JIG DESIGN FOR DISASSEMBLY OF UNDERCARRIAGE COMPONENT

Tomáš SZOTKOWSKI [1], Ivan MRKVICA [1]

[1]*Faculty of Mechanical Engineering, VSB-Technical University of Ostrava, Czech Republic EU*
tomas.szotkowski.st1@vsb.cz, ivan.mrkvica@vsb.cz

Abstract

The article deals with the design of a vehicle dismantling component. It is the front axle of the SUV, with a 4 x 4 drive produced by Brembo. The main part of the article describes design of the dismantling product, which allows a reliable removal of the scrap assembly by a hydraulic press. Subsequently design of the individual parts of the product and the process of disassembling the scraper knuckle from the whole assembly to the individual parts is described. The material of product components is designed with respect to the safety and maximum load of the hydraulic press. Finally, a technical and economic evaluation is carried out for the dismantle product, which calculates the financial savings associated with the practical use of the disassembly tool.

Keywords: Knuckle, dismantle jig, undercarriage component

1. INTRODUCTION

Tke knuckle of car-body is the dismantlig jig part of which is designed and constructed for. This knuckle is assembled with cast aluminum body and metallic elements (**Figure 1**). The main part is the aluminum frame of knuckle, and a steel hub with internal grooving and five screws mounted on the head of the hub. Another component is a two-row ball bearing from NTN-SNR, which assures the movement of the hub in the knuckle [1]. This bearing is then secured with an inner ring according to DIN 472 to a diameter D = 98 mm. The knuckle also includes a steel bushing with an outer diameter d = 30 mm. All of these components are assembled into an aluminium body of knuckle on a single assembly line, where the bearing is not pressed into the bush, which is then locked by a locking ring. Then hub is pressed into this bearing in the same press. As a last assembled component is a steel bushing pressed into the side of the body of knuckle.

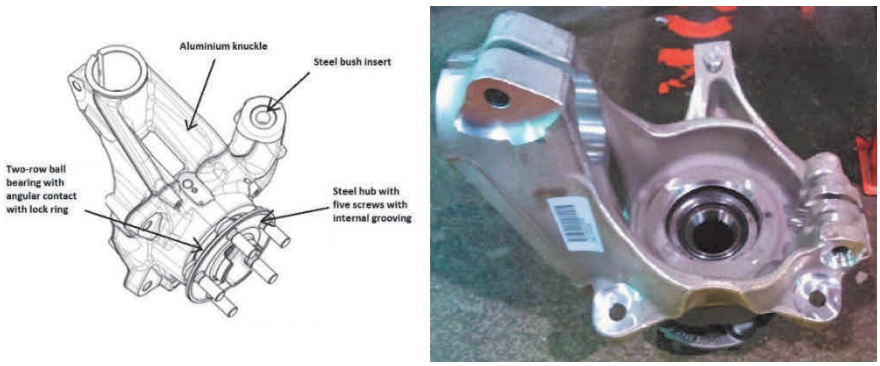

Figure 1 Assembly of knuckle

If a product defect is found during machining or assembly of knuckle, it is necessary throw out the entire assembly between the scrap pieces and remove this part from the line. For example defect may be a badly milled groove, a drilled hole, or poor fitting [2]. The scraper knuckle travels to the disassembly area of the scrap components. Here it is a necessary to dismantle all the metal parts of the aluminum body of the knuckle so that the body can be sent to the foundry for fusion. The problem of the existing disassemble is destruction of disassembled parts such as bearing [3] and hub.

In economic therms, when the knuckle is labeled as SCRAP, and already contains all the components as bearing, hub and bushing, all these components are subject to destruction during the actual dismantling, even if the scrap was detected on the aluminum parts. The bearing and the hub are some of the more expensive items in this assembly since the aluminum body of knuckle is to be rolled again.

2. DISMANTLING JIG DESIGN

One of the main problems of the existing disassembly is the more sophisticated and also the safer attachment of the disassembled parts in the work area of the press. In the first dismantling step, the needle assembly must be secured in the work area to avoid any displacement or fall of the knuckle. For this reason, it is necessary to construct the jig, which will be clamped in the working space of the hydraulic press. For disassemble the knuckle jig is made for clamp entire assembly and next to disassemble it step by step without removing the operator in the working area of the press (**Figure 2**) during the contact of the piston with the disassembly part. This jig is divided into 3 positions according to the disassembly procedure (**Figure 3**). At each position, one of the steel component is disassembly for which these positions are precisely adjusted [4].

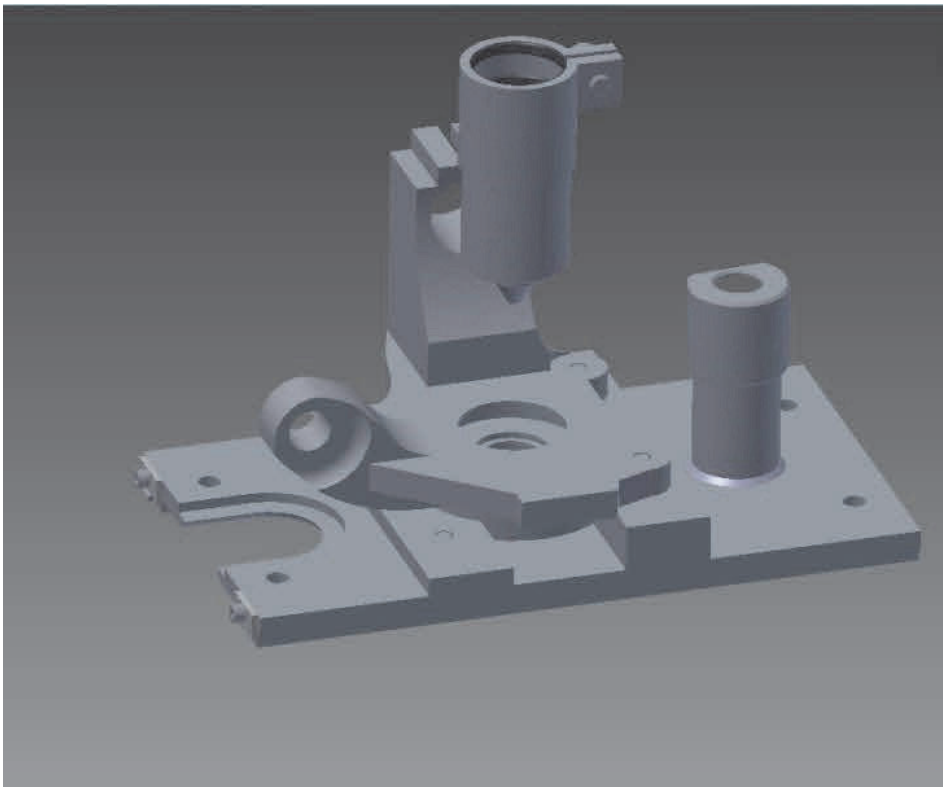

Figure 2 Disassembly knuckle on the jig

Disassembly on this product is using the P30 / ML [5] hydraulic press, used in the current method. The jig is placed on the hydraulic press in the working space on the transverse beams by means of guiding grooves with movable cylindrical segments of diameter d_s = 5 mm (**Figure 4**) which provide for the displacement of the preparation on the beams of the press.

Securing the knuckle on the jig was done by means of centering pins. These centering pins serve for the positioning of the lining pads. Two of these pins are longer and serve additionally as the centering elements of the knuckle. The pins have thread with M12 on length 15 mm to prevent the pin from projecting from the bottom of the base plate. The pads that are attached to the pins serve to position the knuckle so that the hub axis with the bearing is identical to the axis of the mandrel that will be disassembled [6].

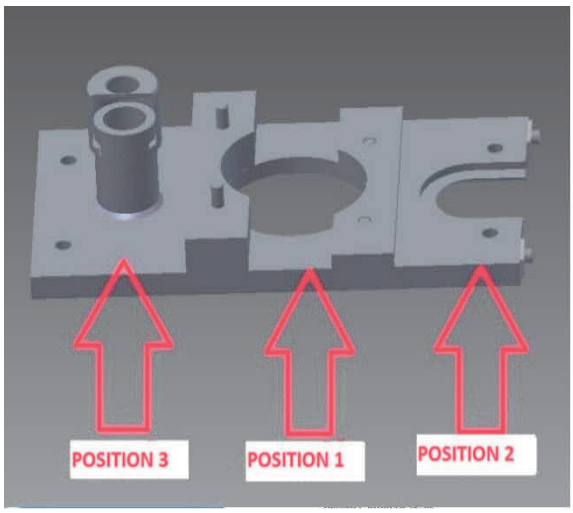

Figure 3 Clamping part of the jig

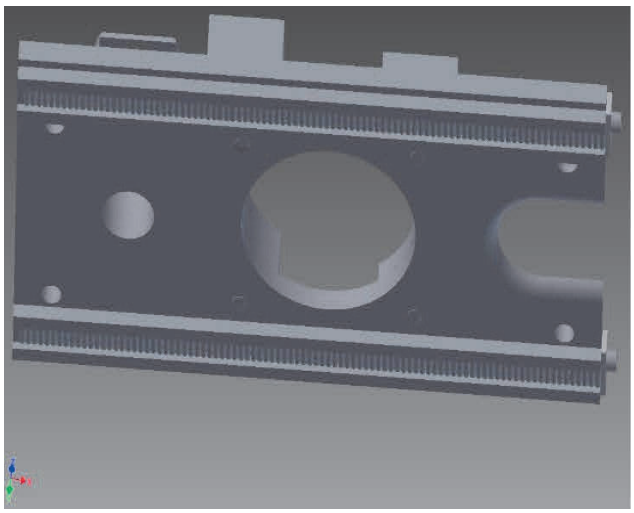

Figure 4 Cylindrical segments for moving the jig into press

The bearing is disassemble at position 2 (**Figure 5**). Position 2 is on the disassemble jig, mainly in shape. This position is a milled groove with a rounded shape that matches the shape of the hub. This rounding follows the part of the hub that is supported by the pressed bearing (**Figure 6**). When dismantling, the hub-bearing assembly is inserted in such a way that the bearing is supported by the jig and the thorn pushes the hub downwards out of the bearing. In this case, it is necessary to design the jig so that there is no large deflection or damage to the jig during dismantling since the force of the hub mounting in the bearing can reach up to 35.000 N.

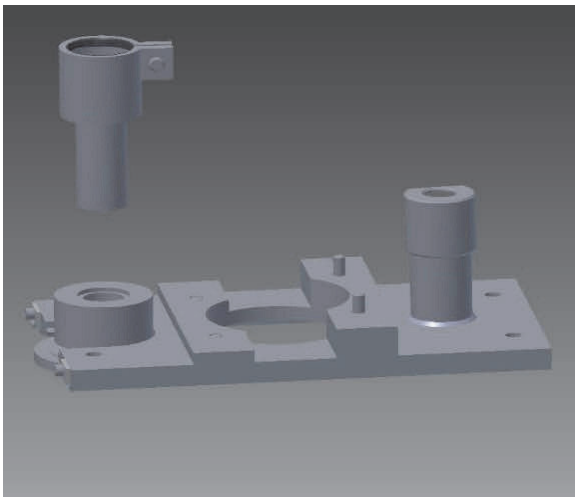

Figure 5 Example of disassemble bearing

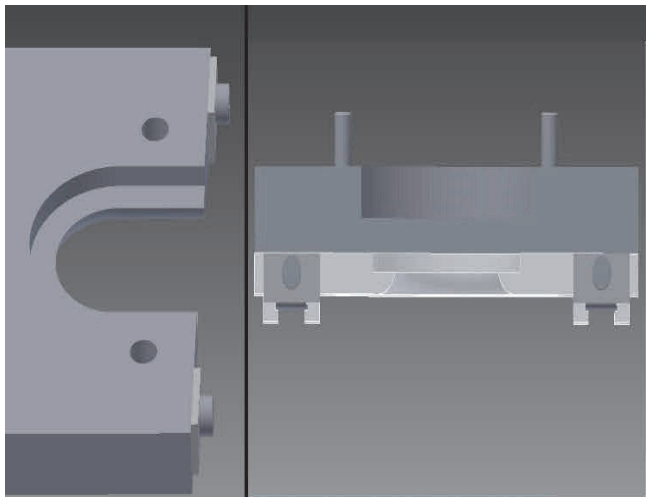

Figure 6 Position for disassembly hub out of the bearing

To dismantle the remaining part, the bushing serves as position number 3 (**Figure 7**). At this position is a hole with a diameter bigger than the maximum diameter of the bushing is drilled in the jig. A steel tube (half-wave V-weld over the entire diameter) is welded to this opening with a diameter of the inner diameter equal to the hole in the jig, that is 42 mm. A groove for securing the locking segment is formed on the tube.

This locking segment serves to secure the knuckle against tilting or otherwise pulling out the pipe face (**Figure 8**). The knuckle are insert on the tube with a bushing arm so that the largest diameter of the bushing is inserted into the upper tube opening and the axis of the bushing is identical to the axis of the pipe.

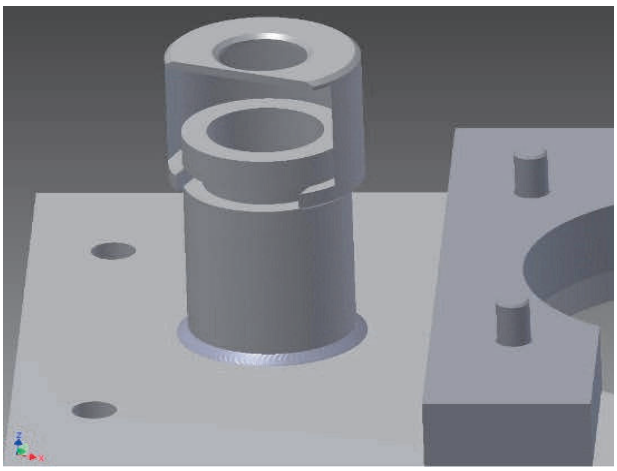

Figure 7 Position for removing bushing

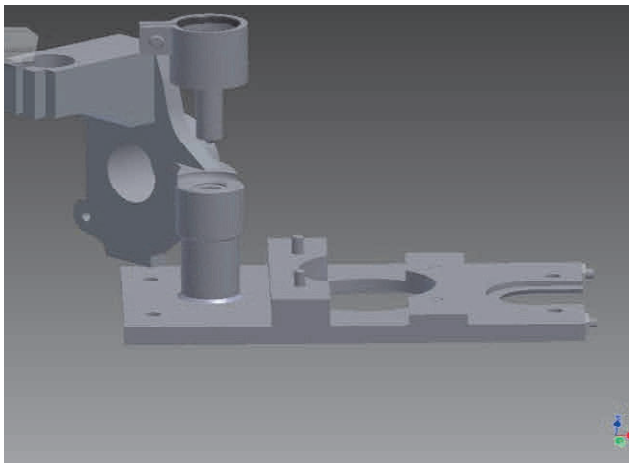

Figure 8 Example of disassemble bushing

The jig is designed in such a way that the disassembled component is installed and disassembled without the need for the holding the component by the operator. As for the problem of the thorn jamming possibility, three spindles are designed for this disassembly variant, used to mold individual components. Each of the thorn has a given diameter for the disassembly operation (**Figure 9**). Additionally, they have thorns on the head of cones, used to accurately guide the thorn over the disassembled part.

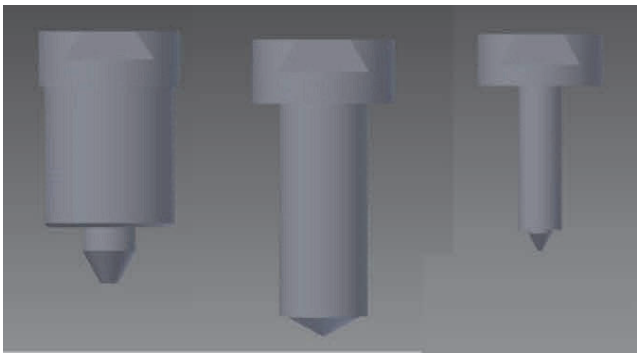

Figure 9 Thorns for disassemble of the knuckle

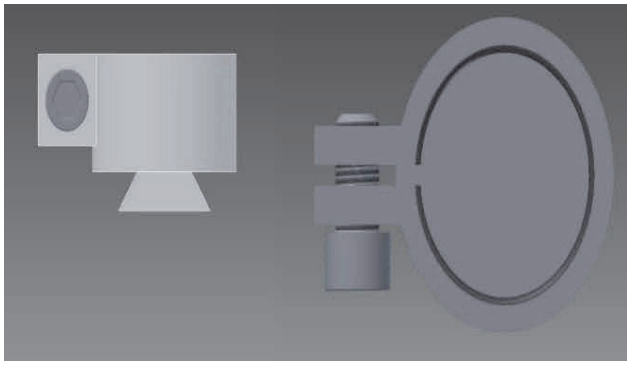

Figure 10 Clamping part of the thorn

Table 1 - Properties and chemical composition of the material

Properties	Values
Ultimate tensile strength R_m (MPa)	520 - 628
Yield point $R_{e\ min}$ (MPa)	333
Hardness (HB)	274
C (wt. %)	0.2
Mn (wt. %)	1.6
Si (wt. %)	0.55
P (wt. %)	0.5
S (wt. %)	0.45

A component which serves as a spacer between the piston and the thorn were used for the clamping of the thorns to the hydraulic piston. It is a clamping part, which is formed by a rubber band at the place of mounting

of the hydraulic piston (**Figure 10**). Hydraulic piston clamping is solved by a ISO 4762 M16 hexagon socket head screw with which the clamping part tightens. Clamping of the thorn on this clamping part is accomplished by means of a dovetail groove with an angle β = 55°, which is provided with each thorn. With this dovetail groove and the clamping part on the press piston, the respective thorn on the piston is clamped at each operation, and it is not necessary for the operator to hold it dangerously in the working space of the press.Critical place of the preparation is position 2. In this position, the bearing is removed from the hub, which can be stretched to F_{nm} = 35.000 N. The model of the base plate of the jig was subjected to the number 2 load test at F_{nm} = 35.000 N. The product was designed from S355J2G3 steel according to EN 10025-2 (11 523 according to ČSN)

The strength analysis of the 2nd position of the disassembly base plate was developed in the ANSYS Workbench version 17.2. During the simulation, the base plate at position 2 was loaded with a force of Fnm = 35.000 N, simulating the removal of the hub from the bearing (**Figure 11**). For the simulation, material values identical to the proposed S355J2G3 material were used [7].

It can be seen from the results that the maximum deflection of the stressed part on the jig is not bigger than 0.2 mm, which is negligible for this product (**Figure 12**). According to the following output it can be stated that the resulting stress is about 120 - 130 MPa, which satisfies the proposed steel. The stress peaks emerging around the handle holes are misleading and negligible as these holes are not functional areas of the disassembly position of the device. According to the strength analysis, it is clear that the proposed S355 J2G3 material is suitable for the preparation [8].

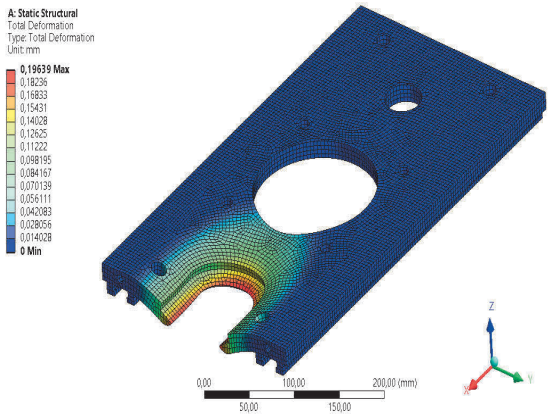

Figure 11 Deflection at disassembly site

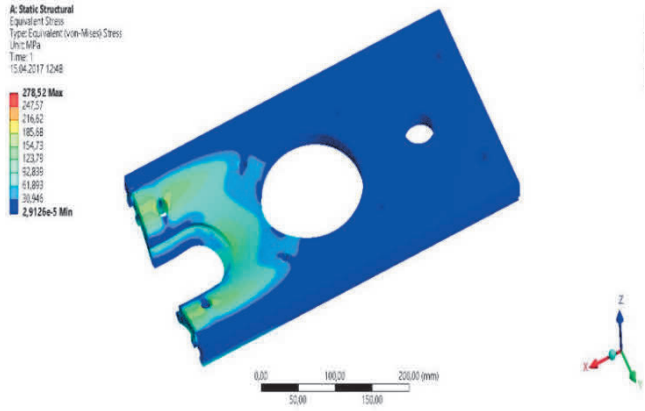

Figure 12 Stress in the loaded place

3. CONCLUSION

The disassembly procedure is similar to the previous variant, but its steps are more sophisticated and guarantee the dismantling safety and prevent destruction of the disassembled parts. From this perspective, the return of the tested disassembled parts back to production is the main technical and economic benefit. In the case of a dismantled bearing, it is a very complex check. This part has not been 100 % checked yet whether the rolling segment has not been pushed inside. Even such annoyance can lead to a reduction in service life for the bearing. For this reason, it is not planned yet to deploy the dismantle bearings until the bearing has undergone all tests. However, the hub as a disassembled part can be checked mainly visually.

If there is no damage or change dimension in the hub at the bearing place during the removal of the hub from the bearing, it is possible to return the hub back to production. In the case of a bushing, it is also possible to return to production, but after checking the change of the shape of a larger number of pieces. According to the information, the average annual scrap rate of these types of weights is 0.88 %. Subsequently, the return of the

disassembling jig was recalculated after returning part of the dismantled hubs back to production, which did not exceed a quarter of a year.

From a safety point of view, when disassembling the jig, the disassembly spikes are secured against jamming during the press operation. Each disassembled component is clamped during the press operation itself. In this respect, it is not necessary to manipulate the disassembled part by the operator during disassembly, thus eliminating the safety risk of injuring the operator during disassembly.

ACKNOWLEDGEMENTS

Article has been done in connection with projects Education system for personal resource of development and research in field of modern trend of surface engineering - surface integrity, reg. no. CZ.1.07/2.3.00/20.00.37 financed by Structural Founds of Europe Union and from the means of state budget of the Czech Republic and by project Students Grant Competition SP2018/150 and SP2018/136 financed by Ministry od Education, Youth and Sports and Faculty of Mechanical Engineering VŠB-TUO.

REFERENCES

[1] RABINĚR, E.G. *Montáž, demontáž a použití valivých ložisek. 1*. Praha: Statní nakladatelství technické literatury, 1954. p. 204 .

[2] PETRŮ, J, PETŘKOVSKÁ, L, ZLÁMAL, T, MRKVICA, I. Resistance of Sintered Carbide Materials against Heat Shocks Induced by Cutting Process. In *METAL2014: 23rd International Conference on Metallurgy and Materials*. Ostrava: Tanger, 2014, pp. 1-6.

[3] SKF: Kuličková ložiska s kosoúhlým stykem. *SKF* [online]. [viewed 2017-04-06]. Available from: http://www.skf.com/cz/products/bearings-units-housings/ball-bearings/angular-contact-ball-bearings/index.html

[4] MRKVICA, M. *Přípravky a obráběcí nástroje II. Díl. Přípravky*. 1st ed. Ostrava: VŠB - Technical University of Ostrava, 1988. 184 p.

[5] OMCN: Hydraulic presses. Automotiv [online]. Italy [viewed 2017-03-04]. Available from: http://www.omcn.it/wp-content/uploads/2015/02/29_Presse-idrauliche.pdf

[6] Material Standards. *Poltech* [online]. 2013 [viewed 2016-04-28]. Available from: [http://www.poltech.cz/poltech/10-Normy-CSN-DIN-ISO/15-Vlastnosti-oceli-10-19]

[7] JURKO, J., PANDA, A., DŽUPON, M., PANDOVA, I., GAJDOŠ, M. Deformation of Material uder the Machined Surface in the Manufacture of Drilling Holes in Austenitic Stainless Steel. *Chemické listy*,2011, vol. 105, no. 1, pp. 600-602.

[8] VÁCLAV, Š, JURKO, J, LECKÝ, Š, BALC, N. Allowance treatment static designed couple and repeatable precision in assembly. MATEC Web of Conferences [online]. 2017, 137, 04007- [viewed 2018-04-10]. DOI: 10.1051/matecconf/201713704007. ISSN 2261-236X. Available from: http://www.matec-conferences.org/10.1051/matecconf/201713704007