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DETERMINING THE FORCE AND PRESSURE AT THE EXTRUSION OF UNION NUTS FROM CYLINDRICAL SEMIPRODUCTS

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1. General considerations

The extrusion force is the most complex and important parameter of extrusion technological process determining the applicability of this procedure. The value of the extrusion force is used especially for the development of equipment and designing tools.

The extrusion force depends upon a number of parameters. Among them the following ones are the most important: the deformation degree and rate, the flow curve of the processed steel, friction between the tool and material; sizes of the extended profile, the shape and sizes of the semiproduct, the temperature variation during the process, physico-mechanical properties and structural inhomogenity of the semiproduct material.

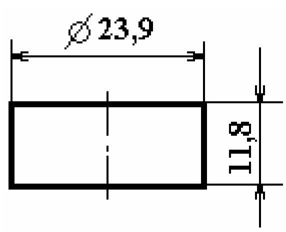
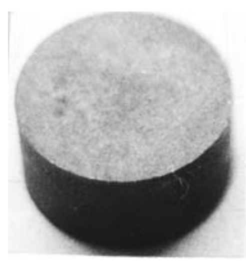
Though there are many analytical and experimentally determined relationships that allow to calculate the extrusion force, none of them can take into account all the influences. So, the values of the extrusion force obtained using these relationships are only approximative. That is why researchers prefer to determine them by experiment.

The paper aims to determine by experiment the total force and pressure of deformation as a function of the punch stroke and the deformation degree at the indirect extrusion of steel union nuts from cylindrical semiproducts.

2. Experimental conditions

We have used cylindrical samples of OLC 15 prepared using chemical phosphating and lubrication with molybdenum disulfide (Table 1**)**.

Table 1

Semiproduct	Shape and sizes	Phosphated semiproducts
cylindrical		

Extrusion has been performed on a hydraulic press PH 200 using the extrusion device designed and patented by the authors, Fig. 1.

For force measurements a load cell of 1000 KN was used, and for punch stroke an inductive transducer was used.

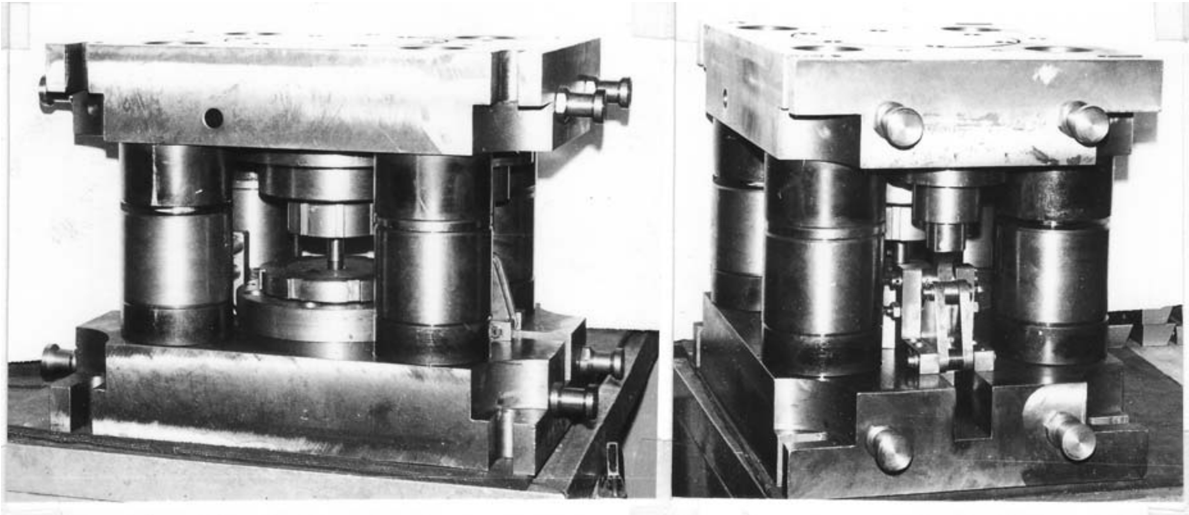


Fig. 1. Extrusion device

Equipment for data acquisition and processing includes:

- 2100 SYSTEM tensometric amplifier;
- movable 16-channel AT - 2016 P/S data acquisition module;
- laptop;
- E.S.A.M. (Electronic Signal Acquisition Module) software with frequency up to 200000 acquisitions per second.

Equipment enables to perform both the calibration of used transducers and data acquisition.

For determining the extrusion force as a function of the punch stroke the load cell was mounted inside the extrusion device. The displacement transducer was mounted between the fixed table and the moving table of the press (Fig. 2).

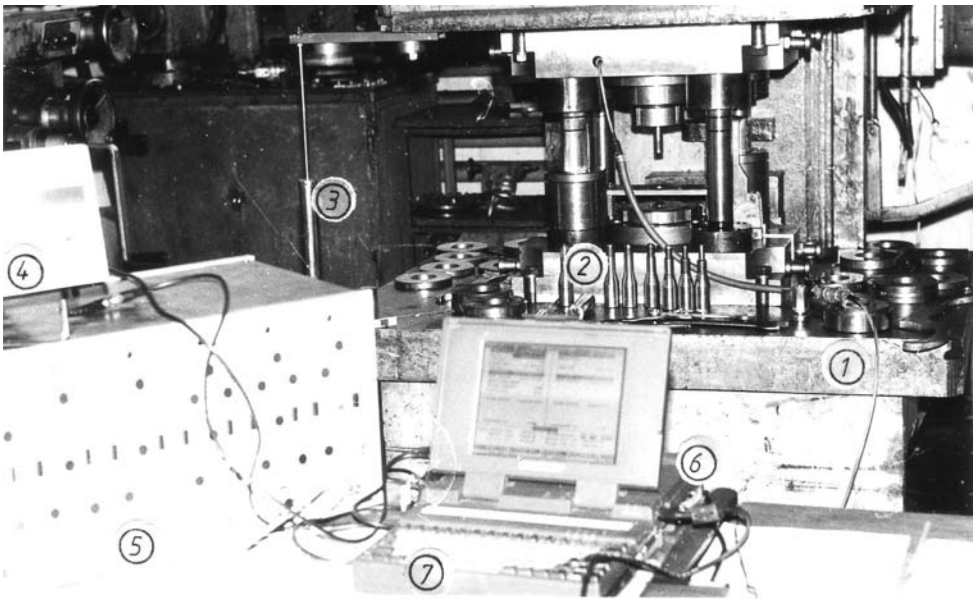


Fig. 2. General view of the installation for determining the extrusion force.
1 – hydraulic press; 2 – extrusion device; 3 – displacement transducer; 4 – tensometric amplifier;
5 – electronic tensometer; 6 – acquisition module; 7 – laptop

In the E.S.A.M. program tests for measuring dependences force - displacement have been developed using calibration factors determined previously. During the punch active stroke dependences force - displacement have been measured with frequency of 100 acquisitions/second.

3. Experimental results

After extruding semiproducts union nut pieces have been obtained (Fig. 3**)**.

Fig. 3. A union nut piece

Experimental data processing has been made using the Microsoft Excel program, the results are presented in Table 3, where:

c is the extrusion punch stroke measured during deformation;

ε is the conventional deformation degree calculated as $\varepsilon = \frac{h_0 - h}{h_0} \cdot 100$ [%];

F is the extrusion force measured during the process;

p is the total extrusion pressure determined as the measured extrusion force divided by the area of the frontal punch surface.

Table 2

No.	Punch stroke s [mm]	Force F [KN]	No.	Punch stroke s [mm]	Force F [KN]
1	0.00	1.0	17	4.00	349.4
2	0.25	18.0	18	4.25	373.5
3	0.50	35.9	19	4.50	397.3
4	0.75	54.5	20	4.75	420.7
5	1.00	74.0	21	5.00	443.4
6	1.25	94.2	22	5.25	465.5
7	1.50	115.1	23	5.50	486.6
8	1.75	136.6	24	5.75	506.8
9	2.00	158.8	25	6.00	525.7
10	2.25	181.5	26	6.25	543.2
11	2.50	204.7	27	6.50	559.2
12	2.75	228.3	28	6.75	573.5
13	3.00	252.3	29	7.00	585.8
14	3.25	276.5	30	7.25	595.9
15	3.50	300.8	31	7.50	603.7
16	3.75	325.1	32	7.75	609.0

Table 3

No.	Deformation degree ε [%]	Extrusion pressure P [MPa]	No.	Deformation degree ε[%]	Extrusion pressure P [MPa]
1	0	23	8	35	1371
2	5	158	9	40	1580
3	10	323	10	45	1774
4	15	512	11	50	1946
5	20	717	12	55	2090
6	25	933	13	60	2199
7	30	1153	14	65	2268

The variation of the extrusion force vs. the punch stroke is shown in Fig. 4, and the variation of the extrusion pressure vs. the conventional deformation degree is presented in Fig.5.

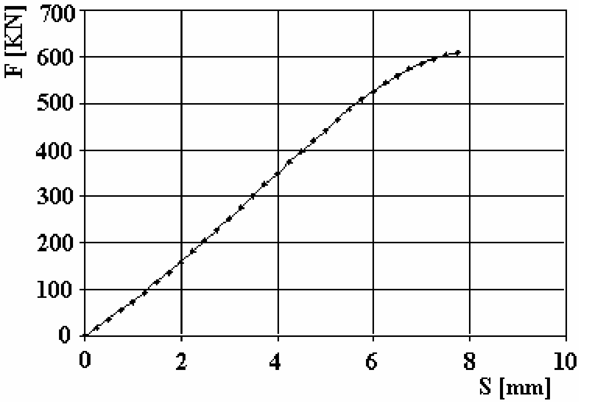


Fig. 4. Variation of the extrusion force vs. the punch course

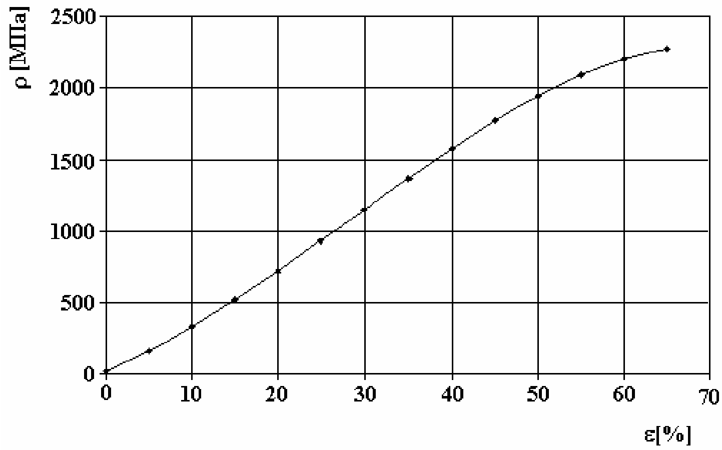


Fig. 5. Variation of the extrusion pressure vs. the conventional deformation degree

4. Conclusions

1. In the case of indirect cold extrusion of union nuts the diagram of the force variation vs. the punch stroke only slightly differs for different pieces.

2. Deformation during the entire extrusion period practically occurs at the same pressure for a given deformation degree.

Received 08.11.06

Summary

The paper aims to determine by experiment the total force and pressure of deformation as a function of the punch stroke and the deformation degree at the indirect extrusion of steel union nuts from cylindrical semiproducts.