Nomograph for Design of Power Plant and Industrial Precipitator Shell

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The shell of power plant and industrial precipitators are often designed on the basis of large deflection theory. It gives a lighter precipitator. As a consequence, the supporting structure also becomes lighter. The resultant savings in weight of the precipitator and its support structure can be significant.

The table given on p. 408 of Ref. 1 can be used to design the stiffened plate with large deflection. But some groundwork is needed before this table can be used. Furthermore, this table gives stress as a function of E and b/t, which again needs additional computation before its actual value can be obtained. If this stress exceeds the allowable limit, the entire process has to be repeated.

The nomograph, Fig. 1, will help the designer bypass this computation work and save some design office time to obtain a safe stiffener spacing. This nomograph gives deflection and stress directly; therefore, very little time is lost if the designer wants to try another combination for the stiffener spacing.

When the value of $(w/E)(b/t)^4$ lies within 50 and 200, stress and deflection bear following relationships:

$$\frac{s}{E}\left(\frac{b}{t}\right)^2 = \left[\frac{w}{E}\left(\frac{b}{t}\right)^4\right]^{0.77} \tag{1}$$

$$\frac{\bar{y}}{t} = \left[\frac{w}{E}\left(\frac{b}{t}\right)^4 \times \frac{1}{72}\right]^{0.53} \tag{2}$$

where

b = Smaller dimension of the plate (in.)
E = Young's modulus at design temperature (psi)
s = Stress (psi)
t = Plate thickness (in.)
$\bar{y}$ = Plate deflection (in.)

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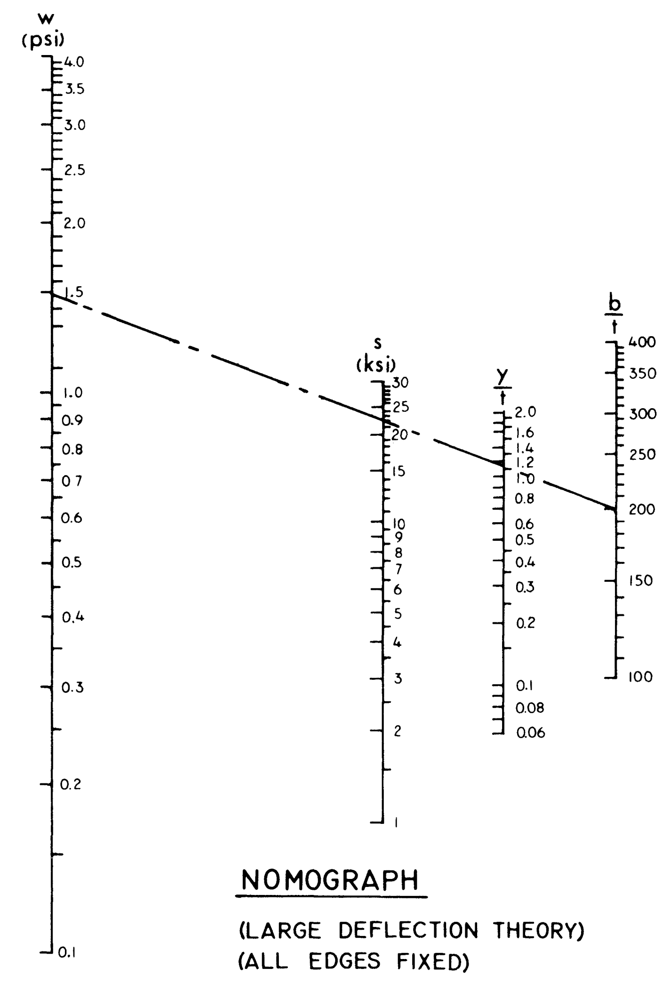

Figure 1

The nomograph has been prepared to satisfy Eqs. (1) and (2).

EXAMPLE 1

Given:
Find stiffener spacing if internal pressure is 1.5 psi, temperature is 350 °F and plate thickness is ¼-in. Allowable deflection is two times the plate thickness.

Solution:
At 350 degree temperature, $F_{yt} = 29.6$ ksi

$F_b = 0.75 \times 29.6 = 22.2$ ksi

Connect $w = 1.5$ with $s = 22.2$ to get

$y/t = 1.14$

$b/t = 200$

Since $t = 1/4$-in., $b = 50$ in.

EXAMPLE 2

Given:
Find stiffener spacing in Example 1 if pressure is 0.5 psi.

Solution:
Connect $w = 0.5$ with $y/t = 2$ to get

$s = 18$ ksi, $b/t = 360$

Since $t = 1/4$-in., $b = 90$ in.

REFERENCE

1. *Roark, Raymond J. and Warren C. Young* Formulas for Stress and Strain *Fifth Edition, McGraw-Hill Book Co., New York, p. 408.*