BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LXVI No. 3/2014	84 - 86	Seria Tehnică

Considerations Regarding the Safety Span of the Pipes

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Abstract

We present a method for computing the safety span of pipes that are simply supported at the end. The safety span is obtained using three restrictions: a strength one and two flexibility conditions. We illustrate our approach with a calculus example.

Key words: *deflection, slope, elastic curve, span*

General Equations

A pipe with the external diameter of the cross sectional area (d) and the wall thickness x is simply supported at the ends and is externally loaded with a uniform pressure q (see figure 1). The uniform external pressure q represents the effect of the proper gravity of the steel (q_1) and of the internal fluid (q_2).

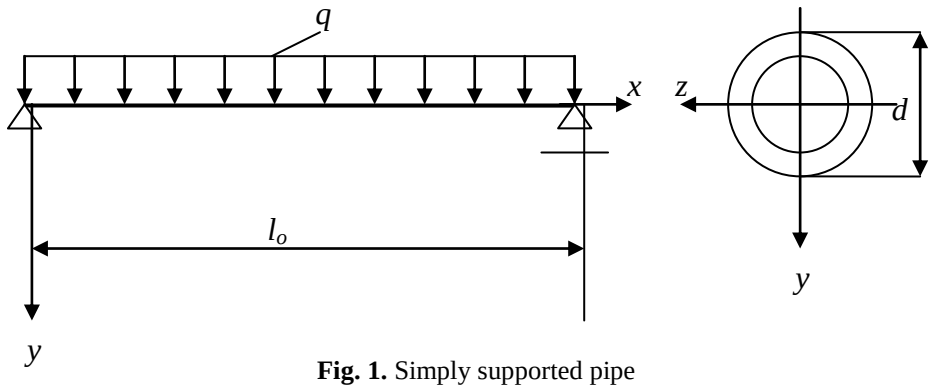

Fig. 1. Simply supported pipe

The main geometrical characteristics of the pipe are:

- the cross sectional area of the steel:

$$A_1 = \pi(d - x)x \tag{1}$$

- the cross sectional area of the fluid:

$$A_2 = \pi \frac{(d-2x)^2}{4} \tag{2}$$

- the uniform intensity of the external pressure :

$$q = q_1 + q_2 = \rho_1 \cdot \pi \cdot g \cdot x \cdot (d-x) + \rho_2 \cdot \pi \frac{(d-2x)^2}{4} \cdot g \ , \tag{3}$$

where *g* represents the acceleration of the gravity field.

- the bending moment of inertia of the cross sectional area :

$$I = \frac{\pi \cdot d^4}{64}\left[1-\left(\frac{d-2x}{d}\right)^4\right] \tag{4}$$

- the bending strength modulus of the cross sectional area :

$$W = \frac{\pi \cdot d^3}{32}\left[1-\left(\frac{d-2x}{d}\right)^4\right] \tag{5}$$

In order to find the safety span of the pipe the following criteria have to be used :

- the strength condition :

$$\sigma_{\max} \le \sigma_a \Rightarrow \frac{q \cdot l_o^2}{8 \cdot W} \le \sigma_a \Rightarrow l_o \le \sqrt{\frac{8 \cdot W \cdot \sigma_a}{q}} \ , \tag{6}$$

where σ_a represents the allowable limit of the material

- the flexibility condition :

$$v_{\max} = \frac{5}{384}\frac{q \cdot l_o^4}{EI} \le v_a \Rightarrow l_o \le \sqrt[4]{\frac{384 \cdot E \cdot I \cdot v_a}{5 \cdot q}} \ , \tag{7}$$

where *E* represents the longitudinal elasticity modulus of the material and v_a the allowable limit of the deflection of the beam.

- the second flexibility condition :

$$v_{\max} = \frac{5}{384}\frac{q \cdot l_o^4}{EI} \le \frac{l_o}{1000} \Rightarrow l_o \le \sqrt[3]{\frac{384 \cdot E \cdot I}{5000 \cdot q}} \tag{8}$$

The more conservative value from the above relations (6,7,8) can be considered the safety span of the pipe. The value can be corrected taking into account the fact that the pipe is rested on more than two supports.

A Numerical Example

In order to evaluate numerically the value of the safety span of a 6" pipe a specialized programme has been developed, considering the thickness of the pipe to be variable (*x*). For the above pipe the (6), (7) and (8) relations have been graphically represented (above *x*) in order to find the most conservative value of the span for any value of the thickness. The results obtained are presented respectively in Figures 2, 3 and 4.

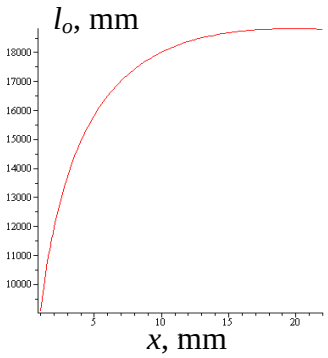

Fig. 2.

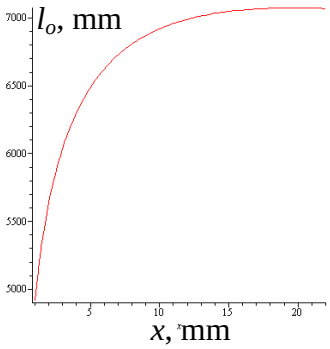

Fig. 3.

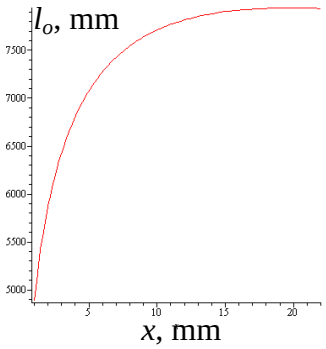

Fig. 4.

By analysing the above results it can be noticed that the second condition (see relation 7) is the most conservative one. For a standard schedule (7.11 mm) the safety span results (see fig. 3) 6500 mm. If the pipe is rested on more than two supports the above value can be corrected up to 30% more.

Conclusions

In this paper we presented a very easy way of determining the safety span of a pipe, for any geometry (diameter and thickness) of the cross sectional area. Three restrictions are used (a strength condition and another two flexibility restrictions) and the most conservative are the flexibility conditions. When the allowable limit of the deflection is not specified, it is recommended to use the third condition that approximates the second restriction. For pipes rested on more than two supports the values obtained can be extended by 30%.

References

1. Posea, N. – *Rezistenţa materialelor* , Editura Didactică şi Pedagogică, Bucureşti, 1979.
2. Vasilescu, Ş. – A Method of Calculation of the Tension and Displacements in an Extensible Cable Loaded with Uniform External Pressure, *Buletinul U.P.G. Ploieşti, Seria Tehnică*, Vol. LVIII, Nr. 4, 2006.
3. Vasilescu, Ş., Talle, V. – *Rezistenţa materialelor-solicitări fundamentale*, Editura U.P.G., Ploieşti, 2007.

Consideraţii privind deschiderea sigură a conductelor

Rezumat

În lucrare se prezintă o metodă de calcul al deschiderii sigure a unei conducte considerând că aceasta este simplu rezemată la capete. Deschiderea dintre suporturi este obţinută prin utilizarea a trei restricţii: una de rezistenţăşi alte două de flexibilitate. Rezultatele obţinute sunt analizate pe un exemplu de calcul.