DESIGNING THE TOOL FOR MECHANICAL JOINING BY TOX-TWIN POINT METHOD

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Abstract

The paper deals with designing the tool for mechanical joining by relatively new method of joining known as TOX-TWIN Point. This method is an alternative method to resistance spot welding which can be used in automotive industry, mechanical engineering industry, building industry, electrical engineering industry. The tool for joining by this method was proposed for laboratories of Department of Technology and Materials.

Key words: mechanical joining, tool proposal, TOX-TWIN Point

INTRODUCTION

The automotive industry is working to accommodate the requirements of both environmental legislation and customer demands for greater performance and more features luxury and safety, by developing a light-weight and energy-efficient vehicle [1]. One of the possibilities of decreasing the car weight and consequently lowering the fuel consumption is using various combinations of materials, such as a combination of conventional deep-drawn steel sheet and high-strength steel sheet. Assembly and joining techniques must also be redesigned when adopting alternative materials [2,3].

The increasing use of coated, lightweight and high-strength materials has led the automotive industry to re-examine the traditional methods of material assembly. Welding (mainly resistance spot welding) of dissimilar sheet metals is difficult or even impossible, therefore alternative joining techniques, such as mechanical fastening systems, have attracted increasing interest and applications in recent years [4]. Mechanical fastening encompasses a wide range of methods, such as clinching, clinchrivet or self-piercing riveting. [5].

MECHANICAL JOINING BY TOX-TWIN POINT METHOD

The TOX-TWIN Point sheet metal joining system is an alternative technology in relation to inseparable methods like welding and riveting. In many cases, it also replaces bending and screwing methods. The TOX-TWIN Point along with the TOX-Round-Point initial joint and its variants, form a wide range of possibilities to join sheet metal. This joint is a 2 in 1 solution – two joints formed from one stroke of the press, using one set of tools (punch and die). The basic aim was to improve productivity and protect joints against rotation [6]. The double-joint design, made with a single tool strike, enables small parts or narrow flanges to be joined. Compared to the basic TOX-Round-Point joint (Fig. 1), where a simple round punch presses the materials to be joined into the die cavity. As the force continues to increase, the punch side material is forced to spread outwards within the die side material. The single-element die of the double joint opens up new possibilities for the clinching of small parts.

Fig. 1 TOX-ROUND Point – principle [3]

The key attribute of the new joint is its shear strength, which is up to double, and its tensile strength up to 1.5 times greater than in the single TOX-Round Point. The very close positioning of the two tool cavities reduces the zipper effect which might occur on long components where joints are arranged in a row (peeling load charge on the end position might cause end points to tear open, which is reminiscent of a zip fastener).

The joint by definition protects sheets from rotating (Fig. 2 and 3). Single TOX-Round Point joints have equal load carrying capacity on all sides - the positioning of the tools is irrelevant [7].

The effect of the form direction on the joint's strength (along both joints or crosswise), is
not noticeable. Especially in the case of soft materials, the increase in strength compared to a single joint is highly distinct.

Therefore the tool was designed on the principle of shearing tool with following main parts: upper (Fig. 5) and lower (Fig. 6) fixture plates, hardened support plate, base plate with guide posts and guide cases. The active tool parts such as punch and die are from TOX Pressotechnik Company.

The digital catalogues of Fibro and Hasco companies were utilized for choosing the fixture shank, upper and lower fixture plates, hardened support, guide posts and cases as well as the base plate. Ram of the tool and clamps were chosen from digital catalogue of Halder Company. Screws and pins were chosen from STN standards.

The following materials were proposed for parts of the tool:
- EN C45 for fixture shank,
- X33CrS16 for hardened plate,
- EN 10025-90 for base plate,
- Fe360B for feeder, where die is fixed in.

All the parts were then joined together in module Assembly of CAD/CAM system Catia V5.
(Computer Aided Three dimensional Interactive Applications). At present, this is one of the most used CAD/CAM/CAE Systems, supplying a large variety of integrated solutions to satisfy all the aspects related to design and manufacture.

Within designing the tool, some calculations were done. Calculation of hardened support plate (Fig. 7) which is situated between upper and lower fixture plates:

\[ q = \frac{F}{A} \leq \sigma_{Dd} \tag{1} \]

\[ q = \frac{F}{\pi \cdot d^2 / 4} = \frac{100000}{\pi \cdot 3.4^2 / 4} = 110,142 \text{ MPa} \tag{2} \]

\[ \sigma_D \leq \sigma_{Dd} \tag{3} \]

\[ 110,142 \text{ MPa} \leq 930 \text{ MPa} \]

Upper and lower fixture plates together with hardened support plate made clamping head of the tool, where the punch of the tool is fixed on. Guide posts with a feeder were assembled with the base plate – Fig. 8. The feeder is a part of the tool, where the die is situated in as well as the part, where the sheets are joined together.

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CONCLUSION

The TOX-TWIN Point method of mechanical joining is become perspective method, because this method can be utilized in joining the materials of various thickness, various mechanical properties as well as combinations of ferrous and non-ferrous metals. It is an alternative method to conventional joining methods, especially resistance spot welding.

CAD/CAM system Catia was used for designing the tool as well as the free version of digital catalogs of standard commercial parts in native or neutral format. The tool of TOX-TWIN Point was designed on the base of principle of shearing tool for an eccentric press.

Very important thing is arrangement of the active tool parts – punch and die to avoid any failures or crack during joining process.

References


