Analysis the Influence of Steel Sheet Production Technology on the Quality Products in Steel Service Polska

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INTRODUCTION

Analysis of the production process. Preparation of the material for the cutting procedure.

The persons responsible for the preparation of the material are the crane driver and the cutting machine boss.

- Plates up to 15 mm thick are cut with rotary shears.
- Plates up to 80 mm thick are cut to final size with guillotine shears.

After receiving a complete cutting plan from the supervisor, the machine operator provides the gantry with a list of raw materials used for this purpose. The overhead crane transports the sheet coils to the appropriate stock location in the machine, while maintaining the parameters according to the list (Brodny, J. and Tutak, M. 2018). Each coil remains marked with a tag identifying it. Besides information such as type, width, thickness or weight, more detailed information can be found on it.

After these procedures, the operator first checks and compares the tags on the bench

with the production plan to identify the material. A group of essential practical materials to undertake cutting are steels.

Once the material selection has been made, the next stage is to measure the dimensions and the registration fed into the system to start the automatic insertion of the material onto the working part of the delimbing machine (Brodny, J. and Tutak, M. 2016). After communicating to the machine operator that the machine is ready, the material is fed into the knives at a length of 0.5. At this stage, accurate measurements are taken. The width of each piece and the thickness at the edges and in the centre are measured. The results of the measurements are recorded.

The results are recorded on a card which is stored in a database. If the measurements are within the cutting tolerance set in the plan, the material is passed through the rest of the machine and fastened to the winder (Biały, W.

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2017). If the tolerance is found to be exceeded, the knife design must be checked and the material re-measured (Biały, W., Wedzicha. J. and Nordin V. 2018). Current methods of acceptance of constructions, often require care to be taken to a much higher degree of precision.

The montage knife sets

The blade shears for cutting metal sheets into strips consist of two sets of blades, situated on rollers. The first set is seated on the upper roller in the spacers used together with the material stabilizing rubbers. The spacers used are of a width such that the distance between the cutting edges of the knives is equal to the width of the cut steel strips.
(Bołoz, Ł. Midor, K. 2018). The second set has the knives seated on the lower roll at intervals limited by spacers and with stabilising rubbers. The dimensions are differentiated from the set on the upper roll by the thickness of the knives and the corresponding margin between them. Table 1 shows examples of the parameters of sets of roller knives.

Table 1 Parameters for disc knife sets

Thickness of material (mm)	Width of knives (mm)	Margin between cutting surfaces (%)	Seizure of knives (%)
0.5-0.68	8	5	25
0.6-0.97	10	10	
1.0-1.95	8	8	
2.2-3.99	10	8	

Source: own work

Quantitative data on the used spacers and stabilising rubbers as well as the width of the used knives are provided by a specialised computer programme.
In the data, the parameters of the material to be added and the quantity of the individual results to be obtained must be entered (Fretsch, M. 2003). The computer program has all the data on spacers, knives and rubber elements. The assembly of the knives is carried out on so-called trestles. It consists of four sets of knives on which the worker assembles the final set. Each set of parts corresponds to one blade. After the knives have been assembled, the whole set is placed in the working cage. The set is connected to the actuator, the cage is closed and the production can start (Fig. 1).

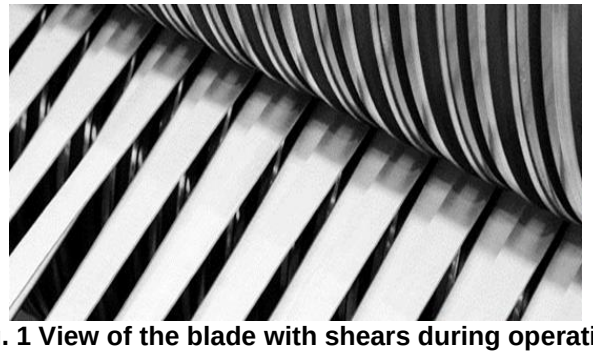

Fig. 1 View of the blade with shears during operation

Source: own work

The automatic cut

The slitting line component is the main part of the process is the slitting line component. This is a device that works in conjunction with a slitting machine weighing up to 25 tonnes. Slitting belts can be produced in thicknesses from 0.4 mm to 4.0 mm and in widths from 25 mm to 1800 mm. The strength of the materials is up to 1400 MPa. The machine operator, is required to record into the sensor-based computerised cutting line the necessary parameters to run it (Górniak, A., Midor, K., Kaźmierczak, J. and Kaniak, W. 2018). These are thickness of the sheet, diameter of the decoiler, diameter of the winder and diameter of the winding coil. After these steps, scan the barcode from the production docket and print the labels, which will be archived after cutting. At the end of the operation they will be used for further product identification. Throughout the operation of the machine, the machine operator observes the cut steel strip, monitors and, if necessary, corrects the machine operating parameters. (Gajdzik, B, and Sitko, J. 2014). The rest of the steel strip is cut for scrap, or after measuring the thickness, it is re-wrapped in the winders and the cutting test is repeated. The cut strips are transported to a conveyor where their thickness is measured and then packaged.

Due to its excellent material properties, hot rolled strip achieves high requirements both in terms of property retention and surface quality and dimensional accuracy (Gajdzik B. 2013). These parameters make strip an ideal material for further processing into finished products such as stamped parts, pipes, car rims, but also agricultural machinery and furniture systems.

The list of basic given tapes represents in Table 2.

Table 2 Mechanical proprieties two chosen sorts of steel tapes

Sort	Lower limit of plasticity R_{eL}, N/mm^2		Endurance on extension R_m N/mm^2 max.	Extension at tearing		
	1.5 ≤ e ≤ 2	2 ≤ e ≤ 8		1.5 ≤ e ≤ 2	2 ≤ e ≤ 3	3 ≤ e ≤ 8
Not alloy mild steels to immediate cold working (DIN EN 10111)						
DD11	160-370	170-350	450	22	22	28
DD12	160-350	180-310	440	24	25	29

Source: own work

Cold rolled sheets

Cold rolled steels compared with hot-rolled steels are characterized by a better surface quality and good formability at lower thicknesses. Cold-rolled sheets are multifaceted materials that are used in different variants: in the automotive industry, in the food industry, for the production of tubes and sections, for the production of barrels (Hąbek, P. 2014).

The data of basic cold-rolled sheets are presented in Table 3

Table 3 Proprieties of steel tapes, rolled in cold

Sort	Border of plasticity Re, N/mm^2	Endurance on extension Rm, N/mm^2	Extension at tearing A_{80}, %min	r_{90} min.	r_{90} min.
Not alloy mild steels to immediate plastic tooling (DIN EN 10130)					
DC 01	120-290	250-420	29	-	-
DC 07	110-140	240-320	42	2	0.24

Source: own work

The thin sheet zinc

Zinc provides very good protection for steel against oxidation. Galvanised sheet has excellent anti-corrosion properties and an excellent, durable appearance (Krzyżaniak, S. 2001). Application possibilities: automotive industry, ventilation ducts, insulation, drainage, elements for coverings, doors, construction of racks, industrial equipment, construction and Household appliances (Collective work. Poradnik inżyniera. Mechanika, t. 3, WNT, Warsaw 1970).

Basic data of galvanised steel strips are presented in Table 4.

Table 4 Mechanical proprieties of chosen steel tapes, zinc

Sort	Border of plasticity Re, N/mm^2	Endurance on the extension Rm, N/mm^2	Extension at tearing A_{80}, % min.	r min.	n min.
Mild steels to plastic tooling in cold blood (DIN EN 10327)					
DX 56 D+Z	110-190	270-370	38	1.90	0.20
DX 57 D+Z	120-180	270-370	40	2.10	0.22

Source: own work

The sheet is electrolytically galvanized.

The electrolysis process enables the refining of cold-rolled sheets (Skowronek, Cz. 1989). A single-sided or double-sided zinc layer protects the sheet against corrosion. In combination with selected surface treatments, this coating provides an excellent adhesion substrate for coatings (Sitko, J., Mikuś, R. and Bożek, P. 2018) Typical applications are external parts of vehicles and other components with high requirements, production of appliances of the household and electrical industry and protection, housing of industrial equipment (Sitko, J. 2007).

The basic grades of electrolytically galvanised sheets are presented in Table 5.

Table 5 The basic proprieties mechanical chosen steel tapes, zinc electrolytically

Sort	Border of plasticity Re, N/mm^2	Endurance on the extension Rm, N/mm^2	Extension t tearing A_{80}, % min.	r_{90} min.	n_{90} min.
Not alloy mild steels to plastic tooling (DIN EN 10152)					
DC 01 +ZE	120-290	280-420	29	-	-
DC 03 + ZE	120-250	290-380	35	1,25	-

Source: own work

For plate thicknesses 0.70 mm > 0.50 mm, a maximum of higher yield strengths are permissible for the limit for 25 N/mm^2. At a thickness of 0.50 mm, the maximum allowable yield strengths at the limit are 50 N/mm^2.

Thin aluminium sheet

Hot-dip aluminium sheet combines excellent corrosion resistance and good resistance to high temperatures. An additional advantage is the combination of the gloss of aluminium with the mechanical durability of steel (Mazurkiewicz, J., Szymszal, J. and Ścierski, J. 2003). In many applications, a significant improvement in corrosion protection has been achieved: in the automotive industry for the manufacture of exhaust systems in the construction industry for the insulation of pipes, dust extraction equipment, hot air duct extraction equipment, in the construction of apparatus or in the manufacture of household appliances.

The basic data of hot-dip aluminium sheets are presented in Table 6.

Table 6 The basic proprieties mechanical chosen steel tapes

Sort	The agreed upon border of the plasticity $R_{0.2}$, N/mm^2	Endurance on the extension Rm, N/mm^2	Extension at tearing A_{80}, % min.	r min.	n min.
Construction steel (DIN EN 10326)					
S 250 GD+AS	240	320	18	-	-
S 280 GD+AS	270	350	17	-	-

Source: own work

ANALYSIS OF CAUSES OF COMPLAINTS

The main causes of complaints in the Stahl Serwis Company are the following material, human and mechanical. Mechanical parameters have a significant impact on the cutting procedure itself. Differences in the thickness of plates contribute to uneven coiling and the possibility of their subsequent damage (Urbaniak, M. 2004).

When cutting DC01 sheets, a tendency to overlap the wound fragments is noticeable. This is due to the release of stresses created during the rolling process.

Various mechanical factors are the main reason for the possibility of damage to the material, as well as deformation caused by improper transport of goods and the possibility of damage, chipping of the knives when cutting.

The selection of workers (the human factor) and their training is essential in steelworking processes, as their duties determine the entire production cycle. The cause of the increase in the number of complaints reflecting the mistakes of workers may be incorrect measurement, setting the wrong machine parameters, as well as errors in documentation. The human factor is of great importance in the functioning of Steel Service. It can significantly influence production processes, both in terms of quantity and quality. According to the

assumptions of the Integrated Quality System, continuous improvement should be a constant objective of the company.

The organisation of training courses for employees is aimed at providing opportunities for the development of specialist skills and entitlements, as well as the acquisition of knowledge in the field of quality management. Internal, external, mandatory and specialised instructions are used. The qualification needs of the instruction are based on periodic evaluations of employees, certificates and assessments held, as well as the ability to operate machinery and equipment. A very important factor included in the group of human factors is the analysis of the number of mistakes made.

Measurement errors depend on:

- the precision and technical condition of the measuring tools,
- qualifications of the employee carrying out the measurement,
- measurement methods,
- physical conditions,
- analysis of results.

Errors in the operation of a measuring tool have many sources. The most significant of these are:

- Errors made in model making. They are connected with incorrect comparison of the parameters of the measuring tools with the pattern. It should be remembered that tool indications are also subject to measurement error.
- Defects resulting from friction. They mainly result from the influence of forces acting on the material.
- Problems resulting from excessive play in the mechanism. These result in inaccurate readings.
- Errors resulting from temperature differences. These can be caused by changes in tool measurements, differences in material properties such as elasticity coefficient, etc.
- Misalignment of the material to be machined. These can be caused by the deviation of certain parts of the measuring tools from the vertical, horizontal, etc. In addition to general sources of error, the measuring tool has other, individual sources, which must be analysed during operation.
- Errors related to measurement by a worker are due to human error. To a large extent, this phenomenon is eliminated by tools equipped with a digital readout. Errors, resulting from certain tendencies, e.g. to always read a slightly smaller (or larger) value of the machine parameters, play an important role in measurements.

Consequential errors from calculations results of measurement come into being mostly in consequence the unsuitable rule levelling errors in series of measurement or in consequence of rounding indicated values.

Based on the collected information, the proportional share of all complaints in the company is presented in Fig. 2.

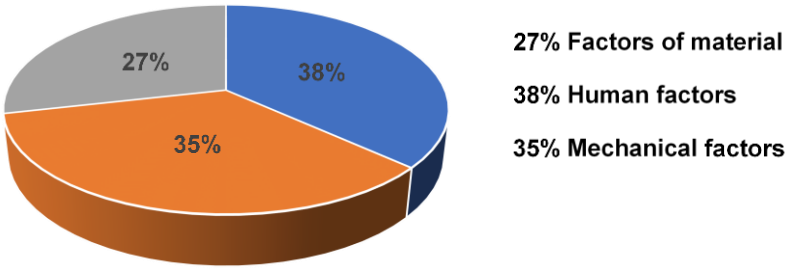

Fig. 2 Number of individual factors in recognised complaints

Source: own work

CONCLUSION

The article describes the manufacturing process of steel sheets. Examples of steel grades and important technological parameters affecting the quality and efficiency of work are presented. The analysed elements of the process directly translate into the precision of workmanship and the quality level of products. The parameters presented, such as the input state of the material used in the production process, the characteristics and scope of the parameters of machine operation (cutting shears) and the influence of the human factor have a significant impact on the final parameters of the company. Taking them into account in the production and improvement process will contribute to reducing stocks and complaints.

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Abstract: The process of production and processing and preparation for distribution of steel products is associated with the requirements of maintaining appropriate procedures. They allow, in accordance with industry standards to avoid unforeseen problems associated with the preparation, implementation and finalization of activities aimed at achieving the intended purpose, which is a finished product of adequate quality and customer satisfaction. It is not always possible in the production process to meet all the requirements and technological, organizational and human factor recommendations. The analysis of selected problems, which includes the content of the article allows to significantly determine the factors and parameters associated with the preparation and technical implementation affecting the implementation of the intended objectives of the company, i.e. achieving an appropriate level of quality and minimizing the defects in the process of steel sheet preparation. Analysis of selected parameters was made on the basis of data obtained in the company operating on the international market Company Steel Service Poland. At the request of company representatives, the name has been changed due to the production data used in the article, which may be considered as sensitive. The article contains data based on research carried out in Steel Service Poland. Selected problems are the subject of analysis of steel sheets cutting processes with the analysis of causes of customer complaints with reference to the produced steel products. Selected steel grades and factors affecting the efficiency of the technological process are presented. The analysed set of factors translates into the level of product quality and reduction of arising defects.

Keywords: production, material, steel, quality, defects