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Evaluation of Axial Bearing Properties Bronze C93200-Steel St37

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A B S T R A C T
In this paper, the goal is to study the properties of axial bearing C93200-St37 that has been produced through the casting using pre-mould. In order to bond, the pre-mould are cleaned chemically. Then, the bronze C93200 is melted and then solidified in St37 pre-mould. The hardness has been measured by using the Vickers test triple; the Bond's strength has been measured by using the shear test triple; wear resistance has been measured by using pin-on-disc machine and corrosion resistance has been measured by using salt spray method. The results indicate that the minimum shear strength of bond is at least 94.8 MPa; hardness of bronze, bond and St37 are 80, 100 and 120 HV, respectively; wear rate of bronze is 100% with applying stress of 7.9 MPa and without lubrication by lose weights; and corrosion rate of bronze is 0.86% by lose weights.

Keywords: Wear rate; Corrosion resistance; Hardness; Pin-on-disc; Salt spray; Bond's strength

1. Introduction

In old courses, Egyptians transfer big rocks by moving on trunks and used water or oil to cover them for easy movement. Next, the application of wheels, wooden axle and bearings in transportation and the application of animal oil for lubricating them became common.

Another developments in the progress of bearings was the Babbitt alloy and its application in generating bearings of engines that this alloy was discovered by Isaac Babbitt in 1839 [1].

Bearing is a piece between at least two parts that permits relatively easy movement. In another word, bearing is a piece that decreases friction of two contact surfaces. Two major roles of bearing in machines are as following:

(a) Keeping axis in such a way that prevents its loosening too much.

(b) Inhibiting axle lateral displacement so that prevents collision of moving portions and they became fixing.

Bearings are categorized in term of the kind of force applying on it containing radial force, axial force and radial-axial force [2]. Axial bearing is a bearing, which performs axial load through service [1]. Thus, the quality of the St37-C93200 bond should be responsive to this force.

Axial bearing beares the total weight corresponding to rotating parts, for example, in diesel engines, the total weight corresponding to the crankshaft, connecting rods, pistons, related screws and so on. Also, axial force corresponding to axial block is moved to bearing pieces. These parts are located on spring plates and evantually on the axial bracket. Oil required for lubricating and cooling the bearings are provided through pumping of radial holes in axial block over the rotation of this piece [1]. Thus, the quality relating to the St37-C93200 bonds is very important as they will be separated when the St37-C93200 has weak bonds. To obtaine admissiblebond, 4 main factors are as following [3]:

(a) The bond quality.

(b) The filler metals quality.

(c) Uniform heat.

(d) Suitable reactant are involved.

Therefore, in current research, washing is first performed through immersing in cleaner. Next, oxidization of the surface is carried out using sand paper. Then cleaning is performed over the electrical approach. Eventually, the activation of the surface is carried out with H_2SO_4 solution for ensuring good bond.

Horizontal centrifugal casting method is a technique to produce steel-Cu alloy bearing. In this method, the the bond has a length up to 2.4 μm [4]. Strength of the bond has not been reported in those studiies. Although, in

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current research a simpler and cost effective approach with good strength of the bond is suggested.

Cladding with brazing approach is a method for coating components to produce intermediate layer [5]. In this technique, a filler metal with a melting point smaller than the base metal, is used to coat components. In cladding procedure, which utilized for coating pieces, applied fillers are in different forms, including wire, straps, profiles, powder or even molten [6, 7]. In this research, as the bond has not a simple shape, the bronze filler in the type of respected profile is utilized .

On the other hand, the brazing process has been applied to produce CK25-ASTM B2 Babbitt bearing with a 6.6 μm length of bondof [8]. This method has been effective for Babbitt bearings. Therefore, in this study, this approach has been applied to produce St37-C93200 bearing.

Moreover, brazing technique is utilized to produce CK20-C52100 bearing. In that investigation, the length has been reported inconsiderable. Thus, this technique was not effective in that investigation because of relatively low temperatures and short time of the procedure [9]. Therefore, in current study, time of the casting have been enhanced 2 times.

In current study, the study is aimed to strength, hardness, corrosion resistance and wear resistance in axial bearing (St37-C93200) generated using casting in the pre-mould.

2.Materials and Method:

As presented in Table 1, ARL quant-meter device has been used to determine the chemical composition of the axial bearing, which was a piece of St37 with a diameter of 100 mm, and the results has been reported based on ASTM E415-15 [10]. Thickness and diameter of bronze profile were 5 mm and 90 mm, respectively. The thicknesse of pre-mould and bronze were 15 mm and 5 mm, respectively. The applied flux was made of $ZnCl_2$, NH_4Cl, NaCl and Sn powder.

In this study, all the tests were performed using the Standardization Administration of Iran for ensuring accuracy. In addition, all the tests were performed at least 2 times for ensuring precision,.

A 6 mm-thick St37 sheet was prepared from Sepahan Steel Company. ARL quant-meter device was used to check the chemical composition of the sheet and the results was presented in Table 1. Bronze C93200 is machined as filler in a profile form with thickness of 5 mm and diameter of 90 mm so that it has no contamination. Chemical composition of C93200 is determined according to standard DIN EN 15079-15 [11] by means of WAS quant-meter machine and the results was presented in Table 1.

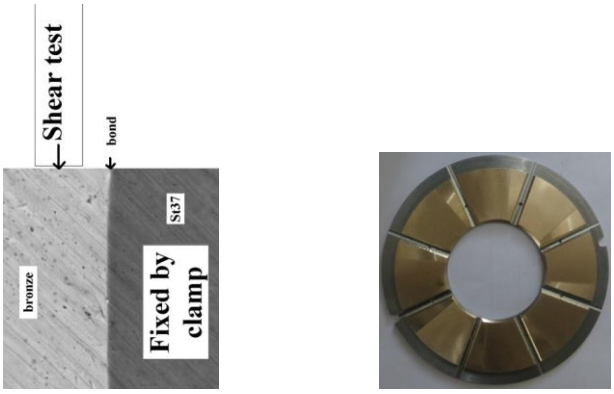
Table 1: Chemical composition of St37 and C93200

Element	Fe	C	Mn	Si	Cr	Cu	Al	Ni	S	P
Wt%	Balance	0.15	0.47	0.24	0.06	0.06	0.047	0.02	0.005	0.019
Element	Cu	Sn	Pb	Zn	Fe	Ni	S	Ag		
Wt%	Balance	7.0	9.0	2.1	0.29	0.53	0.014	0.01		

In current paper, bond's strength, hardness, corrosion resistance and wear resistance of C93200 with 5 mm thickness to St37 with 10 mm thickness are studied to assess the features of St37-C93200 axial bearing fabricated via casting in the pre-mould. For this goal, the shear test device according to Figure 1a, hardness test device according to ASTM E92-17 [12], salt spray test device based on ASTM B117-16 [13] and pin-on-discc device according to ASTM G99-17 [14] (for wear test) available in the laboratory, approved with the Standardization Administration of Iran were utilized. Before C93200 cladding, St37 is cleaned as follows:

1. Cleaning is carried out mechanically using steel brush.
2. Immersion of parts in H_2SO_4 solution will be performed for 5 minutes.
3. Parts are cleaned with CH_3OH for 10 minutes.
4. Parts are coated manually using flask contain $ZnCl_2$, NH_4Cl, NaCl and Sn powder.
5. C93200 (Filler metal) is cleaned using H_2SO_4 solution for 10 minutes.

For cladding, bronze filler is first located in profile and next it will be heated to melt. Finally, torch will be kept on 6 minutes. Next, cladding piece is cooled down until room temperature. Figure 1b represents final product.



(a)Shear test procedure (b)Final product of axial bearing

Figure 1: (a)Shear test procedure, (b)Final product of axial bearing

3.Results and Discussion:

The results of the shear test, hardness test, salt spray test and wear test listed in Table 2.

Table 2:Properties of St37-C93200 axial bearing

No.	Contact area (mm^2)	Force (N)	Bond's strength (Mpa)	Hardness (HV)		Wear (weight loss)	Corrosion (weight loss)
1	38.84	3681	105.6	St37	120		
2	31.3	3361	107.3	Interface	100		
3	37.44	3550	94.8	Bronze	80	100%	0.86 %

3.1.Evaluation of strength and hardness:

Bond's strength and hardness of St37-C93200 is listed in Table 2. The bond's strength of at least 94.8 Mpa is observed.

Yield strength corresponding to C93200 is nearly 138 MPa[3] and its tensile strength is almost 241 MPa[3]. Moreover, yield strength corresponding to St37 is nearly 290 MPa[15] and its tensile strength is nearly 440 MPa[15]. In current research the least strength of bond for St37-C93200 is 94.8 MPa, which is acceptable for bearing uses. The least strength of bond (94.8 MPa) is smaller than yield strength of bearing metal (138 MPa) and greater than the half of its yield strength (138÷2=69 MPa). Therefore, strength of bond is not very small, but it will be separated from the St37 before plastic deformation of bearing metal.

In bearings, abovementioned property is effective as plastic deformation corresponding to bearing in movable series of crankshaft and connecting rod (even near smaller than 1 μm) leads lack of lubrication and also in cause's great damage [1, 16].

3.2.Evaluation of corrosion resistance:

Corrosion test by salt spraying at a concentration of 5±1% by weight of salt and distilled water and with acidity of 6.5 to 7.2 at 35°C and with salt spraying pressure from 0.83 to 1.24 bar, so that the angle of 15 to 30 degrees relative to the vertical direction in the enclosure is suspended for 168 hours. The volume of the collected solution is 1 to 2 liters per hour and the sample was washed with raw water. The initial weight of the sample was 89.24 g and the sample weight after the end of the test was 88.47 g (Fig. 2). In this way, weight loss is 0.86%.

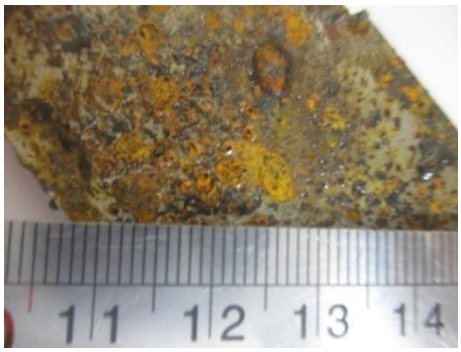


Figure 2: Sample image after 168 hours of corrosion

3.3.Evaluation of wear resistance:

The wear resistance was tested by abrasive disk with a hardness of at least 2060 HV under a stress of 7.9 MPa (applied force to the 150 N) at a linear speed of 10 m/min. The surface area of the sample is 18.92 mm^2 (Fig. 3a). After a distance of 22 m, the bronze was completely (100%) removed (Fig. 3b) by 40.1 mm^3, and the test was stopped. It should be noted that no lubrication has been used.

(a) before wear test (b) after wear test

Figure 3: Image of pin-on-disc sample (a) before wear test, (b) after wear test

4.Conclusion

In current investigation, the goal was to investigate the properties of St37-C93200 axial bearing fabricated via the casting through pre-mould. At first, the metals were cleaned chemically using H_2SO_4 solution for 5 minutes to bond. Then, they were cleaned with CH_3OH for 10 minutes. In the next step, the casting of C93200 was performed in the St37 pre-mould holding for 6 minutes. Findings showed that:

1-The strength of the bond is at least 94.8 MPa.

2-C93200, bond and St37 are 80, 100 and 120 HV; respectively.

3-Corrosion resistance of C93200 is excellent in accordance with the salt spray test for 168 hours.

4-According to the pin-on-disc test (the applying stress of 7.7 MPa during the wear distance of 22 m and without lubrication), the wear rate is acceptable.

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