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Sheet Metal Operations Formulas

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List of 26 Sheet Metal Operations Formulas

Sheet Metal Operations

Bending Operation

1) Bend Allowance

fx $$B_{al} = \theta \cdot (r_c + \lambda \cdot t_{bar})$$

Open Calculator

ex $$0.026125\text{mm} = 3.14\text{rad} \cdot (0.007\text{mm} + 0.44 \cdot 0.003\text{mm})$$

2) Bending Force

fx $$F_B = \frac{K_{bd} \cdot L_b \cdot \sigma_{ut} \cdot t_{blank}^2}{w}$$

Open Calculator

ex $$32.5425\text{N} = \frac{0.031 \cdot 1.01\text{mm} \cdot 450\text{N/mm}^2 \cdot (8.99\text{mm})^2}{34.991620\text{mm}}$$

3) Clearance between Two Shears

fx $$C_s = 0.0032 \cdot t_b \cdot (\tau)^{0.5}$$

Open Calculator

ex $$51.13796\text{mm} = 0.0032 \cdot 1.13\text{mm} \cdot (200\text{N/mm}^2)^{0.5}$$

4) Length of Bent Part in Bending Operation

Open Calculator

fx $$L_b = \frac{F_B \cdot w}{K_{bd} \cdot \sigma_{ut} \cdot t_{stk}^2}$$

ex $$1.007757\text{mm} = \frac{32.5425\text{N} \cdot 34.991620\text{mm}}{0.031 \cdot 450\text{N/mm}^2 \cdot (9\text{mm})^2}$$

5) Stock Thickness used in Bending Operation

Open Calculator

fx $$t_{stk} = \sqrt{\frac{F_B \cdot w}{K_{bd} \cdot L_b \cdot \sigma_{ut}}}$$

ex $$8.99\text{mm} = \sqrt{\frac{32.5425\text{N} \cdot 34.991620\text{mm}}{0.031 \cdot 1.01\text{mm} \cdot 450\text{N/mm}^2}}$$

6) Width between Contact Points during Bending

Open Calculator

fx $$w = \frac{K_{bd} \cdot L_b \cdot \sigma_{ut} \cdot t_{blank}^2}{F_B}$$

ex $$34.99162\text{mm} = \frac{0.031 \cdot 1.01\text{mm} \cdot 450\text{N/mm}^2 \cdot (8.99\text{mm})^2}{32.5425\text{N}}$$

Drawing Operation

7) Blank Diameter from Percent Reduction

Open Calculator

fx $$D_b = d_s \cdot \left(1 - \frac{PR_{\%}}{100}\right)^{-1}$$

ex $$84.21053\text{mm} = 80\text{mm} \cdot \left(1 - \frac{5}{100}\right)^{-1}$$

8) Blank Size for Drawing Operation

Open Calculator

fx $$D_b = \sqrt{d_s^2 + 4 \cdot d_s \cdot h_{shl}}$$

ex $$84.19026\text{mm} = \sqrt{(80\text{mm})^2 + 4 \cdot 80\text{mm} \cdot 2.15\text{mm}}$$

9) Drawing Force for Cylindrical Shells

Open Calculator

fx $$P_d = \pi \cdot d_s \cdot t_b \cdot \sigma_y \cdot \left(\frac{D_b}{d_s} - C_f\right)$$

ex $$0.004498\text{N/mm}^2 = \pi \cdot 80\text{mm} \cdot 1.13\text{mm} \cdot 35\text{N/mm}^2 \cdot \left(\frac{84.2\text{mm}}{80\text{mm}} - 0.6\right)$$

10) Percent Reduction after Drawing

Open Calculator

fx $$PR_{\%} = 100 \cdot \left(1 - \frac{d_s}{D_b}\right)$$

ex $$4.988124 = 100 \cdot \left(1 - \frac{80\text{mm}}{84.2\text{mm}}\right)$$

11) Shell Diameter from Percent Reduction

Open Calculator

fx $$d_s = D_b \cdot \left(1 - \frac{PR_{\%}}{100}\right)$$

ex $$79.99\text{mm} = 84.2\text{mm} \cdot \left(1 - \frac{5}{100}\right)$$

Ironing Operation

12) Average of Tensile Strength before and after Ironing

Open Calculator

fx $$S_{avg} = \frac{F}{\pi \cdot d_1 \cdot t_f \cdot \ln\left(\frac{t_0}{t_f}\right)}$$

ex $$0.181902\text{N/mm}^2 = \frac{8.01\text{N}}{\pi \cdot 2.5\text{mm} \cdot 13\text{mm} \cdot \ln\left(\frac{20.01\text{mm}}{13\text{mm}}\right)}$$

13) Ironing Force after Drawing

Open Calculator

fx $$F = \pi \cdot d_1 \cdot t_f \cdot S_{avg} \cdot \ln\left(\frac{t_0}{t_f}\right)$$

ex $$8.009301\text{N} = \pi \cdot 2.5\text{mm} \cdot 13\text{mm} \cdot 0.181886\text{N/mm}^2 \cdot \ln\left(\frac{20.01\text{mm}}{13\text{mm}}\right)$$

14) Mean Diameter of Shell after Ironing

Open Calculator

fx $$d_1 = \frac{F}{\pi \cdot S_{avg} \cdot t_f \cdot \ln\left(\frac{t_0}{t_f}\right)}$$

ex $$2.500218\text{mm} = \frac{8.01\text{N}}{\pi \cdot 0.181886\text{N/mm}^2 \cdot 13\text{mm} \cdot \ln\left(\frac{20.01\text{mm}}{13\text{mm}}\right)}$$

15) Thickness of Shell before Ironing

Open Calculator

fx $$t_0 = t_f \cdot \exp\left(\frac{F}{\pi \cdot d_1 \cdot t_f \cdot S_{avg}}\right)$$

ex $$20.01075\text{mm} = 13\text{mm} \cdot \exp\left(\frac{8.01\text{N}}{\pi \cdot 2.5\text{mm} \cdot 13\text{mm} \cdot 0.181886\text{N/mm}^2}\right)$$

Punch Operation

16) Blank Size when there is Corner Radius on Punch

Open Calculator

fx $$d_{bl} = \sqrt{d_s^2 + 4 \cdot d_s \cdot h_{shl} - 0.5 \cdot r_{cn}}$$

ex $$84.18135\text{mm} = \sqrt{(80\text{mm})^2 + 4 \cdot 80\text{mm} \cdot 2.15\text{mm} - 0.5 \cdot 0.003001\text{mm}}$$

17) Maximum Shear Force given Shear Applied to Punch or Die

Open Calculator

fx $$F_s = L_{ct} \cdot t_{stk} \cdot \frac{t_{stk} \cdot p}{t_{sh}}$$

ex $$0.015584\text{N} = 615.66\text{m} \cdot 9\text{mm} \cdot \frac{9\text{mm} \cdot 0.499985\text{mm}}{1.599984\text{mm}}$$

18) Penetration of Punch as Fraction

Open Calculator

fx $$p = \frac{F_s \cdot t_{sh}}{L_{ct} \cdot t_{stk}^2}$$

ex $$0.499581\text{mm} = \frac{0.015571\text{N} \cdot 1.599984\text{mm}}{615.66\text{m} \cdot (9\text{mm})^2}$$

19) Perimeter of Cut when Shear is Applied

Open Calculator

fx $$L_{ct} = \frac{F_s \cdot t_{sh}}{p \cdot t_{stk}^2}$$

ex $$615.1629\text{m} = \frac{0.015571\text{N} \cdot 1.599984\text{mm}}{0.499985\text{mm} \cdot (9\text{mm})^2}$$

20) Punch Load

Open Calculator

fx $$L_p = L_{ct} \cdot t_{bar} \cdot S_c$$

ex $$16.83061\text{N} = 615.66\text{m} \cdot 0.003\text{mm} \cdot 9112.5$$

21) Punching Force for Holes Smaller than Sheet Thickness

Open Calculator

fx $$P = \frac{d_{rm} \cdot t_b \cdot \varepsilon}{\left(\frac{d_{rm}}{t_b}\right)^{\frac{1}{3}}}$$

ex $$178.3896\text{N} = \frac{13.3\text{mm} \cdot 1.13\text{mm} \cdot 27\text{N/mm}^2}{\left(\frac{13.3\text{mm}}{1.13\text{mm}}\right)^{\frac{1}{3}}}$$

22) Shear on Punch or Die

Open Calculator

fx $$t_{sh} = L_{ct} \cdot t_{stk} \cdot \frac{t_{stk} \cdot p}{F_s}$$

ex $$1.601277\text{mm} = 615.66\text{m} \cdot 9\text{mm} \cdot \frac{9\text{mm} \cdot 0.499985\text{mm}}{0.015571\text{N}}$$

23) Stock Thickness when Shear used on Punch

Open Calculator

fx $$t_{stk} = \sqrt{\frac{F_s \cdot t_{sh}}{L_{ct} \cdot p}}$$

ex $$8.996366\text{mm} = \sqrt{\frac{0.015571\text{N} \cdot 1.599984\text{mm}}{615.66\text{m} \cdot 0.499985\text{mm}}}$$

Stripping Operation

24) Perimeter of Cut given Stripper Force

Open Calculator

fx $$L_{cut} = \frac{P_s}{K \cdot t_{blank}}$$

ex $$617.3526\text{mm} = \frac{0.000111\text{N}}{0.02 \cdot 8.99\text{mm}}$$

25) Stripping Force

Open Calculator

fx $$P_s = K \cdot L_{cut} \cdot t_{blank}$$

ex $$0.000111\text{N} = 0.02 \cdot 616.6667\text{mm} \cdot 8.99\text{mm}$$

26) Thickness of Stock given Stripper Force

Open Calculator

fx $$t_{blank} = \frac{P_s}{K \cdot L_{cut}}$$

ex $$9\text{mm} = \frac{0.000111\text{N}}{0.02 \cdot 616.6667\text{mm}}$$

Variables Used

- B_{al} Bend Allowance *(Millimeter)*
- C_f Cover Friction Constant
- C_s Clearance between Two Shears *(Millimeter)*
- d_1 Mean Shell Diameter after Ironing *(Millimeter)*
- D_b Sheet Diameter *(Millimeter)*
- d_{bl} Blank Diameter *(Millimeter)*
- d_{rm} Punch or Ram Diameter *(Millimeter)*
- d_s Outer Diameter of Shell *(Millimeter)*
- F Ironing Force *(Newton)*
- F_B Bending Force *(Newton)*
- F_s Maximum Shear Force *(Newton)*
- h_{shl} Shell Height *(Millimeter)*
- K Stripping Constant
- K_{bd} Bending Die Constant
- L_b Bent Part Length *(Millimeter)*
- L_{ct} Cutting Perimeter *(Meter)*
- L_{cut} Perimeter of Cut *(Millimeter)*
- L_p Punch Load *(Newton)*
- p Punch Penetration *(Millimeter)*
- P Punching Force or Load *(Newton)*
- P_d Drawing Force *(Newton per Square Millimeter)*

- **P_s** Stripper Force *(Newton)*
- **$PR_{\%}$** Percent Reduction after Drawing
- **r_c** Radius *(Millimeter)*
- **r_{cn}** Corner Radius on Punch *(Millimeter)*
- **S_{avg}** Average Tensile Strength Before & After Ironing *(Newton per Square Millimeter)*
- **S_c** Strength Coefficient
- **t_0** Shell Thickness before Ironing *(Millimeter)*
- **t_b** Sheet Thickness *(Millimeter)*
- **t_{bar}** Bar Thickness *(Millimeter)*
- **t_{blank}** Blank Thickness *(Millimeter)*
- **t_f** Shell Thickness after Ironing *(Millimeter)*
- **t_{sh}** Shear on Punch *(Millimeter)*
- **t_{stk}** Thickness of Stock *(Millimeter)*
- **w** Width between Contact Points *(Millimeter)*
- **ε** Tensile Strength *(Newton per Square Millimeter)*
- **θ** Subtended Angle in Radians *(Radian)*
- **λ** Stretch Factor
- **σ_{ut}** Ultimate Tensile Strength *(Newton per Square Millimeter)*
- **σ_y** Yield Strength *(Newton per Square Millimeter)*
- **τ** Shear Strength of Material *(Newton per Square Millimeter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Function: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Function: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Millimeter (mm), Meter (m)
  Length Unit Conversion
- Measurement: **Pressure** in Newton per Square Millimeter (N/mm²)
  Pressure Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Radian (rad)
  Angle Unit Conversion

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