

Static analysis of a stepped main shaft in a mine hoist by means of the modified 1D higher-order theory

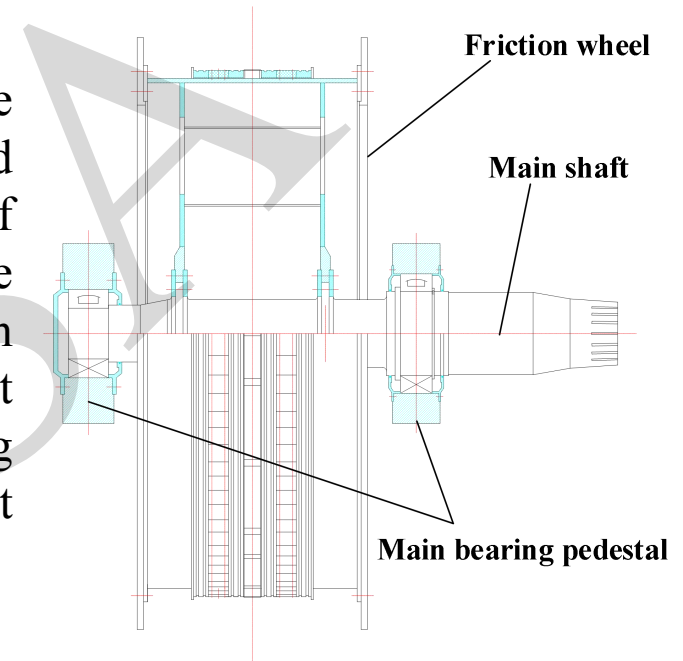
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Key words:

Carrera unified formulation (CUF); 1D higher-order theory; Finite element method; Strain field; Stepped main shaft; Main hoist

Problem Statement

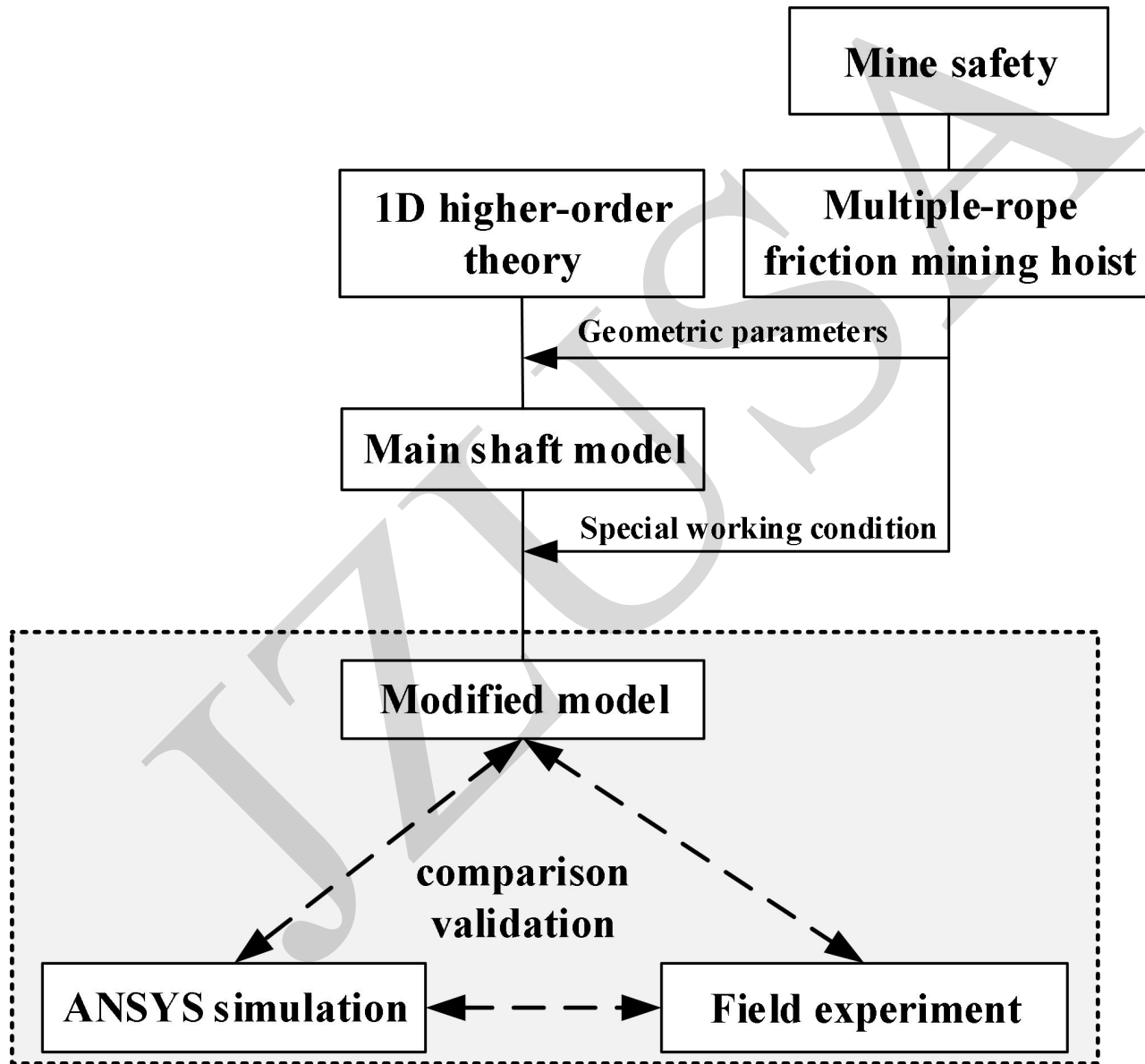
- Mine safety has become an urgent problem because thousands of miners die from mining accidents around the world every year. These accidents have a variety of causes including dust explosions, collapsing of mine stopes, flooding, and general mechanical errors from improperly used or malfunctioning mining equipment or systems. Therefore, how to indicate the hoisting condition accurately via an easy method is of great importance for mine safety.
- The classical beam theories have disadvantages since their innate hypothesis and the 3D solid element have high computational cost, both can not predict reliable results of the required accuracy on the surface of segments.



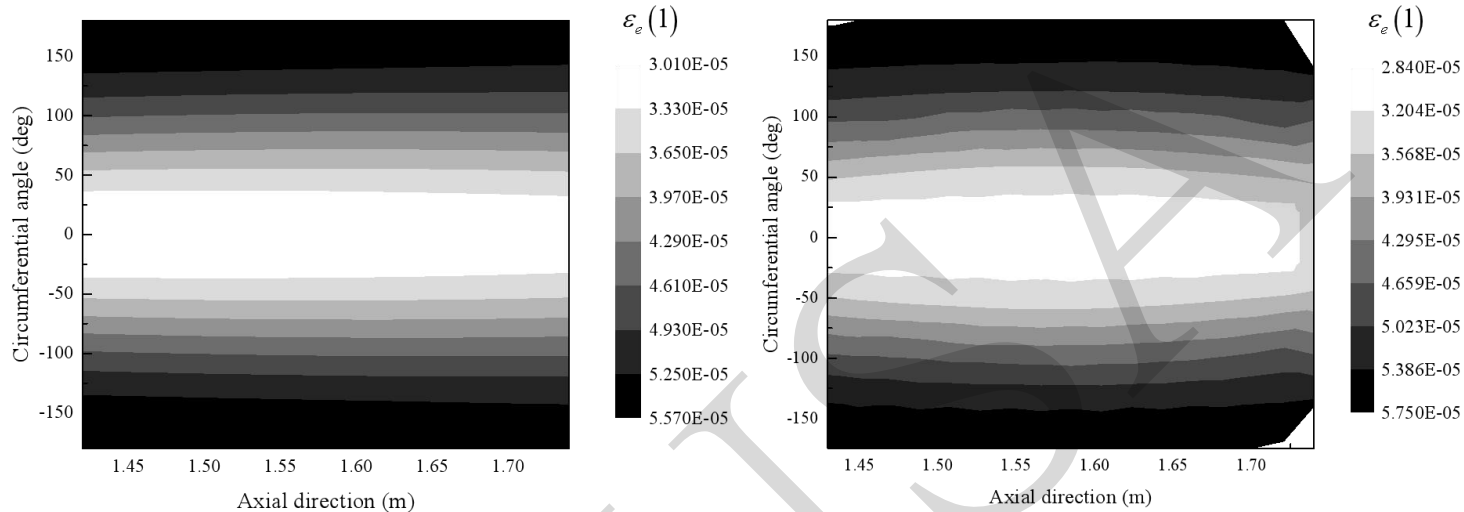
Main Contributions

- **1D higher-order theory based on Carrera unified formulation is employed to model a stepped main shaft in a mine hoist and modified for a lower computational effort according to the special working condition.**
- **Classical beam theories and lower-order TE models are compared with higher-order TE models with different slender ratio and we get a interesting value of slender ratio that classical beam theories and lower-order TE models are inapplicable when the slender ratio exceeds the value.**
- **In the case of static analysis, the modified one-dimensional higher-order model is in good agreement with the ANSYS solid model with much less computational effort and complexity. Finally, the practicability of the present model in predicting the strain field on the surface of the main shaft of the mine hoist is validated by comparison with experimental results.**

Research framework



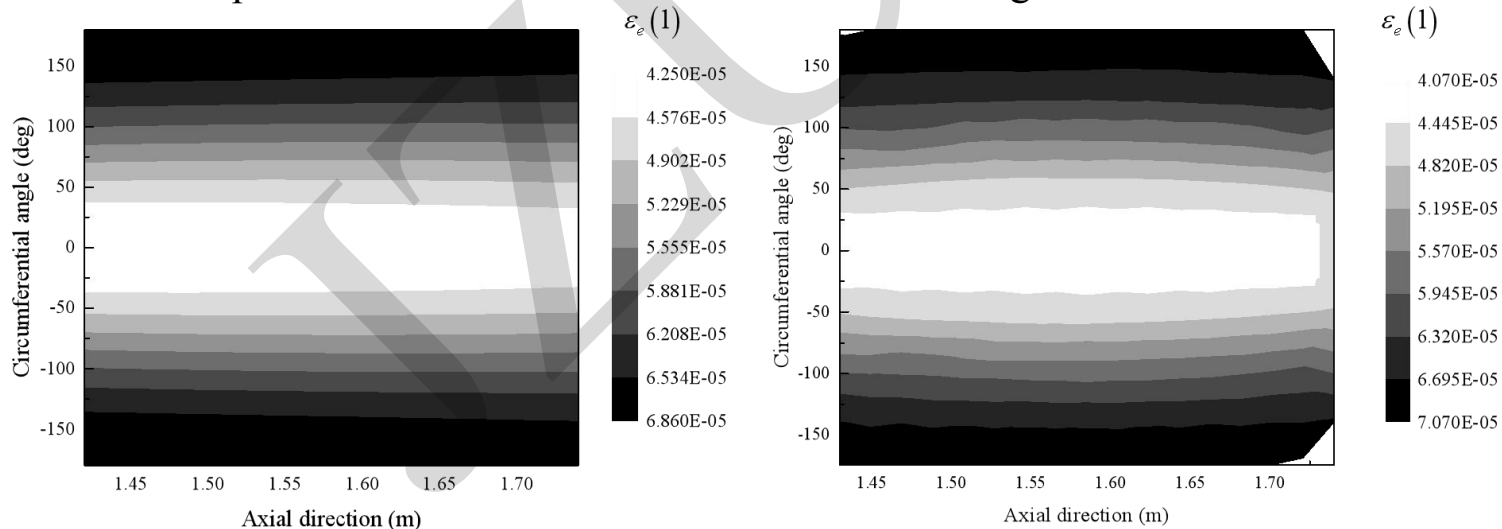
Results



TE ($N=4$) model

ANSYS solid model

Comparison of strain contours on the surface of segment 7 in constant status



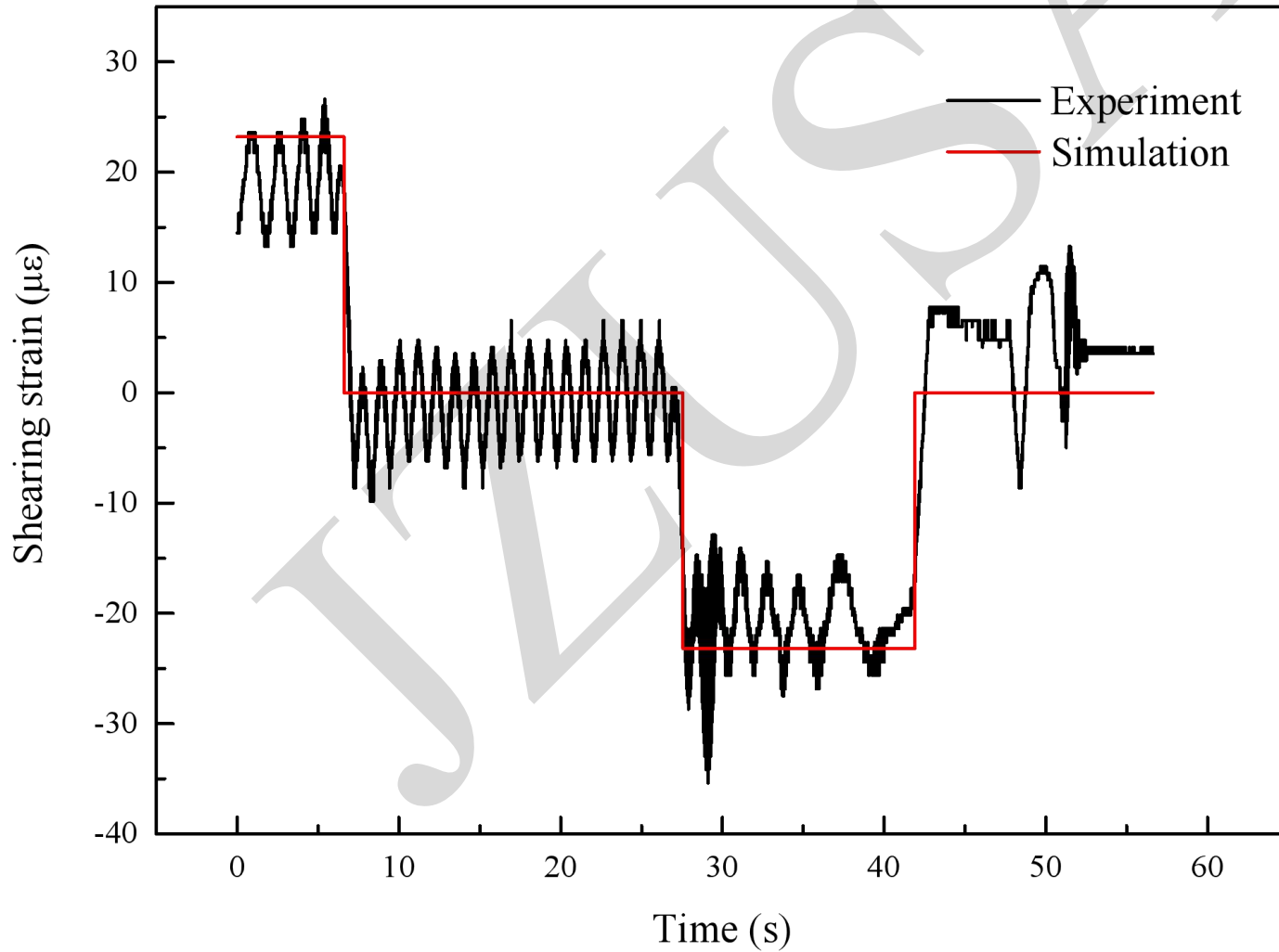
TE ($N=4$) model

ANSYS solid model

Comparison of strain contours on the surface of segment in acceleration status

Results

Curves of shearing strain vs running time on the surface of segment 9 of the main shaft



Conclusions

- **Results by TE models is in good agreement with the ANSYS solid model, both in terms of displacements and stresses;**
- **Modified TE models can provide solid-like results with very low computational costs;**
- **The modified main shaft model can predict the strain field on the surface of the mine hoist.**