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*Young Researches and Scientist Paper / * Supervisor, Mentor*

THIN SHEET METAL STAMPING WITH ELASTIC MEDIA

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Abstract: *The article covers a part of the PhD research on sheet metal stamping with elastic media. Calculations have confirmed that stamping with elastic media is much cheaper than traditional punching technology. Nevertheless the weak point of the stamping with elastic media is the relatively large technological wastage size deriving from the need to support forces to hold technological bridges. The metrological achievements allow for the creation of a 3D surface roughness model for the working surfaces of the stamp. In its turn, this 3D surface roughness model can help reduce technological wastages. By knowing the surface friction dependence between sheet material, base plate and elastic area, it is possible to calculate the precise minimal size of the technological bridge.*

Key words: *thin sheet metal, stamping, elastic media.*

1. INTRODUCTION

In production engineering small scale production is commonly associated with prototype making and aviation industry and is extensively used in different repair facilities. Although a large variety of machine components are made from sheet metal with a thickness up to 2 mm, production of such parts is not economically reasonable in the traditional stamps that are designed for mass production: the technological expenses turn out to be too high. Compared 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. This is especially true if the production outcome number (No of details) is less than 10 000 pieces (Hodirev, 1973).

However, the weak point of this method is the relatively large technological wastage, especially when cutting or stretching operations are performed. The large size of the technological bridges is justified by the necessity to withstand the force applied to hold the technological bridges in their places. Usually, the following parameters in dimensional calculations of these bridges are used: a) geometry, b) required force to cut details, c) actual holding force or friction. Nevertheless, the mechanical friction factors between the elastic area and sheet material as well as with a base plate should not be neglected either. Naturally, friction is directly related to the surface properties and roughness parameters. Nowadays there exist technical possibilities to elaborate the 3D surface roughness model for the above motioned surfaces. Thus the impact of the 3D surface roughness parameters to the metal stamping with elastic media can be determined. The simplified approximation dependent on the base plate surface roughness may be used. Furthermore, by the definition of the surface friction dependence between the elastic area, sheet material and base plate, it becomes possible to calculate the exact (minimal) technological bridge size. This would allow to considerably improve the above mentioned technology and minimize the technological wastages. Thus the consumption of the sheet material itself could also be significantly reduced.

2. OUTLINE OF THE BASIC PRINCIPLES

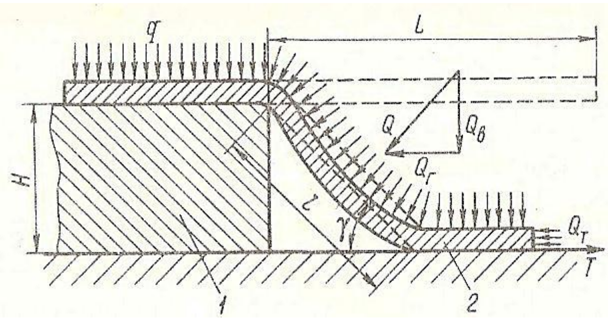

Fig.1. Stamping with flexible area scheme: 1-die, 2-workpiece

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. This method may be applied to a variety of stamping operations, namely, material forming (Fig.1), forming and cutting (Fig.2), as well as calibration and stretching. The main advantages of this technology are: the mould instrument volume, simplicity of the stamp components, and the reduced quantity of material used. The latter is a key factor in modern engineering where the economical considerations are predominant. In fact, this new approach significantly 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 serve for the manufacture of 100 or even 1000 details with many different configurations. At the same time industrial practice shows that its life cycle may last up to 2 years (Hisaki, 2000).

Furthermore, the analysis of the available literature sources confirms that stamping with elastic area has already for a while been considered much preferable in comparison with the other traditional stamping methods. Naturally, a comparison of the methods for which components are similar or the same are not included in these economical calculations. However, in this particular case this comprises only material components costs. The main costs for stamped details are composed by supporting equipment and staff remuneration expenses.

Fig.2. Die and its end product

In its turn the supporting equipment depends directly on the choice of the stamping technology. Analyses reveal that a particularly important factor therein is the production quantity. The economically advantageous option is to punch parts with the flexible environment, if the output number of details does not exceed 10 000 units (Bogojavlensko, 1991).

Details with the strength ribs and bosses can be made cheaper if the production processes are accomplished by moulding polyurethane tool. Apparently, the production of such type of details by using the polyurethane dies may be carried out with good economic performance not only under small scale but also under large series manufacture.

The above mentioned considerations clearly indicate that the stamping with elastic media (polyurethane) in certain circumstances may be very convenient and economically attractive. However, some problems have to be solved beforehand.

3. PROBLEM STATEMENTS AND RESEARCH COURSE

The weak point of this method is the relatively large volume of technological wastages. This especially concerns the cutting and/or stretching operations. The size of the technological bridges (and thus wastage) is rather large, because they have to withstand the working force and hold the bridge in its right place. Usually the dimensional calculations of the technological bridges are based on geometrical parameters; required force to cut the details as well as the holding force. The latter is closely related to the surfaces friction parameters. In 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.

The aforesaid technology has already been used in the seventies and has been further developed over the following years (Bērenfelds, 1980). Now polyurethane materials take their rightful place in manufacturing, since they have inherently better physical properties. Available information reveals that there is a lack of information on stamping within flexible environment. Mostly, this 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 (see Fig.3). This should be looked at in detail and comprehensive research has still to be carried out, so that the impact of the 3D surface roughness parameters to the metal stamping with elastic media can be mathematically described. For this a simplified approximation method dependent on the base plate surface roughness can be used. Furthermore, by defining 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 would considerably improve the above mentioned technology and would allow for minimizing the technological wastages, as a consequence significantly economizing the sheet material. However, the necessary calculations may be rather complex and might require solid experimental proof and comprehensive reliability checks.

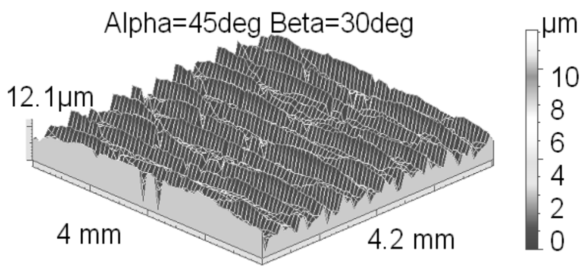

Fig.3. Die support plate: 3D surface roughness image

4. FIRST RESULTS OF THE RESEARCH

Although the preliminary research with the aim to justify this technology has been successfully carried out, it should be largely enhanced to obtain the initial results that can be scientifically proven. These first results confirmed that stamping technology with elastic media is very perspective, especially in small scale production. Therefore currently there is PhD research on metal stamping in flexible environment and the process exploration conducted at the Riga Technical University and its first results are compiled in this article.

The overall literature research showed that information regarding stamping with elastic media, with a few exceptions, is very poor and basic. One of the reasons for this lack of reference materials is the fact that this technology is usually used in small scale production and does not represent a major interest for metal processing industry and academics. Another reason is that the aforesaid technology has been probed already decades ago and has since been developed into a different direction or abandoned. Classic rubber in the past was widely used as a flexible environment, but today in most cases it is substituted by polyurethane that has much better physical properties and can better withstand the cyclic workloads.

Therefore the latest publications about stamping technology sometimes mention the existence of the aforesaid technology, however rarely providing some basic drawing samples. Still, they fail to provide a detailed description or a mathematical model for the metal stamping with elastic media.

5. CONCLUSION

The underlying purpose of this article is to discuss, within the international forum, the initial PhD research results and to confirm the authors' preliminary conclusions that are as follows: stamping with elastic media can provide many new opportunities for manufacturing industry; and this technology may be economically attractive and technologically less complicated than the traditional stamping techniques.

Research showed that stamping with elastic media can be improved with better interaction between the working surfaces. Therefore the friction processes between the stamp working surfaces, polyurethane and sheet material has to be understood. For this purpose one has to take into account the 3D surface roughness as a one of the major factors affecting the stamping process. That would aid to determine and experimentally confirm the minimal necessary size of the technological bridges. Consequently, it would become possible to reduce the technological wastages and sheet material consumption itself.

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