TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics and Mechanics
Vol. 56, Issue IV, November, 2013

SOME CONSIDERATIONS FOR THE DETERMINATION OF THE LOADING CAPACITY ON ASSAMBLIES THROUGH COMPRESSION WITH BICONICAL INTERMEDIATE ELEMENTS

Niculae GRIGORE

Abstract: *The assemblies through compression with biconical intermediate elements practically represents an advancement of the assemblies through cone compression. This essay presents the way of determination of the torsion moment capable of assembling through computation and experimental established on a properly stand.*
Key words: *flange, tapered rings, elastic compression, biconical intermediate element, transmission force,*

1 . GENERAL CONSIDERATIONS

The assemblies through elastic compression it's made with a forced contact between the conjugated members of the assembling members.
The assemblings through elastic compression with intermediate compression organs have a broad usage in the cars construction and can be:
-assemblies with cone tightening (fig.1);

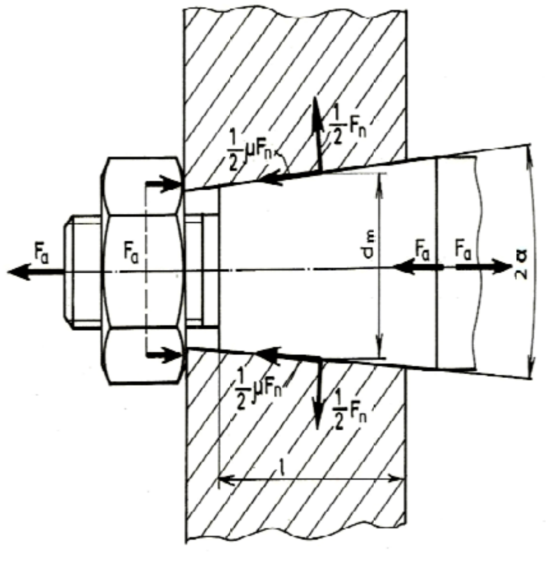

Fig .1 Assemblies with cone tightening

-assemblies with bracket tightening (fig. 2);

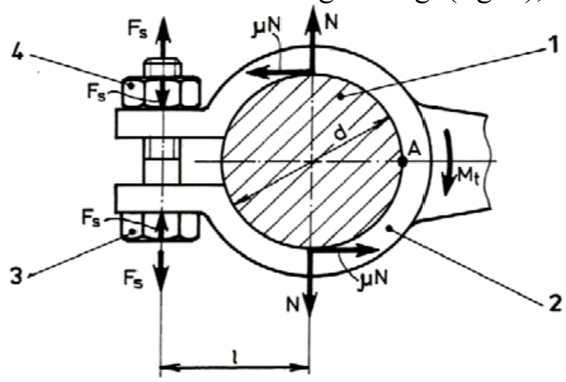

Fig.2 Assemblies with bracket tightening

- assemblies with bracket and cap (fig. 3);

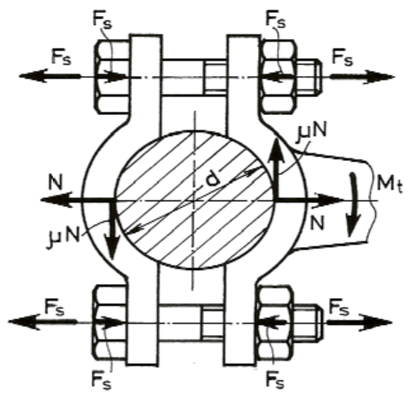

Fig. 3 Assemblies with bracket and cap

- assemblies with tapered rings (fig. 4).

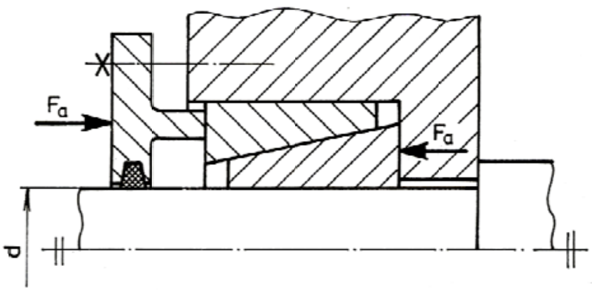

Fig. 4 Assembly with tapered rings

The assemblies through compression with biconical intermediate elements are drifting from the assemblings advancenment through compression on the cone and the ones with tapered rings.

An assembly through compression with biconical intermediate elements it's described in the figure number 5 and it's used to assemble the shaft - hub type parts.

A tapered rings set it's made from an exterior ring 1,an interior ring 2 and an intermediate ring 3, the surfaces in mutual contact being conical and the surfaces that make contact with the assembly parts (the shaft and the hub) are cylindrical.

Through compression with screwed elements which are actuating on the intermediate ring, the rings are in contact on the conical surfaces, so that the exterior ring is expanding and bound to the hub and the inside ring is compressed and it's accumulated on the shaft.

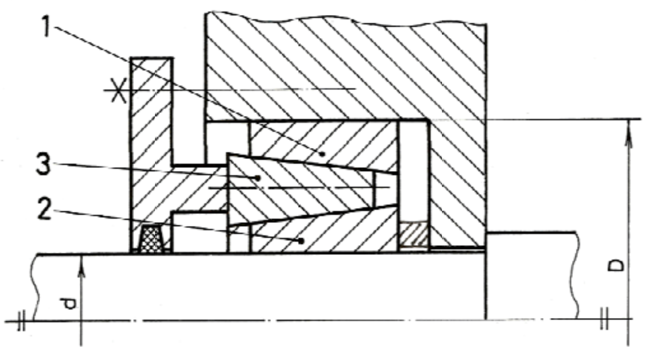

Fig. 5 Assambling through compression with biconical intermediate elements

The interior and the exterior rings are divided unilateral(they are elastic rings) in order to adapt without big pretentions on the shaft and on the hub.

The advantages of assemblings with biconical intermediate elements are:
- the possibility of repeted assemblig and disassembling without the damage of the surfaces.
- the assurance of a very good alignment of the hub towards the shaft and also of a precised pivotal and angular position.
- remedies less austere and quality less demanding then the assemblig trough pressing.
-the absence of the channels on the shaft and the hub.

We can mention the following disadvantages :
- bigger radial extentions of the hub.
- a higher cost price .

2. THE FORCE SYSTEM AND THE CAPACITY OF THE TRANSMISSION OF THE ASSEMBLING THROUGH COMPRESSION WITH BICONICAL INTERMEDIATE ELEMENTS.

By the aid of a bolt nut(or other device of attachment) to this asemblings the tapered rings are tightening so that through their pivotal gliding and elastic distortion are resulting tightening presure on the contact surfaces.

The torsion moment is conducting based on the friction over the contacts with compression between the rings and the assembling mambers.To establish the capacity of transmission of the assembling we calculate tightening of radial forces Q_1 according to the axial force value of pressing F_{a1}.

The relation between Q_1 and F_{a1} is established by consecutively writing the balanced condition after the direction of the axial force for each exterior, interior and intermediate ring (fig. 5) based on the forced system assigned in figure number 6 considering the friction coefficient different on the 4 contact surfaces.

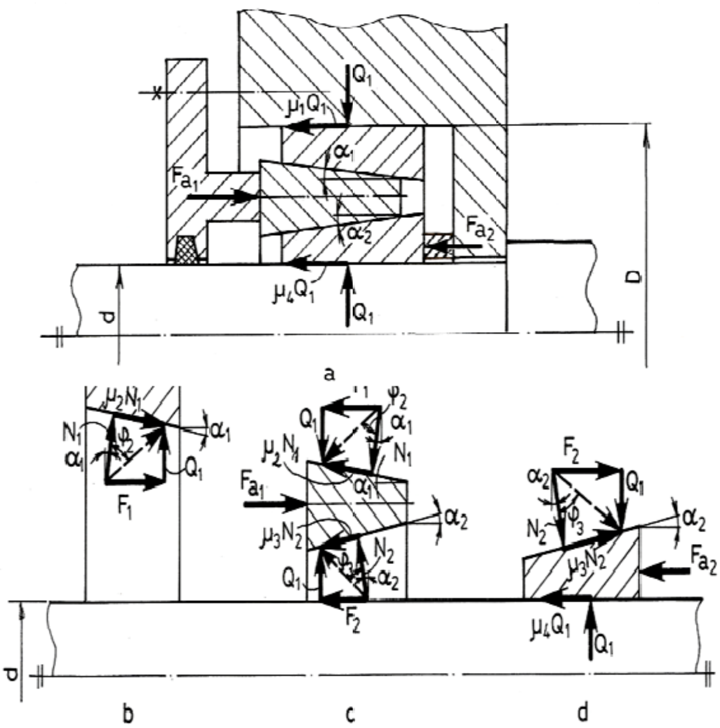

Fig. 6 Some geometrical elements by the assamblies through compression with biconical intermediate elements –a

b - forces wich actuating on exterior ring

c - forces wich actuating on intermediate ring

d - forces wich actuating on interior ring

For the intermediate ring (as in the figure number 6) we obtain:

, (1)

where:

, (2)

and

, (3)

and it's resulting:

. (4)

From relation (4) we obtain:

. (4')

For the system assembly, from the equilibrium equation of forces according to the axis of the assembly it results:

– – – (5)

from which results:

– – , (5')

according to (4') it results:

;

a2 a1 .

It is noticed:

, (6)

the reduction factor of the axial forces and so:

. (7)

The torsion moment that can be transmitted by the assembly it is minimal at the periphery of the arbor diameter, where the eventual slippage may occur:

M_{f1} = – =

= μ_4 – . (8)

The functional condition of a friction transmission of the torsion moment is:

M_{f1} $M_{tc} = \beta M_t$; (9)

where β is the safety coefficient to slippage (β = 1,5...3) and results:

μ_4 – = βM_t ; (9')

or else:

μ_4 – = βM_t ,

from where we obtain the axial force depending on the nominal torsion moment M_t and on the geometric elements of the assembly:

F_{a1} = ———————————— ; (10)

Knowing F_{a1} we can determinate the size of the tightening screws.

3. THE PILOT PLANT AND THE EQUIPMENT USED

The testing pilot of the assamblings through tightening with intermediate biconical elements is combined from:

- the assambly through compression with intermediate biconical elements (fig 7);
- the assay stand at assambly on torsion testing;
- the measure equipment.

The assembly through compression with intermediate biconical elements is combined from the shaft type member 1 which has a terminal accomplished with a cylindrical area and the other terminal with a parcel having the exterior centre hexagonal necesarry for assembling in the assay attachment torsion ,the three tapered rings 4,5,6, the flange 7, the pusher bush 8, the radial pivotal bearing 9 ,the bonnet 10 as well as the assambling with threaded parts, the bolt 3 and the bolt nut 2.

The axial force the compression is made through screwing the bolt nut 2 with the aid of a dynamometric key.

The assambly through compression with intermediate biconical elements it's assembling on the assay pilot at torsion in which the principle scheme is presented in figure number 8 .The torsoin moment applyed to the bolt nut 2 is measured with the dynamometer key.

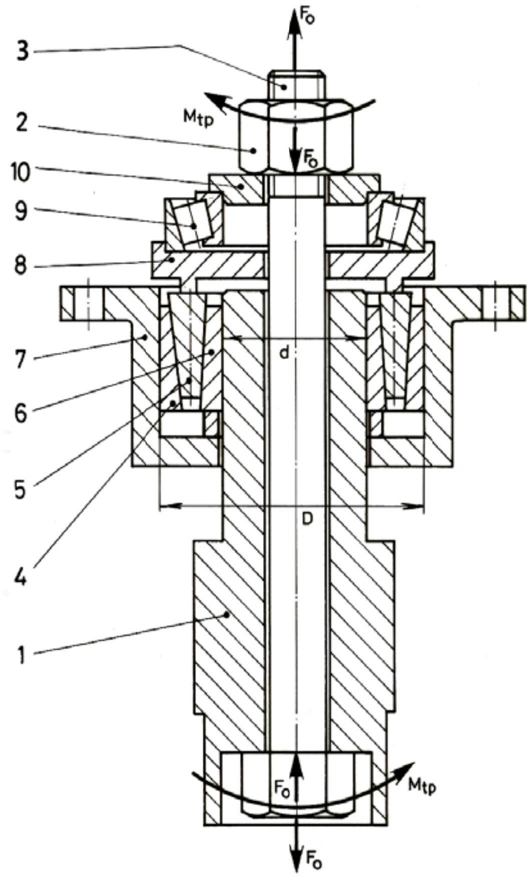

Fig. 7 Assambly through compression with intermediate biconic elements

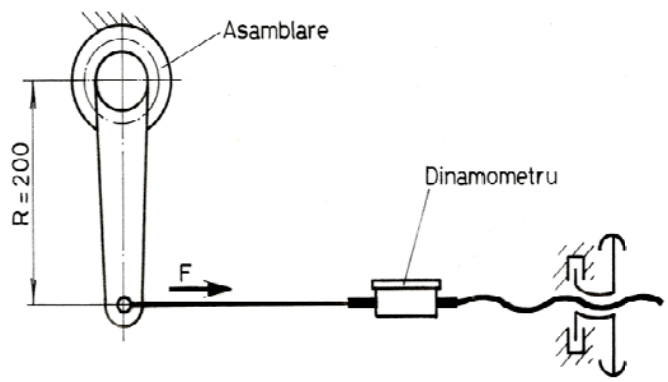

Fig. 8 Principle sheme of assay pilot at torsion.

4. THE CALCULATION OF THE COMPRESSION AXIAL FORCE AND OF THE TORSION MOMENT OF THE ASSAMBLING.

Through compressing the bolt nut 2 with the aid of the dynamometer key ,it's developing an initial compression force F_0 which bents the screw type member 3 and compresses the members of flange type.

Neglecting the friction forces moment developed between the rollers and the radial - pivotal bearing rings with conic rollers depending on the torsion moment value applyed to the dynamometer key M_{tp} it's obtaining the initial compression force:

———— . (11)

In (11) ,d_2 is the medium width of the

Nr. Crt. / Parameter	1	2	3
M_{tp} [daN·cm]	500	700	900
μ_1			
μ_2			
μ_3			
μ_4			
φ_1 [°]			
φ_2 [°]			
φ_3 [°]			
φ_4 [°]			
α_1 [°]			
α_2 [°]			
α_m [°]			
β' [°]			
k_1 [cm^{-1}]			
$F_0=F_{a1}$ [daN]			
k_2			
Q_1 [daN]			
k_3 [cm]			
M_{tc}			
R [cm]		20	
F_s [daN]			
M_{tmexp} [daN·cm]			

thread, φ' it's the friction reported angle which is determined with the relation :

$$\varphi' = arctg\frac{\mu}{cos\frac{\beta}{2}} \ , \qquad (12)$$

the expresion of k_1 [cm^{-1}] it's obvious. It's applyed the relation (4') and results normally reaction Q_1:

$$Q_1 = \frac{1}{\tan(\alpha_1+\varphi_2)+\tan(\alpha_2+\varphi_3)} \cdot F_{a1} = k_2 \cdot F_{a1} \ , \qquad (13)$$

where:

$$k_2 = \frac{1}{tg(\alpha_1+\varphi_2)+tg(\alpha_2+\varphi_3)}; \qquad (14)$$

The capable torsion moment of the assembly is:

$$M_{tc} = M_{f1} = \mu_4 \cdot Q_1 \cdot \frac{d}{2} = k_3 \cdot Q_1 \ . \qquad (15)$$

The relation of k_3 [cm] is evidenced in relation (15) .

5. THE EXPERIMENTALLY DETERMINATION OF THE CAPABLE TORSION MOMENT OF THE ASSEMBLY

The determination of the load capacity of the assembly is performed on the stand.
The torsion moment that books the assembly is realised with a motion screw that operates a lever of length R. The axial force developed in the motion screw is measured with a dynamometric clock and we obtain:

$$M_{tm(exp)=} = F_s \cdot R \cdot \eta_r \ , \qquad (16)$$

where η_r is the mechanical efficiency of the stand.

The experimentally determination of the bearing capacity of the assemblies by tightening with biconical intermediate elements requires the following stages of work:

- the nut of the assembly is thightened on, by applying a torsion moment whose value is read at torque indicator handle wrench and we can determinate the initial clamping force (relation 11), the normal reaction (relation 13) and the capable torsion moment of the assembly (relation 15);
- the assembly is fit in the stand and request to torsion reading on the clock of the dynamometer the value of the developed force in operating screw F_s, which leads to the rotation of the shaft 1, as against the interior tapered ring 6, resulting the value of the capable torsion moment of the assembly experimentally determinated (relation 16) . The capable torsion moment of the assembly M_{tc} (relation 15) it's compare with the capable torsion moment of the assembly experimentally determinated $M_{tm(exp)}$ (relation 16).

The test of the assemly is repeted more than once for increasing values of the screwing moment of the nut.

The results can be written in table 1.

Table 1

6. CONCLUSIONS

The paper work shows how to determinate the bearing capacity of the assembly by tightening biconical intermediate elements both theoretically and experimentally. Any potential discrepancies between capable torsion moment calculated and the capable torsion moment of the assembly experimentally determinated can be explained by the reading errors of the torsion moment at torque indicator handle wrench through the initial assessment and the values of the friction coefficients, etc.

7. REFERENCES

[1] Mădăraş, L. Argeşanu, V. – *Design. Îmbinări-arcuri*, Editura Politehnica Timişoara, 2002.

[2] Chişiu, Al., Mătieşan, D., ş.a,- *Organe de maşini,* Editura Didactică şi Pedagogică, Bucureşti, 1981.

[3]Gafiţanu, M. ş.a, – *Organe de maşini*, Editura Tehnică, Bucureşti, 1981.

[4]Grigore, N. – *Organe de maşini vol I. Asamblări,* Editura Tehnică Bucureşti, 2000.

[5] Grigore, N. –*Organe de masini.Transmisii mecanice,* Editura Universităţii din Ploieşti, 2003.

[6] Ivan, M., Antonescu, N. N., ş.a., *Maşini–unelte şi control dimensional*, Editura Didactică şi Pedagogică, Bucureşti, 1980.

[7] Drăghici, I., ş.a.-*Organe de maşini. Probleme,* Editura Didactică şi Pedagogică, Bucureşti, 1981.

[8] Manea, Gh., ş.a.- *Organe de maşini, Vol.I,* Editura Tehnică, Bucureşti, 1970.

[9] Minoiu, I., Tatu, N., *Organe de maşini, Vol.I.*, Editura Didactică şi Pedagogică, Bucureşti, 1964.

[10] Jula, A. ş.a.- *Organe de maşini, Vol. I şi II*, Universitatea din Braşov, 1986.

UNELE CONSIDERAŢII PRIVIND DETERMINAREA CAPACITĂŢII PORTANTE A ASAMBLĂRILOR PRIN STRÂNGERE CU ELEMENTE INTERMEDIARE BICONICE

Rezumat: *Asamblările prin strângere cu elemente intermediare biconice reprezintă în esenţă o perfecţionare a asamblărilor prin strângere pe con.Lucrarea prezintă determinarea momentului de torsiune capabil al asamblării atât prin calcul precum şi determinat experimental pe un stand corespunzător.*

Niculae GRIGORE, *Prof.univ. Dr. Ing., University „Oil and Gas" Ploieşti, Department of Mechanical Engeneering, ngrigore@upg-ploiesti.ro, Phone:* + 40 - 244.573 171, 0244 573 555, B-dul Bucureşti, nr. 39 , cod 100680, Ploieşti, România