文責：島根大学総合理工学部機械設計研究室教授　李　樹庭
2026 年 2 月 22 日 Email: shutingnpu@yahoo.co.jp

FEM Developed for Contact Analysis of Angular Ball Bearings

By Prof. Shuting Li

1． Abstract

When designing machinery, it is necessary to determine the support stiffness and service life of the selected bearings. Furthermore, if a bearing used in the machinery fails, it is also necessary to determine the contact pressure, internal shear stress, and oil film thickness of the selected bearing. However, since the support stiffness, contact pressure, oil film thickness and shear stress of bearings cannot be easily calculated, the author proposed a numerical analysis method using the three-dimensional, finite element method (3D-FEM) to analyze bearing contact problems and also developed software capable of performing these calculations. Here, we present the contact pressure distribution of an angular contact ball bearing analyzed using the developed software; for details on this research, please refer to References [1–2].

A key feature of the FEM software developed in this study is that it enables the analysis of angular contact ball bearing contact problems on a standard personal computer. Unlike software such as Abaqus, there is no need to create a model for FEM analysis; simply enter the bearing dimensions, radial load, axial load, and bending moment into the software, and it will perform the entire analysis automatically.

2． Structure and Dimensions of Angular Ball Bearings

Figure 1 shows the structural dimensions of the angular contact ball bearing under study. The ball diameter is 10.3188 mm, and there are 32 balls. The contact angle is 30 degrees and the raceway radius is 5.365776 mm.

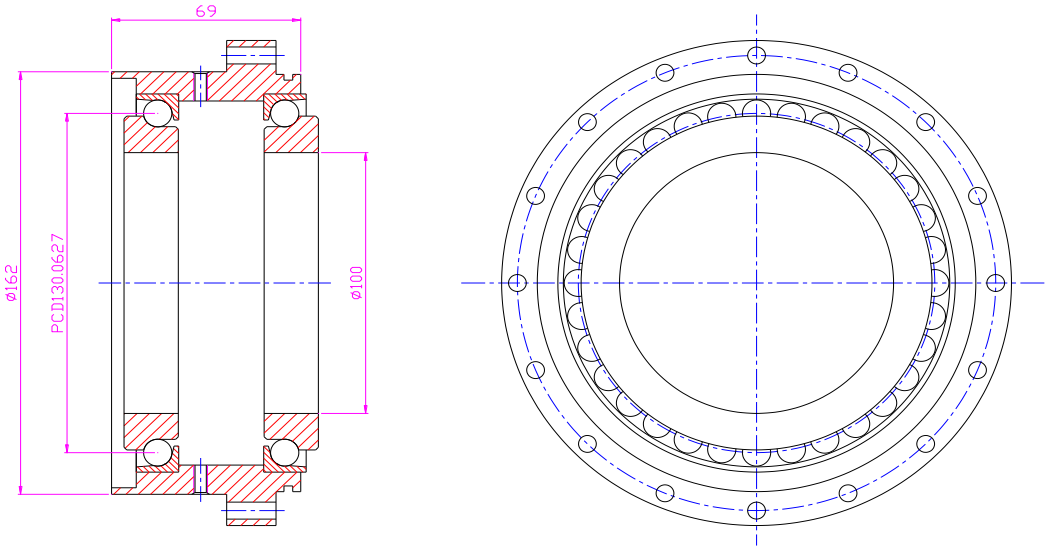

Figure 1: Structural dimensions of the angular ball bearing under study

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3． FEM Model for Contact Analysis

The contact analysis of an angular ball bearing is treated as an elastic body contact problem. Figure 2 shows the model used for the contact analysis. When performing a radial contact analysis, applying a radial load from the top to the bottom of Figure 2 yields the surface pressures on balls 1 through 15 at the top of the bearing, as shown in Figure 2. To perform contact analysis in the axial direction, simply apply a load in the axial direction.

Figure 3 shows a mesh diagram of the angular ball bearing and an enlarged view of the contact area.

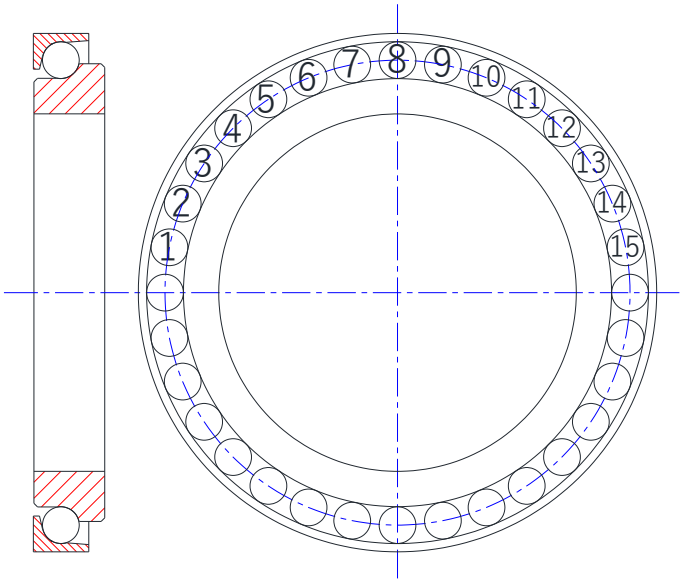

Figure 2: Model for contact analysis and FEM element meshing

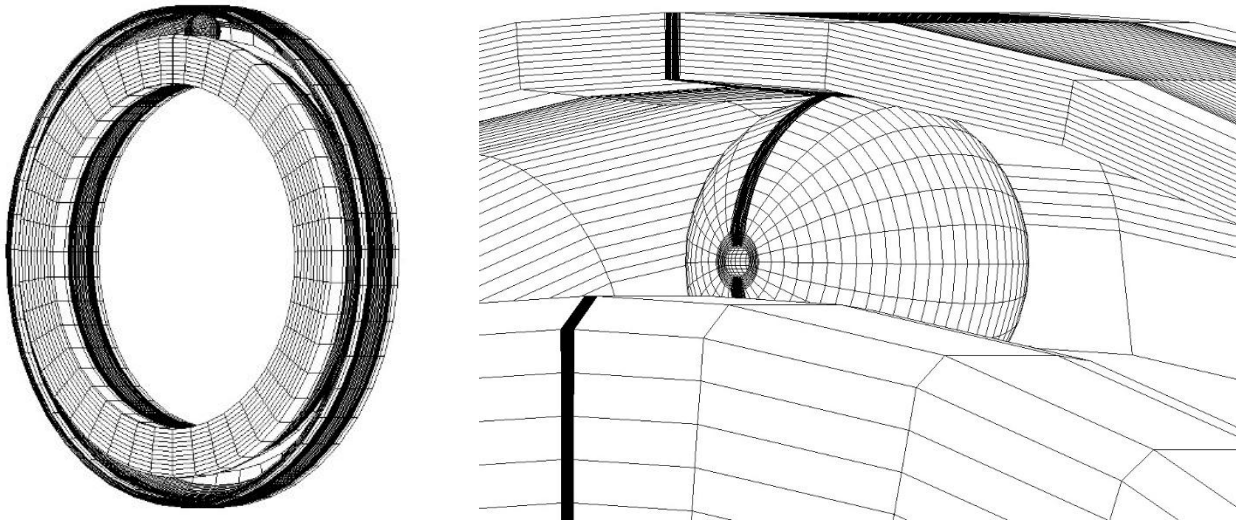

Figure 3: An enlarged view of the element mesh-dividing

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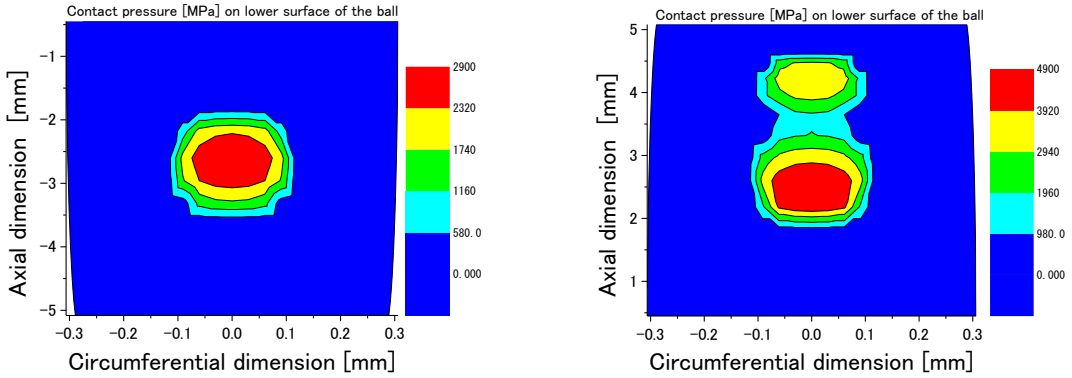
4． Axial Contact Analysis

Figure 4 shows the contact pressure distributions on the upper and lower surfaces of the balls in an angular ball bearing, as obtained from axial contact analysis. Figure 4(a) shows the contact pressure distribution on the upper surface of the ball (the surface in contact with the outer ring raceway), and Figure 4(b) shows the contact pressure distribution on the lower surface of the ball (the surface in contact with the inner ring raceway).



(a)　Top surface of the ball　　(b)　Underside of the ball

Figure 4: Surface pressure distribution on the ball's surface

5． Radial Contact Analysis

Figures 5 and 6 show the contact pressure distributions on the upper and lower surfaces of the balls in an angular ball bearing, as obtained from radial contact analysis. Figures 5(a) through (h) show the contact pressure distribution on the upper surface of the ball while Figures 6(a) through (h) show the contact pressure distribution on the lower surface of the ball.

References：

(1) Shuting Li, "Strength analysis of the roller bearing with a crowning and misalignment error", **Engineering Failure Analysis**, Vol. 123, 2021, pp.1-15

(2) Shuting Li, "A mathematical model and numeric method for contact analysis of rolling bearings", **Mechanism and Machine Theory**, Vol. 119, 2018, pp.61-73

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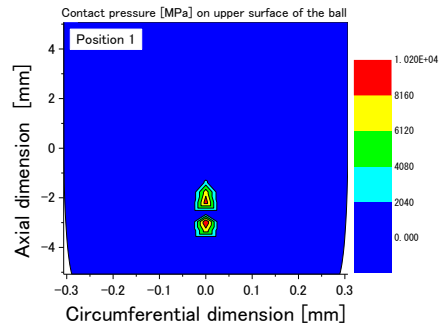
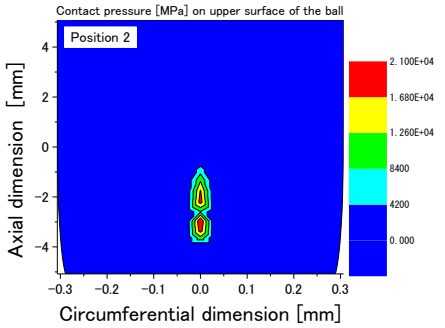
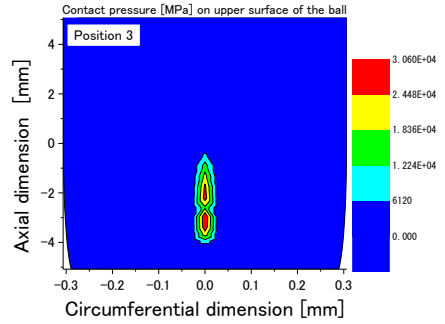


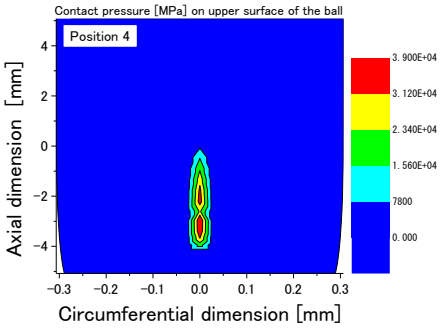
(a) Ball No.1



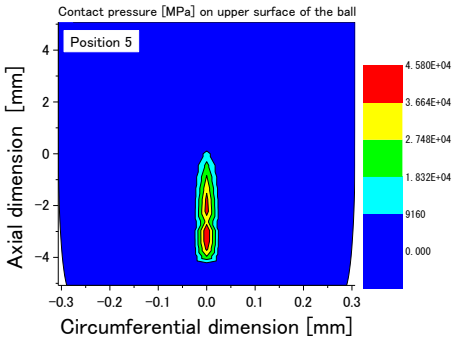
(b) Ball No.2



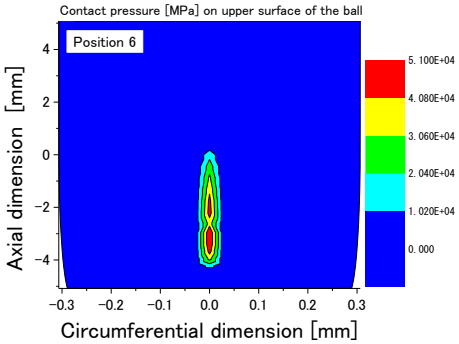
(c) Ball No.3



(d) Ball No.4



(e)Ball No.5



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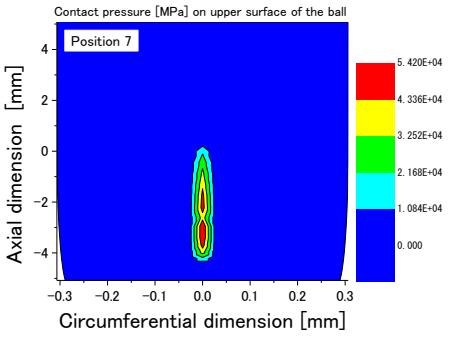
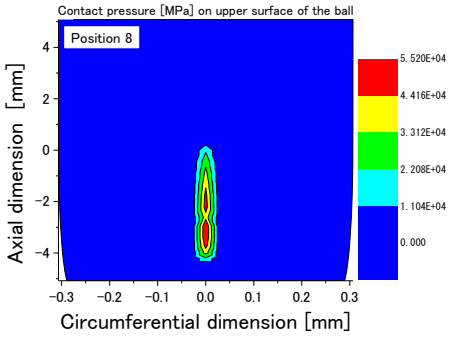


(g)Ball No.7



(h) Ball No.8

Figure 5: Surface pressure distribution on the upper surface of the ball

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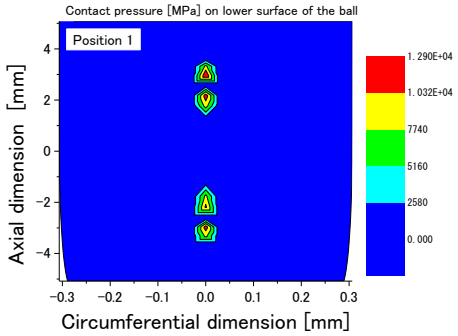
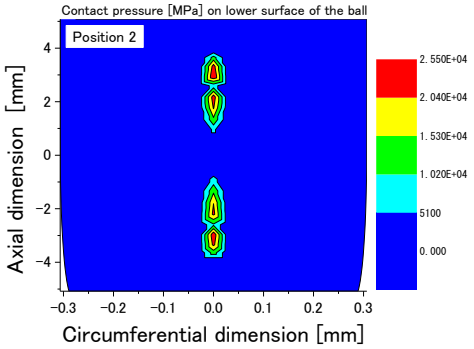


(b) Ball No.1



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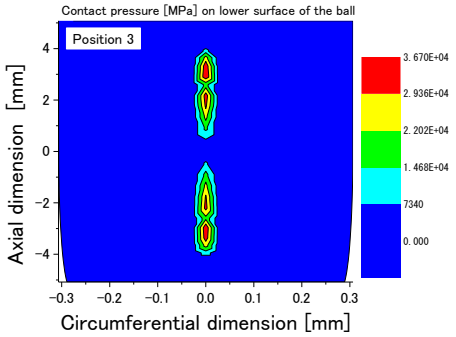

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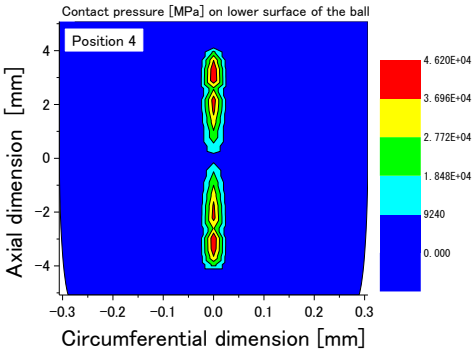
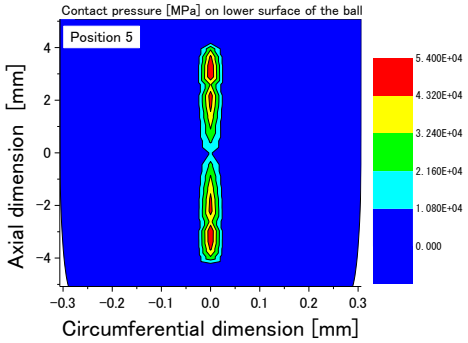


(d) Ball No.4



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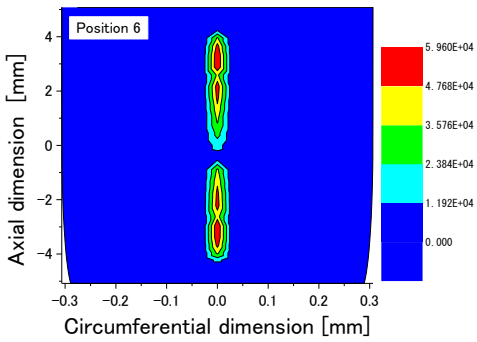
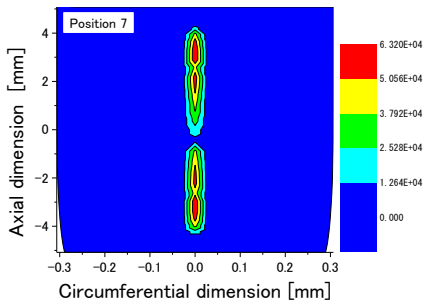


(f) Ball No.6



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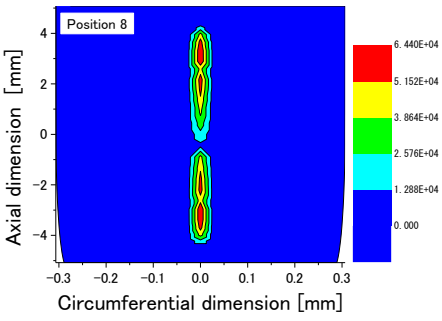

(h) Ball No.8

Figure 6: Surface pressure distribution on the underside of the ball