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Experimental Research in Relation to Determine Technologically Forces Respecting Elements Elasticity of Mechanisms

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ABSTRACT

Experimental researches accomplished on the asseted prototype machine, define a methode to determine unknowed technologically forces. Knowing technologically forces is necesary to prototype improvement, material saving by redimensioning of elements and saving of energy by choosing adapted electric engine.

The analyse of driving gear of advance slide and tool-holder slide was realized using finite element method (FEA), certainly involving elasticity of mechanisms elements.

Keywords: *prototype, techologically forces, finite element analyse.*

1. Introduction

In labs of Strength of Materials and Machines Parts was realized a prototype machine for paper-clips. Machine is build by changing gear drive that exists actually, with oscillatory washer. Basic diagram is show in figure 1.

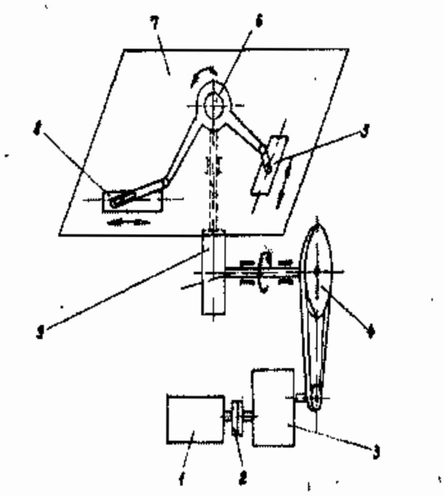


Fig. 1 Schematic sketch of the prototype

Notations from figure 1 are:

1. Electric engine
2. Flange coupling
3. Reducer
4. Belt gearing
5. Tool-holder slide
6. Walking beam
7. Foot plate
8. Advance slide
9. Oscillatory washer

Oscillatory washer drive achieve a silent operating of machine, allow grow of productivity and allow installation of two working positions.

The prototype operates only with one working position. The accomplished model is show in figure 2.

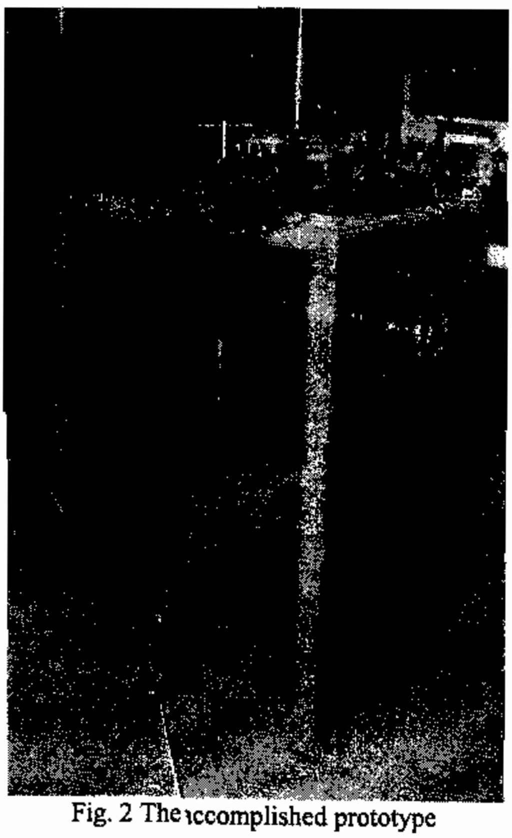


Fig. 2 The accomplished prototype

2. The calculus of stresses in parts of drive mechanism of advance slide

To determine stresses from parts of drive mechanism of advance slide was considered driving force equal with unit. The drive mechanism of slide is show in figure 3.

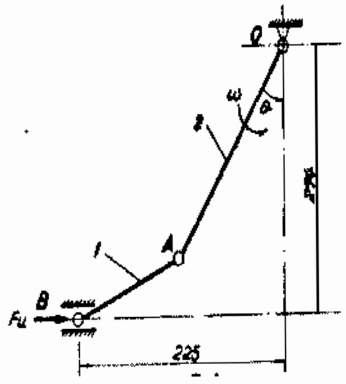


Fig. 3 The sketch of drive mechanism of the slide

The calculus of stresses in parts of drive mechanism of advance slide requires first, separation of elastic deformation from displacements of solid.

Separation of elastic deformation from displacements of solid is realized by transformation of the joint from point O into constraining, and then the mechanism parts are divided in beam finite elements like in figure 4.

Was established the coordinates of nodes in fixed axis system (x, y) with origin in node 1 for three consecutive positions of mechanism $\theta = 28^0, 18^0, 8^0$, and also was established geometrically characteristics of mechanism parts.

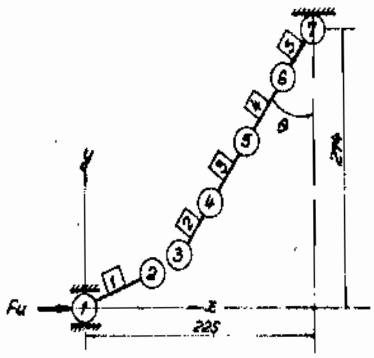
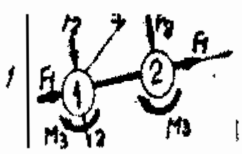


Fig. 4 Divided beams in finite elements

The driving force, unit equal, is considered like force directly applied in node 1.

Using existent software from department was determined nodes displacements and forces at end of beam elements, for different positions of mechanism (Table 1).

Table 1

BEAM		FORCES IN ELEMENTS NODES					
		NODE 1			NODE 2		
		F_1 $[daN]$	F_2 $[daN]$	M_3 $[daN \cdot cm]$	F_1 $[daN]$	F_2 $[daN]$	M_3 $[daN \cdot cm]$
1		1,09 $\theta = 28^0$	$-1,09 \cdot 10^{-6}$	$-1,9 \cdot 10^{-6}$	-1,09	$-1,9 \cdot 10^{-6}$	$-1,53 \cdot 10^{-5}$
		1,03 $\theta = 18^0$	$9,53 \cdot 10^{-7}$	$9,54 \cdot 10^{-7}$	-1,03	$-2,86 \cdot 10^{-6}$	$9,54 \cdot 10^{-7}$
		1,01 $\theta = 8^0$	$1,31 \cdot 10^{-7}$	$-3,82 \cdot 10^{-6}$	-1,01	$3,58 \cdot 10^{-7}$	$-5,72 \cdot 10^{-6}$
2		0,86 $\theta = 28^0$	-0,68	0	0,86	0,68	4,64
		0,52 $\theta = 18^0$	-0,88	0	- 0,52	0,88	-6,17
		0,23 $\theta = 8^0$	-0,98	0	-0,23	0,98	-6,86
3		0,85 $\theta = 28^0$	-0,68	4,62	-0,85	0,68	-10,0
		0,51 $\theta = 18^0$	+0,89	6,17	-0,51	0,89	-13,20
		0,23 $\theta = 8^0$	-0,98	6,86	-0,23	0,98	-14,80
4		0,82 $\theta = 28^0$	-0,72	10,0	-0,82	0,72	-15,10
		0,49 $\theta = 18^0$	-0,90	13,20	-0,49	0,90	-19,70
		0,23 $\theta = 8^0$	-0,98	14,80	-0,23	0,98	-21,60
5		0,89 $\theta = 28^0$	-0,62	15,10	-0,89	0,62	-17,60
		0,55 $\theta = 18^0$	-0,87	19,70	-0,55	0,87	-23,00
		0,24 $\theta = 8^0$	0,98	21,70	-0,24	0,98	-25,50

3. The calculus of stresses in parts of driving mechanism of tool-holder slide

The calculus of stresses in parts of driving mechanism of tool-holder slide, counting driving force unit equal, is made for respecting sketch of mechanism from figure 5.

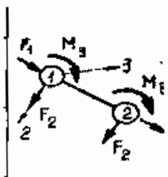
For this, is made separation of elastic deformation from displacements of solid through transformation of the joint from point O into constraining. The dividing of mechanism parts into beam finite elements, and nodes and beam numbering is show in figure 6.

Was established the coordinates of nodes in fixing axis system (x,y) with origin in node 1 for three consecutive positions of mechanism $\theta = 62^0, 52^0, 42^0$, and also geometrically characteristics of mechanism elements.

The driving force, unit equal, is considered like force directly applied in node 6.

Using existent software from department was determined nodes displacements and forces at end of beam elements, for different positions of mechanism (Table 2).

Table 2

	FORCES IN ELEMENTS NODES						θ $[grad]$
	NODE 1			NODE 2			
	F_1 $[daN]$	F_2 $[daN]$	M_3 $[daN \cdot cm]$	F_1 $[daN]$	F_2 $[daN]$	M_3 $[daN \cdot cm]$	
	0,735	0,741	15,34	-0,735	-0,741	-12,36	62
	0,492	0,894	17,36	-0,492	-0,984	-13,75	52
	-0,0398	1,013	20,85	-0,0398	1,013	-16,68	42
	0,728	0,748	12,96	-0,728	-0,748	-7,84	62
	0,517	0,879	13,75	-0,517	-0,879	-8,40	52
	-0,0319	1,013	16,80	0,0319	-1,013	-10,72	42
	0,729	0,746	7,84	-0,729	-0,746	$4,59 \cdot 10^{-5}$	62
	0,504	0,888	8,40	-0,504	-0,888	$-1,53 \cdot 10^{-5}$	52
	-0,043	1,013	10,72	0,043	-1,013	$-1,53 \cdot 10^{-5}$	42
	1,04	$-1,09 \cdot 10^{-6}$	$-6,1 \cdot 10^{-5}$	-1,04	$-9,54 \cdot 10^{7}$	$-3,05 \cdot 10^{-5}$	62
	1,02	$-6,72 \cdot 10^{-6}$	$-2,77 \cdot 10^{-5}$	-1,021	$-9,54 \cdot 10^{7}$	0	52
	1,014	$-1,80 \cdot 10^{-5}$	$-4,67 \cdot 10^{-5}$	-1,014	$7,83 \cdot 10^{-6}$	$8,58 \cdot 10^{-6}$	42

4. Establishment of technologically forces by experimental results

Experimental determinations for the driving mechanism of advance slide were realized through two transducers (T_1, T_2) mounted in position of node 5 from element 4.

Loading the mechanism with unit driving force, was determined stretching stress σ_t and bending stress σ_i, and also linear unit deformations $\varepsilon_t, \varepsilon_i$.

The results are show in Table 3.

Table 3

θ $[grad]$	N $[daN]$	σ_t $\left[\frac{daN}{cm^2}\right]$	ε_t	M_i $[daN \cdot cm]$	σ_i $\left[\frac{daN}{cm^2}\right]$	ε_i
28	0,82	0,340	$0,136 \cdot 10^{-6}$	10,00	6,25	$2,98 \cdot 10^{-6}$
18	0,49	0,204	$0,097\ 10^{-6}$	13,20	8,25	$3,93 \cdot 10^{-6}$
8	0,23	0,096	$0,046 \cdot 10^{-6}$	14,80	9,25	$4,40 \cdot 10^{-6}$

The recordings from mounted transducers were accomplish for full-load running and idle running. Computing the difference between full-load running records and idle running records for each transducers were determinate linear unit deformations from stretching and bending, which are show in Table 4.

Table 4

θ [grad]	28	25	22	19	16	13 - 8
ε_{T_1}	$12 \cdot 10^{-6}$	$8 \cdot 10^{-6}$	$4 \cdot 10^{-6}$	$2 \cdot 10^{-6}$	$1 \cdot 10^{-6}$	0
ε_{T_2}	$12,48 \cdot 10^{-6}$	$6,24 \cdot 10^{-6}$	$4,16 \cdot 10^{-6}$	$2,08 \cdot 10^{-6}$	$1,25 \cdot 10^{-6}$	0
ε_t^m	$12,24 \cdot 10^{-6}$	$7,12 \cdot 10^{-6}$	$4,08 \cdot 10^{-6}$	$2,04 \cdot 10^{-6}$	$1,125 \cdot 10^{-6}$	0
ε_i^m	$0,24 \cdot 10^{-6}$	$0,88 \cdot 10^{-6}$	$0,08 \cdot 10^{-6}$	$0,04 \cdot 10^{-6}$	$0,125 \cdot 10^{-6}$	0

The linear unit deformations from stretching, experimental determined, and those computed from unit driving force, are ploted in fig.5.

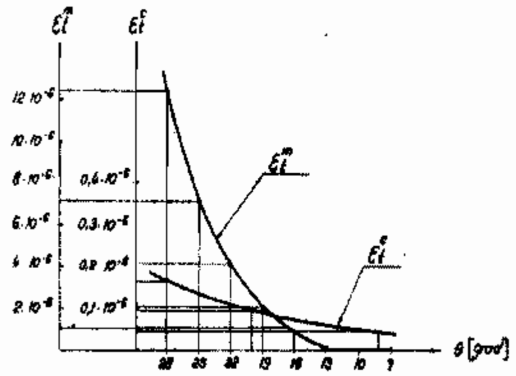


Fig. 5 Linear unit deformations from stretching

The ratio between the recorded and computed linear unit deformation ε_t^c at wire cutting moment (moment at mechanism position for $\theta = 19^0$), is unknowed techologically force:

$$\frac{\varepsilon_t^m}{\varepsilon_t^c} = 23 \Rightarrow F_t = 23[daN]$$

Knowing the technologically force, is possible to make a new dimensioning of the mechanism elements, that could be builted-up with more less stifness in comparation with those from prototype, because the recorded deformations at full-load running have little value. The new dimensioning of the elements in effect to less stiffness must be maked regarding the imposed precision of working. At the driving mechanism of advance slide were mounted two transducers (T_3, T_4) in corresponsive position of node 3 from element 2. Loading the mechanism with unit driving force, was determined stretching stress σ_t and bending stress σ_i, and also linear unit deformations $\varepsilon_t, \varepsilon_i$, are presented in Table 5.

Table 5

θ [grad]	N [daN]	σ_t $\left[\frac{daN}{cm^2}\right]$	ε_t	M_i [daN·cm]	σ_i $\left[\frac{daN}{cm^2}\right]$	ε_i
62	0,728	0,360	$0,17 \cdot 10^{-6}$	7,84	7,55	$3,59 \cdot 10^{-6}$
52	0,517	0,260	$0,12 \cdot 10^{-6}$	8,40	8,08	$3,85 \cdot 10^{-6}$
42	0,032	0,020	$0,008 \cdot 10^{-6}$	10,7	10,32	$4,91 \cdot 10^{-6}$

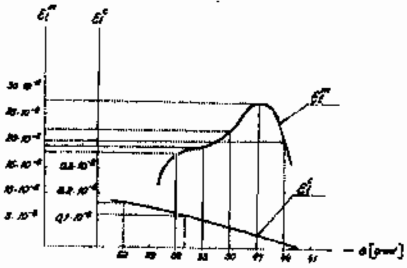


Fig. 6 Linear unit deformations from stretching

The recordings from transducers T_3 and T_4 were accomplish for full-load running and idle running. Computing the difference between full-load running records and idle running records for each transducers were determinate linear unit deformations from stretching and bending. The linear unit deformations from stretching, experimental determined, and those computed from unit driving force, are ploted in Fig. 6.

The ratio between recorded linear unit deformation ε_t^m and computed ε_t^c has maximum value at $\theta = 47^0$, resulting:

$$F_t = \frac{\varepsilon_t^m}{\varepsilon_t^c} \Rightarrow 540[daN]$$

Analysing the results from experimental recording, ascertain also for driving mechanism of tool-handling slide, that is possible a new dimensioning of the elements in effect to less stiffness of the elements.

In conclusion, the experimental researches acomplished on the builted-up prototype, define a process to establishing unknowed technologically forces, in this situations.

To know the techonologically forces is nedeed for prototype improvement, also from look-out of material and energy saving, by right choose of electric engine.

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Experimental Research in Relation to Determine Technologically Forces Respecting Elements Elasticity of Mechanisms

Rezumat

Cercetările experimentale efectuate pe mașina prototip realizată, definesc un procedeu pentru stabilirea forțelor tehnologice necunoscute, în astfel de situații.Cunoașterea forțelor tehnologice este necesară pentru îmbunătățirea prototipului, atât din punct de vedere al economiei de material prin redimensionarea elementelor, cât și din punct de vedere al consumului de energie prin alegerea rațională a motorului electric. Analiza mecanismelor de acționare a saniei de avans și a saniei port-sculă a fost efectuată utilizând metoda elementului finit, care implică desigur considerarea elasticității elementelor mecanismelor.

Zusammenfassung

Experimentelle Forschung, die auf der asseted Prototyp Maschine vollendet wird, definiert einen methode, unknowed technologisch Kräfte zu bestimmen. Technologisch zu wissen, daß Kräfte necesary zu Prototypverbesserung, Material ist, spart das durch redimensioning von Elementen und von Energie durch Wählen sparend, hat elektrischer Maschine angepaßt. Das analysiert von Treibengang von Fortschrittdia und Werkzeugbehälterdia wurde erkannt, daß das Benutzen von begrenzter Elementmethode (FEA), verwickelnd sicher Elastizität von Mechanismenelementen.