

METAL STAMPING WITH ELASTIC MEDIA

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Abstract: *The given work is devoted to the sheet metal stamping with elastic media, with a thickness up to 2 mm. This method is effective for the small scale production. Compared with a traditional punching technology, stamping with elastic media appears to be much cheaper. However, a weak point is relatively large technological wastage size: it is needed to support force, which holds technological bridge in its place. The latest technical developments give an opportunity to elaborate the three-dimensional surface roughness model for the above motioned surfaces. Thus impact of the 3D surface roughness parameters to the metal stamping with elastic media can be determinate. Furthermore, it is possible to define the surface friction correlations between elastic areas, sheet material and base plate.*
Keywords: *Sheet metal, stamping, elastic media, punching tools, 3D surface roughness.*

1. INTRODUCTION

In modern industry a small scale production is commonly used for prototype making, aviation industry as well as in repair industry. Variety of machine components is made from the sheet metal with a thickness up to 2 mm. Production of such parts is not very reasonable in the the traditional stamps which are designed for the serial-mass production. It is because the technological expenses are too high. Comparing with

the traditional technological methods of details manufacturing from the sheet material (with holes and/or bends), the stamping with elastic media appears to be an optimal choice. Especially if the production outcome number (No of details) is not bigger than 10 000 pieces. Weak point of this method is relatively large technological wastages, especially when cutting or stretching operations are made. The large size of technological bridges is justified by need to withstand a force, which is necessary to hold the bridges in their places. In dimensional calculations of the technological bridges usually the following parameters are used: a) geometrical, b) force which is needed to cut the details, c) actual holding force or friction. However, the mechanical friction factors between the elastic area and sheet material as well as with a base plate should not be neglected too. Naturally, friction is directly related with the surface properties and roughness parameters. Nowadays there are technical possibilities to elaborate the 3D surface roughness model for the above motioned surfaces. Thus impact of the 3D surface roughness parameters to the metal stamping with elastic media can be determinate. The simplified approximation which is dependent from base plate surface roughness can be used. Furthermore, by the definition of the surface friction dependence between elastic area, sheet material and base plate, it could be possible to calculate the exact (minimal) technological bridge size. That will allow to improve considerably the above mentioned technology and will

allow to minimize the technological wastages and by this to economy the sheet material altogether.

2. STAMPING WITH ELASTIC MEDIA

2.1. Essentials of the Process

One of the most effective and easiest ways to produce parts from sheet and tube materials, in experimental or small scale production industry is to use stamping with flexible area. With this method a variety of stamping operations can be performed, namely, material cutting (Fig. 1.), forming (Figs. 1 and 2.), calibration, and stretching.

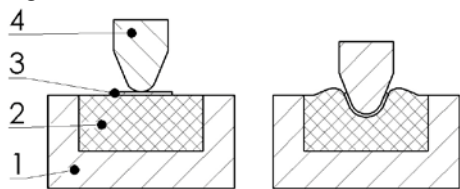


Fig.

1. Forming with flexible area

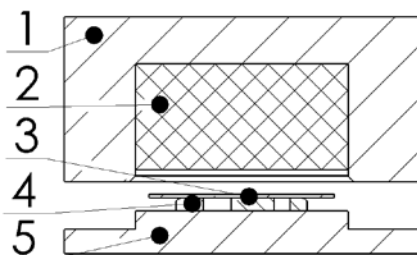


Fig. 2. Cutting and forming with flexible media container

Where: 1 – support, 2 - elastic media, 3 - detail 4 – die and 5 – support plate

The main advantages of this new technology are: the mould instrument volume, simplicity of the stamp components, and quantity of the used material. The last one is a key factor in modern engineering where the economical considerations are predominating. Actually, this new approach significantly simplifies the overall stamp construction and since one mould cavity or core side has to be made. The other half of mould is a flexible area itself and punching is

carried out in universal containers. Astonishingly, the flexible area could serve for manufacture of 100 or even 1000 details with many different configurations. In the same time industrial practice shows that its live cycle is up-to 2 years long.

2.3. Economical considerations

Analysis of the available literature sources confirms that stamping with elastic area is much more favourable in comparison with the other traditional stamping methods [4,5]. Obviously, a comparison of the methods for which components are similar or the same are not included in these economical calculations. In this particular case these are material components costs. The main costs for stamped details are composed by supporting equipment and staff remuneration expenses. In its turn the supporting equipment directly depends from the choice of stamping technology. Analyses revealed the fact that a particularly important factor is the production quantity. Therefore several examples of punched details manufacturing technologies were analysed within the research. The following figures are illustrating the main results. Cost unit are conditional value, which can be applied to any plant.

Figure 3 describes the cost dependency on the technology and the industrial output. The given graph shows results for parts which are made from the sheet material, not thicker than 1.5 mm.

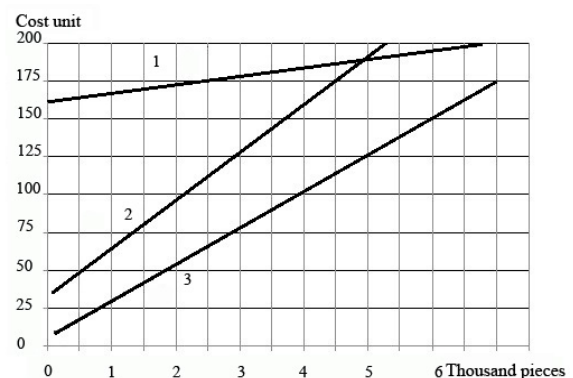


Fig. 3. Cost of the parts dependent on the cost of additional equipment

Where lines representing the following: 1- traditional stamps, 2 - step by step stamping, 3 - stamping with flexible environment.

Thus, these judgments will also be applicable to the punched details, up-to 1.5 mm. From the above mentioned graph it is clear that the economically advantageous option is to punch parts with the flexible environment, if the output number of parts does not exceed 10 000 units (line – 3). In order to assess this in the most accurate manner, it has been decided to carry out also the comparison of more complex configurations too (see Fig. 4.).

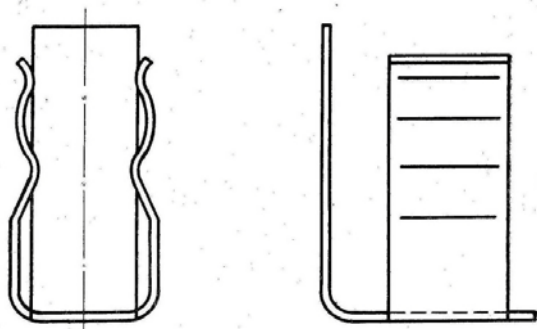


Fig. 4. Detail for cost calculations

Components with different technological complexity are providing an excellent opportunity to analyse the production cost tendencies (see Fig. 5,6,7).

Figure 5 shows that bend component with polyurethane is economically the most attractive option (curve 3).

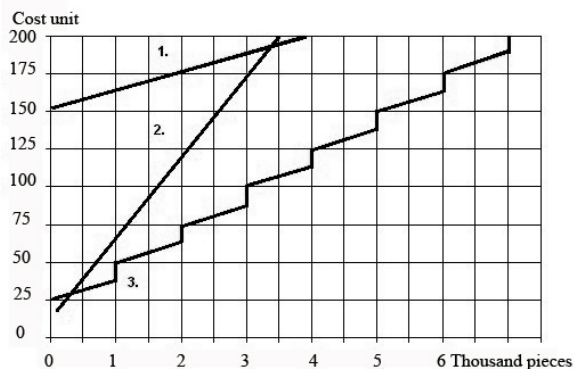


Fig. 5. Costs for the parts, which are bend in a complex contour

Where: 1 - traditional stamps, 2 - step by step stamping, 3 - stamping with flexible environment.

The gradual step-by-step curve has been obtained because polyurethane insert has to be changed after the production of every 1000 details. In the same time bending with traditional presses is more profitable if the production yearly outcome accounts for more than 9000 produced pieces.

Figure 6 shows that details with the strength ribs and bosses can be made cheaper if the production processes are accomplished by moulding polyurethane tool. Apparently production of such kind of details by using the polyurethane dies can be applied with good economic performance not only to small scale but also to the large series manufacture.

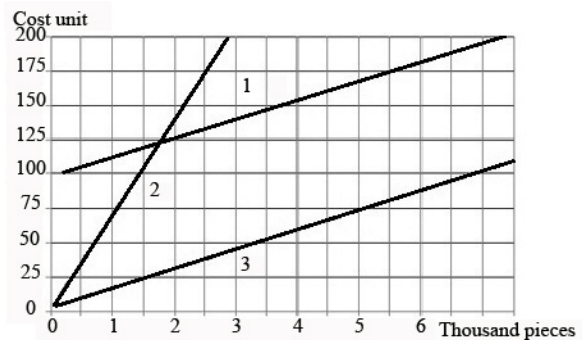


Fig. 6. Forming operations costs for details with strength ribs and bosses

Where: 1- traditional stamps, 2-step by step stamping, 3-stamping with flexible environment.

Curves displayed in the Figure 7 are allowing one to conclude that the vessels shape parts can be most economically manufactured with the polyurethane die, in case if the production program is more than 5000 pieces.

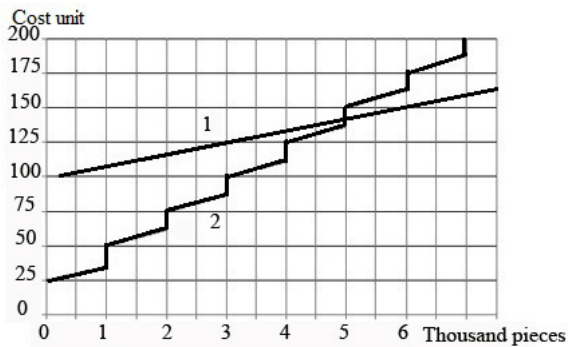


Fig. 7. Costs for vessels type details manufacturing.

Where: 1- traditional stamps and 2- stamping with flexible environment.

This example was selected based on extrusion widely apply in the cases like: cutting, bending, forming and stretching. The same calculations and the economical benefits could be applied to the more complex components too. By choosing a more efficient technology, economic calculations can be enhanced to the other important factors, e.g. preparation size, the necessary forces and the planned outlet number of components. Then the much more accurate costs of the technology and products could be obtained. The above mentioned considerations and graphs are clearly indicating that stamping with elastic media (polyurethane) in certain circumstances is very convenient and economically attractive. However, some problems have to be solved beforehand. Economical considerations were based on all mentioned literature.

2.4. Problem statements

The weak point of this method is a relatively large volume of technological wastages. Especially it concerns cutting and/or stretching operations. Size of the technological bridges (and thus wastages) is rather large, because they have to withstand working force and to hold the bridge in its right place. Usually dimensional calculations of technological bridges are based on geometrical parameters; force which is needed to cut the details as well as a holding force. The

last one is closely related with the surfaces friction parameters. In case of stamping with elastic media the friction phenomena can be observed between elastic area and sheet material as well as with the base plate.

2.5. Research course

The aforesaid technology has been used already in the seventies and has been developed over the following years. In the past rubber was used as a flexible environment, however, now polyurethane materials took their place since they have a much better physical properties. Available information reveals that there is lack of information on stamping within flexible environment. Especially it concerns punch material and support plate interaction, depending on surface roughness. Even more nowadays there are technical possibilities to elaborate the 3D surface roughness model for the above motioned surfaces. This should be looked in detail and comprehensive research has to be carried out.

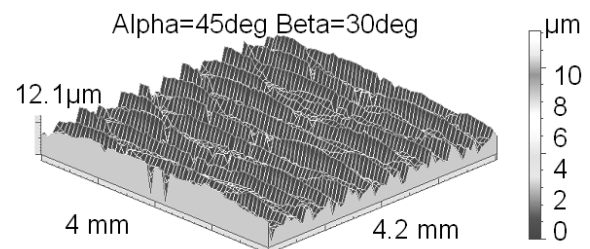


Fig. 8. 3D surface of support plate

Thus impact of the 3D surface roughness parameters to the metal stamping with elastic media can be determinate. The simplified approximation which is dependent from base plate surface roughness can be used. Furthermore, by the definition of the surface friction dependence between elastic area, sheet material and base plate, it could be possible to calculate the exact (minimal) technological bridge size. That shall considerably improve the above mentioned technology and will allow to

minimize the technological wastages and by this economy the sheet material.

2.6. Status and results

Although, a master thesis has been written with an aim to justify this technology, the obtained results should be enhanced and scientifically proved.. Indeed the conclusions of this work stated that this novel stamping technology with elastic media is very perspective. Particularly in small scale production. Therefore, now at Riga Technical University the comprehensive research of this topic is under its way. As a result a promotion work "Metal stamping in flexible environment: the process exploration" is in its initial stage. The initial considerations are compiled in this article.

3. CONCLUSIONS

Research showed that stamping with elastic media is apparently cheapest way how to produce in small scale quantities the sheet material details with thickness up to 2 mm. Therefore it is necessary to further develop this advantageous

technology taking into account 3D surface roughness correlations between flexible environment, punched material and support plate.

4. REFERENCES

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