

## PREDICTION OF NUMERICAL RUNNING-IN PROFILE MODIFICATION OF TAPERED ROLLERS BASED ON NEURAL NETWORK

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### KEYWORDS

*Machine learning, Mixed Lubrication, Modelling in tribology, Profile modification*

### ABSTRACT

Tapered Roller Bearings (TRB) are widely used under large radial and axial loads at heavy-duty operations, such as gas turbine engines, axle boxes of bogies, etc. One of the technical problems in TRBs is the existence of sharp spikes of the contact pressure in the vicinity of the two ends of the tapered rollers. Modifying roller profiles is usually required to smooth the pressure concentration at the ends of rollers, which can result in extended bearing fatigue life.

A numerical running-in method for profile modification of tapered roller, which combines the average Reynolds equation and Kogut and Etsion's rough surface contact model, was developed by Cao et al.[1]. The new optimized profile was proved that it has immense advantages in terms of the asperity contact pressure uniformity and the elimination of the end effect of stress concentration not only for a single tapered roller but also for all tapered rollers in the bearing. However, due to the need for iterative updating of the new roller profile during a moderate running-in duration and then inputting it into the mixed lubrication model for calculation, it takes a long time, 8.39 in average, to calculate for one case, as shown in Fig.1 (a). In order to reduce the computation time cost, a more convenient and efficient algorithm is needed, and the neural network method offers a new approach for the purpose. Marian et al.[2] found that the majority of publications on machine learning in bearings are related to bearing vibration rather than tribology. Therefore, studying the application of neural networks in the field of tapered roller bearing tribology is of significant importance.

This study employed neural network methods to conduct predictive research on the optimized roller profiles. A comparison between the conventional numerical running-in calculation results and the predictions from the neural network model showed excellent consistency, as shown in Fig.1 (b). Furthermore, as the number of hidden layers and neurons

increased, the predictions became closer to the numerical

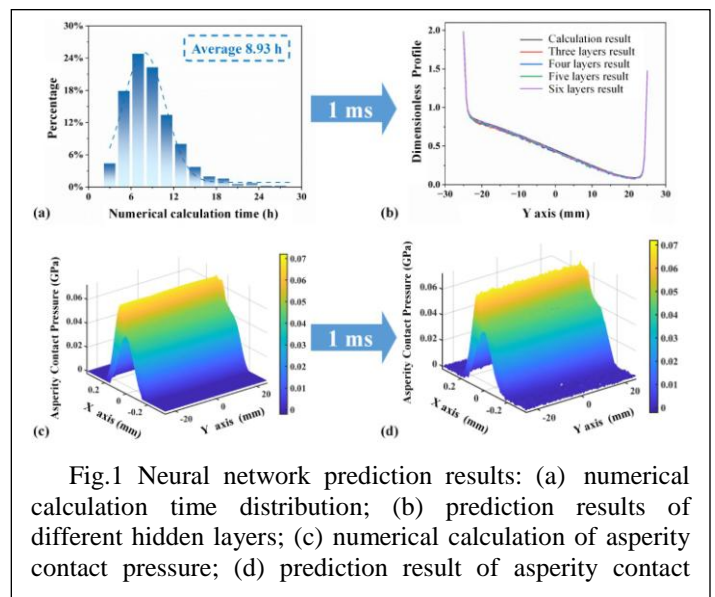


Fig.1 Neural network prediction results: (a) numerical calculation time distribution; (b) prediction results of different hidden layers; (c) numerical calculation of asperity contact pressure; (d) prediction result of asperity contact

calculation results, with smaller differences.

The prediction time was only 1 ms by using the neural network, which greatly improves the efficiency compared to the mean 8.93 h of the numerical calculation. In addition, this study also predicted the three-dimensional distribution of film thickness, asperity contact pressure (Fig.1 (d)), and elasto-hydrodynamic pressure of tapered roller. The predicted results accord well with the calculation results, and the prediction time is less than 1 ms.

### REFERENCES

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