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Structural Strength Evaluation and Wear Prediction of Double Helix Steel Wire Ropes for Heavy Machinery

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Abstract : Wire ropes combine high tensile strength and flexibility as compared to other general steel products. They are used in various application areas such as cranes, mining, elevators, bridges, cable cars, etc. The earliest reported use of wire ropes was for mining hoist application in 1830s. Over the period, there have been substantial advancement in the design of wire ropes for various application areas. Under operational conditions, wire ropes are subjected to varying tensile loads and bending loads resulting in material wear and eventual structural failure due to fretting fatigue. The conventional inspection methods to determine wire failure is only limited to outer wires of rope. However, till date, there is no effective mathematical model to examine the inter wire contact forces and wear characteristics. The scope of this paper is to present a computational simulation technique to evaluate inter wire contact forces and wear, which are in many cases responsible for rope failure. Two different type of ropes, IWRC-6xFi(29) and U3xSeS(48) were taken for structural strength evaluation and wear prediction. Both ropes have a double helix twisted wire profile as per JIS standards and are mainly used in cranes. CAD models of both ropes were developed in general purpose design software using in house developed formulation to generate double helix profile. Numerical simulation was done under two different load cases (a) Axial Tension and (b) Bending over Sheave. Different parameters such as stresses, contact forces, wear depth, load-elongation, etc., were investigated and compared between both ropes. Numerical simulation method facilitates the detailed investigation of inter wire contact and wear characteristics. In addition, various selection parameters like sheave diameter, rope diameter, helix angle, swaging, maximum load carrying capacity, etc., can be quickly analyzed.

Keywords : steel wire ropes, numerical simulation, material wear, structural strength, axial tension, bending over sheave
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