Important Distortion in Weldments Formulas PDF

Formulas
Examples
with Units

List of 25
Important Distortion in Weldments Formulas

1) Angular Distortion Formulas

1.1) Angular Change when there is Maximum Distortion of Fillet Welds Formula

Evaluate Formula

Formula

$$\varphi = \frac{\delta_{max}}{0.25 \cdot L}$$

Example with Units

$$1.2\,\text{rad} = \frac{1.5\,\text{mm}}{0.25 \cdot 5\,\text{mm}}$$

1.2) Angular Distortion at x of Fillet Welds Formula

Evaluate Formula

Formula

$$\delta = L \cdot \left(0.25 \cdot \varphi - \varphi \cdot \left(\frac{x}{L} - 0.5\right)^2\right)$$

Example with Units

$$0.54\,\text{mm} = 5\,\text{mm} \cdot \left(0.25 \cdot 1.2\,\text{rad} - 1.2\,\text{rad} \cdot \left(\frac{0.5\,\text{mm}}{5\,\text{mm}} - 0.5\right)^2\right)$$

1.3) Length of Span for Maximum Angular Distortion of Fillet Welds Formula

Evaluate Formula

Formula

$$L = \frac{\delta_{max}}{0.25 \cdot \varphi}$$

Example with Units

$$5\,\text{mm} = \frac{1.5\,\text{mm}}{0.25 \cdot 1.2\,\text{rad}}$$

1.4) Maximum Angular Distortion of Fillet Welds Formula

Evaluate Formula

Formula

$$\delta_{max} = 0.25 \cdot \varphi \cdot L$$

Example with Units

$$1.5\,\text{mm} = 0.25 \cdot 1.2\,\text{rad} \cdot 5\,\text{mm}$$

1.5) Rigidity of Fillet Welds Formula

Evaluate Formula

Formula

$$R = \frac{E \cdot p_{tb}^3}{12 + \left(1 - \nu^2\right)}$$

Example with Units

$$0.6013\,\text{Nm/rad} = \frac{15\,\text{N/m} \cdot 802.87\,\text{mm}^3}{12 + \left(1 - 0.3^2\right)}$$

2) Transverse Shrinkage in Joints Formulas

2.1) Butt Joints Formulas

2.1.1) Cross-sectional area of weld for given transverse shrinkage in butt joints Formula

Evaluate Formula

Formula

$$A_w = \frac{p_{tb} \cdot \left(S_b - 1.27 \cdot d \right)}{5.08}$$

Example with Units

$$5.5\,\text{mm}^2 = \frac{802.87\,\text{mm} \cdot \left(0.365\,\text{mm} - 1.27 \cdot 0.26\,\text{mm} \right)}{5.08}$$

2.1.2) Degree of Restraint (Butt joints) Formula

Evaluate Formula

Formula

$$k_s = \left(\frac{1000}{86} \cdot \left(\frac{S}{s} - 1 \right) \right)^{\frac{1}{0.87}}$$

Example with Units

$$647.3872 = \left(\frac{1000}{86} \cdot \left(\frac{100\,\text{mm}}{4\,\text{mm}} - 1 \right) \right)^{\frac{1}{0.87}}$$

2.1.3) Depth of First V-groove for Minimum Distortion of Butt Joint Formula

Evaluate Formula

Formula

$$t_1 = \frac{0.62 \cdot t_2 + 0.12 \cdot t_3}{0.38}$$

Example with Units

$$6.2947\,\text{mm} = \frac{0.62 \cdot 2.6\,\text{mm} + 0.12 \cdot 6.5\,\text{mm}}{0.38}$$

2.1.4) Depth of Last V-groove for Minimum Distortion of Butt Joint Formula

Evaluate Formula

Formula

$$t_2 = \frac{0.38 \cdot t_1 - 0.12 \cdot t_3}{0.62}$$

Example with Units

$$2.5971\,\text{mm} = \frac{0.38 \cdot 6.29\,\text{mm} - 0.12 \cdot 6.5\,\text{mm}}{0.62}$$

2.1.5) Depth of Root Face for Minimum Distortion of Butt Joint Formula

Evaluate Formula

Formula

$$t_3 = \frac{0.38 \cdot t_1 - 0.62 \cdot t_2}{0.12}$$

Example with Units

$$6.485\,\text{mm} = \frac{0.38 \cdot 6.29\,\text{mm} - 0.62 \cdot 2.6\,\text{mm}}{0.12}$$

2.1.6) Metal Deposited in First Pass of Welding given Transverse Shrinkage Formula

Evaluate Formula

Formula

$$w_0 = \frac{w}{10^{\frac{S_t - S_0}{b}}}$$

Example with Units

$$4.99\,\text{g} = \frac{5.14064\,\text{g}}{10^{\frac{5.30\,\text{mm} - 2.20\,\text{mm}}{0.24}}}$$

2.1.7) Plate Thickness for given Transverse Shrinkage in Butt Joints Formula

Evaluate Formula

Formula

$$p_{tb} = \frac{5.08 \cdot A_w}{S_b - \left(1.27 \cdot d \right)}$$

Example with Units

$$802.8736\,\text{mm} = \frac{5.08 \cdot 5.5\,\text{mm}^2}{0.365\,\text{mm} - \left(1.27 \cdot 0.26\,\text{mm} \right)}$$

2.1.8) Root Opening given Transverse Shrinkage Formula

Evaluate Formula

Formula

$$d = \frac{S_b - 5.08 \cdot \left(\frac{A_w}{p_{tb}}\right)}{1.27}$$

Example with Units

$$0.26\,\text{mm} = \frac{0.365\,\text{mm} - 5.08 \cdot \left(\frac{5.5\,\text{mm}^2}{802.87\,\text{mm}}\right)}{1.27}$$

2.1.9) Shrinkage of Unrestrained Joint from given Shrinkage of Restrained Butt Joint Formula

Evaluate Formula

Formula

$$S = s \cdot \left(1 + 0.086 \cdot k_s^{0.87}\right)$$

Example with Units

$$100\,\text{mm} = 4\,\text{mm} \cdot \left(1 + 0.086 \cdot 647.3872^{0.87}\right)$$

2.1.10) Total Metal Deposited in Weld given Total Transverse Shrinkage Formula

Evaluate Formula

Formula

$$w = w_0 \cdot \left(10^{\frac{S_t - S_0}{b}}\right)$$

Example with Units

$$5.1406\,\text{g} = 4.99\,\text{g} \cdot \left(10^{\frac{5.30\,\text{mm} - 2.20\,\text{mm}}{0.24}}\right)$$

2.1.11) Total Transverse Shrinkage during Multi-Pass Welding of Butt Joint Formula

Evaluate Formula

Formula

$$S_t = S_0 + b \cdot \left(\log10\left(\frac{w}{w_0}\right)\right)$$

Example with Units

$$5.3\,\text{mm} = 2.20\,\text{mm} + 0.24 \cdot \left(\log10\left(\frac{5.14064\,\text{g}}{4.99\,\text{g}}\right)\right)$$

2.1.12) Transverse Shrinkage in Butt Joints Formula

Evaluate Formula

Formula

$$S_b = \left(5.08 \cdot \left(\frac{A_w}{p_{tb}}\right)\right) + \left(1.27 \cdot d\right)$$

Example with Units

$$0.365\,\text{mm} = \left(5.08 \cdot \left(\frac{5.5\,\text{mm}^2}{802.87\,\text{mm}}\right)\right) + \left(1.27 \cdot 0.26\,\text{mm}\right)$$

2.1.13) Transverse Shrinkage in First Pass given Total Shrinkage Formula

Evaluate Formula

Formula

$$S_0 = S_t - b \cdot \left(\log10\left(\frac{w}{w_0}\right)\right)$$

Example with Units

$$2.2\,\text{mm} = 5.30\,\text{mm} - 0.24 \cdot \left(\log10\left(\frac{5.14064\,\text{g}}{4.99\,\text{g}}\right)\right)$$

2.1.14) Transverse Shrinkage of Restrained Joint Formula

Evaluate Formula

Formula

$$s = \frac{S}{1 + 0.086 \cdot k_s^{0.87}}$$

Example with Units

$$4\,\text{mm} = \frac{100\,\text{mm}}{1 + 0.086 \cdot 647.3872^{0.87}}$$

2.2) Lap Joint with Fillets Formulas

2.2.1) Length of Fillet Leg in Lap Joints from Shrinkage Formula

Evaluate Formula

Formula

$$h = \frac{s \cdot p_{tl}}{1.52}$$

Example with Units

$$2.1057\,\text{mm} = \frac{4\,\text{mm} \cdot 800.17\,\text{mm}}{1.52}$$

2.2.2) Thickness of Plates in Lap Joints Formula

Evaluate Formula

Formula

$$p_{tl} = \frac{1.52 \cdot h}{s}$$

Example with Units

$$908.2\,\text{mm} = \frac{1.52 \cdot 2.39\,\text{mm}}{4\,\text{mm}}$$

2.2.3) Transverse Shrinkage in Lap Joint with Fillets Formula

Evaluate Formula

Formula

$$s = \frac{1.52 \cdot h}{p_{tl}}$$

Example with Units

$$4.54\,\text{mm} = \frac{1.52 \cdot 2.39\,\text{mm}}{800.17\,\text{mm}}$$

2.3) T-Joint with Two Fillets Formulas

2.3.1) Length of Fillet Leg from Transverse Shrinkage in T-Joints Formula

Evaluate Formula

Formula

$$h_t = \frac{s \cdot t_b}{1.02}$$

Example with Units

$$0.0118\,\text{mm} = \frac{4\,\text{mm} \cdot 3\,\text{mm}}{1.02}$$

2.3.2) Thickness of Bottom Plate in T-Joints Formula

Evaluate Formula

Formula

$$t_b = \frac{1.02 \cdot h_t}{s}$$

Example with Units

$$2.55\,\text{mm} = \frac{1.02 \cdot .01\,\text{mm}}{4\,\text{mm}}$$

2.3.3) Transverse Shrinkage in T-Joint with Two Fillets Formula

Evaluate Formula

Formula

$$s = \frac{1.02 \cdot h_t}{t_b}$$

Example with Units

$$3.4\,\text{mm} = \frac{1.02 \cdot .01\,\text{mm}}{3\,\text{mm}}$$

Variables used in list of Distortion in Weldments Formulas above

- A_w Cross Sectional Area of Weld *(Square Millimeter)*
- **b** Constant For Multi Pass Shrinkage
- **d** Root Opening *(Millimeter)*
- **E** Young's Modulus *(Newton per Meter)*
- **h** Length of Fillet Leg *(Millimeter)*
- h_t Length of Fillet Leg in T Joint *(Millimeter)*
- k_s Degree of Restraint
- **L** Length of Span of The Fillet Welds *(Millimeter)*
- p_{tb} Plate Thickness in Butt Joint *(Millimeter)*
- p_{tl} Plate Thickness in Lap Joint *(Millimeter)*
- **R** Rigidity of Fillet Weld *(Newton Meter per Radian)*
- **s** Transverse Shrinkage *(Millimeter)*
- **S** Transverse Shrinkage of Unrestrained Joint *(Millimeter)*
- S_0 Transverse Shrinkage in First Pass *(Millimeter)*
- S_b Transverse Shrinkage of Butt Joint *(Millimeter)*
- S_t Total Transverse Shrinkage *(Millimeter)*
- t_1 Depth of The First V Groove *(Millimeter)*
- t_2 Depth of The Last V Groove *(Millimeter)*
- t_3 Depth of Root Face *(Millimeter)*
- t_b Thickness of Bottom Plate *(Millimeter)*
- **w** Total Weight of Weld Metal Deposited *(Gram)*
- w_0 Weld Metal Deposited in First Pass *(Gram)*
- **x** Distance from the Center Line of the Frame *(Millimeter)*
- **δ** Distortion at Some Distance *(Millimeter)*
- δ_{max} Maximum Distortion *(Millimeter)*
- **φ** Angular Change in Restrained Joints *(Radian)*
- **ν** Poisson's Ratio

Constants, Functions, Measurements used in list of Distortion in Weldments Formulas above

- Functions: **log10**, log10(Number)
  The common logarithm, also known as the base-10 logarithm or the decimal logarithm, is a mathematical function that is the inverse of the exponential function.
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Weight** in Gram (g)
  Weight Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Angle** in Radian (rad)
  Angle Unit Conversion
- Measurement: **Torsion Constant** in Newton Meter per Radian (Nm/rad)
  Torsion Constant Unit Conversion
- Measurement: **Stiffness Constant** in Newton per Meter (N/m)
  Stiffness Constant Unit Conversion

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