Load on Boiler Stays, Flat Plates and Manhole Doors

Load carried by each stay of a stayed flat plate from the pressure and the stay pitches, the stress in the stay, and the total load on an elliptical manhole door.

Method: Pressure × supported area (statics, textbook)

Input parameters

Unit system: SI

Parameter	Value	Unit
Working pressure	9.8066	bar g
Horizontal pitch of the stays	200.00	mm
Vertical pitch of the stays	200.00	mm
Stay diameter (at the root of the thread)	30.000	mm
Allowable stress in the stay	75.000	MPa
Manhole major axis	400.00	mm
Manhole minor axis	300.00	mm

Calculated results

Parameter	Value	Unit
Plate area carried by one stay	0.040000	m²
Load on one stay	39.227	kN
Stress in the stay	55.494	MPa
Smallest stay diameter for the allowable stress	25.806	mm
Manhole area	0.094248	m²
Total load on the manhole door	92.425	kN

Notes for this case

- Each stay carries the pressure on one pitch × pitch rectangle of plate (the stay's own area is not deducted). Plate thickness between stays is a code calculation and is not done here.

Formula and method

$$F_s = (p - p_{atm})\, p_h\, p_v, \quad \sigma = \frac{F_s}{\pi d^2/4}, \quad d_{min} = \sqrt{\frac{4F_s}{\pi \sigma_a}}$$

$$F_m = (p - p_{atm})\,\frac{\pi a b}{4}$$

Variables

p	Working pressure	Pa
p_h	Horizontal pitch of the stays	m
p_v	Vertical pitch of the stays	m
d	Stay diameter (at the root of the thread)	m
σ_a	Allowable stress in the stay	Pa
a	Manhole major axis	m
b	Manhole minor axis	m
A_s	Plate area carried by one stay	m²
F_s	Load on one stay	N

σ	Stress in the stay	Pa
d_{min}	Smallest stay diameter for the allowable stress	m
A_m	Manhole area	m²
F_m	Total load on the manhole door	N

Method and standards

Each stay supports the rectangle of plate around it; the manhole door carries the pressure on its whole elliptical area.

Assumptions and limits

- Stay area not deducted from the supported area.
- The manhole load is the pressure on the a × b ellipse you enter: for an internal door the pressure acts out to the gasket line, so enter the axes at the gasket (not the clear opening) for the load the door and its studs carry.
- No code check of plate or stay; a warning is given only when the stay stress exceeds the allowable stress entered.

References

- Pressure × supported area (statics, textbook)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/boilers/stay-and-plate-load

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.