TIN COATED STEELS AS A MATERIAL FOR BLANKING STAMPS

Stanisław Kut, Jacek Mucha and Feliks Stachowicz

Politechnika Rzeszowska, ul. W. Pola 2, 35-959 Rzeszów, Poland

Abstract: *The paper present the results of operating investigations of blanking process efficiency in high speed blanking of generator sheet metal. Evaluation of a shearing tool material quality was performed on the base of measurements of the burr height. The experiment has been carried out using different shearing tool materials; uncoated as well as TiN coated ASP23 sintered steel and SW7M high-speed steel.*

Key words*: generator sheet, blanking stamps, burr height, wear*

1. INTRODUCTION

Plastic deformation of a material which takes place during generator sheet blanking process results in decreasing of magnetic properties of products, in the greater degree the largest is the plastic deformation region [6, 4]. Electrical resistance increases with increasing plastic strain. This can be explained by the fact that any anomaly formed in cold deformation causes scattering of electron waves.

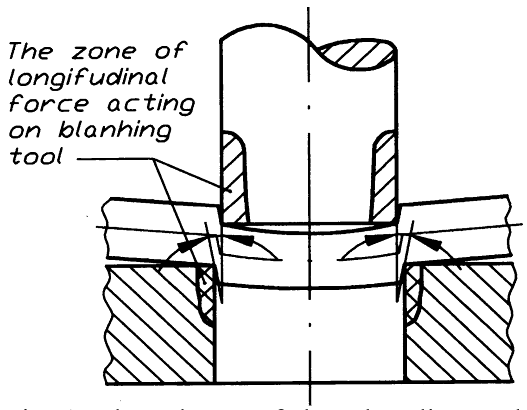


Fig. 1. The scheme of sheet bending and longitudinal forces acting during blanking process

The magnetic properties of iron depend on the distribution of the magnetic field in the crystallographic structure, which is disrupted by this deformation, thus disrupting the magnetic field and impairing the magnetic properties.

During blanking process of generator sheets intensive wear of shearing tools occurs, what results in decreasing of the blanking part quality. The wear of shearing edge resulted in [6];

bending of the parts (Fig. 1), presence of high burrs on the parts edge, deviation of shearing surface from orthogonality according to the part surface, high plastic deformation of material in the vicinity of the shearing line. Bending of the parts and the presence of burrs cause troubles in the process of mounting single parts into electric motor banches.

The second important factor influencing blanking part quality and proper proceeding of blanking process is the value of clearance and its distribution around shearing circuit (line). Depending on the type of guidance for the shearing elements with respect to one another, the tools are divided into free, plate guided and pillar-guided blanking tooling [5]. When the blanking of electric motor parts is concerned, because of the magnetic sheet thickness (0.5 mm) and rather complicated shape of stamps, the shearing elements guidance has to be very precise. So only the pillar-guided tooling could be taken into consideration. There are different types of pillar guides. Guidance can be accomplished with either bushings or ball bearings. Guides with ball bearings are rigid under load. They have little friction, and are hence used in fast-stroking presses or in cases where sufficient lubrication is not possible. Pillar-guided tooling can also be equipped with movable guidance plates for punch. The guidance plates are mounted on the pillar-guided tooling body and are in general supported by springs on the upper portion of the tool. This design is generally used for blanking thin sheets to ensure the flatness of blanked sheets. The punch can be guided until touches the sheet. This calls for very precise manufacture of the guidance hole in the plate since there is double guidance, namely, guidance of the punch in the pillar-guided tooling and in the guidance plate. However double guidance is always costly to manufacture.

Because of the relative movement between tool and workpiece, wear on the shearing tool elements is unavoidable. Besides of the force acting perpendicular to the sheet surface (Fig.1), the additional force component exists, acting perpendicular to punch stroke direction, created by material pressure on the lateral surface of the die and punch during plastic flow phase, what results in wear of the tools. The wear take place on the face of the shearing blade and on its free surface. It causes the shearing edges to be removed. Sometimes shearing edge crushing also occurs. The shearing edge wear increases the penetration depth of the punch needed for cracks to form. With worn-out tools the cracks do not emanate from the blanking edge but from the free surface. This change in crack propagation leads to burr formation, which increases as the number of pieces made with a single tooling increases [5]. The wear degree depends on both the material of blanked sheet and tool material as well as on the quality of punch guidance. Evaluation of sheet metal punchability could be performed on the base of measurements of the burr height or on the shearing edge wear intensity (Fig. 2).

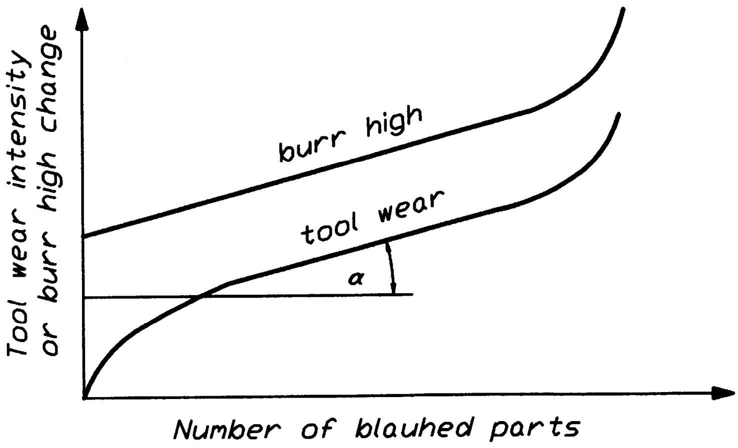
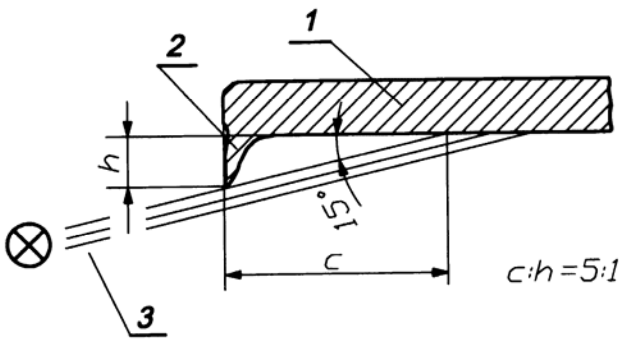


Fig.2. The characteristic of tool wear intensity and burr height growth process



Measurement of burr hight could be performed using several methods [3]. The most popular is optical measuring of shadow (Fig. 3) and mechanical measuring of surface profile in the vicinity of blanked part edge (Fig. 4).

Fig. 3. The scheme of optical measurement of burr height

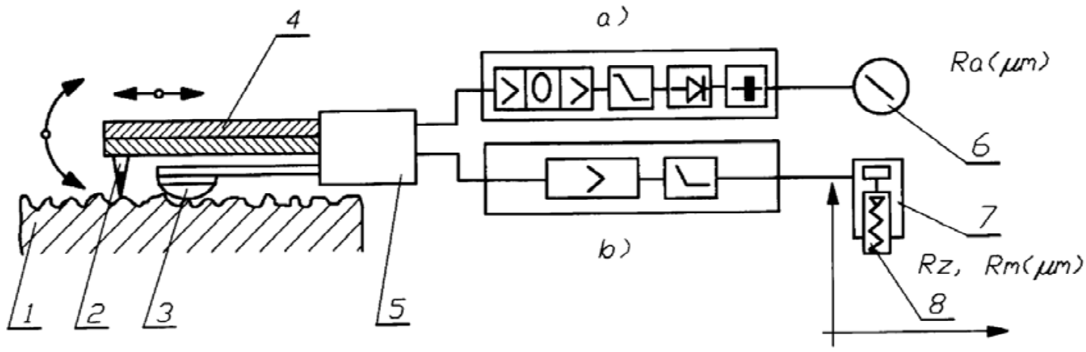


Fig. 4. The principle of mechanical measurement of burr height

2. EXPERIMENTAL PROCEDURE AND RESULTS

The experimental investigations were curried out using blanking tool made of four different material options:

- SW7M high ductility and high wear resistance steel, hardness 63 HRC,
- ASP23 sintered steel, hardness 66 HRC,

- SW7M steel coated with TiN,
- ASP23 sintered steel coated with TiN.

The microhardness of the TiN layer was in the range of 2100 HV [2]. Improvement in manufacturing of electric motor parts was the reason of experimental works.

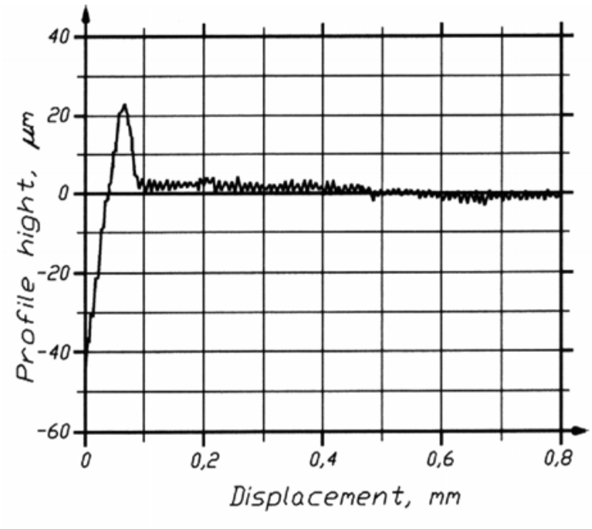


Fig. 5. The example of burr height measurement observed on the display screen

The analysed electric motor parts are made of 0.5 mm thick generator steel sheet type *EP 470-50A* coated with insulating varnish (additionally obeying good lubricant ability in the blanking process). The blanking process was performed using the high-speed *BRUDERER - BSTA 80L* press equipped with special construction of the precision slide guidance. The blanking speed amount 400 parts per minute. The evaporating oil type *Produkt D305* of *Castrol Co.* was used as a technological lubricant. At different stage of the parts manufacturing process the burr height edge was measured in a few points of the parts using the Taylor-Hobson Surtronic 3+ profilometer. The example of burr height measurement observed on the display screen is presented in Fig. 5. When the burr height was above the value of $h_{max} = 0.05$ *mm* the production process was stopped. The blanking die was disassembled and the punches surface was observed. Then the shearing tool was sharpened in the grinding process and a new experimental series was curried out.

Taking into account measurements curried out during the operating investigations concerning the analysed punch material options, the relationship between amounts of blanked parts versus the burr height was determined. Additionally by the less square method the experimental points were described using the III-grade polynomial curve (Fig. 6 and Fig.7). On the base of this presentations the following remarks could be drawn:

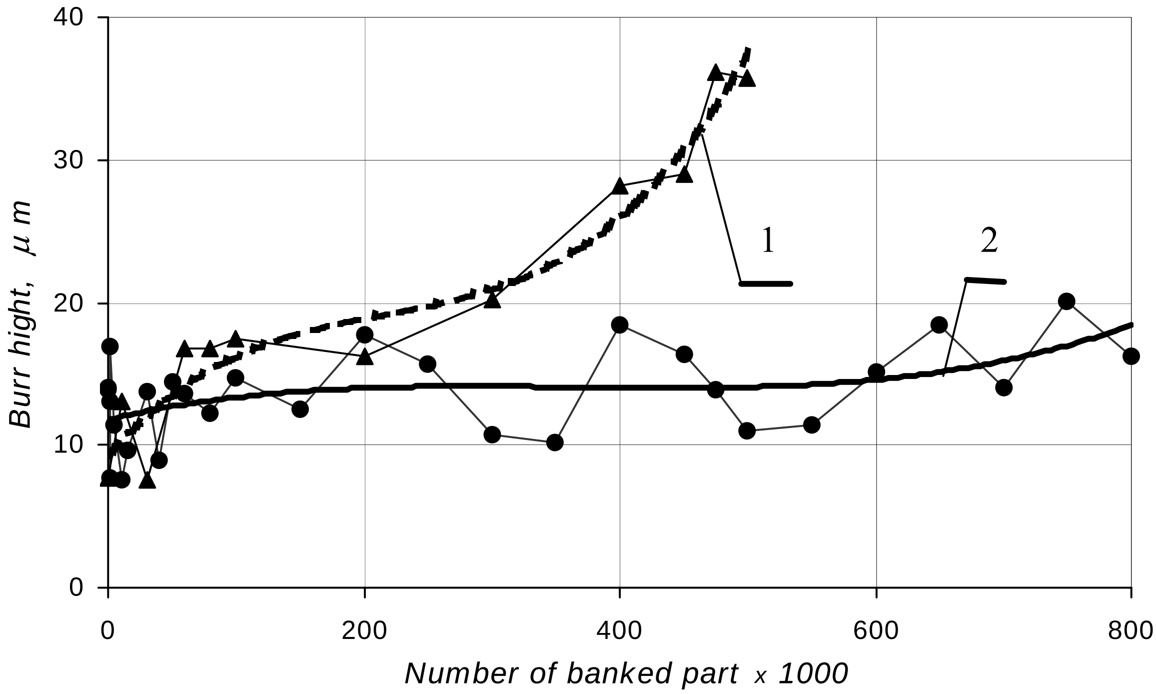


Fig.6. Burr hight as a function of blanked part number in the case of SW7M (line 1) and SW7M+TiN (line 2) tool material

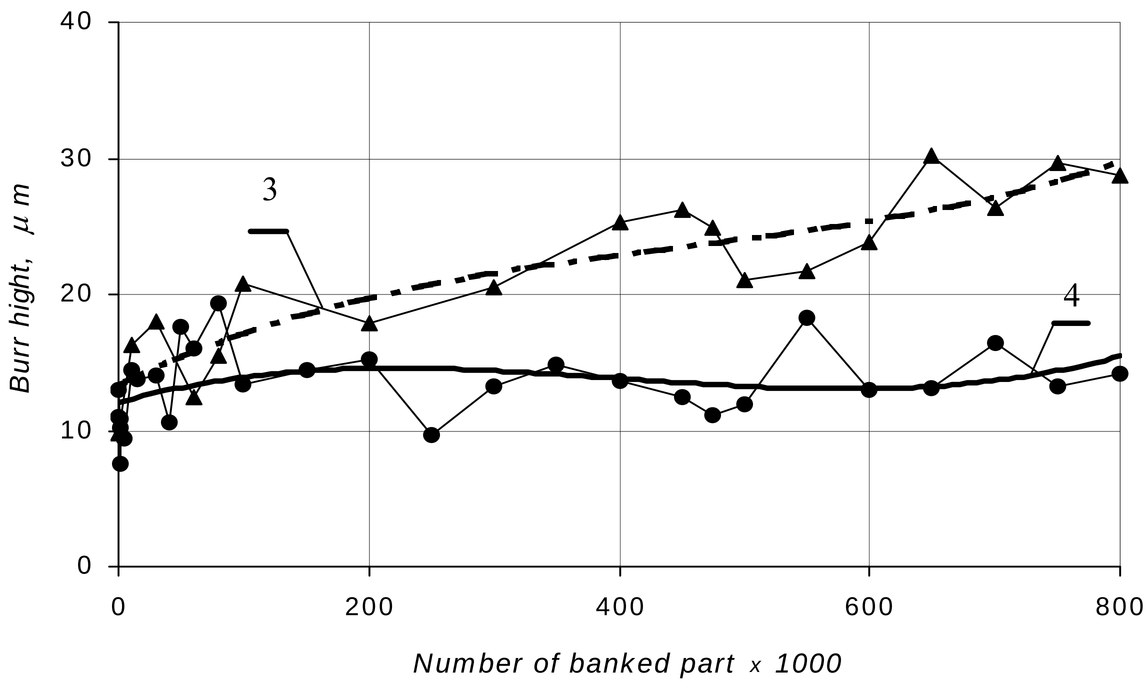


Fig.7. Burr hight as a function of blanked part number in the case of ASP23 (line 3) and ASP23+TiN (line 4) tool material

- coating of both the SW7M high ductility and high wear resistance steel as well as ASP23 sintered steel with TiN layer visibly reduced the intensity of burr height growth with blanking process proceeding, in comparison with uncoated tool materials – especially in the case of SW7M+TiN material option,

- at the beginning of blanking process (amount of blanked parts less than 100 000) no evident relationship exists between the burr high and amount of blanked parts for different kind of punch material. Probably at this stage of blanking a tool edge lapping process took place,
- in the range up to 800 000 blanked parts, the burr height seemed to be constant when using ASP23+TiN tool material, as it was observed in the case of blanking tool made of G40 sintered carbide [1].

3. CONCLUSION

TiN layer applied on both the high speed steel and sintered steel is very beneficial when taking into account the wear of shearing tool in generator sheet blanking process. The use of profilometer, applied for measurements of burr hight on the edge of blanked parts, enable to make measuring process simple and quick with high precision.

4. REFERENCES

1. Bać S., Jaworski J., Stachowicz F., *Durability dependence on cutting tool material in blanking process of generator sheet metal*, Conf. Proc. Technology'99, Bratislava, p. 452.
2. Burakowski T., Wierzchoń T., *Inżynieria powierzchni metali. Podstawy, urządzenia, technologia*, WNT Warszawa 1995.
3. Doubravský M., Frček V., *Badania wykrawalności zimno walcowanych blach prądnicowych przez pomiar wzrostu zadzioru w wycinanych płytkach*, Obróbka plastyczna, 12 (1973) 27.
4. Lachvač J.: *Examination of the quality of cut blanks for magnetic circuits of electric motors,* Transactions of the Technical University of Košice, 2 (1992) 258.
5. Lange K.: *Ha ndbook of Metal Forming*, McGraw-Hill Book Co. 1985.
6. Matuszak A.: *Metodyka określania wykrawalności blach,* Prace Naukowe Instytutu Technologii Budowy Maszyn Politechniki Wrocławskiej, nr 44, seria: Monografie z. 11, Wrocław 1989.