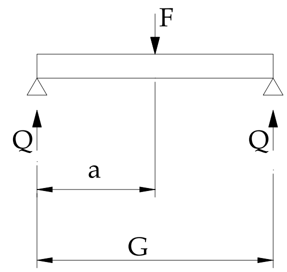
The Kellogg Method reloaded

Hints:

No.1 "Assuming the equivalent pressure is the pressure that will create the same amount of gasket stress as the pipe load does…" from the famous article "Evaluation of Flanged connections due to piping load" of Mr. Peng.

No.2 "Above equivalence is believed to be conservative because the maximum gasket stress produced by the piping load exists only at the extreme edge of the gasket, whereas the stress generated by the pressure is uniform" from the same source.

No.3 The "Theory of Plates and Shells" by S. Timoshenko and S. Woinowsky-Krieger, Copyright 1940 by the United Engineering Trustees, Inc **was** on the Kellogg desks.



$Q = \dfrac{F}{2\pi a}$ is the linear reaction ("stress") on the gasket

A Circular Plate under the force F

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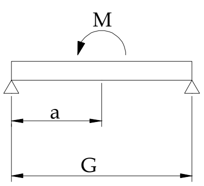
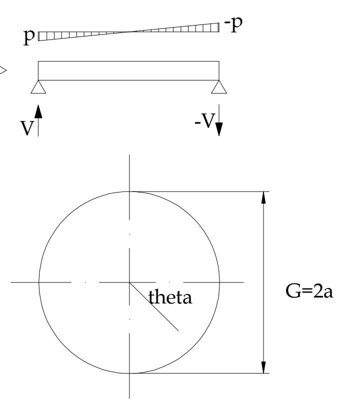


A Circular Plate under the bending moment M



$$V = \frac{pa}{4}\cos\theta \ \text{ and } \ M = 4\int_0^{\frac{\pi}{4}} \frac{pa}{4}\cos\theta\, a^2\cos\theta\, d\theta = \frac{\pi a^3 p}{4}$$

[Ref: Timoshenko/ paragraph Circular plates under linear loads]

so

$$p = \frac{4M}{\pi a^3}$$

and $V_{max} = \dfrac{pa}{4} = \dfrac{4M}{\pi a^3}\dfrac{a}{4} = \dfrac{M}{\pi a^2}$ is the maximum of the linear reaction on the gasket ("the maximum gasket stress produced by the piping load exists only at the extreme edge of the gasket")

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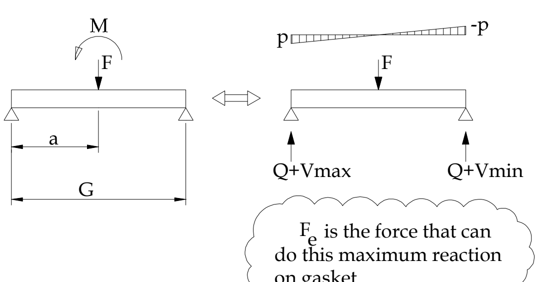

And F_e can be counted in terms of an equivalent pressure. However: "whereas the stress generated by the pressure is uniform..."

$Q + V_{max} = \dfrac{F}{2\pi a} + \dfrac{M}{\pi a^2} = \dfrac{F_e}{2\pi a} = \dfrac{p_e \pi a^2}{2\pi a}$ is the maximum "stress" on the gasket, F_e is the equivalent force and p_e is the equivalent pressure due to this equivalent force.

That means:

$$F + \frac{2\pi a}{\pi a^2}M = p_e \pi a^2 \quad \text{or} \quad \frac{F}{\pi a^2} + \frac{2}{a}\frac{1}{\pi a^2}M = p_e$$

Finally: $$p_e = \frac{F}{\pi a^2} + \frac{2M}{\pi a^3}\bigg|_{a=\frac{G}{2}} = \frac{4F}{\pi G^2} + \frac{16M}{\pi G^3}$$