CONSIDERATIONS REGARDING THE USE OF CHUCK COLLETS IN MECHANICAL SYSTEMS

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Abstract: In this paper the authors aim to present the theoretical study of of constructions such as clenching mechanisms with chuck collets. For this to has been modernized the test stand clenching mechanisms with chuck collets existing in the laboratory. Also in the paper were aimed experimental tests of clenching characteristics: clenching stress, dependence of clenching stress upon the main influencing factors

Keywords: *clench, chuck collets, acquisition board, force.*

1. General characterization of mechanical systems with chuck collets

The main use of chuck collets:

- in the construction of grabbing systems of robots', of fixing mechanisms from working technical structures, self-feeding systems within working centres, etc.
- technical helping systems to fix working tools: drills, cutters, reamers, etc.
- control systems, positioning systems and / or measurement systems, etc.

Chuck collets have one or two conical inside or outside surfaces, a series of longitudinal nicks delimiting a series of elastic areas, called jaws. Besides chuck collets, the mechanisms of type MA comprise rigid collets which act upon chuck collet which is deformed until the active surfaces of the latter one get in contact with the piece centring surface, making its centring and clenching.

Chuck collets-mechanisms have some advantages, some of which are mentioned below:

- provide high centring accuracies (radius range of centred surfaces being under 02...0.05mm);
- allow clenching of thin walls, easily deforming and law gauge pieces;
- due to the relatively uniform repartition of clenching stress , they are easily to be made and so low cost.

Their main disadvantage consists in the working field limited by values of $0.05\sqrt{D}$, where D is the diameter of centring surfaces. To cover a wide range of D dimensions, sets of different dimension chucks are required. If the centring dimension tolerance does not fit within the working region, then the mechanism does not ensure the clenching stress required by minimum dimensions or they are overdemanded, up to breakage in the case of high dimensions when being centred on outside surfaces. Also, under such conditions, they lead to high accuracy and low rigidity as a result of some (imperfect) line contacts between the chuck collet and piece, between chuck collet and rigid mandrel or collet respectively. In some constructions there may occur errors of axial orientation as well, especially when the chuck collet has axial mobility.

2. Mathematical modeling of calculation

2.1 Mathematical model for stress calculation

The drive force calculation Q of chuck collet and mechanisms is made generally for each type of stress, depending on constructive peculiarities.

The physics model for stress calculation

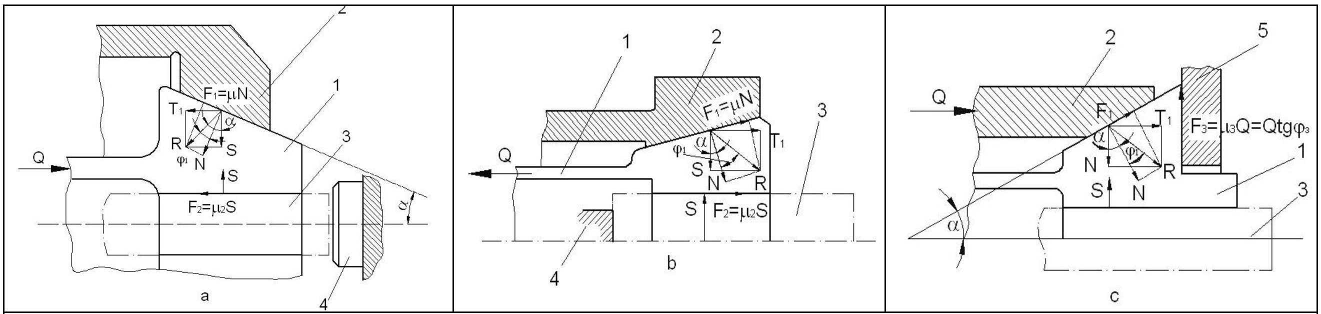

Figure 1. *Physics model of calculation*

The calculation relations of drive forces Q depending on total clenching forces S are:

- for mechanisms in fig. 1a and 1b:

$$Q = T1 + F_2 = S\,tg(\alpha + \varphi_1) + \mu_2 \mathbf{S} \qquad (1)$$

- for mechanism in fig. 1c:

$$S = Qctg(\alpha + \varphi_1) - Q\,tg\varphi_3. \qquad (2)$$

Calculation relations are valid whether chuck collets 1 or rigid mandrels 2 are mobile.

Frontal anterior 4 (fig. 1a), or posterior (fig. 1b) bearings lead to appearance of axial friction forces

$F_2 = \mu_2 \mathbf{S}$ between piece 3 and chuck collet 1 whereas the frontal bearing 5 of chuck collet (fig. 1c) leads to the appearance of radius friction force $F3 = \mu_3 Q$.

The significance of noted items of relations is:

- -μ1and μ3 are friction coefficients between the chuck collet 1 and rigid collet 2, frontal bearing 5 respectively;
- -μ2 – friction coefficient between chuck collet and piece, having values between 0.2... 0.7, depending on the shape of centring surfaces of chuck collets (fig.3).

Chuck collets- mechanisms have become widely spread, especially in the construction of devices such as self-centred mandrels and chucks. They are frequently used in works from pig and pipe on turret lathes, semi-automatic or automatic lathes for large-scale series production and for machine equipment as well – universal tools meant especially to fine mechanics. In this case the devices are fitted with sets of chuck collets to satisfy the current centring demands of pieces even under conditions of small series production or unique. The fixing of straight-shank tools on cutting machines is also made by the help of devices containing such mechanisms. Under these working conditions, constructive and functional restrictions are called for regarding the fixing accuracy and axial shares carrying out.

Between the axial run of a chuck collet and the run c_e of a jaw, the following relation may be written:

$$c_e = c_i\,tg\alpha. \qquad (3)$$

3 Experimental stand

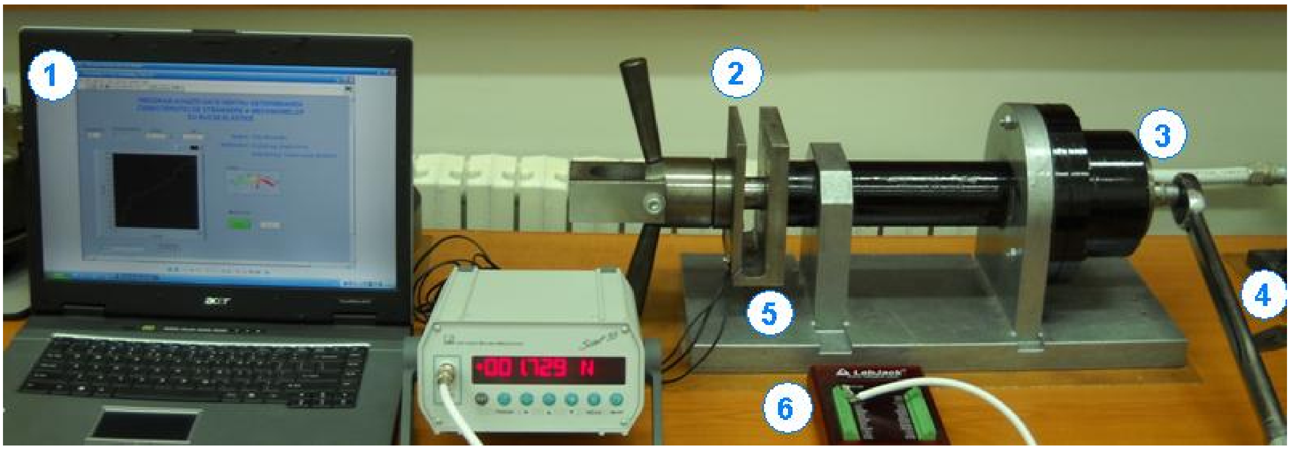

Figure 2. *Structure of experiment stand, 1-computer – labview soft, 2-dynamometer, 3-chuck collet, 4-dynamometer key, 5- tensiometer bridge, 6-Labjack acquisition board*

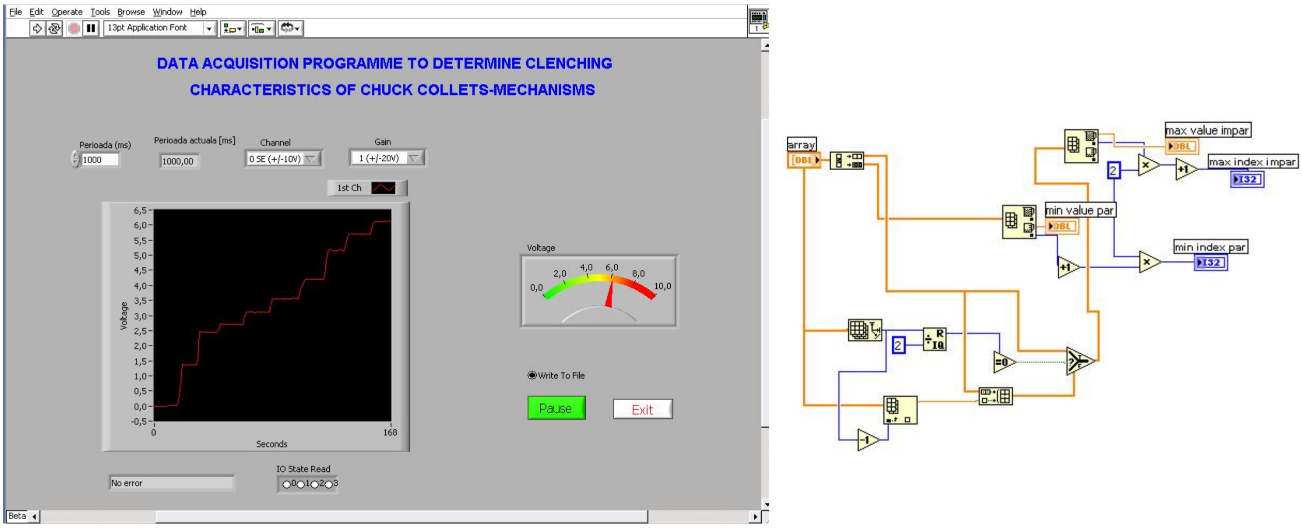

Figure 4 –*Login scheme of data acquisition soft.*

On the above presented stand, the value of effective clenching forces F_{ef} at the level of chuck collet jaws was taken and compared to the calculation force F_{Sc} approximated by model F_{Sc} (1), (2).

At the same time, the precison degree of clenching forces, depending on the level of working/stress force could be determined.

The research stand of functional characteristics of fixing chuck collets – mechanisms uses a data acquisition soft of a highly appreciable originality.

The experimental results obtained are shown in table 1

Tabel.1 *Experimental results of chuck collets with experimental data processing*

Nr.crt.	Nr.div.(V)	K_f(N/V)	F_i (N)	F_{Sc} (N)	F_{ef} (N)	Introduced Moment M_i(N/m)	Measured Moment M_f(N/m)	Moment measured by S_c M_f'(N/m)	i= F_{ef}/ F_{Sc}
1.	1.74	1385	2409.9	1025.05	388.88	35	42	46.127	0.32
2.	2.481		3436.18	1401.58	435,.8	40	47	63.071	0.31
3.	2.743		3799.05	1615.92	555.55	45	60	72.716	0.34
4.	3.014		4174.39	1775.58	657.4	50	71	79.901	0.37
5.	3.218		4456.93	1895.75	712.96	55	77	85.309	0.376
6.	3.345		4632.82	1970.57	842.59	60	91	88.676	0.427
7.	3.480		4819.8	2050.1	916.6	65	99	92.254	0.447
8.	3.605		4992.92	2123.74	981.48	70	106	95.566	0.464
9.	3.724		5157.74	2193.84	1018.51	75	110	98.723	0.465
10.	3.862		5348.87	2275.14	1250	80	135	102.381	0.54
11.	3.951		5472.13	2327.57	1268.51	85	137	104.74	0.544
12.	4.105		5685.42	2418.23	1314.81	90	142	108.82	0.546

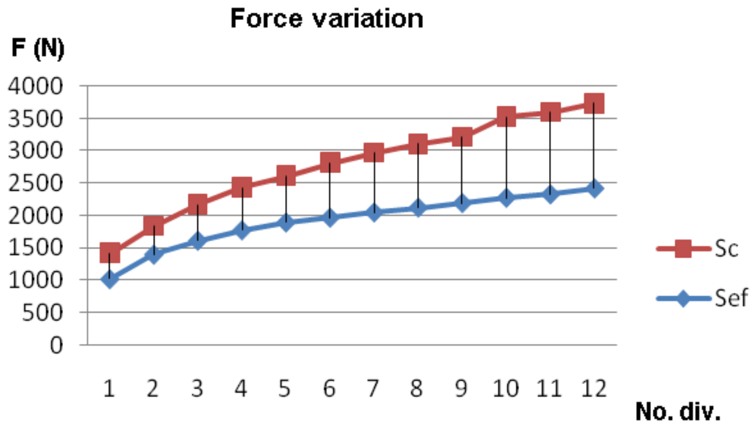

Fig.5. Variation of calculation forces and experimental forces

4. Conclusions

From the analysis of experimentally obtained graphs, the following conclusions may be drawn:

- experimental forces are smaller than those obtained by calculation, as friction forces occur between collet and conical bearing, between collet and semiproduct;
- an efficiency field in using the mechanisms in technical systems may be defined;
- for mechanical systems of automatized structures, corrections are necessary to be taken to have in view determination errors of these characteristics.

References

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