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INNOVATION IN WOODWORKING INDUSTRY AND ENGINEERING DESIGN, 2/2022 (22): 23–28

INVESTIGATION OF THE QUALITATIVE DEPENDENCE BETWEEN THE CHARACTER OF WEAR AND THE MUTUAL LOCATION OF BEARING SUPPORTS

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ABSTRACT

The most common failures and reasons for subsequent repair of large-scale sliding bearings are: deviation from the initial geometric shape of the friction surfaces, scratches and cuts occurring on the friction surfaces, tolerances and defects as a result of diameter and length discrepancies – sagging, bending, divergence, axles intersection and boundary wear. Sliding bearings and the bearing journals below them are flaw detected by measuring the bearing surface macrogeometry, followed by a comparison with the standard tolerances and defects at various diameters and lengths, and inspection of the defects. The present study analyses different friction surfaces of large-scale sliding bearings and the results show a correlation between the type of wearing, the relative position of the bearing supports and the deviations from the correct geometric shape of the friction surfaces. A qualitative correlation between the type of wearing and the relative position of the two bearing supports has been investigated and established. Bearing journal wear is out of the scope of the present study.

Key words: geometric shape, defects, diameters, sliding bearings, surfaces.

INTRODUCTION

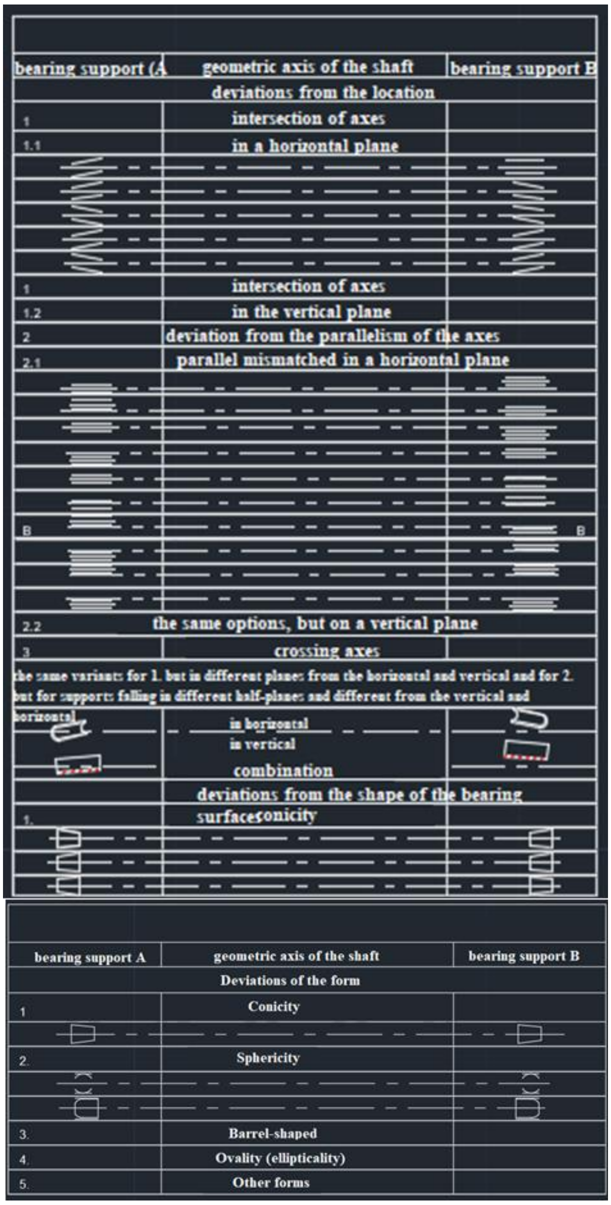
The conducted analysis is based on wearing type of the bearing shells. The investigated cases are as follows: axels intersection, deviation from the parallel positions both in the horizontal and the vertical planes, deviation from the initial geometric shape of the friction surfaces – taper, sphericity, ovality (ellipsoidity), barrel-shape and other shapes (Ivanova et al., 2018, http://mash-xxl.). For greater clarity and systematicity and due to the vast variety of possible correlations of the studied parameters, they are here presented in a tabular form – Table 1 (http://www.detalmach.ru).

In the cases when this is not possible and for the sake of comprehensiveness of the presentation,they are presented descriptively (Stoyanov et al., 2016). Option 2.3 is possible – positioning of the supports in different half-planes with respect to the geometric axis of the shaft.

For cases 1. and 2. (Deviation from the position) it is possible for one of the axes of the bearing supports to coincide with the geometric axis of the shaft.

As it is obvious from the classified in Table 1cases, the type of wearing depends on the support axis inclination angle and the shaft α geometric axis, the distance between the supports d, the diameter of the bearing surface D, the length of the bearing shell L and the size of the clearances, which for the studied diameters – 800 mm. and larger – are significant (in the range of a few millimetres) (http://techliter.ru).

Table 1: Investigated parameters



bearing support (A	geometric axis of the shaft	bearing support B
	deviations from the location	
1	intersection of axes	
1.1	in a horizontal plane	
1	intersection of axes	
1.2	in the vertical plane	
2	deviation from the parallelism of the axes	
2.1	parallel mismatched in a horizontal plane	
B		B
2.2	the same options, but on a vertical plane	
3	crossing axes	
the same variants for 1. but in different planes from the horizontal and vertical and for 2. but for supports falling in different half-planes and different from the vertical and horizontal		
	in horizontal in vertical combination	
	deviations from the shape of the bearing surface	
1.	conicity	

bearing support A	geometric axis of the shaft	bearing support B
	Deviations of the form	
1	Conicity	
2.	Sphericity	
3.	Barrel-shaped	
4.	Ovality (ellipticality)	
5.	Other forms	

DEPENDENCE BETWEEN THE NATURE OF WEAR AND THE MUTUAL LOCATION OF TWO BEARING SUPPORTS

The following figures, Fig. 1 to Fig. 7, show the repeated in the various possible schemes of Table 1 cases of left – A and right – B support deviations from their position as well as deviations from the friction surface initial geometric shapes (Mehmedov, 2020). Due to the variable dimension range of the bearing surfaces (d, D, L), the different critical clearances (hkr.), the different support axis inclination angle and the different geometric axis of the shaft α, the drawings are not scaled. Figure 1 shows the left support A diagram – the first case of deviation from its position: 1. Intersection of the axes, 1.1 In the horizontal plane.

Due to the nature of the deviation, it can be seen that the clearance at the left end L of the left support A in the diagram is greater than that at the right end R and the critical clearance hkr. occurs closer to the horizontal plane of the bearing support. At the same time, the clearance at the right end is at a greater angle from the horizontal plane. These are represented in the figure (the diagram shown in the upper left end of Fig.1) by the hatched areas between the shaft surface and respectively the left end L and the right end R of the left support A bearing shell.

This has also been empirically confirmed by observing the friction surfaces of machinery in operation. The results of the observation are shown at the bottom left end of the same figure.

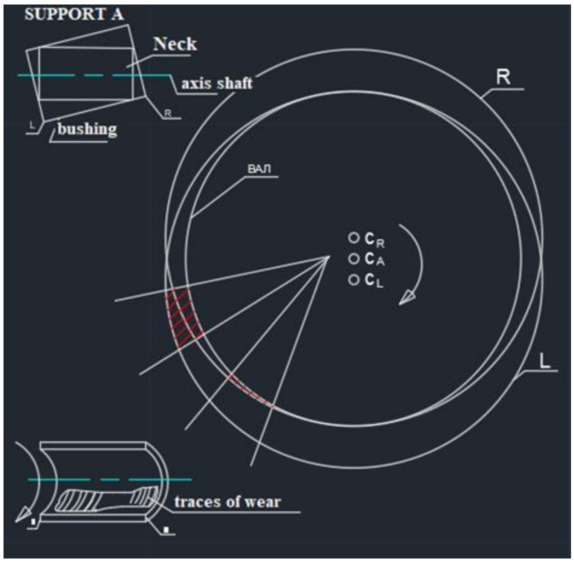


Figure 1: Shows the left support A

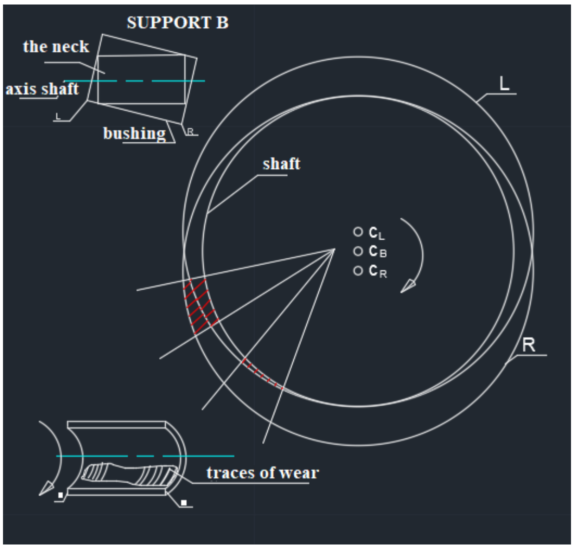


Figure 2: Shows the right support B

Wear during normal operation, without deviation from the position, can be found in the middle section between the indicated wear zones – lower than that at the left end L and higher than that at the right end R. Figure 3 shows the left support B1 diagram – fifth case of 2. Deviation from the parallel position of the axes. 2.1 Parallel, but not coinciding in the horizontal plane (Nikolov, 2015).

Due to the nature of deviation and taking into account the direction of rotation, it can be seen that an oil wedge of the required critical clearance (hkr.) is difficult to be formed. In this case the type of lubrication will rather fall into the category of boundary or mixed-film lubrication of the Stribeck curve. No wear was observed as a result of the operation under these circumstances, which are unfavourable and only in the case of a reverse rotation hydrodynamic lubrication can be applied.

Figure 3 shows the left support B1 diagram – fifth case of 2. Deviation from the parallel position of the axes. 2.1 Parallel, but not coinciding in the horizontal plane. Due to the nature of deviation and taking into account the direction of rotation, it can be seen that an oil wedge of the required critical clearance (hkr.) is difficult to be formed. In this case the type of lubrication will rather fall into the category of boundary or mixed-film lubrication of the Stribeck curve. No wear was observed as a result of the operation under these circumstances, which are unfavourable and only in the case of a reverse rotation hydrodynamic lubrication can be applied.

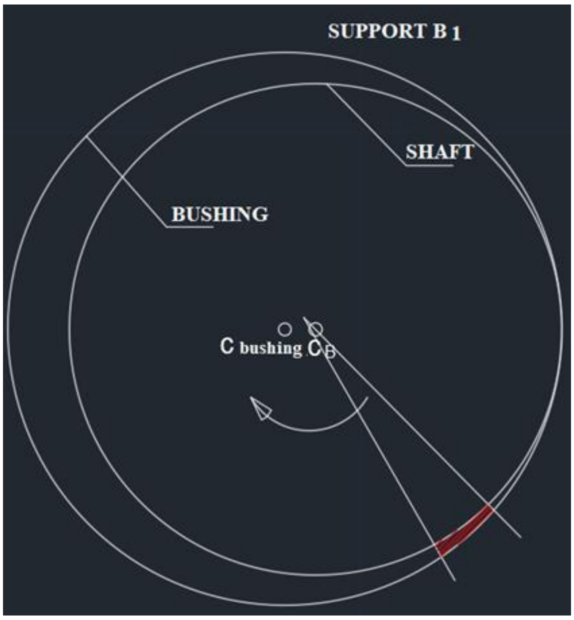


Figure 3: Shows the left support B1 diagram-fifth case of 2

Figure 4 shows the diagram of the right support B2 – fifth case of 2. Deviation from the parallel position of the axes, 2.1 Parallel, but not coinciding in the horizontal plane.

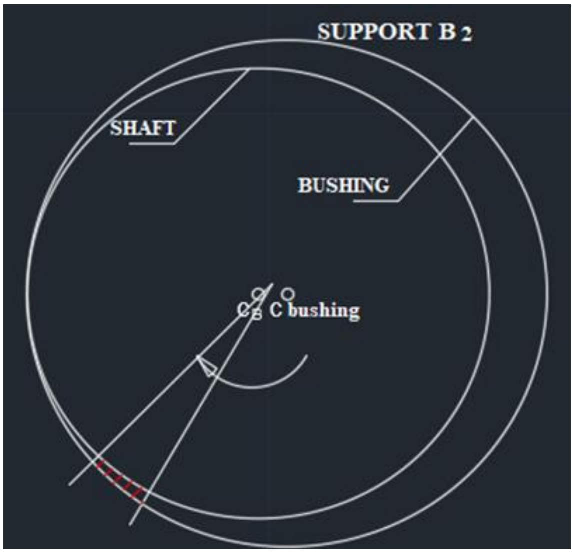


Figure 4: Shows the diagram of the right-support B2- fifth case of 2

Due to the nature of deviation and taking into account the direction of rotation, it can be seen that an oil wedge of the required critical clearance (hkr.) can be obtained at a smaller angle to the horizontal plane compared to normal operating conditions.

Wear and operation of the kind shown in the scheme was observed under the conditions of forced lubrication with an amount of oil greater than the necessary at start-up moments.

Figure 5 shows the left support A diagram – the first case of Deviation from the bearing surface shapes (cylindricality), 1. Conicity (of the journals, bushings or both).

Due to the nature of deviation from the initial shape, it can be seen that the clearance at the right end R of the left support A on the scheme is smaller than that at the left end L and the critical clearance hkr. is formed closer to the horizontal plane of the bearing support.

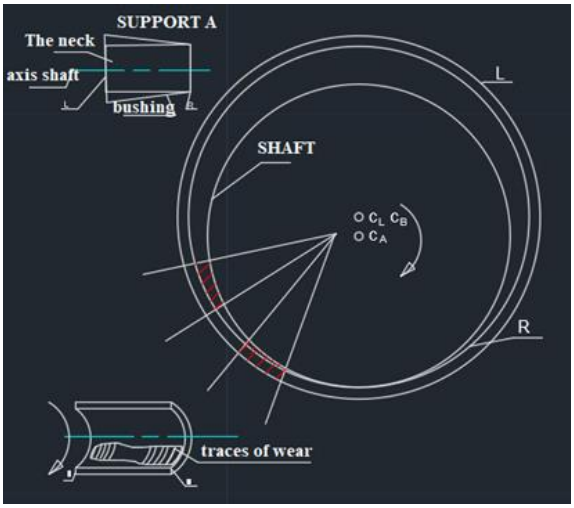


Figure 5: Shows the left support A diagram – deviation from the bearing surface – Conicity

The clearance at the left end L is at a greater angle from the horizontal plane. These are represented in the figure (the diagram shown in the upper left end of Fig.5) by the hatched areas between the shaft surface and respectively the left end L and the right end R of the left support A bearing shell. This has also been empirically confirmed by observing the friction surfaces of machinery in operation. The results of the observation are shown at the bottom left end of the same figure. Wear during normal operation, without deviation from the position, can be found in the middle section between the indicated wear zones – lower than that at the left end L and higher than that at the right end R.

Fig. 6 shows the left support A diagram – the first case *of Deviation from the bearing surface shapes (cylindricality),* 2. Sphericality (of the journals, the bushings or both).

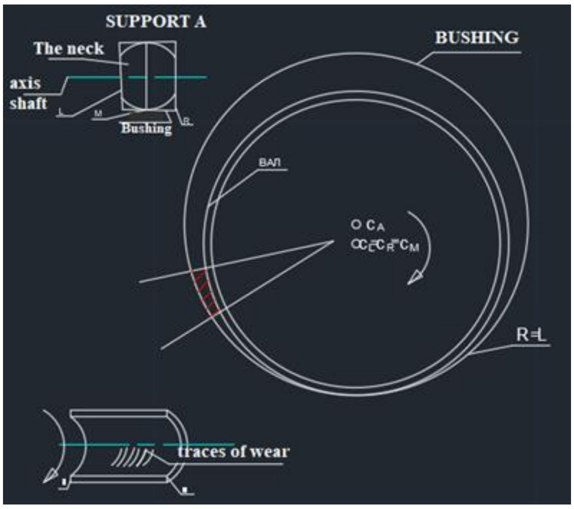


Figure 6: Shows the left support A diagram – deviation from the bearing surface – Sphericality

Due to the nature of deviation from the initial shape, it can be seen that the clearance at the right end R and at the left end L of the left support A on the scheme is greater than that in the middle section M. The size of the formed critical clearance (hкр) is approximating that, formed under normal operating conditions in the middle section M.

It is represented in the figure (the diagram shown in the upper left end of Fig.6) by the hatched area between the surface of the shaft in the middle section M and the bearing shell of the left support A. This has also been empirically confirmed by observing the friction surfaces of machinery in operation. The results of the observation are shown at the bottom left end of the same figure.

Fig. 7 shows the left support A diagram – second case of *Deviation from the shape of the bearing surfaces* (cylindricality), 2. Sphericity (the journals, the bushings or both).

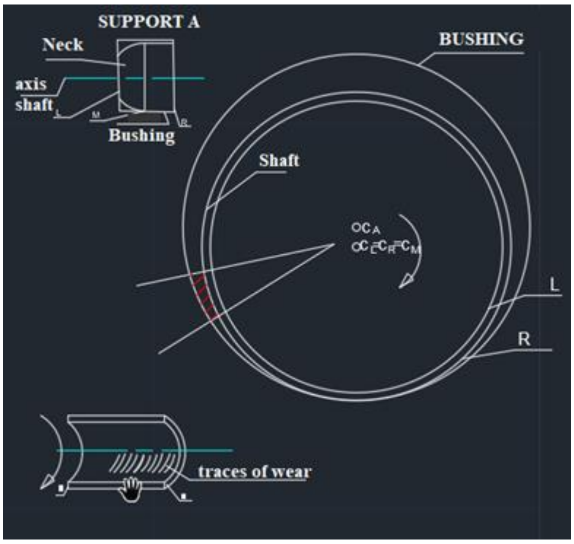


Figure 7: Shows the left support A diagram – second case of Deviation from the shape of the bearing surfaces (cylindricality), 2. Sphericity

Due to the nature of the deviation from the initial shape it can be seen that the clearance at the left end L of the left support A on the scheme is greater than that in the middle section M and that at the right end R. The size of the formed critical clearance(hkr.) is approximating that, formed under normal operating conditions in the middle section M and at the right end R. It is represented in the figure (the diagram shown in the upper left end of Fig.7) as the hatched area between the shaft surface in the middle section M, the right end R and the bearing sleeve of the left support A. This has also been empirically confirmed by observing the friction surfaces of machinery in operation. The results of the observation are shown at the bottom left end of the same figure.

CONCLUSION

Based on the research, certain empirical and theoretical dependencies have been identified allowing for some more important conclusions and recommendations to be made:

If the type of bearing shell wear is acknowledged, the cause of the wear (deviation from the initial bearing surface shape and position as well as the type of the deviation) must be established and therefore recommendations must be made in order to eliminate the causes of the irregular wear.

It is necessary the wear of the two supports – the left and the right one – to be always considered in correlation, taking into account their location. It is obligatory, the wear type and degree to be estimated in three cross-sections – at both ends and at the middle of the bearing shells.

It is obligatory, a diagram of the bearing journals and shafts wear to be produced taking into account their location (left or right support).

Due to the large number of possible combinations for deviation from the initial bearings surface shape or their relative position, only some basic cases have been considered. The regarded cases are those which can provide a highly reliable reasoning for the incorrect wear of the bearing surfaces and give grounds to recommend measures for its prevention or elimination.

After establishing the wear degree and the type well as the deviations in the shape and position, the results must be related to the mandatory requirements of the relevant subject area standards and the corresponding actions – repair, restoration or scrapping – must be taken.

RECOMMENDATIONS

In case of deviation from parallel position in the horizontal plane, cases 2.1, one of the supports must be repositioned in order to coincide with the geometrical axis of the shaft.

In case of deviation from the parallel position in the vertical plane, cases 2.2, one of the supports must be raised in order to coincide with the geometric axis of the shaft.

When the axes cross in the horizontal plane, cases 1.1, one of or both the supports must be adjusted in order to coincide with the geometric axis of the shaft. This can be achieved either by a slight rotation in the horizontal plane or, in cases 2.1, by lifting (adjusting) one of or both the supports unilaterally in order to coincide with the geometric axis of the shaft.

When the axes cross – cases 3, it is necessary to adjust one or as in most cases the two supports in both the horizontal and the vertical planes. This is achieved by first lifting them, through laying pads or plates, and then rotating the supports to an appropriate position.

REFERENCES

IVANOVA E., TENEV S., ET AL. 2018. The theoretical model for determinig critical rotation speed flexible coupling type SEGE, "Scientific Bulletin of Naval Academy" Volume XXI ISSUE no.1, MBNA Publishing House Constanta 2018, pg. 326-329, ISSN: 2392-8956; ISSN-L: 1454–864X.

MEHMEDOV I, HRISTOV HR. 2020. Dynamic characteristics of a modified automotive vibration isolator under asymmetric loading. "ECO-VARNA".

NIKOLOV, K. 2015. Requirements for the shape and materials for large hydrodynamic plain bearings, dis. Sofia, 10, 67–72.

STOYANOV ST., TENEV ST., ET AL. 2016. Variant of a generalized model for inspection of a four-point lifting beam, magazine "Mechanics of Machines" vol. 2, Technical University – Varna, pp. 7–10, ISSN 0861 – 9727.

http://mash-xxl.info/info/211500/ Энциклопедия по машиностроению XXL.

http://www.detalmach.ru/lect7.htm.

http://techliter.ru/news/remont_valov_i_osej/2013-03-10-81.