Investigation of Stress Distribution and its Analysis in Dragline Boom

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Doctor of Philosophy

By

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CHAPTER 5

CONCLUSIONS AND RECOMMENDATION FOR FUTURE WORK

The present research study integrates state-of-art of finite element method (FEM) in conjunction with computer aided design (CAD) techniques to predict stress state of dragline boom in 3D. The SolidWorks as a tool for computer based 3D construction of models and sub-models has gained vast acceptance by various industries as well, in addition to mining industry for prediction of the behaviour of gigantic structure, which are otherwise difficult to be tested in real time. Similarly, Ansys-18.0 is equally accepted with proven results by mining and other industries. The result provided by these designing and analysis system, like any other system are largely dependent on the reliable data, clear understanding of loading condition and constraints for precise simulation and results. Following are the salient conclusions drawn from the analysis of present work.

1. The design of dragline boom structure as a beam model and its analysis by using the state –of –art techniques has provided suitable insights in investigating the behaviour of boom under static and dynamic loading conditions.
2. The study has been able to propose a safe design of boom structure as the values obtained for the direct stresses, maximum bending stresses and maximum combined stresses are within the safe limits.
3. The proposed design of the boom reveals that the main chord remains in axial compression or axial tension during the loading while bracing members are subjected to bending loads.
4. It may be inferred that the stresses are very high near the nodes, where the bracing members are connected with the main chord. These node points seen to be

concentrated within the welded joint region. Therefore, due to the continuous action of cyclic stresses, these node points are susceptible to develop minor or major cracks.

5. The solid sub modelling of boom cluster (Joints) reveal that the stresses within the joints are concentrated at the fillet region. However, the stresses in the joints in the given loading conditions are within the yield strength of material of tubular steel members. Von-Mises stress, fatigue life and factor of safety for the study joints fall within the endurance limit of the material.

6. The study further brings forth an important feature that deformation and stress values attain max magnitude in the vicinity of boom point sheave both in static and dynamic loading conditions. However, the magnitudes of these parameters are slightly higher in the dynamic loading conditions in comparison to static loading conditions.

7. Under the static loading condition with bucket payload the joint 1 appears to be the most critical joint, whereas for the dynamic loading condition, joint 3, which is in the proximity of the centre of gravity of the boom, appears to be most critical.

8. Axial tensile forces in the suspension wire ropes have been found to be within the safe limit of the wire ropes, as the minimum breaking strength of these ropes is very high. Therefore, the design of wire rope also appears to be safe under the given loading conditions.

9. CIDECT design guide for the CHS joints should be followed in order to create a safe design of the structure. The joint design model C2, C3 and D3, which do not follow the design criteria are stressed beyond the yield strength of material. The study reveals the importance of CIDECT design guidelines in the

design and evaluation of boom cluster joints. The proposed design and analysis have provided a viable solution for analysing complex truss like structure, such as, dragline boom and its related assemblies.

Limitations of the study and recommendations for future work

1. Only tubular type of boom design has been considered in the present work. Although, the main chord having rectangular cross-section, I sections, H sections structures are also being used by the different manufacturers, a comparison may be made between these designs through suitable methods and techniques.
2. The material properties for welding as fillet geometry have been assumed identical to the tubular members in the joints. However, the fillet properties in the real time may be different from the tubular steel members.
3. The submodel constructed for the assessment of fatigue life does not consider a sudden change in cross-section. Hence, the stress extrapolation techniques may be done in future work to enhance the predictive accuracy of the sub-model in the needed region.
4. Insufficient real time data availability for the design of dragline boom structure and its related assemblies is a limitation of the present work. Field validation of the obtained results is almost impossible.
5. Bucket with payload case is considered only at boom in a global beam model. Boom loading under different ratio of the hoist rope and drag rope while boom is swinging from end of the dragging position to the dumping position will put the boom under different loading conditions. Its repeated

nature can accelerate fatigue. However, this aspect is not covered in this study and should be considered in future work.