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Some Considerations on Yield of Assembly with Threaded Parts

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Abstract

The paper sets out the exact relationship of the mechanical yield of the assembly with threaded parts. It highlights the fact that square thread has a higher yield than any thread with inclined flanks indicating as a practical solution, using threads with more than 3-4 the beginning or introduction of screws with balls.

Key words: *assembly, yield, threaded parts, step, kinetics coupling screw and nut, friction angle, coefficient of friction.*

Introduction

The assemblies with threaded parts are used for fixed assembly, removable assembly, but also for mobile assembly, of movement.

One of the disadvantages of assembly with the threaded parts is that the yield of assembly threaded of movement is reduced.

The work aims to establish a calculation relationships of yield more accurate, as well as some ways to improve it.

Yield Expression of Assembly with Threaded Parts

In the case of square thread, as shown in Figure 1.a, a complete rotation of the nut, it is moving a step length.

Kinematic coupling yield, screw-nut is:

$$\eta = \frac{L_u}{L_c} = \frac{F \cdot p}{H \cdot \pi d_2} = \frac{F \cdot \pi d_2 \cdot tg\alpha_m}{F \cdot tg(\alpha_m + \varphi') \cdot \pi d_2} = \frac{tg\ \alpha_m}{tg(\alpha_m + \varphi')}, \quad (1)$$

where: α_m is the tilt angle of the spire (fig. 1.b) and it is given by the relation:

$$tg\alpha_m = \frac{p}{\pi d_2} \quad (2)$$

φ – friction angle given by relationship:

$$\mu = tg\ \varphi, \tag{3}$$

μ being the coefficient of friction.

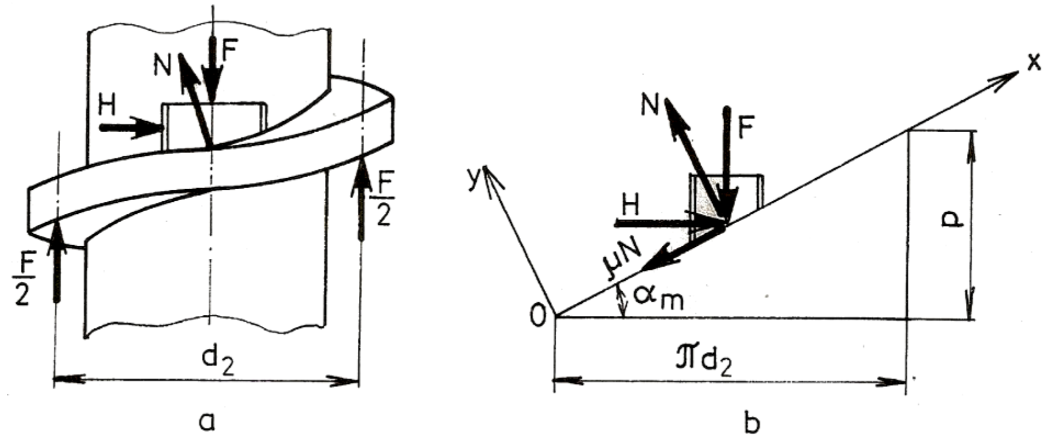

Fig. 1.

In the case of triangular thread yield expression is:

$$\eta = \frac{tg\ \alpha_m}{tg(\alpha_m + \varphi')}, \tag{4}$$

where φ' is the friction angle reported with relationship:

$$tg\varphi' = \frac{\mu}{\cos\frac{\beta}{2}}, \tag{5}$$

where β is the angle of the top of the profile.

To determine the maximum value of yield the first derivative of the relationship (4) is calculated:

$$\frac{d\eta}{d\alpha_m} = \frac{\frac{1}{\cos^2\alpha_m} \cdot tg(\alpha_m + \varphi') - tg\alpha_m \cdot \frac{1}{\cos^2(\alpha_m + \varphi')}}{tg^2(\alpha_m + \varphi')} =$$

$$= \frac{\frac{\sin(\alpha_m + \varphi')}{\cos(\alpha_m + \varphi')} \cdot \cos^2(\alpha_m + \varphi') - \frac{\sin\alpha_m}{\cos\alpha_m} \cdot \cos^2\alpha_m}{\cos^2\alpha_m \cdot \cos^2(\alpha_m + \varphi') \cdot \frac{\sin^2(\alpha_m + \varphi')}{\cos^2(\alpha_m + \varphi')}} = \frac{\sin\varphi' \cdot \cos(2\alpha_m + \varphi')}{\cos^2\alpha_m \cdot \sin^2(\alpha_m + \varphi')},$$

canceling the first derivative

$$\frac{d\eta}{d\alpha_m} = 0, \tag{6}$$

we obtain:

$$\cos(2\alpha_m + \varphi') = 0, \tag{7}$$

with the solution:

$$2\alpha_m + \varphi' = \frac{\pi}{2} + 2k\pi, \tag{7'}$$

resulting, for $k = 0$,

$$\alpha_m = \frac{\pi}{4} - \frac{\varphi'}{2} \,. \tag{8}$$

With this value we obtaine by inserting (8) in (4):

$$\eta_{max} = \frac{tg\left(\frac{\pi}{4}-\frac{\varphi'}{2}\right)}{tg\left(\frac{\pi}{4}-\frac{\varphi'}{2}+\varphi'\right)} = \left(\frac{1-tg\frac{\varphi'}{2}}{1+tg\frac{\varphi'}{2}}\right)^2 = \left(\frac{cos\frac{\varphi'}{2}-sin\frac{\varphi'}{2}}{sin\frac{\varphi'}{2}+sin\frac{\varphi'}{2}}\right)^2 = \frac{1-sin\varphi'}{1+sin\varphi'} \,. \tag{9}$$

φ' is determined by the relationship (5).

From relation (8), one finds that the friction angle value reported, φ =(2...6), and obtains:

$$\alpha_m = (42\,...\,44) \text{ and } \eta_{max} \in (0{,}81\,...\,0{,}93)$$

Because at a value so high of the angle α_m, autobraking can not be achieved, in practice the angle of the coil can not exceed (20...25°).

Yield represents a rapid increase to α_m=20 after the increase is negligible.

For this reason it is indicated the use of threads with more than (3-4) separate beginnings, coefficient of friction acting on the by lubricating or ball screws introduction.

Square thread has a higher yield than any thread with inclined flanks.

At limit of autobraking meaning for $\alpha_m = \varphi'$ to obtain:

$$\eta = \frac{tg\varphi'}{tg(2\varphi')} = \frac{1-tg^2\varphi'}{2} = 0{,}5 - \frac{tg^2\varphi'}{2}, \tag{10}$$

Therefore less than 0.5 yield threaded assembly is considered at energy transmission respective at screw motion at long life and short interruptions of work, cases in which have recourse to threads with large turn inclination angle, although occurs simultaneously increasing disadvantage of the horizontal force H.

Conclusions

The paper establishes the exact expression for the calculation of the maximum yield assembly with threaded parts. It is found advantage in using square thread instead the trapezoidal thread.

It is specified the practical solution use of threads with more than 3-4 beginnings, reducing the coefficient of friction by lubricating or introducing the screws with balls.

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Unele considerații asupra randamentului asamblărilor cu piese filetate

Rezumat

Prezenta lucrare stabileşte expresia randamentului maxim al asamblărilor cu piese filetate. Se constată faptul că filetul pătrat are un randament mai mare decât orice filet cu flancuri înclinate. Se precizează că o soluție practică de mărire a randamentului este utilizarea filetelor cu mai mult de 3-4 începuturi şi se poate acționa asupra coeficientului de frecare prin ungere sau introducerea şuruburilor cu bile.