Design of Railingwire Rope by Finite Element Method

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Abstract: *Crane is a hoisting device use for lifting and lowering load with means of drum or lift wheel around which there will be rope or chain wraps. EOT crane is a mechanical devices used for lowering or lifting material, also used for making the material move vertically or horizontally. The results reveal that all three wire rope is bearing almost equal amount of stress on applying same load, this may be because the effective area of the WR are almost same or all three wire ropes. The results reveal that Seale type wire rope is bearing more shear stress on the same amount of load, the stress generated is almost 80% more than the ordinary wire rope, the torsion stresses act more on the first layer and this may be the reason as less diameter of the wires to resist stresses.*

Keywords: hoisting, 3D, stainless steel, deformation and shear stress.

Introduction

Crane is a hoisting device use for lifting and lowering load with means of drum or lift wheel around which there will be rope or chain wraps. EOT crane is a mechanical devices used for lowering or lifting material, also used for making the material move vertically or horizontally. It will be useful when the task is beyond the human capacity to moving or lifting the loads. Crane is a special design structure equipped with mechanical elements for load by lowering or raising by manual or electrical operation. Applications of cranes are generally in the transport industries for unloading and loading of load, in construction industries for the materials movement; and in manufacturing industries for assembling of heavy equipments. This device decreases the cost of the production by increase the output, speed up the deliveries & improves quality. Due to increase in labour costs and issues related to labour management the utility of this device has further been increased. Crane is very much useful in increasing human comfort by picking up load from one point and transport the object from one place to another. In designing of cranes there are three major considerations. First, the weight of load must be lifted up by the crane. Second, no topple of the crane. Third, rupture should not be there in crane. Cranes are available in lot of categories. They are called as Jib crane, Telescopic crane, Tower crane, Gantry crane, Truck mounted, Aerial crane, EOT crane, etc. The constructions of EOT cranes are typically of two types, either single girder or in double girder.

Fiber Core, it is constructed by synthetic material like polythene/poly- propylene strands (NYLON) ropes. Fiber cores are the most elastic & flexible, in which lubricant is bind. The advantage of fiber core is when there is a tensile load act on wire rope it crush the fiber as wire ropes diameter is reduces and the lubricant is comes out of the fiber and friction is reduced in between the wires. On the removal of load the core expands to its actual shape and absorb again the lubricants, but it have the downside. Whenever there is a temperature environment fiber cores are melts out of the wire and also it getting crushed easily on applying heavy load.

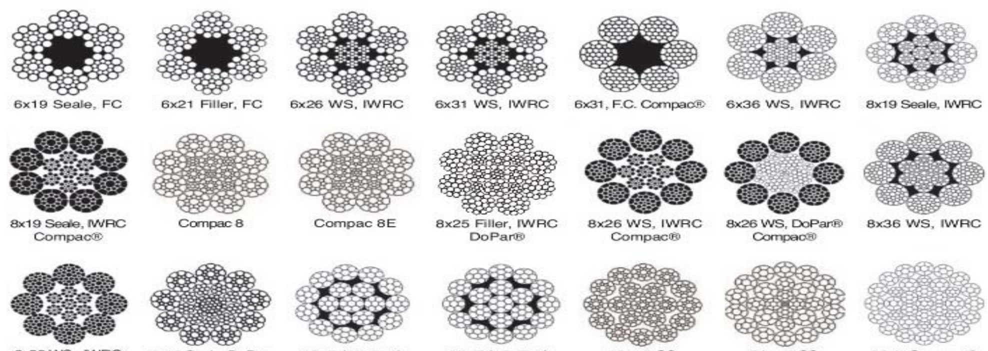

Fig 1: WR with Fiber Core.

II. Design Parameters

Design Parameter for ordinary WRS

Table 1: Design parameter for ordinary WRS

Model	Specification
Centre wire dia.	2mm (No. of wires 1)
1st layer wire dia.	2mm (No. of wires 6)
2nd layer wire dia.	2mm (No. of wires 12)
strand dia	10mm
length	70mm
Lay Length	70mm
Fill factor	87.17%
Helix Angle	65.82 degree

Design Parameter for Warrington WRS

Table 2: Design parameter for Warrington WRS

Model	Specification
Centre wire dia.	2.1mm (No. of wire 1)
1st layer wire dia.	2.1mm (No. of wires 6)
2nd layer wire dia.(a)	2.35mm (No. of wires 6)
2nd layer wire dia.(b)	1.75mm (No. of wires 6)
strand dia	10mm
length	70mm
Lay Length	70mm
Fill factor	82.38%
Helix Angle	65.82 degree

Design Parameter for Seale WRS

Table 3: Design parameter for Seale WRS

Model	**Specification**
Centre wire dia.	2.74mm (No. of wire 1)
1st layer wire dia.	1.37mm (No. of wires 9)
2nd layer wire dia.	2.585mm (No. of wires 9)
strand dia.	10mm
length	70mm
Lay Length	70mm
Fill factor	80.65%
Helix Angle	65.82 egree

III. Discretisation of IWSC

Selection of appropriate element type is necessary for the analysis. A three-dimensional brick solid element is to use as element for discretization of structure. Or the selection of mesh density of an appropriate convergence studies are conduct, with aim to achieve suitable accurate results. It is a higher order 3D 20-nodes solid element which exhibits behavior of quadratic displacement. The element having three degrees of freedom per node: translations in the nodal x, y, and z directions. The element supports plasticity, creep, large deflection, hyper-elasticity, large strain capabilities and stress stiffening. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyper-elastic materials. This type of element is well suited to modeling irregular meshes (such as those produced by various CAD/CAM systems), which was the case here. Meshing of independent wire strand, the overall elements and nodes in independent wire strands core are given below in the table, the discretization caused here is very well.

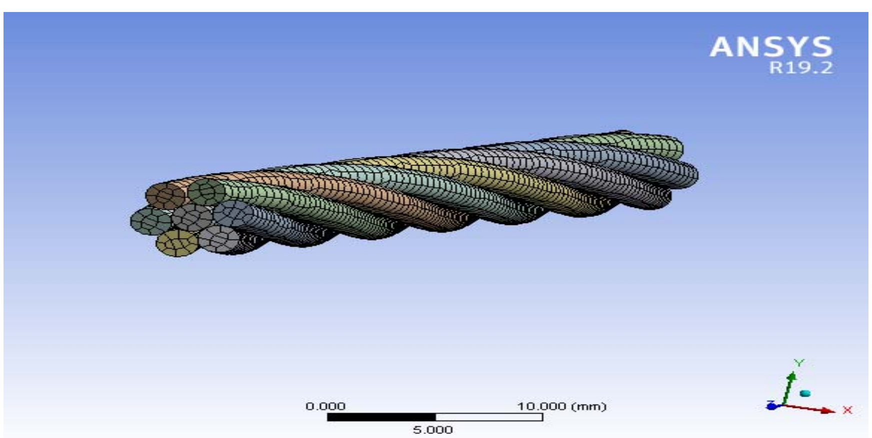

Fig 2: Meshing of Ordinary wire rope.

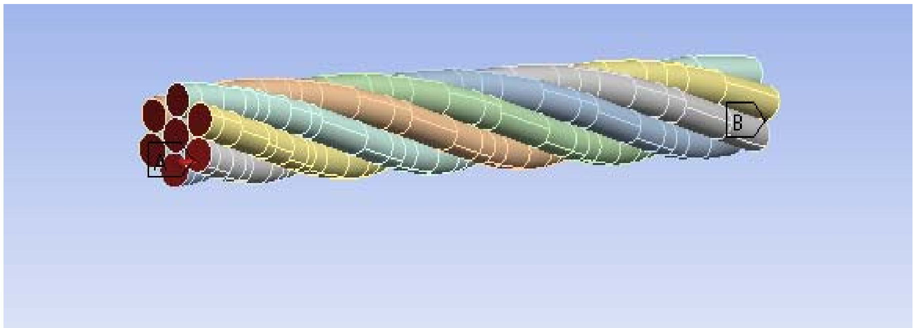

Fig 3: boundary conditions or wire rope.

Material used for wire rope:

Galvanized steel of Grade 37 is used as a material for the wire ropes, the typical material composition is (Carbon 0.2% Phosphorous 0.1% Manganese 1.35% Sulphur 0.04%).

IV. Results

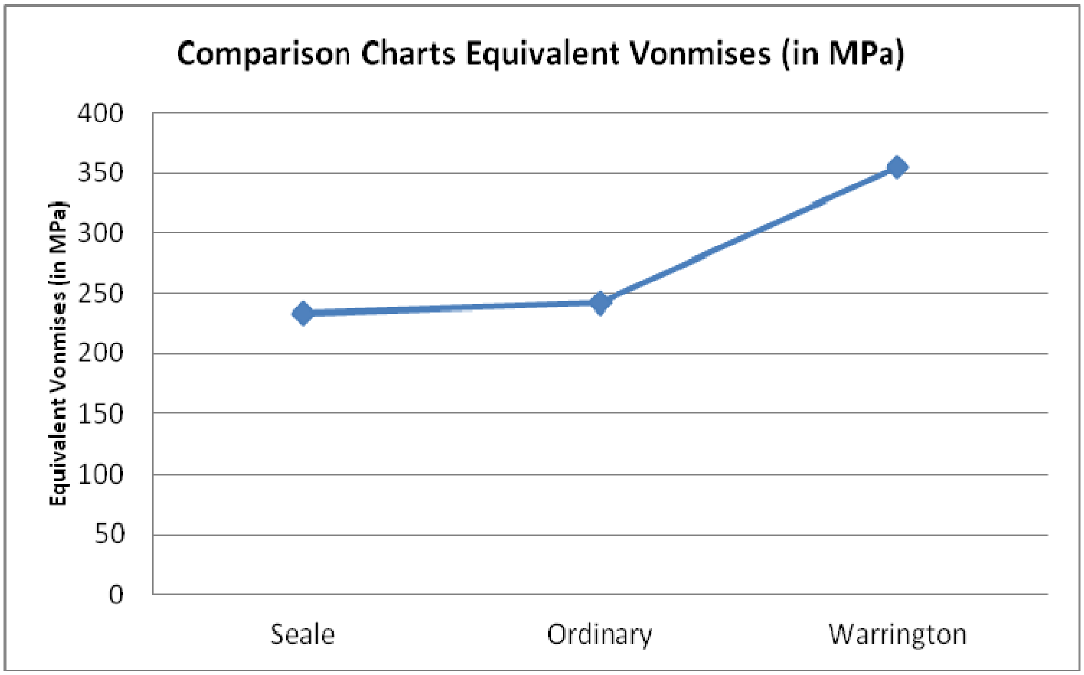

Fig 4: Comparison Charts Equivalent Vonmises (in MPa).

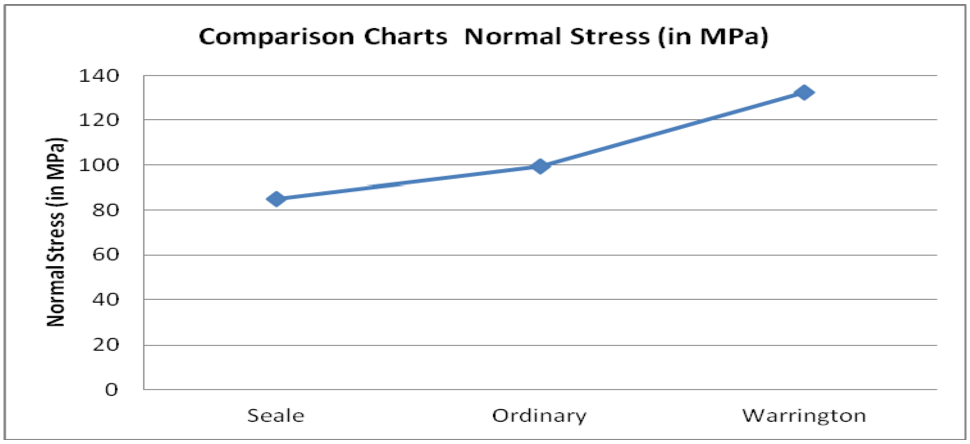

Fig 5: Comparison Charts Normal Stress (in MPa).

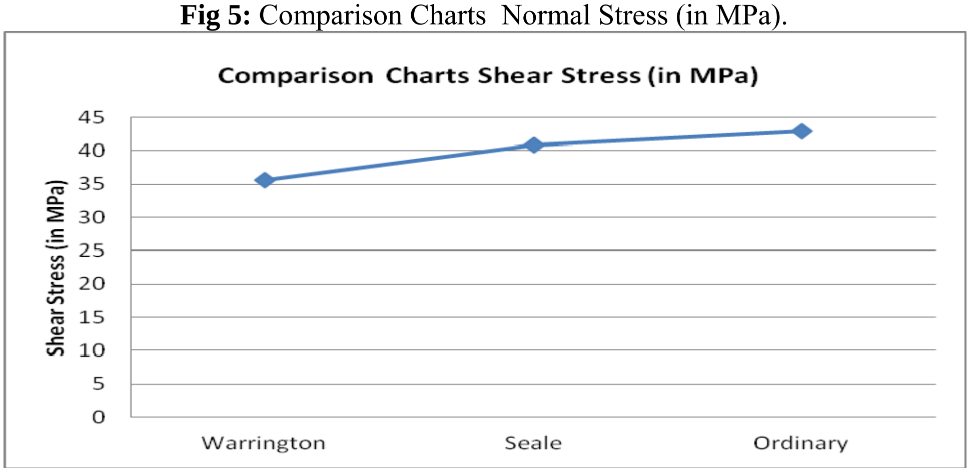

Fig 6: Comparison Charts Shear Stress (in MPa).

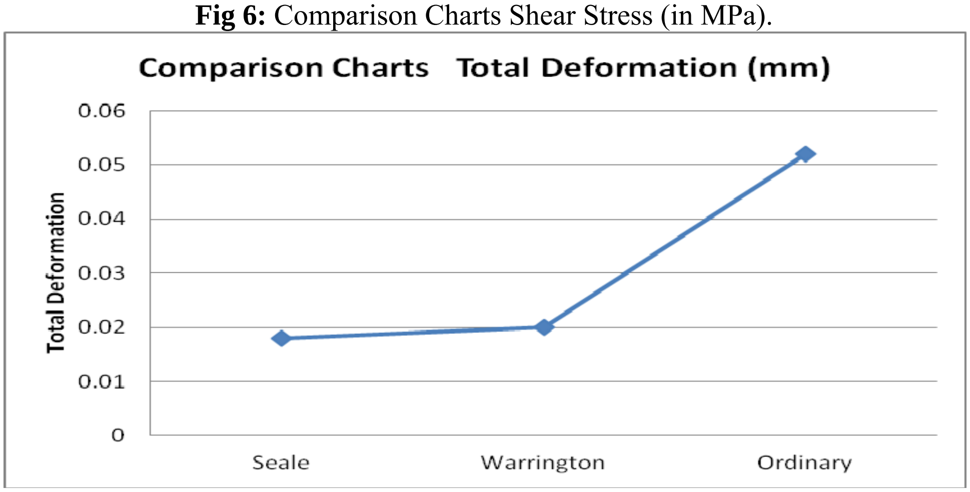

Fig 7: Comparison Charts Total Deformation.

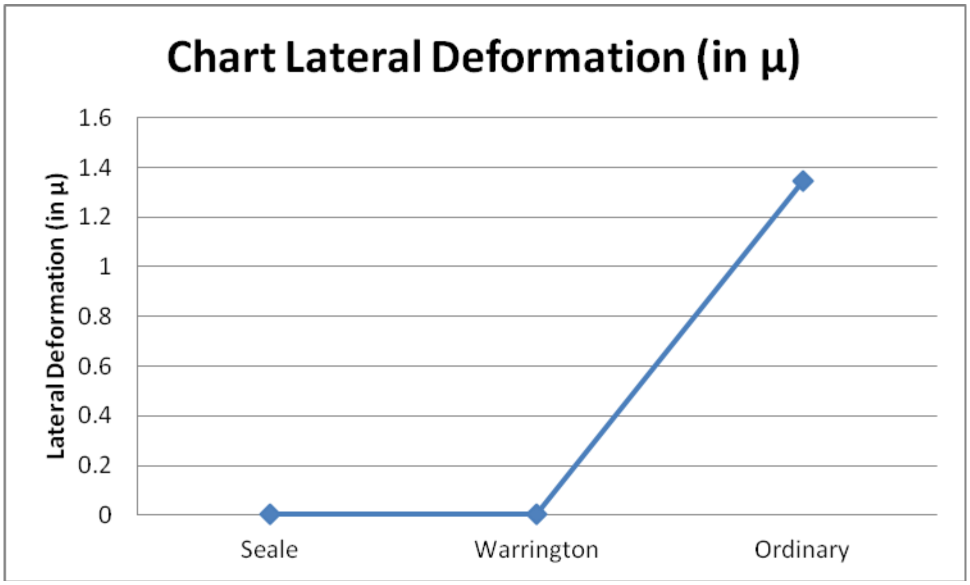

Fig 8: Chart Lateral Deformation (in µ).

V. Conclusion

The equivalent strain generated in the Seale type wire rope is least and in ordinary is most, but the lateral deformation is more in Seale type but this is much within the limit and do not cause failure of the WR. The results obtained after analysis suggest that the stress generated at any particular load is least in Seale type wire rope and at most in ordinary type wire rope. So, the conclusion is that the load bearing capability is more in Seale type wire rope.

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