

## IMPROVEMENT OF THE ANCHOR PRODUCTION FOR MINING INDUSTRY

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### Abstract

Mining industry is a very specific economic field. The products used in it should be of high quality and safety. These products should provide a safe and peaceful work for miners who, in the rough conditions, usually extract the raw materials needed by every economy in the world. Nowadays, the aim is to reduce the cost of underground mining, so sometimes there is a very dangerous phenomenon such as the attempt to save on a mining casing. This is a very critical and misleading approach to the issues of savings in mining. This industry is characterized by very severe working conditions and a high degree of life threatening, so we should not save on the safety of miners. It is important that the products and equipment used in the mining industry are always of high quality. This is a key element for ensuring security. Therefore, the correct production of these products and equipment is so important. That is why work has been done to improve the anchor production process from the S235JR steel.

**Keywords:** Improvement of the production process, mining supplies from the S235JR steel

### 1. INTRODUCTION

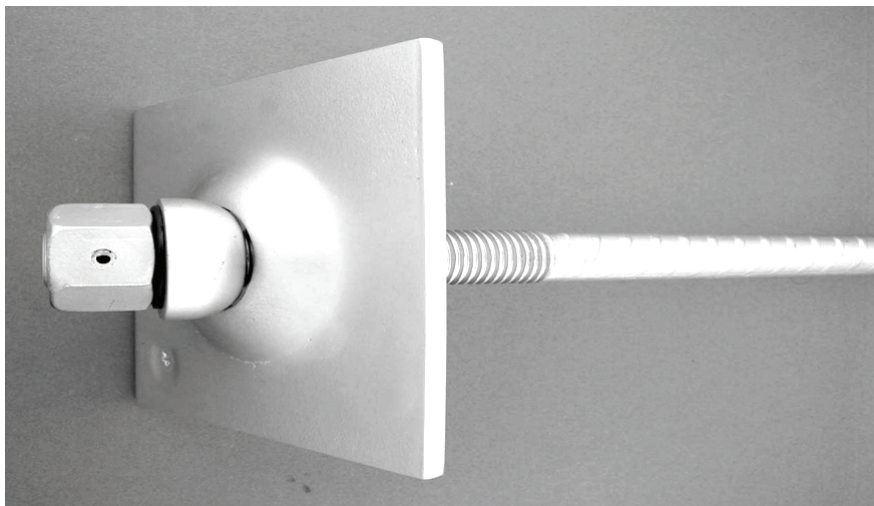
Mining requires a highly developed transport and safety infrastructure in the mine, especially underground. The problem has always been and is the issue of adequate protection of the pit. For the protection of mining excavations serves a broadly understood mining casing is differently all technical means to ensure the stability and durability of the excavation. The housing is exposed to very high stresses due to the pressure of rocks and earth. There are many types of mining enclosure. The housing is exposed to very high stresses due to the pressure of rocks and earth. There are many types of mining enclosure [1]. Mining enclosure can be divided [2]:

- a) due to the type of construction:
  - support,
  - anchored (anchor).
- b) due to its usage time:
  - permanent,
  - temporary.
- c) due to the material used (steel, wood, etc.);
- d) due to shape:
  - straight,
  - circular,
  - arc.
- e) because of the security used:
  - anchored,
  - anchored-plate
  - anchored-reticular,
  - anchored-roof-bar,
  - anchored with injection of rocks.

The main task of the mining enclosure is to secure the workpiece in a way that protects people, machinery, equipment and devices from falling off rock fragments or from infarction for the operation of the mine. Additional housing tasks include:

- protection of the exposed rock surface of the excavation from the negative effect of mine air,
- to prevent the effects of gases from rocks,
- reduction of air resistance flowing through the excavation,
- closing or controlling the water inflow to excavations,
- isolation of workings, people and equipment from fire fires.

Matching a suitable mining enclosure requires extensive knowledge of mining, geology, mechanics, mining technology. Material used to manufacture the enclosure must meet certain technical quality requirements. Improving the production process must not affect the deterioration of product quality and safety, but only the minimization of production costs. In most cases, special anchors and support elements are used to secure the excavation work. **Figure 1** shows the APB anchors together with the base washer, spherical washer, anti-clock washer and nut. The anchor is designed for the protection of the roof and hollows of mining excavations, as a stand alone or reinforcing anchor casing and for the suspension of various mining equipment.



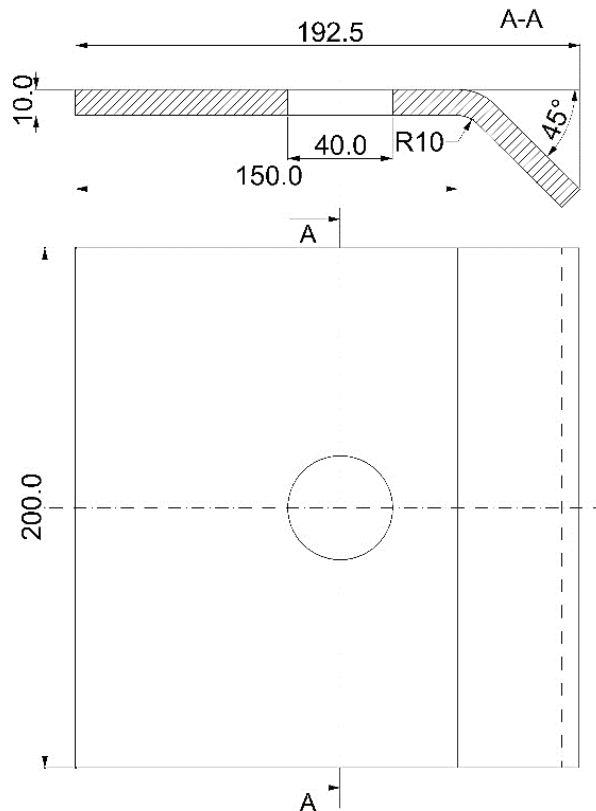
**Figure 1** APB type anchors

## 2. THE TESTED PRODUCT DESCRIPTION

The assortment of the company is used for the protection of mining excavations, as a stand alone anchor box and in civil engineering for strengthening bridges and tunnels. The conditions in which the company's products are used determine the characteristics of the company's products - durability, safety, high quality and durability. The products are exposed to high stresses and forces acting directly on the mining casing, so it is important that all components are manufactured in accordance with the technical documentation.

One of the products is a specialist base washer 10 x 200 x 200 mm Ø40 mm / bent 50 mm - 45 ° (**Figure 2**). The washer is made from sheet 10 x 1000 x 2000 mm grade S235JR. This steel is classified as non-alloy steel construction. The grade of steel used is most often used on unreliable constructions in general and industrial construction. Elements that are made of this grade of steel can be combined by welding, riveting and screwing. Non-alloy steels after hot rolling are delivered in the form of flat and long products (sheets, strips, bars, sections). The basis for the classification of these steels is mechanical properties and the chemical composition is an additional acceptance criterion (Polish Standard PN-EN 10025, 2002) [3-7]. In order to reduce the production waste, the company scrupulously selects the sheet metal sheet to the manufactured product. It is

important that production costs be reduced at each stage of the product's life cycle [8]. Its use is found as a basic washer for fastening anchors in underground mining. **Figure 2** is part of the technical documentation of the product prepared by the Technical Department of the analyzed company. This documentation is indispensable for the production of each product, so it must be made very meticulously and in detail.



**Figure 2** Square washer 10 x 200 x 200 mm Ø40 mm / bent 50 mm - 45 °

Washer production 10 x 200 x 200 mm Ø40 mm / 50 mm curved - 45 ° takes place in a planned and properly organized. In the first place, when the order is sent to the Department of Commerce is checked for correctness of previously agreed data. Then the order is run in Navision system where the material demand and production capacity are checked. After confirmation of the order in the system of Production Department proceed to implementation. The technological process of the washers 10 x 200 x 200 mm Ø40 mm / bends 50 mm - 45 ° runs in the following stages:

- metal sheet cutting to 10 x 200 x 200 mm;
- pressing the Ø40 mm hole on the press;
- 50 mm washer bent at 45 ° on a specialist bender;
- final acceptance by Quality Control,
- product designation;
- preparation for shipping.

All stages of production are subject to continuous quality control. In addition, each production batch is finally marked for possible identification. Weekly workers process 3500 kg of metal sheet for about 1000 pieces of product. Three employees are responsible for the production of these washers. For the production of this production devote 7 h and 40 min. This is the total time devoted to the above mentioned technological operation.

### 3. IMPROVEMENT OF THE SQUARE WASHER PRODUCTION PROCESS 10 X 200 X 200 MM Ø40 MM / BENT 50 MM - 45 °

Today's high market competitiveness forces technology and manufacturing engineers to optimize and streamline production processes. Thanks to such actions it is possible to reduce production costs and thus lower the price of a given product [9, 10]. The washer production process 10 x 200 x 200 mm Ø40 mm / bent 50 mm - 45 ° consists of three main technological operations:

- metal sheet cutting to 10 x 200 x 200 mm of S235JR steel to the size of the washer;
- pressing the Ø40 mm hole on the press;
- 50 mm washer bent at 45 ° on a specialist bender.

The whole process also includes a number of support measures such as broad customer service, storage and delivery of materials, quality control, production planning, stockpiling and preparation for shipping. A number of correct functioning of these activities directly affects customer satisfaction. In order to perfect the washer production process of a 10 x 200 x 200 mm Ø 40 mm / bend 50 mm - 45 ° pad, the engineers decided to combine two following technological operations:

- pressing the Ø40 mm hole on the press;
- 50 mm washer bent at 45 ° on a specialist bender.

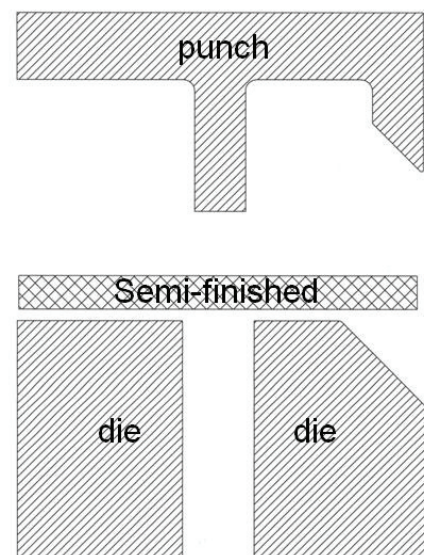
There is a technical possibility to combine the above two operations into one. These operations were previously performed on two separate machines. The production manager was forced to commit to this task by two employees, who generated additional costs, which made the whole production process longer. The first operation was carried out on the hydraulic press, while the second was on the specialist plate bender. Introducing the improvement of the production process caused the bender to switch off the production process. The washer bend operation was taken over by the press. This is a technical device that multiplies the pressure by applying the pressure constants in a closed hydraulic system. Allows a number of operations dependent solely on the die and punch type. They are usually used for metalworking due to the high pressure required.

In order to improve the washer manufacturing process, special matrices and stamps were specially designed for this type of special operations. This is an innovative tool that requires additional technical requirements to ensure the correct operation of this operation, namely:

- inserting an elongated stamp to stabilize the washer when it is bent;
- the top bending edge of the top die should be 50 mm above the cutting edge of the punch to stabilize and prevent the bending of the bent material;
- minimum pressure 200 tons due to bending process.

**Figure 3** shows an illustrated diagram of a constructed die and punch for a washer 10 x 200 x 200 mm Ø40 mm / bent 50 mm - 45 °.

The matrix was made according to the technical requirements of the constructor. Creating every new matrix requires a great deal of experience from the designer. Each die must be carefully checked in advance for quality and technical drawings. The test series of the respective die is then carried out and the dimensions of the article are examined in detail. It is only after these processes that matrices are allowed to be used in production. The use of this solution has reduced the production process by one workstation and one bender operator. This has also increased the quality of the washer in terms of dimensional requirements of the customer. This is due to a better centering of the bend



**Figure 3** Diagram view of the die and punch for stamping and bending the washer

opening for bending the washer when performing these operations on one workstation and one set of machine and workpiece. It also shortened the execution time of the production process by 80 minutes, up to 6 hours and 20 minutes.

#### 4. CONCLUSION

There are many ways to improve production. Depending on the situation, engineers, production managers need to select the right method for the process and the company. The conditions for implementing methods of improving production will always be different. It is often the case that by streamlining certain processes in an enterprise employees do not realize that they use one of the methods of improving production. In the analyzed company, the improvement of the production process was carried out in the form of a change in the organization of production technology. There were connected two stations where two different technology operations were performed. This resulted in the reduction of the number of technological operations for the main washer 10 x 200 x 200 mm Ø40 mm / 50 mm curved - 45 ° from three to two:

- metal sheet cutting;
- hole punching and washer bending.

It managed to combine two operations into one, thus achieving the purpose of the whole operation - the production time of these operations was reduced from 7 h 40 min to 6 h and 20 min (shortening by about 17%). By shortening the time to add value to the process, the time of the entire production process has also been shortened, which in turn has resulted in lower production costs while maintaining a high level of production. This improvement has ensured that the company's products were produced faster, cheaper and more economical. This enables the company to reduce the price of the product offered while undermining its competitive position. Nowadays, in most cases, only the lower price counts, so it is important to constantly reduce production costs.

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