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Design of Lever Formulas

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List of 34 Design of Lever Formulas

Design of Lever

Components of Lever

1) Bending stress in lever of elliptical cross section

Open Calculator

fx $$\sigma_b = \frac{32 \cdot (P \cdot (l_1 - d_1))}{\pi \cdot b \cdot a^2}$$

ex $$239.6157\text{N/mm}^2 = \frac{32 \cdot (310\text{N} \cdot (900\text{mm} - 12.3913\text{mm}))}{\pi \cdot 14.3\text{mm} \cdot (28.6\text{mm})^2}$$

2) Bending stress in lever of elliptical cross section given bending moment

Open Calculator

fx $$\sigma_b = \frac{32 \cdot M_b}{\pi \cdot b \cdot a^2}$$

ex $$239.8293\text{N/mm}^2 = \frac{32 \cdot 275404\text{N*mm}}{\pi \cdot 14.3\text{mm} \cdot (28.6\text{mm})^2}$$

3) Bending stress in lever of rectangular cross section

Open Calculator

$$\sigma_b = \frac{32 \cdot (P \cdot (l_1 - d_1))}{\pi \cdot b_l \cdot d^2}$$

$$244.7137\text{N/mm}^2 = \frac{32 \cdot (310\text{N} \cdot (900\text{mm} - 12.3913\text{mm}))}{\pi \cdot 14.2\text{mm} \cdot (28.4\text{mm})^2}$$

4) Bending stress in lever of rectangular cross section given bending moment

Open Calculator

$$\sigma_b = \frac{32 \cdot M_b}{\pi \cdot b_l \cdot (d^2)}$$

$$244.9319\text{N/mm}^2 = \frac{32 \cdot 275404\text{N*mm}}{\pi \cdot 14.2\text{mm} \cdot \left((28.4\text{mm})^2\right)}$$

5) Effort Force Applied on Lever given Bending Moment

Open Calculator

$$P = \frac{M_b}{l_1 - d_1}$$

$$310.2764\text{N} = \frac{275404\text{N*mm}}{900\text{mm} - 12.3913\text{mm}}$$

6) Effort using Length and Load

Open Calculator

fx $$P = l_2 \cdot \frac{W}{l_1}$$

ex $$310.8611\text{N} = 95\text{mm} \cdot \frac{2945\text{N}}{900\text{mm}}$$

7) Effort using Leverage

Open Calculator

fx $$P = \frac{W}{MA}$$

ex $$310\text{N} = \frac{2945\text{N}}{9.5}$$

8) Leverage

Open Calculator

fx $$MA = \frac{l_1}{l_2}$$

ex $$9.473684 = \frac{900\text{mm}}{95\text{mm}}$$

9) Load using Lengths and Effort

Open Calculator

fx $$W = l_1 \cdot \frac{P}{l_2}$$

ex $$2936.842\text{N} = 900\text{mm} \cdot \frac{310\text{N}}{95\text{mm}}$$

10) Load using Leverage

Open Calculator

fx $W = P \cdot MA$

ex $2945\text{N} = 310\text{N} \cdot 9.5$

11) Maximum bending moment in lever

Open Calculator

fx $M_b = P \cdot (l_1 - d_1)$

ex $275158.7\text{N*mm} = 310\text{N} \cdot (900\text{mm} - 12.3913\text{mm})$

12) Mechanical Advantage

Open Calculator

fx $MA = \frac{W}{P}$

ex $9.5 = \frac{2945\text{N}}{310\text{N}}$

13) Reaction Force at Fulcrum of Lever given Bearing Pressure

Open Calculator

fx $R_f = P_b \cdot d_1 \cdot l_f$

ex $2963.999\text{N} = 20.8\text{N/mm}^2 \cdot 12.3913\text{mm} \cdot 11.5\text{mm}$

14) Reaction Force at Fulcrum of Lever given Effort, Load and Contained Angle

Open Calculator

fx $$R_f = \sqrt{W^2 + P^2 - 2 \cdot W \cdot P \cdot \cos(\theta)}$$

ex $$2966.646\text{N} = \sqrt{(2945\text{N})^2 + (310\text{N})^2 - 2 \cdot 2945\text{N} \cdot 310\text{N} \cdot \cos(91^\circ)}$$

15) Reaction Force at Fulcrum of Right Angled Lever

Open Calculator

fx $$R_f = \sqrt{W^2 + P^2}$$

ex $$2961.271\text{N} = \sqrt{(2945\text{N})^2 + (310\text{N})^2}$$

Design of Fulcrum Pin

16) Bearing pressure in fulcrum pin of lever given reaction force and diameter of pin

Open Calculator

fx $$P_b = \frac{R_f}{d_1 \cdot l_f}$$

ex $$20.80001\text{N/mm}^2 = \frac{2964\text{N}}{12.3913\text{mm} \cdot 11.5\text{mm}}$$

17) Compressive stress in fulcrum pin of lever given reaction force, depth of lever arm

Open Calculator

$$\sigma t_{fp} = \frac{R_f}{d_1 \cdot l}$$

$$25.88184\text{N/mm}^2 = \frac{2964\text{N}}{12.3913\text{mm} \cdot 9.242006\text{mm}}$$

18) Diameter of fulcrum pin given compressive stress in pin

Open Calculator

$$d_1 = \frac{R_f}{\sigma t_{fp} \cdot l}$$

$$12.38261\text{mm} = \frac{2964\text{N}}{25.9\text{N/mm}^2 \cdot 9.242006\text{mm}}$$

19) Diameter of fulcrum pin of lever given bending moment and effort force

Open Calculator

$$d_1 = (l_1) - \left(\frac{M_b}{P}\right)$$

$$11.6\text{mm} = (900\text{mm}) - \left(\frac{275404\text{N*mm}}{310\text{N}}\right)$$

20) Diameter of fulcrum pin of lever given reaction force and bearing pressure

Open Calculator

fx $$d_1 = \frac{R_f}{P_b \cdot l_f}$$

ex $$12.3913\text{mm} = \frac{2964\text{N}}{20.8\text{N/mm}^2 \cdot 11.5\text{mm}}$$

21) Length of flucrum pin of lever given reaction force and bearing pressure

Open Calculator

fx $$l_f = \frac{R_f}{P_b \cdot d_1}$$

ex $$11.5\text{mm} = \frac{2964\text{N}}{20.8\text{N/mm}^2 \cdot 12.3913\text{mm}}$$

22) Length of fulcrum pin boss given compressive stress in pin

Open Calculator

fx $$l = \frac{R_f}{\sigma t_{fp} \cdot d_1}$$

ex $$9.235524\text{mm} = \frac{2964\text{N}}{25.9\text{N/mm}^2 \cdot 12.3913\text{mm}}$$

23) Maximum length of flucrum pin of lever given diameter of fulcrum pin

Open Calculator

fx $$l_f = 2 \cdot d_1$$

ex $$24.7826\text{mm} = 2 \cdot 12.3913\text{mm}$$

Lever Arm

24) Angle between arms of lever given effort, load and net reaction at fulcrum

Open Calculator

fx $$\theta = \arccos\left(\frac{W^2 + P^2 - (R_f')^2}{2 \cdot W \cdot P}\right)$$

ex $$90.99991^\circ = \arccos\left(\frac{(2945\text{N})^2 + (310\text{N})^2 - (2966.646\text{N})^2}{2 \cdot 2945\text{N} \cdot 310\text{N}}\right)$$

25) Depth of lever arm given width

Open Calculator

fx $$d = 2 \cdot b_l$$

ex $$28.4\text{mm} = 2 \cdot 14.2\text{mm}$$

26) Length of Effort Arm given Leverage

Open Calculator

fx $$l_1 = l_2 \cdot MA$$

ex $$902.5\text{mm} = 95\text{mm} \cdot 9.5$$

27) Length of Effort Arm given Load and Effort

Open Calculator

fx $$l_1 = W \cdot \frac{l_2}{P}$$

ex $$902.5\text{mm} = 2945\text{N} \cdot \frac{95\text{mm}}{310\text{N}}$$

28) Length of effort arm of lever given bending moment

Open Calculator

fx $$l_1 = (d_1) + \left(\frac{M_b}{P}\right)$$

ex $$900.7913\text{mm} = (12.3913\text{mm}) + \left(\frac{275404\text{N*mm}}{310\text{N}}\right)$$

29) Length of Load Arm given Leverage

Open Calculator

fx $$l_2 = \frac{l_1}{MA}$$

ex $$94.73684\text{mm} = \frac{900\text{mm}}{9.5}$$

30) Length of Load Arm given Load and Effort

Open Calculator

fx $$l_2 = P \cdot \frac{l_1}{W}$$

ex $$94.73684\text{mm} = 310\text{N} \cdot \frac{900\text{mm}}{2945\text{N}}$$

31) Length of major axis for elliptical cross sectioned lever given minor axis

Open Calculator

fx $$a = 2 \cdot b$$

ex $$28.6\text{mm} = 2 \cdot 14.3\text{mm}$$

32) Length of minor axis for elliptical cross sectioned lever given major axis

Open Calculator

fx $$b = \frac{a}{2}$$

ex $$14.3\text{mm} = \frac{28.6\text{mm}}{2}$$

33) Outside diameter of boss in lever

Open Calculator

fx $$D_o = 2 \cdot d_1$$

ex $$24.7826\text{mm} = 2 \cdot 12.3913\text{mm}$$

34) Width of lever arm given depth

Open Calculator

fx $$b_l = \frac{d}{2}$$

ex $$14.2\text{mm} = \frac{28.4\text{mm}}{2}$$

Variables Used

- **a** Major Axis of Lever Ellipse Section *(Millimeter)*
- **b** Minor Axis of Lever Ellipse Section *(Millimeter)*
- b_l Width of Lever Arm *(Millimeter)*
- **d** Depth of Lever Arm *(Millimeter)*
- d_1 Diameter of Lever Fulcrum Pin *(Millimeter)*
- D_o Outside Diameter of Lever Boss *(Millimeter)*
- **l** Length of Pin Boss *(Millimeter)*
- l_1 Length of Effort Arm *(Millimeter)*
- l_2 Length of Load Arm *(Millimeter)*
- l_f Length of Lever Fulcrum Pin *(Millimeter)*
- M_b Bending Moment in Lever *(Newton Millimeter)*
- **MA** Mechanical Advantage of Lever
- **P** Effort on Lever *(Newton)*
- P_b Bearing Pressure in Fulcrum Pin of Lever *(Newton per Square Millimeter)*
- R_f Force at Lever Fulcrum Pin *(Newton)*
- R_f' Net Force at Lever Fulcrum Pin *(Newton)*
- **W** Load on lever *(Newton)*
- **θ** Angle Between Lever Arms *(Degree)*
- σ_b Bending Stress in Lever Arm *(Newton per Square Millimeter)*
- σt_{fp} Compressive Stress in Fulcrum Pin *(Newton per Square Millimeter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **arccos**, arccos(Number)
  Arccosine function, is the inverse function of the cosine function.It is the function that takes a ratio as an input and returns the angle whose cosine is equal to that ratio.
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- 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)
  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 Degree (°)
  Angle Unit Conversion
- Measurement: **Torque** in Newton Millimeter (N*mm)
  Torque Unit Conversion
- Measurement: **Stress** in Newton per Square Millimeter (N/mm²)
  Stress Unit Conversion

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