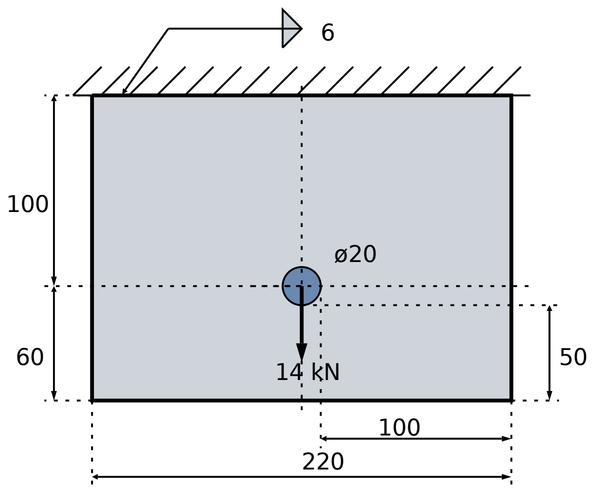
REFERENCES	CALCULATIONS	RESULTS

Input Summary

Input	Description	Value
F_y	**F_y** *Yield Strength of Steel Plate*	250 MPa
F_u	**F_u** *Ultimate Strength of Steel Plate*	360 MPa
d	**d** *Hole Diameter*	20 mm
d_{pin}	**d_{pin}** *Pin Diameter*	16 mm
t_p	**t_p** *Plate Thickness*	20 mm
a_p	**a_p** *Horizontal Edge Distance (Perpendicular to Load)*	100 mm
e_p	**e_p** *Vertical Edge Distance (Parallel to Load)*	50 mm
w_s	**w_s** *Weld Size*	6 mm
P	**P** *Service Load*	14 kN
y_1	**y_1** *Distance of Hole Center from Top (i.e. from Welded Edge)*	100 mm
in_p	**in_p** *Maximum Angle of Load, in Plate*	30 °
out_p	**out_p** *Maximum Angle of Load, out-of-Plane*	10 °

Typical Lift Lug Detail



Design Calculations

Position of Hole from the Plate Bottom

$$y_2 = e_p + \frac{d}{2} = 50 + \frac{20}{2}$$

$$y_2 = 60mm$$

Total Width of the Plate

$$w = d + 2 \times a_p = 20 + 2 \times 100$$

$$w = 220mm$$

Geometric Check

$t_p > Min(0.25 * d, 13) =$	OK
$a_p > d/2 =$	OK
$e_p > 0.67 * d =$	OK

Design Check for Lug Plate

Tensile Ultimate Rupture Resistance

Eq.D5-1,AISC 360-16

$$P_u = \frac{2 \times a_p \times t_p \times F_u}{1000} = \frac{2 \times 100 \times 20 \times 360}{1000}$$

$$P_u = 1440kN$$

Utilization ratio

$$UR_{Pu} = \frac{5 * P}{P_u} = \frac{5 * 14}{1440.000} = 0.049$$

UTILITY: 0.049

Tensile Yield Resistance

$$a_{eff} = min(a_p, e_p, t_P, d)$$
$$a_{eff} = min(100, 37.5, 80, 16)$$
$$a_{eff} = 16.000mm$$

Eq.D2-1,AISC 360-16

$$P_y = \frac{2 \times aeff \times t_p \times F_y}{1000} \times 0.45 = \frac{2 \times 16 \times 20 \times 250}{1000} \times 0.45$$

$$P_y = 72kN$$

Utilization ratio

$$UR_{Py} = \frac{1.5 * P}{P_y} = \frac{1.5 * 14}{72.000} = 0.292$$

UTILITY: 0.292

Bearing Resistance

Eq.J3-6a,AISC 360-16

$$P_b = \frac{phis_s \times F_y \times dpin \times t_p}{1000} = \frac{0.9 \times 250 \times 16 \times 20}{1000}$$

$$P_b = 72kN$$

Utilization ratio

$$UR_{Pb} = \frac{1.5 * P}{P_b} = \frac{1.5 * 14}{72.000} = 0.292$$

UTILITY: 0.292

Shear Resistance

Eq.J4-2,AISC 360-16

$$P_v = \frac{2 \times 0.4 \times F_y \times e_p \times t_p}{1000} = \frac{2 \times 0.4 \times 250 \times 50 \times 20}{1000}$$

$$P_v = 200kN$$

Utilization ratio	$$UR_{Pv} = \frac{1.5 * P}{P_v} = \frac{1.5 * 14}{200.000} = 0.105$$	UTILITY: 0.105
	Pin Tear-out Resistance	
Eq.J3-6c,AISC 360-16	$$P_t = \frac{1.25 \times phis_s \times F_y \times (e_p)^2 \times t_p}{(d \times 1000)} = \frac{1.25 \times 0.9 \times 250 \times (50)^2 \times 20}{(20 \times 1000)}$$ $$P_t = 703.125kN$$	
Utilization ratio	$$UR_{Pt} = \frac{1.5 * P}{P_t} = \frac{1.5 * 14}{703.125} = 0.030$$	UTILITY: 0.03

Design Check for Weld Resistance (E49XX Electrode)

Combined Actions: Tension + Bending

$$f = \frac{p}{((w + t_p) \times 2)} + \frac{\tan\left(\frac{\pi}{180} \times out_p\right) \times y_1 \times p}{\left(w \times t_p + \frac{(t_p)^2}{3}\right)} = \frac{14}{((220 + 20) \times 2)} + \frac{\tan\left(\frac{\pi}{180} \times 10\right) \times 100 \times p}{\left(w \times t_p + \frac{(t_p)^2}{3}\right)}$$

$$f = 0.084kN/mm$$

$$f_1 = f + \frac{\tan\left(\frac{\pi}{180} \times in_p\right) \times y_1 \times P}{\left(w \times t_p + \frac{(w)^2}{3}\right)} = 0.084 + \frac{\tan\left(\frac{\pi}{180} \times 30\right) \times 100 \times 14}{\left(220 \times 20 + \frac{(w)^2}{3}\right)}$$

$$f_1 = 0.123kN/mm$$

In-Plane Shear

$$f_2 = p \times \tan\left(\frac{\frac{\pi}{180} \times in_p}{(2 \times (w + t_p))}\right) = 14 \times \tan\left(\frac{\frac{\pi}{180} \times 30}{(2 \times (220 + 20))}\right)$$

$$f_2 = 0.015kN/mm$$

Out-of-Plane Shear

$$f_3 = p \times \tan\left(\frac{\frac{\pi}{180} \times out_p}{(2 \times (w + t_p))}\right) = 14 \times \tan\left(\frac{\frac{\pi}{180} \times \$ou20}{(2 \times (220 + t_p))}\right)$$

$$f_3 = 0.005kN/mm$$

Resultant

$$r_e = \sqrt{(f_1)^2 + (f_2)^2 + (f_3)^2} = \sqrt{(0.123)^2 + (0.015)^2 + (0.005)^2}$$

$$r_e = 0.124kN/mm$$

Eq.J2,AISC 360-16	**Weld Resistance** $$f_u = \frac{0.22 \times w_s}{\sqrt{2}} = \frac{0.22 \times 6}{\sqrt{2}}$$ $$f_u = 0.933kN/mm$$		
Utilization ratio	$$UR_w = \frac{5 * r_e}{f_u} = \frac{5 * 0.124}{0.933} = 0.665$$	**UTILITY: 0.665**	

Design Check for Lug Base Resistance

Combined Actions: Tension + Bending

$$f = \frac{p}{(w \times t_p)} + \frac{p \times \tan\left(\frac{\pi}{180} \times out_p\right) \times y_1}{\left(\frac{w \times (t_p)^2}{6}\right)} = \frac{14}{(220 \times 20)} + \frac{p \times \tan\left(\frac{\pi}{180} \times 10\right) \times 100}{\left(\frac{w \times (t_p)^2}{6}\right)}$$

$$f = 0.02MPa$$

$$f_1 = f + \frac{p \times \tan\left(\frac{\pi}{180} \times in_p\right) \times y_1}{\left(\frac{t_p \times (w)^2}{6}\right)} \times 1000 = 0.02 + \frac{14 \times \tan\left(\frac{\pi}{180} \times 30\right) \times 100}{\left(\frac{20 \times (220)^2}{6}\right)} \times 1000$$

$$f_1 = 5.03MPa$$

Utilization ratio

$$UR_{Fu} = \frac{5 * f1}{Fu} = \frac{5 * 5.030}{360} = 0.070$$

UTILITY: 0.07

Capacity Summary

Symbol	Description	Capacity
P_u	Tensile Ultimate Resistance of Lug Plate	1440.000kN
P_y	Tensile Yield Resistance of Lug Plate	72.000kN
P_b	Bearing Resistance of Lug Plate	72.000kN
P_v	Shear Resistance of Lug Plate	200.000kN
P_t	Pin Tear-out Resistance	703.125kN
Weld	Weld Resistance	0.933kN/mm
F_u	Lug Base Resistance	5.030MPa

Ratio Summary

Symbol	Description	Ratio
UR_{Pu}	Tensile Ultimate Resistance of Lug Plate	0.049
UR_{Py}	Tensile Yield Resistance of Lug Plate	0.292
UR_{Pb}	Bearing Resistance of Lug Plate	0.292
UR_{Pv}	Shear Resistance of Lug Plate	0.105
UR_{Pt}	Pin Tear-out Resistance	0.030
UR_w	Weld Resistance	0.665
UR_{Fu}	Lug Base Resistance	0.070

Results Summary

Result Name	Results
Tensile Ultimate Utility, UR_{Pu}	0.05
Tensile Yield Utility, UR_{Py}	0.29
Bearing Utility, UR_{Pb}	0.29
Shear Utility, UR_{Pv}	0.10
PinTear-out Utility, UR_{Pt}	0.03
Weld Utility, UR_{weld}	0.67
Lug Base Utility, UR_{Fu}	0.07
Tensile Ultimate Capacity	1440.00
Tensile Yield Capacity	72.00
Bearing Capacity	72.00
Shear Capacity	200.00
PinTear-out Capacity	703.13
Weld Capacity	0.93
Lug Base Capacity	5.03

About this Calculator

Calculator Name: Lifting Lug Capacity Calculator
Description: This tool allows you to calculate the capacities of a Lifting Lug based on its length, width & height. The capacities calculated include maximum tension capacity, maximum bearing capacity, maximum shear capacity, maximum pin tear-out capacity and weld capacity. This tool is based on the American Institute of Steel Construction (AISC) code.

Powered by SkyCiv

URL: https://platform.skyciv.com/quick-design?uid=6003-lifting-lug-capacity-calculator

Contact: support@skyciv.com