS OF PRESS BRAKE TONNAGE LIMITS

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**Based on the May 2015 Bending Basics Column
From the Fabricator magazine**



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*"So...you are you here to learn about
press brake tonnage limits"*



The Methods of forming

"Air forming, Bottom Bending and Coining; there all are different, all have a purpose!"

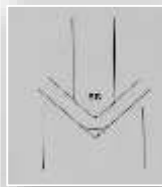


Air forming
[+/- 1°]



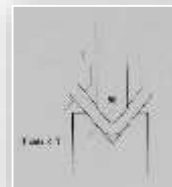
Least amount tonnage

Bottom bending
[+/- 1/2°]



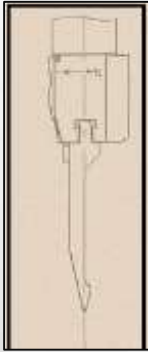
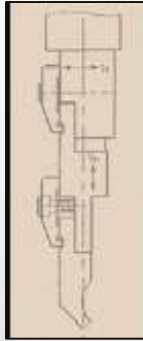
**3x to 5x the tonnage
of Air forming**

Coining
[+/- 1/4°]



**10x to infinity the tonnage of
Air forming**

Bending method accuracy and tonnage requirments

**Traditional Planed****Precision Ground****New standard**

The three basic mounting styles



Calculate tonnage's - quickly and accurately

$$\text{Tonnage per inch} = (M_t^2 \times 575) / \text{die width} / 12$$

**Based on cold rolled steel AISI-1035 at 60,000 psi
tensile strength and having a factor of 1.0**

Pillar #1: Determine the tonnage requirements

"PRECISION TOOLING IS RATED"



Allowable Tonnage For Press Brake Tooling

Tool #	Ton/Foot	Ton/F	Ton/Foot	Tool #	Ton/Foot	Tool #
325	30	12500	8	326	30	340
326	30	12500	8	341	21	342
340	30	12500	8	342	21	343
341	21	12790	30	343	24	
342	21					
343	24					

Tonnage limits of precision ground tooling

***"Traditional planed tooling isn't rated...
So how do you know?"***



Tonnage limits of traditional tooling



Tonnage is calculated where the yield is broken in the material and bending begins to take place...

Not at the bottom of the stroke like bottoming or coining...

Bottoming and coining tonnages are guess's at best!

Where is tonnage is calculated ?

Tonnage per inch = $(Mt^2 \times 575) / \text{die width} / 12$

The 575 constant is the average Yield Strength of mild cold rolled steel



Where does the 575 value come from?

*"Material factors... they need
to be considered
The internet can help!"*



Stainless = 1.4

Aluminum 6061 T6 = 1.3

Cold rolled steel = 1.0 (base line)

Aluminum 5052 = .5

Hot rolled steel = 1.0

*"Methods ... they too need to be
considered"*



Air form = 1 (base line factor)

Bottom bending = 5 times the tonnage

Coining = 10 times as much or more!

- Material type = 304 stainless steel.
- Material thickness = .050
- Punch radius = .030
- Die width = .236
- Bend length = 6.375
- Tons per inch = $((575 * .050^2) / .236) / 12 = .507$ tons per inch.
- Tonnage per length (base line) = $.507 * 6.375$ (bend length) = 3.235 tons.
- Tonnage with material factored in = $3.235 * 1.4$ (material factor) = 4.530 tons.
- Tonnage with method factored in = $4.530 * 5$ (method bottom bending) = 22.65 tons
- Total tonnage for this example 22.65 tons

Walking through the process

No! it exceeds the 30 ton per foot rule !
So, now what?

**Assuming a 30 ton per foot load limit,
22.65 tons an acceptable tonnage?**



"What to do, what to do?"



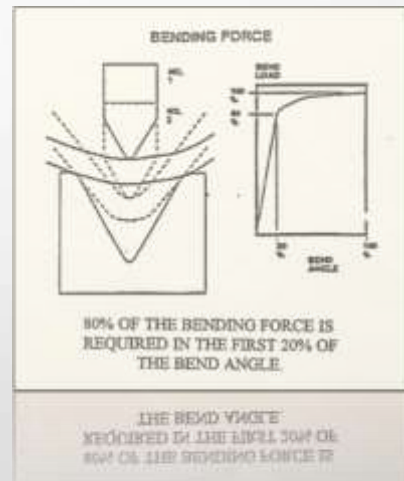
You can't change the material type

You can't change the part

You're bottom bending so you can't change the V-die opening

All that's left is to change to air forming from bottom bending that changes the tonnage back to 4.530 tons... well within the 30 tons rule

"Even a small bend angle is produces the total tonnage required for an air form?"

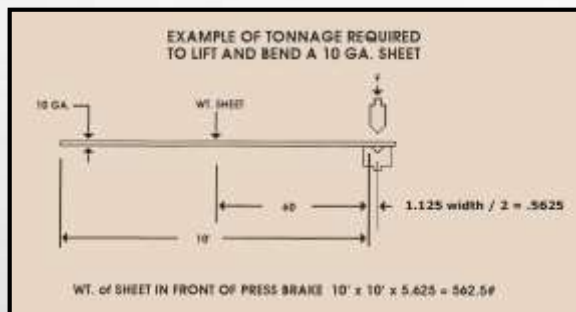


Offsets (two bends at a time) the factor is 5

Square Hat Channel (four bends at a time) the factor is 10

Offsets (two bends at a time) in thick material the factor is 10

Additional tonnage multipliers



Required tonnage to bend 85 tons

Required to lift 30 tons

Total required tonnage 115 tons

$$\text{Force} = \frac{562.5 \times 60}{.5625} = 60,000 \text{ or } 30 \text{ tons}$$

Lifting the sheet



A quick estimate of a punches ability to withstand load can be calculated.
First, by first converting b ", " l " and " T " to millimeters (mm).

b = width

l = length

T = thickness *at the tangent point*

Pillar #2: Determine acceptable tool load

Terms, definitions and interactions that determine tool limits :



Stress
Strain
Yield
Work hardening
Plastic Deformation

Mechanical properties of the material

The strength of a material is its ability to withstand an applied load without failure or plastic deformation.



Strength

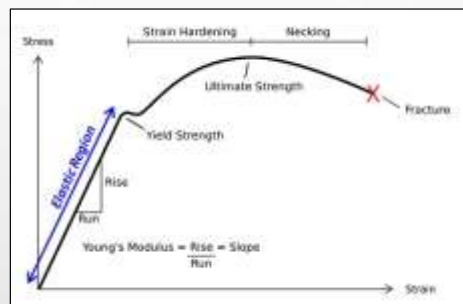
The stresses and strains that develop within tool must be calculated in order to assess the load capacity of that tool.

Stress and Strain

When a load applied to the tool will induce internal stress.

That stress acting on the tool material cause deformation of the material in variety of manners.

Load



The yield point determines the limits of performance and represents the upper limit to forces that can be applied without permanent deformation.

Yield point / Strength

Our tool is made from S45C tool steel

Hardness of 25 Rockwell C

Yield point coefficient of .75

Allowable stress in kg/mm^2 is 60



What our example is made of:

The Safety coefficient is a multiplier applied to the calculated maximum stress to which a component can be subjected and needed to account for imperfections in materials the tool was made from.

Safety coefficient

$l = 1.5$ inches

$$l = 1.5 \text{ inches} \times 25.4 = 38.1 \text{ mm}$$

$T = .625$ inches

$$T = .625 \text{ inches} \times 25.4 = 15.87 \text{ mm}$$



Imperial to Metric conversion

Safety coefficient

δ = safety coefficient for our example

$$60 \text{ kg/mm}^2 \times .3333 = 19.98$$

Our example

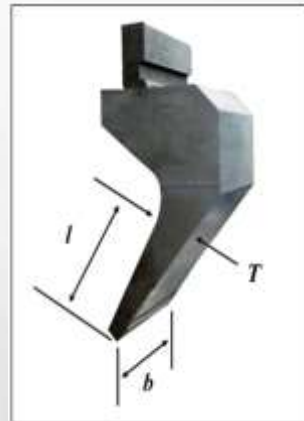
- $l = 38.1\text{mm}$ *height*
- $T = 15.87\text{mm}$ *thickness*
- $b = 1000$ *length*
- $\delta = 19.98$ *safety coefficient*

Step 1) $Z = (b * T^2) / 6$ $(1000 * 251.85) / 6$ $251850/6$ $Z = 41975$

Step 2) $P_1 = (\delta * Z) / l$ $(19.98 * 41975) / 38.1$ $838660.5/38.1$ $P_1 = 22012$

Step 3) $P = \sqrt{2 * P_1}$ $\sqrt{2 * 22012}$ $\sqrt{44024}$ $P = 209 \text{ tons per meter}$

*"Total safe load on the tool
described in this example
209 tons per meter."*





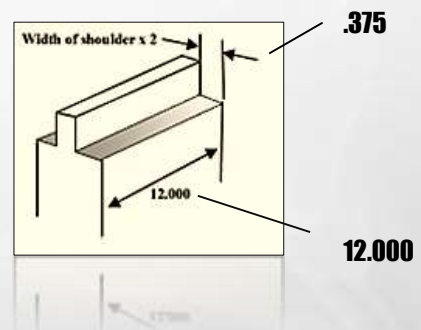
Note that these calculations used a 30% safety coefficient and the weakest tooling material.

This is only an estimate of tonnage load!

Measure both shoulder dimensions
Add shoulder dimensions together
Take total shoulder dimension x 12.000 (width)
This is the "Land Area"

$$.375 \times 2 = .700$$

$$.700 \times 12.000 = 8.5 \text{ square inches of interface (land area)}$$



NOTE: shoulders may be different widths!

Pillar #3: Sink tonnage

Assuming 15 tons of shear load

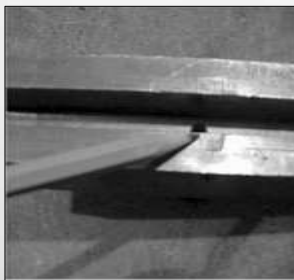
Take the "Land Area" (LA) value and multiply by 15

$8.5 \times 15 = 127.5$ tons of maximum load on the "Land Area"

"Shear load being where the material stops deflecting and penetration begins"



We reduce the tonnage with a 20% safety margin



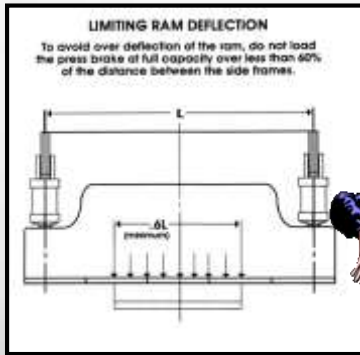
127.5 tons of maximum load on the "Land Area"

X .8

102.0 tons of safe of load to avoid tool embedding

Safety is a concern

Limiting ram deflection

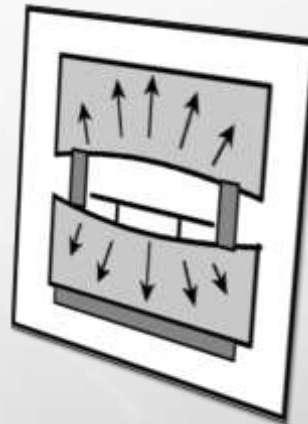


"First, where do we work on a press brake?"



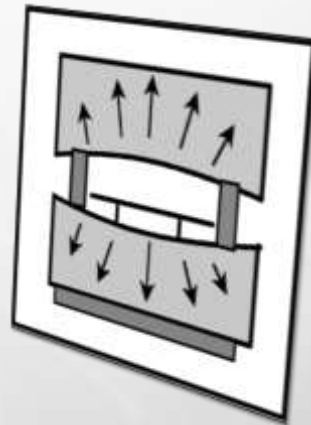
Pillar #4: Centerline load limit

"Deflection is a normal part of press brake function"



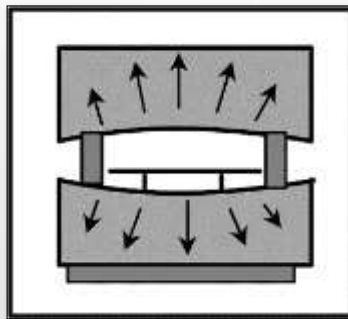
Ram and Bed Deflection

*Ram up-set means
it stays that way !*



Ram Upset

The average design limit for deflection is 0.0015 in. per foot.



0.0015×10 (number of feet between side frames)
equals .015 at center.

Deflection limit

1) Calculate required tonnage

Based on method and material

2) Calculate tool limit

Is this limit greater the required tonnage?

3) Sink load limit

Will I embed the tooling into the ram or bed?

4) Centerline load limit

Is this limit greater the required tonnage?

To summarize:

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The 4 pillars of press brake tonnage limits

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