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# Saddle Support Formulas

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# List of 12 Saddle Support Formulas

## Saddle Support

### 1) Bending Moment at Centre of Vessel Span

Open Calculator

fx $$M_2 = \frac{Q \cdot L}{4} \cdot \left( \left( \frac{1 + 2 \cdot \left( \frac{(R_{vessel})^2 - (Depth_{Head})^2}{L^2} \right)}{1 + \left( \frac{4}{3} \right) \cdot \left( \frac{Depth_{Head}}{L} \right)} \right) - \frac{4 \cdot A}{L} \right)$$

ex $$2.8E\hat{\ }12N^*mm = \frac{675098N \cdot 23399mm}{4} \cdot \left( \left( \frac{1 + 2 \cdot \left( \frac{(1539mm)^2 - (1581mm)^2}{(23399mm)^2} \right)}{1 + \left( \frac{4}{3} \right) \cdot \left( \frac{1581mm}{23399mm} \right)} \right) - \frac{4 \cdot 1210mm}{23399mm} \right)$$

### 2) Bending Moment at Support

Open Calculator

fx $$M_1 = Q \cdot A \cdot \left( (1) - \left( \frac{1 - \left( \frac{A}{L} \right) + \left( \frac{(R_{vessel})^2 - (Depth_{Head})^2}{2 \cdot A \cdot L} \right)}{1 + \left( \frac{4}{3} \right) \cdot \left( \frac{Depth_{Head}}{L} \right)} \right) \right)$$

ex $$1.1E\hat{\ }8N^*mm = 675098N \cdot 1210mm \cdot \left( (1) - \left( \frac{1 - \left( \frac{1210mm}{23399mm} \right) + \left( \frac{(1539mm)^2 - (1581mm)^2}{2 \cdot 1210mm \cdot 23399mm} \right)}{1 + \left( \frac{4}{3} \right) \cdot \left( \frac{1581mm}{23399mm} \right)} \right) \right)$$

### 3) Combined Stresses at Bottommost Fibre of Cross Section

Open Calculator

fx $$f_{cs2} = f_{cs1} - f_2$$

ex $$61.19N/mm^2 = 61.19N/mm^2 - 0.0000044N/mm^2$$

### 4) Combined Stresses at Mid Span

Open Calculator

fx $$f_{cs3} = f_{cs1} + f_3$$

ex $$87.19N/mm^2 = 61.19N/mm^2 + 26N/mm^2$$

## 5) Combined Stresses at Topmost Fibre of Cross Section

Open Calculator

fx $$f_{1cs} = f_{cs1} + f_1$$

ex $$61.197\text{N/mm²} = 61.19\text{N/mm²} + 0.007\text{N/mm²}$$

## 6) Corresponding Bending Stress with Section Modulus

Open Calculator

fx $$f_{wb} = \frac{M_w}{Z}$$

ex $$0.901314\text{N/mm²} = \frac{370440000\text{N*mm}}{411000000\text{mm³}}$$

## 7) Period of Vibration at Dead Weight

Open Calculator

fx $$T = 6.35 \cdot 10^{-5} \cdot \left(\frac{H}{D}\right)^{\frac{3}{2}} \cdot \left(\frac{\Sigma\text{Weight}}{t_{\text{vesselwall}}}\right)^{\frac{1}{2}}$$

ex $$0.012801\text{s} = 6.35 \cdot 10^{-5} \cdot \left(\frac{12000\text{mm}}{600\text{mm}}\right)^{\frac{3}{2}} \cdot \left(\frac{35000\text{N}}{6890\text{mm}}\right)^{\frac{1}{2}}$$

## 8) Stability Coefficient of Vessel

Open Calculator

fx $$Y = \frac{M_{\text{weight}}}{M_w}$$

ex $$0.000634 = \frac{234999\text{N*mm}}{370440000\text{N*mm}}$$

## 9) Stress due to Longitudinal Bending at Bottom most Fibre of Cross Section

Open Calculator

fx $$f_2 = \frac{M_1}{k_2 \cdot \pi \cdot (R)^2 \cdot t}$$

ex $$4.4\text{E\^{}-6N/mm²} = \frac{1000000\text{N*mm}}{0.192 \cdot \pi \cdot (1380\text{mm})^2 \cdot 200\text{mm}}$$

## 10) Stress due to Longitudinal Bending at Mid-Span

Open Calculator

fx $$f_3 = \frac{M_2}{\pi \cdot (R)^2 \cdot t}$$

ex $$26.12199\text{N/mm}^2 = \frac{31256789045\text{N*mm}}{\pi \cdot (1380\text{mm})^2 \cdot 200\text{mm}}$$

## 11) Stress due to Longitudinal Bending at Top most Fibre of Cross Section

Open Calculator

fx $$f_1 = \frac{M_1}{k_1 \cdot \pi \cdot (R)^2 \cdot t}$$

ex $$0.00781\text{N/mm}^2 = \frac{1000000\text{N*mm}}{0.107 \cdot \pi \cdot (1380\text{mm})^2 \cdot 200\text{mm}}$$

## 12) Stress due to Seismic Bending Moment

Open Calculator

fx $$f_{bendingmoment} = \frac{4 \cdot M_s}{\pi \cdot \left(D_{sk}^2\right) \cdot t_{sk}}$$

ex $$0.013135\text{N/mm}^2 = \frac{4 \cdot 4400000\text{N*mm}}{\pi \cdot \left((601.2\text{mm})^2\right) \cdot 1.18\text{mm}}$$

## Variables Used

- **A** Distance from Tangent Line to Saddle Centre *(Millimeter)*
- **D** Diameter of Shell Vessel Support *(Millimeter)*
- $D_{sk}$ Mean Diameter of Skirt *(Millimeter)*
- $Depth_{Head}$ Depth of Head *(Millimeter)*
- $f_1$ Stress Bending Moment at Topmost of Cross Section *(Newton per Square Millimeter)*
- $f_{1cs}$ Combined Stresses Topmost Fibre Cross Section *(Newton per Square Millimeter)*
- $f_2$ Stress at Bottom most Fibre of Cross Section *(Newton per Square Millimeter)*
- $f_3$ Stress due to Longitudinal Bending at Mid-Span *(Newton per Square Millimeter)*
- $f_{bendingmoment}$ Stress due to Seismic Bending Moment *(Newton per Square Millimeter)*
- $f_{cs1}$ Stress due to Internal Pressure *(Newton per Square Millimeter)*
- $f_{cs2}$ Combined Stresses Bottommost Fibre Cross Section *(Newton per Square Millimeter)*
- $f_{cs3}$ Combined Stresses at Mid Span *(Newton per Square Millimeter)*
- $f_{wb}$ Axial Bending Stress at Base of Vessel *(Newton per Square Millimeter)*
- **H** Overall Height of Vessel *(Millimeter)*
- $k_1$ Value of k1 depending on Saddle Angle
- $k_2$ Value of k2 depending on Saddle Angle
- **L** Tangent to Tangent Length of Vessel *(Millimeter)*
- $M_1$ Bending Moment at Support *(Newton Millimeter)*
- $M_2$ Bending Moment at Centre of Vessel Span *(Newton Millimeter)*
- $M_s$ Maximum Seismic Moment *(Newton Millimeter)*
- $M_w$ Maximum Wind Moment *(Newton Millimeter)*
- $M_{weight}$ Bending Moment due to Minimum Weight of Vessel *(Newton Millimeter)*
- **Q** Total Load per Saddle *(Newton)*
- **R** Shell Radius *(Millimeter)*
- $R_{vessel}$ Vessel Radius *(Millimeter)*
- **t** Shell Thickness *(Millimeter)*
- **T** Period of Vibration at Dead Weight *(Second)*
- $t_{sk}$ Thickness of Skirt *(Millimeter)*
- $t_{vesselwall}$ Corroded Vessel Wall Thickness *(Millimeter)*

- **Y** Stability Coefficient of Vessel
- **Z** Section Modulus of Skirt Cross Section *(Cubic Millimeter)*
- **ΣWeight** Weight of Vessel with Attachments and Contents *(Newton)*

## Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  *Archimedes' constant*
- Measurement: **Length** in Millimeter (mm)
  *Length Unit Conversion*
- Measurement: **Time** in Second (s)
  *Time Unit Conversion*
- Measurement: **Volume** in Cubic Millimeter ($mm^3$)
  *Volume Unit Conversion*
- Measurement: **Force** in Newton (N)
  *Force Unit Conversion*
- Measurement: **Moment of Force** in Newton Millimeter (N*mm)
  *Moment of Force Unit Conversion*
- Measurement: **Bending Moment** in Newton Millimeter (N*mm)
  *Bending Moment Unit Conversion*
- Measurement: **Stress** in Newton per Square Millimeter ($N/mm^2$)
  *Stress Unit Conversion*

## Check other formula lists

- Design of Anchor Bolt & Bolting Chair Formulas
- Design Thickness of Skirt Formulas
- Lug or Bracket Support Formulas
- Saddle Support Formulas
- Skirt Supports Formulas



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