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EXPERIMENTAL ANALYSIS OF THE RUBBER PAD FORMING

VILCANS, J[anis]; TORIMS, T[oms]; ZARINS, M[arcis] & RATKUS, A[ndris]

Abstract: *This paper outlines experimental analysis of rubber pad forming, combined with part of the PhD research into sheet metal stamping with elastic media. For small-scale production, rubber pad stamping is the best choice for thin sheet metal parts, compared with traditional stamping methods. The drawback of stamping with elastic media is the relatively large amount of technological wastage, resulting from the need to withstand the forces involved and hold the technological bridges. By finding out the surface dependence of friction between the sheet material, base plate and elastic area, it is possible to precisely calculate the minimum size of the technological bridge. Further research is therefore required in order to enhance the efficiency of rubber pad stamping technology.*

Key words: *stamping, elastic media, rubber pad forming*

1. INTRODUCTION

Although a large number of machine components are made from sheet metal with a thickness of up to 2 mm, production of such parts is not economically viable in traditional dies, which are designed for mass production. Sheet metal parts are deformed by the stamping process. The technological costs prove too high. Compared with traditional technological methods of manufacturing details from sheet material, stamping with elastic media appears to be the optimal choice. This is especially true if the production run is less than 10,000 pieces.

However, the drawback of this method is the relatively high amount of technological wastage, especially when cutting or stretching operations are performed. The relatively large technological bridges are justified by the need to withstand the force applied to hold the technological bridges in place. (Vilcans & Torims, 2010).

Further research is therefore required to improve rubber pad stamping technology for industrial manufacturing. This includes PhD research into "metal stamping in a flexible environment and process exploration" conducted at Riga Technical University, whose audit results are compiled in this article. This would help determine and experimentally confirm the minimum necessary size of the technological bridges. Consequently, it would be possible to reduce technological wastage, as well as consumption of the actual sheet material.

2. STAMPING WITH ELASTIC MEDIA

One of the most effective and easiest ways to produce parts from sheet and tube materials in experimental or small-scale industrial production is to use stamping with flexible area technology. This technology may be applied to a variety of stamping operations, such as material forming (Fig.1), forming and cutting in one step (Fig.2), as well as calibration and stretching. The main advantages of this technology are that the mould instrument volume is less complex than stamp components, and less material is used. In fact, this new approach greatly simplifies the overall stamp construction, since only 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 be used to manufacture 100 or even 1,000 details with many different configurations. Moreover, industrial practice shows that its lifetime may be as much as 2 years (Hisaki, 2000).

Fig. 1. Detail of elastic media

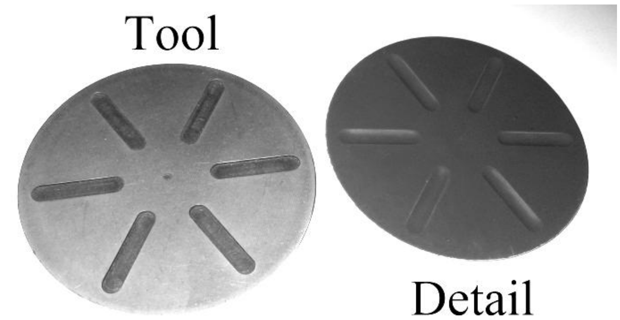

Fig. 2. Rubber pad forming tool and detail

Furthermore, analysis of the available literature confirms that for some time now, stamping with elastic media (polyurethane) has been considered far preferable in comparison with other, traditional stamping methods. The main costs of stamped details result from support equipment and staff remuneration. On the other hand, various problems have yet to be resolved.

3. KEY ISSUES IN RUBBER PAD FORMING

The drawback of this method is the relatively large volume of technological wastage. This is especially the case with cutting and/or stretching operations. The size of the technological bridges (and thus wastage) is relatively large, because they have to withstand the working force and remain in place. The following parameters are normally used when calculating the dimensions of these bridges: a) geometry; b) force required to cut details; and c) actual holding force or friction. Naturally, the friction is directly related to the surface properties and roughness parameters.

In the case of stamping with elastic media, the friction phenomena can be observed between the elastic area and the sheet material as well as with the base plate.

Although preliminary research aiming to justify this technology has been successfully completed, it needs to be enhanced in order to obtain initial results that can be scientifically proven.

In the past, traditional rubber was widely used as a flexible environment. Nowadays it has been substituted in most cases by polyurethane, which has superior physical properties and can better withstand the cyclic workloads. Therefore, although recent publications on stamping technology sometimes mention the existence of the aforementioned technology, they rarely provide any basic drawing samples. They also fail to provide any detailed description or mathematical model for metal stamping with elastic media.

4. EXPERIMENT LAYOUT

The purpose of the research is to determine the significance of the underlying surface roughness (Fig. 3) and in what way the surface roughness characteristics have to be enhanced in order to help improve the technology of stamping with elastic media.

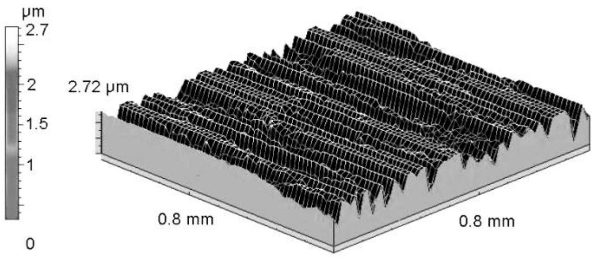

Fig. 3. 3D surface roughness of underlying surface

The principle of the experiment is illustrated in Fig. 4.

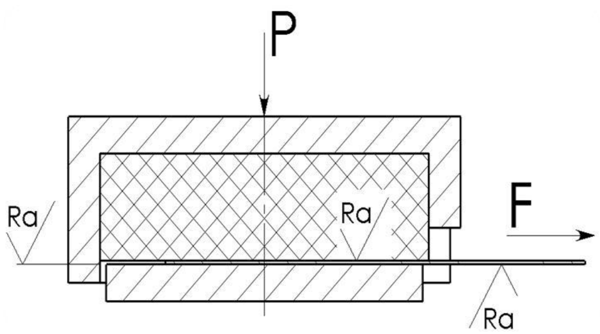

Fig. 4. Principle of the experiment

Research of the available literature showed that for constant parameters can be used workpiece properties and elastic pad properties. The variable parameters will be the underlying surface roughness, pressure force (P) and the force (F) (Fig. 4). The general model of the technological system was established based on the aforementioned studies. (Tab. 1) (Bingato, 2010; Guo, 2004).

The next step is the experiment, consisting of 30 measurements with three different underlying surface roughness parameters, applying the same pressure forces. This will make it possible to determine the force required to pull the workpiece out of mould. The selected Pressure force begins at 100 N/mm^2 and increases by a constant increment of 100 units.

Input factors		**Output factors**
Pressure force (P)	⇨	Pull out force (F)
Polyurethane properties	⇨	
Underlying surface roughness	⇨	Necessary underlying
Workpiece properties	⇨	surface roughness

Tab. 1. General model of the technological system

Maximum pulling force values were determined by the strength test of the workpiece. The endurance limit was also examined experimentally, and does not exceed 4 kN force.

The results of the first experiment will show the force and underlying surface roughness range in which we need to conduct more experiments, increasing by a smaller increment.

5. CONCLUSION

In this paper, rubber pad forming is presented as a new opportunity and economically attractive technological choice for sheet metal parts with a thickness of up to two millimetres, for small-scale production. However, the drawback of stamping with elastic media is the relatively high quantity of technological wastage, owing to the technological bridge size. Research is therefore required to improve the rubber pad stamping technology for industrial manufacturing. Experimental research is needed to determine the significance of the underlying surface roughness and how to improve the surface characteristics. The results of the first experiment show the force and underlying surface roughness range within which to conduct further experiments, increasing by a smaller increment.

The work here will provide a basis for future experiments, and make it possible to draw conclusions on the requisite underlying surface roughness characteristics.

6. ACKNOWLEDGEMENTS

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