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INVESTIGATION OF EMBOSS HEIGHT DISPLACEMENT THROUGH EMBOSSING PROCESS FOR AGRICULTURAL COMPONENT

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ABSTRACT

The Indonesian state has abundant fertile land and is the main producer of various tropical agricultural products. One of the important agricultural commodities in Indonesia is rice. In planting rice, processing equipment such as tractors is needed. Tractor wheel fin is the most important part of a tractor for plowing fields. Damage to the tractor wheel fins due to the lack of ability of the tractor wheel fins to withstand loads and is caused by the age of the fins themselves. Previous research has made a bending tool that can also be used to form the fin wheel of a hand tractor with a hydraulic system, with one stage of the bending process, two embossing in the shape of a radius as reinforcement. Therefore, this study was conducted to see how the effect of embossing on the flexural strength and hardness of the tractor wheel fins using a variation of the triangular embossing model, the number of embossing 1, and the embossing height of 4, 5, 6 mm with carbon steel (St 42), plate thickness 3.8. mm. Based on the results of research conducted, the higher the embossing, the greater the resulting maximum load, where the maximum load is obtained by the tractor wheel fin with a triangular embossing model, and the embossing height of 6 mm, the bending stress is 147.143 N/mm^2. The hardness test results of the tractor wheel fin with a triangular triangle model, height 6 has the greatest hardness, namely 171.43 HB.

Keywords: embossing; emboss height; hardness; agricultural.

INTRODUCTION

Indonesia became an agricultural country and excellent in the agricultural sector a lot of area regions in Indonesia as a granary and rice for Indonesia. One of the supporting factors for producing rice is a hand tractor. The hand tractor is the driving source of agricultural equipment. Typically hand tractors are used to pull earth-moving implements such as plows. As a soil cultivator, hand tractors have high adaptability to land conditions in Indonesia. Hand tractor consists of several constituent components, one of which is the tractor's iron wheel fin which is one of the vital components of several existing components. This is because the fin of the tractor's iron wheel functions as a soil breaker in the rice fields. In plowing the soil is usually determined by the type of plant and the thickness of the topsoil. The depth of the tillage layer for rice plants is approximately 18 cm. There is even soil that has to be plowed even deeper, about 20 cm [1][2]. One of the problems in using a plow is that there are hard objects in the ground, it will provide stronger resistance to the tractor wheel fins so that it can make the tractor wheel fins become bent [3].

The costs can sometimes be reduced by using sheet metal that is thinner than normal. If it requires increased strength and stiffness, it can be done by bending and shaping the sheet of bone [4]. Examinations using experiments and software have been carried out with various types of sheet metal in the embossing process. The results show that this technique is used to improve the stiffness of the plate sheet. Furthermore, to increase the rigidity must consider several parameters such as the number, position, height and distance of emboss. This technique also not only emphasizes the increased stiffness of the sheet metal but can also make the sheet into desired shapes such as panels, car doors, and other parts [5].

Based on the description above, the objectives to be achieved in this study are to determine the effect of emboss height on the hardness produced in the embossing process of tractor wheel fins.

EMBOSSING PROCESS

In this research, the process of forming tractor wheel fin uses metal forming tools, namely punch and dies. In order to determine the magnitude of the force, it is necessary to form the fin wheel of the tractor with one embossing. The force required to bend the fin ends of the tractor wheels.

$$F_{B1} = 0,8 \cdot b \cdot s \cdot R_m \quad (1)$$

$$F_{B2} = 0,5 \cdot b \cdot s \cdot R_m \quad (2)$$

Where F_B is bending force (N), b is bending width (mm), s is plate thickness (mm), and R_m is bending stress of the material (N/mm^2)

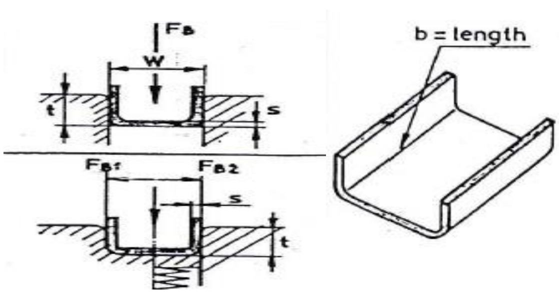

Figure-1. Bending force in U-Bending [6].

By using equations (1) and (2), a force is required to bend the end of the tractor wheel fin. Next, calculate the force required to form the emboss using the equation as follow:

$$Fp = A_{proj} . R_m \quad (3)$$

Where Fp is bending force (N), A_{proj} is embosing area (mm^2), and R_m is tensile strength (N/mm^2).

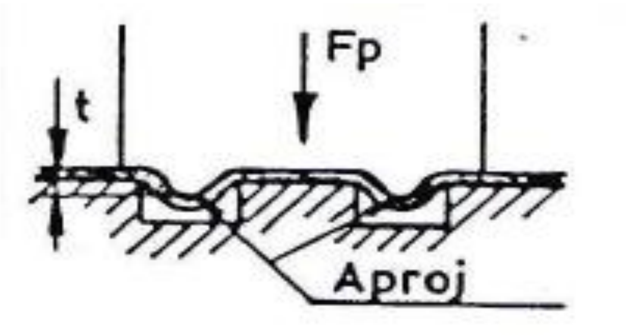

Figure-2. Emboss forming.

Hardness testing is a method commonly used to determine the hardness of a material. Material hardness is the resistance that a material receives against pressure, caused by a pressing device with a certain shape under a certain force. Hardness testing can be carried out by several methods, including Hard Brinnel (HB), Hard Vickers (HV) and HRB (Hard Rockwell Ball) and HRC (Hard Rockwell Cone). The method commonly used for material hardness testing is Hard Brinnel (HB).

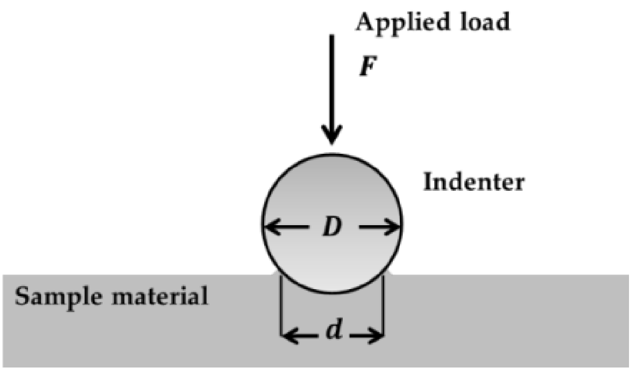

Figure-3. The principle of Brinell hardness testing.

Hardness of Hard Brinnel (HB) is obtained by the comparison between the force (N) and the cross-sectional area of the pressure mark (A), and can be formulated as follows [7]:

$$HB = \frac{F}{A}\,\text{kgf/mm}^2 = \frac{9.8xF}{A}\,\text{N/mm}^2 \quad (4)$$

EXPERIMENTAL METHOD

This research method consists of several stages of working process, namely: material preparation, product manufacturing, product bending, and product testing.

Preparing Materials

This material preparation aims to ensure that the material used in the study is St 42. Before making the tractor wheel fin, the tensile and hardness test is first carried out to determine the mechanical properties of the material including: tensile strength and hardness.

Manufacturing Product

Making samples of tractor wheel fins using a plate cutting machine. The size of the material prepared is 340 mm long and 80 mm wide. The sample shape can be seen in the following figure.

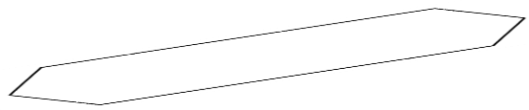

Figure-4. Model for wheel fin.

Bending Product

This stage is carried out to form a hand tractor wheel fin using a punch and dies. The punches and dies are installed on the Press Brake V Bending machine by varying embossing triangular models with a height of 4, 5, and 6 mm. This method of bending test also used in other experiments [8]–[10]. The schematic of bending process was shown in Figure-5.

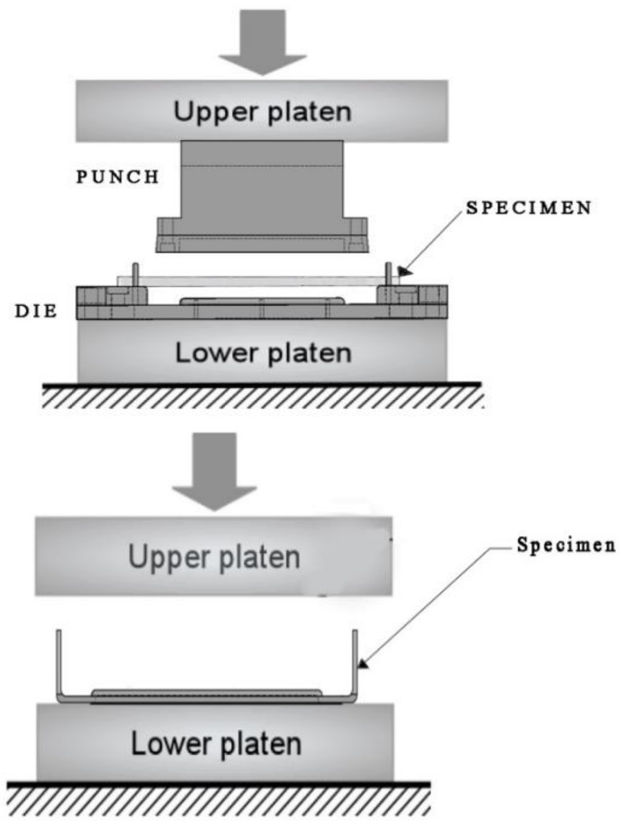

Figure-5. The experimental method for embossing sheet plates with punches and dies.

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The parameters used in the process of forming tractor fins can be seen in Table-1.

Table-1. The parameters of experiments.

Parameter	Value
• Dimension of specimen	270 mm x 80 mm
• Plate thickness	3,8 mm
• Emboss model	Triangle
• Emboss width	5 mm
• Emboss height	4, 5 and 6 mm
• Emboss length	200 mm

Testing Product

Hardness testing is carried out by the Brinnel method to obtain the hardness value in several bending areas. This hardness test was carried out using the Hardness Tester of AFFRI 206 MX machine as shown in Figure-6 [11].

Figure-6. Hardness testing of AFFRI.

RESULTS AND DISCUSSIONS

In this section, the research results will be presented and accompanied by a discussion of each response obtained.

Results

In this study, hardness testing was conducted to determine the effect of embossing on the hardness of the tractor wheel fin. The results of the material hardness test before being formed into the tractor wheel fin are 121.08 HB. Furthermore, the hardness test is carried out on the tractor fin material that has been formed with emboss height of 4 mm. There are 13 points on the tractor wheel fin as shown in Figure-7.

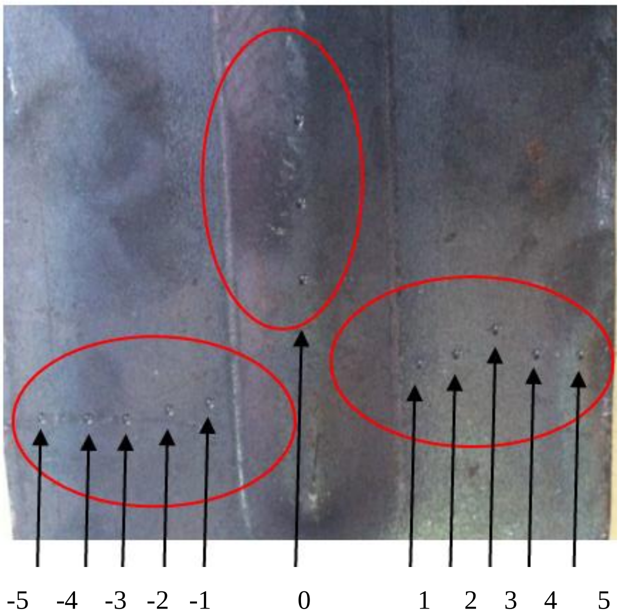

Figure-7. Indenter position after hardness testing.

Hardness testing on tractor fins for embossed height of 4 mm was carried out 3 times for each different position and the results can be seen in Table-2. Furthermore, the hardness test results can be displayed in graphical form as shown in Figure-8. This figure will show changes in the hardness level of the material at each position that is not formed and has been formed.

Table-2. Hardness result for emboss height of 4 mm.

Position	HB_1	HB_2	HB_3	Average
-5	134,0	130,2	136,2	133,5
-4	137,6	133,4	134,4	135,1
-3	136,2	130,8	132,4	133,1
-2	127,5	130,8	132,6	130,3
-1	129,8	137,2	134,8	133,9
0	156,3	154,9	158,0	156,4
1	126,6	133,5	129,6	129,9
2	124,8	123,8	127,2	125,3
3	130,2	130,8	128,2	129,7
4	137,6	131,2	125,6	131,5
5	132,8	138,6	128,0	133,1

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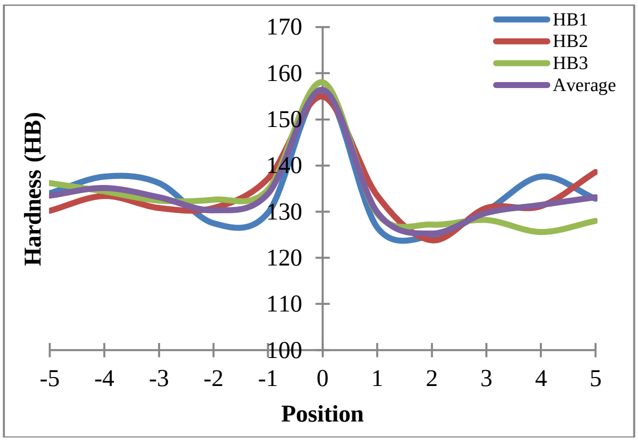

Figure-8. Hardness testing of tractor wheel fin with triangular embossing model with a height of 4 mm.

Hardness testing on tractor fins for embossed height of 4 mm was carried out 3 times for each different position and the results can be seen in Table-3. As well as the hardness test results can be displayed in graphical form as shown in Figure-9.

Table-3. Hardness result for emboss height of 5 mm.

Position	HB_1	HB_2	HB_3	Average
-5	135,0	140,2	140,6	138,6
-4	134,6	139,0	130,0	134,5
-3	125,8	132,9	123,4	127,4
-2	132,0	130,8	128,2	130,3
-1	134,2	130,6	146,6	137,1
0	157,2	163,1	160,7	160,3
1	129,4	149,2	137,2	138,6
2	124,8	122,0	126,4	124,4
3	132,5	131,4	129,2	131,0
4	129,6	138,8	127,2	131,9
5	138,8	136,8	139,2	138,3

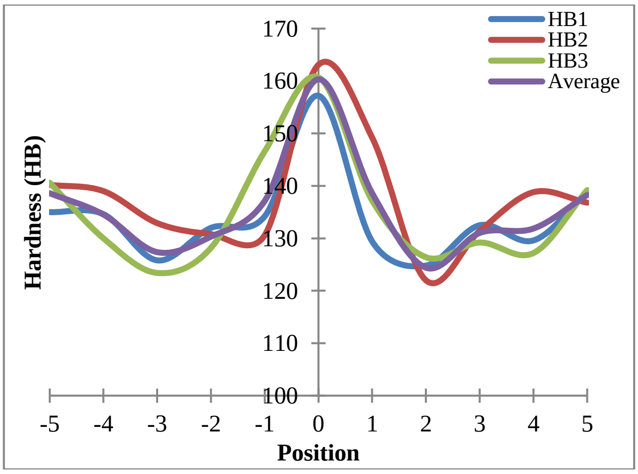

Figure-9. Hardness testing of tractor wheel fin with triangular embossing model with a height of 5 mm.

Hardness testing on tractor fins for embossed height of 4 mm was carried out 3 times for each different position and the results can be seen in Table-4. As well as the hardness test results can be displayed in graphical form as shown in Figure-10.

Table-4. Hardness result for emboss height of 6 mm.

Position	HB_1	HB_2	HB_3	Average
-5	138,2	137,6	139,0	138,3
-4	128,2	133,2	135,8	132,4
-3	124,5	132,6	131,4	129,5
-2	125,8	127,8	126,8	126,8
-1	134,6	133,5	142,4	136,8
0	169,3	168,5	165,2	167,7
1	134,6	129,4	131,4	131,8
2	127,7	126,2	129,4	127,8
3	127,0	133,6	127,8	129,5
4	122,0	135,4	130,8	129,4
5	130,2	134,0	128,2	130,8

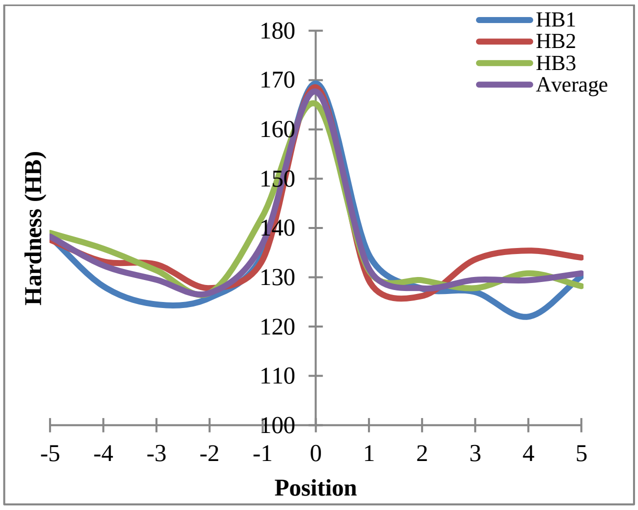

Figure-10. Hardness testing of tractor wheel fin with triangular embossing model with a height of 6 mm.

DISCUSSIONS

Based on the results of the experiments conducted, it can be stated that the HB hardness value will decrease starting from the farthest position from the embossing process (-5) to position -2, then increasing sharply to position 0. After that, HB hardness will be decrease significantly again to position 2 and return increase slightly to position 5. This phenomenon is more dominant at emboss height of 5 mm and 6 mm than emboss height of 4 mm.

In Figures 8, 9 and 10, it shows that the highest HB hardness is obtained at position 0. It means that HB hardness will increase after experiencing the embossing process of the tractor wheel fins.

It can be seen that the increase in hardness that occurs is very significant in the embossing section of the tractor wheel fins. The embossing height affects the hardness, the higher the embossing, the harder the plate. Tractor wheel fin with 6 mm embossing height has the highest hardness (171,433 HB) in the embossing area. This same result also obtained to get highest hardness during bending of JIS3101SS with embossing height 6 mm [12][13]. When comparing the hardness of the embossing tractor wheel fin with a triangular model with an embossing height of 6 mm, it can be seen that it has a greater degree of hardness than other tractor wheel fins.

The emboss height was also studied to determine its effect on increasing the stiffness of the plate sheet, but the results were not felt or the effect was minimal [14].

CONCLUSIONS

Based on the results of experiment and analysis was conducted, it can be concluded as follows:

- The forming tractor wheel fins with the embossing method will result in increased hardness values that obtained at the embossing area.
- The hardness of the tractor wheel fins experienced the most significant increase in the embossing section. The highest hardness value occurs in the tractor wheel fin with 6 mm high triangle embossing model, namely 171.433 HB compared to other tractor wheel fins.

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