International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 12, December-2014

Numerical Analysis of Independent Wire Strand Core (IWSC) Wire Rope

Rakesh Sidharthan[1]
Assistant professor Mechanical Department
Gojan engineering college,
Anna University, Chennai-600052

Gnanavel B K[2]
Professor, Mechanical Department,
Saveetha engineering college,
Anna University, Chennai-602105

Abstract **-In this project, a tensile test is carried out for a single wire and the test is extended for an Independent Wire Strand Core (IWSC) of 7x19 stainless steel wire rope of IWSC by using Universal Testing Machine. The geometrical construction of IWSC has a stranded construction of 1+6+12. A material of stainless steel grade 316 AISI is used. A geometric model is developed using (CAD) for both single wire and wire rope of IWSC. A numerical analysis is carried out for both single wire and wire rope. Depending on the contact region of wires a frictional coefficient are calculated numerically. And also a wear test is carried for wire rope experimentally to check the wear rate.**

CHAPTER 1
INTRODUCTION

1.1 Introduction

Wire rope, or cable, is a type of rope that consists of several strands of metal wire laid (or 'twisted') into a helix. The geometric construction of wire rope varies according to the strand construction. There are different strand constructions like (1+6+12), (1+6+12+18), etc. Depending upon the types the geometric varies.

.

Failures are the main criterion in wire ropes; fatigue and wear are the two mail failures in wire rope.

1.2 Wire Rope Types

The first is a fiber core, made up of synthetic material. Fiber cores are the most flexible and elastic, but have the downside of getting crushed easily.

Fig1.3.1Wire Rope with Fiber Core

The second type, wire strand core, is made up of one additional strand of wire and is typically used for suspension.

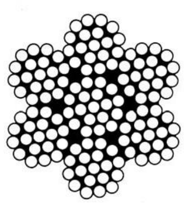

Fig 1.3.2 Wire rope with strand core.

The third type is independent wire rope core, which is the most durable in all types of environments.

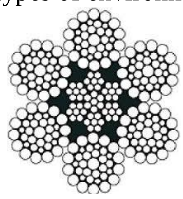

Fig 1.3.3 Wire rope with rope core

1.3 Independent Wire Strand Core

The objective of this Project is to explore the state of parameters of steel wires employing finite element analyses of 7x19 ropes or three-layered strands under axial extension.

A schematic view and a cross sectional view is discussed below Normally Independent wire strand core are widely used in Marine applications due to its corrosion resistance it is widely used.

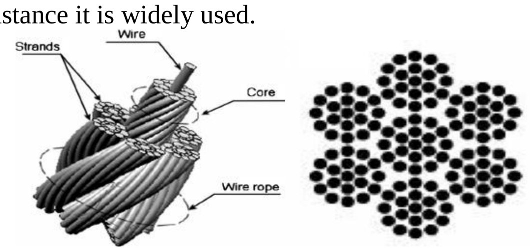

Fig 1.4.1 Independent Wire Strand Core.

1.4 Conclusion

The wire ropes and their types are discussed. Each and every wire rope applications are studied from the literature survey, and the problem is identified the methodology is discussed below. Failures in wire ropes are also discussed.

CHAPTER- II
METHODOLOGY OF APPROACH

2.1 Introduction

The overall literature survey has to be collected and the problem area identification is made, for the particular problem the material has to be selected, the overall.

2.2 Problem Identification

The main problem noted in these journals is the wear and fatigue damage in wire ropes. So to know the behaviour of the wire a tensile test has to be done experimentally, for both Single wire and independent wire strand core.

2.3 Material Selection

The material selected for Experimental analysis is stainless steel wire rope of 316 AISI standards. The main advantage of using this material is corrosion resistance because of strand core wear is the main factor in a failure.

2.4 Experimental Analysis

A tensile test carried for a single wire of Independent wire strand core (IWSC), and the same test is to be extending for Independent wire strand core of wire rope.

2.5 Numerical Analysis

A numerical analysis is carried for a single wire in independent wire strand core (IWSC) and the analysis is extended to wire rope by experimental parameters.

2.6 Result And Discussion Of Present Work

A wide range of comparison is made for a single wire of independent wire strand core. The comparison is made from experimental and numerical analyse and for a wire rope only a numerical analyse is carried out.

2.7 Conclusion Of Present Work

By comparison from numerical, experimental and analytical the overall behaviour of the independent wire strand core is to be found. For that, an experimental made.

CHAPTER III
EXPERIMENTAL WORK

3.1 Introduction

A tensile test is carried for a single wire of independent wire rope (IWSC) by a universal testing machine. From the result, numerical analyse is to done. The overall behaviour of a single wire in wire rope is been illustrated below.

3.2 Universal Testing Machine

Micro universal testing machine (UTM) System for material property measurement of “micro structure” is proposed. This system using for elongation, compression, repeat vibration.

3.3 Tensile Test

A simple tensile test carried for a single wire of independent wire strand core of diameter 0.5 mm; Because of the diameter a micro universal testing machine is used. A tensile specimen is a standardized sample cross-section.

For this test, an electromagnetic powered machine are used with the help of electromagnetic a tensile is created at both the ends and hence failure of the material is calculated. From the reading, a stress-strain graph is plot as shown in fig 4.1.

3.4 Tensile Test For Single Wire Of Iwsc

The experimental work for single wire is show here and a stress strain graph is plot.

The x-axis caries strain and y-axis caries stress. When ultimate tensile load is to apply with one end fixed and other end is to subject to force a deformation occurs.

The material behaves very well within elastic limit when it reaches the proportional limit the behaviour changes from elastic to a plastic limit then the material reaches the ultimate tensile strength then failure occurs.The total load is to apply for a single wire of independent wire strand core (IWSC) 315 N and the ultimate tensile strength

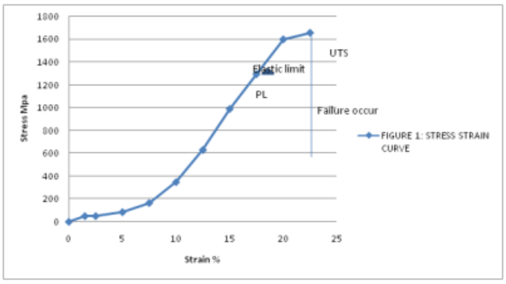

Fig 3.4.1 Stress- train curve

CHAPTER IV
NUMERICAL ANALYSIS

4.1 Introduction

The computer aided design is to develop for a single wire of Independent wire strand core and as well as for wire rope.

DESIGN PARAMETERS

4.2 Design Parameter for Single Wire

Table 4.1 Design parameter for single Wire

Model	Specification
d_c	0.5 mm
A	0.19 mm²
l_c	324 mm

4.2.2 Design parameter for independent wire strand core

Table 4.2 Design Parameter for IWSC

Model	Specification
d_w	5mm
L_w	200mm
p_w	108 mm

4.3 COMPUTER AIDED DESIGN GEOMETRIC MODEL

4.3.1 GEOMETRIC MODEL FOR SINGLE WIRE

A single wire of 0.5 mm diameter is developed by computer aided design software. A circle is to develop by a diameter of 0.5 mm and geometry is to make.

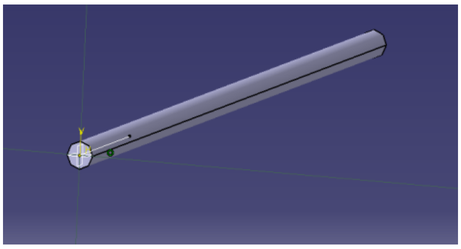

Fig 4.3.1 Generation of a single wire

4.3.2 Geometric Model For Independent Wire Rope

A centre core has to generate in part model and a helical wire of same diameter is to make and generate by using rib function. By using circular pattern six instances are generated around the centre single core. Again a circle is generated by the same methodology and a helix is made around the right hand lay. And a circular pattern is made according to the centre line twelve instances are generated around the centre core..

By the same procedure six strands are generated by circular pattern then the overall independent wire strand core is generated by Computer aided software.

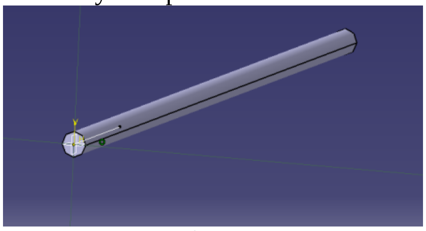

Fig 4.3.2 Generation of centre core in single strand

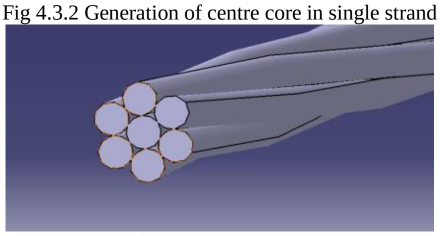

Fig 4.3.3 Generation of helix curve & First layer in centre strand

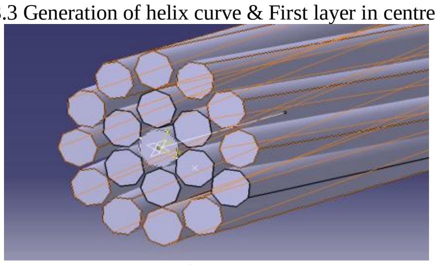

Fig 4.3.4 Generation of helical curve & second layer

Fig 4.3.5 Generation of helical strand in independent wire strand core

The centre core is to develop with a helical strand, and a circular pattern made wisely.

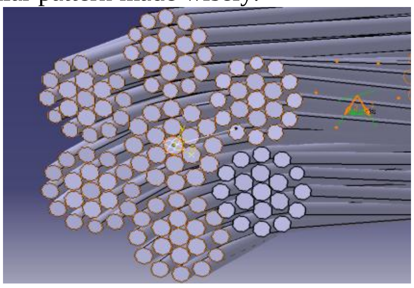

Fig 4.3.6 Generation of full strand by circular pattern

By the geometry, a computer aided modelling is to generate by using Computer aided design software and a full construction is to develop and the tolerance made here is 3 mm. The "cad" file is to convert into IGES for analysing purpose.

4.4 MATERIAL PROPERTIES AND STRUCTURAL DISCRITIZATION

The Young'S modulus is 203 Gpa and Poisson's ratio is 0.3. The actual stress–plastic strain data for wire material after yielding is shown in, which was obtained by the uniaxial tension test. "Three dimensional" solid quadratic element is to use for Discretization.

4.5 CONSTRAINTS AND BOUNDARY CONDITIONS

4.5.1 For Single Wire Of Iwsc

All the numerical analysis of the strand axial behaviour is to perform with one end clamped (displacements were disabled) and the other submitted to a force (with a displacement in the longitudinal axial direction).

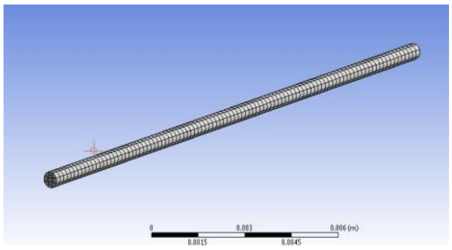

Fig 5.5.1 Finite element meshing of a single wire

The overall elements in a single wire are 16520 with 99120 nodes, and the "von misses" stress is calculated and compared with the experimental result.

4.5.2 STRESS IN A SINGLE WIRE

The application of finite element analysis for predicting the single wire under tension tests is been demonstrated. The behaviour of the model under consecutive loading is noted. The stress, strain distribution, is demonstrated.

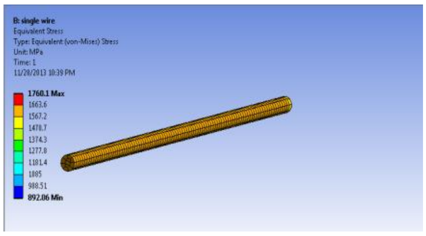

Fig 5.5.2 Equivalent stress in a single wire

4.6 Discretizations Of Independent Wire Strand Core.

A three-dimensional quadratic brick element is to use for structural Discretization, and wires of the strand are to discretize using these elements Convergence studies are to conduct to decide an appropriate mesh density, with the aim of achieving suitably accurate results.

Fig 4.6.1 Meshing of independent wire strand core

The overall elements in independent wire strand core is 141586 and nodes of 25270, hence the discretization caused here is very well and the overall the overall friction in each contact was 0.15.

ISSN: 2278-0181
Vol. 3 Issue 12, December-2014

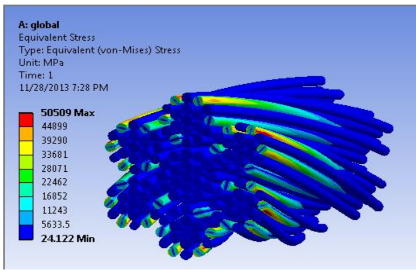

Fig 4.6.2 Equivalent stress for IWSC

4.7 DATA FOR WIRE AFTER YIELDING

Coefficient of friction is the main criterion of causing contact between the wires and hence two numerical analyses takes place under coefficient of friction and without coefficient of friction. The overall coefficient of friction implemented here was 0.15

4.7.1 With Coefficient Of Friction

When the friction is to implement in all the contact surfaces the plastic strain varies normally.

Table.4.3 Data for IWSC after yielding with friction

Actual stress	Plastic strain
1450	0
1498.61	0.00215
1570.51	0.000750
1634.2	0.00172
1657.56	0.00234

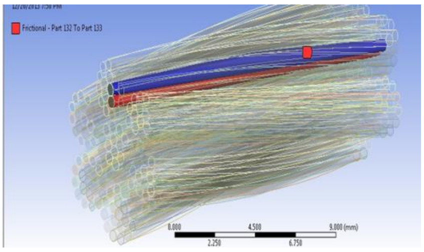

Fig 4.7.1 Coefficient of friction in wire ropes

Here the plastic strain normally deviates because the friction does not allows the wires to move from its contact to ensure that a frictional coefficient is been kept hidden between the surfaces.

4.7.2 WITHOUT COEFFICIENT OF FRICTION

When the friction is zero the contact between the surfaces fails hence the plastic strain varies.

Table 4.4 Data for IWSC after yielding without friction

Actual stress	Plastic strain
1450	0
1498.61	0.00250
1570	0.000800
1634.2	0.00170
1657.56	0.00250

4.8 Conclusion

The numerical analysis is to carry for single wire and the same work is to extend for independent wire strand core. The coefficient of friction in the independent wire strand core is been changed and the plastic strain is been developed for each equivalent stress distributions

CHAPTER V
EROSIVE WEAR

7.1 Introduction:

Erosive wear can be described as an extremely short sliding motion and is executed within a short time interval. Erosive wear is caused by the impact of particles of solid or liquid against the surface of an object. The impacting particles gradually remove material from the surface through repeated deformations and cutting actions. It is a widely encountered mechanism in industry.

The rate of erosive wear is dependent upon a number of factors. The material characteristics of the particles, such as their shape, hardness, and impact velocity and impingement angle are primary factors along with the properties of the surface being eroded. The material used here is Sea water, a flow simulation is to be made in wire rope and erosive wear can be calculated.

7.2 Boundary Conditions:

The boundary conditions used in this wire rope depends up on its inlet and outlet. A Sea water flow simulation is to make for a single wire rope which has inlet and outlet. The diameter of single wire has 0.5 mm thickness and the wall has a diameter of 30 mm.

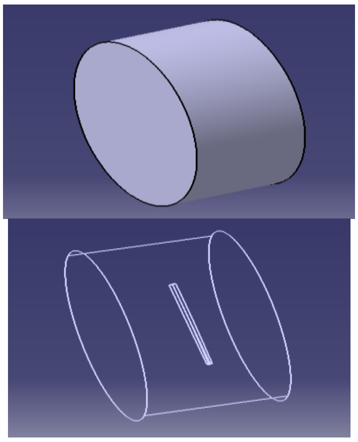

Fig 7.1: Represents single wire is placed at the centre.

The model is been meshed in Finite element software, with proper meshing and boundary condition erosive wear analysis is been carried out.

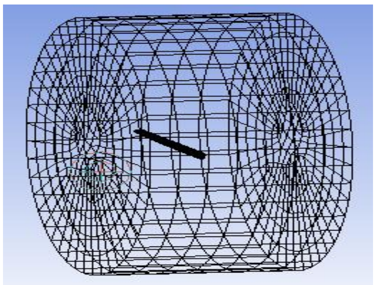

Fig 7.2: Represents meshed image of model

The Discretization of the object was made, the common idea of Meshing in geometry and dynamics is to find and investigate discrete models that exhibit properties and structures characteristic of the corresponding smooth geometric objects and dynamical processes.

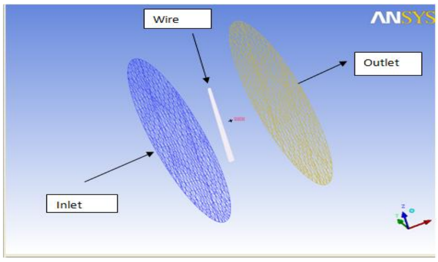

Fig 7.3: Numerical setup for Erosive wear.

A numerical tool will be developed to model corrosion endurance of steel wire ropes of typical constructions under a range of different operational exposure conditions including temperature, flow velocity, dissolved oxygen level and zone location (splash zone, mid-catenary, lowcatenary or ground).

The experimental results will allow validation (or not) of such an assumption and the development of a model for estimating the corrosion loss of low-alloy steel chain under continued immersion corrosion conditions. and surface roughness on steel corrosion under field conditions. Normally sea water properties are calculated and been implemented in numerical setup and thus erosive wear can be calculated.

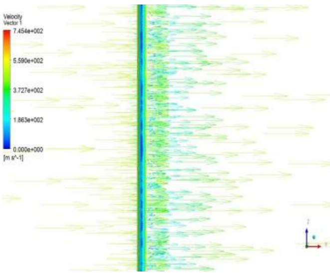

Fig 7.5: Represents flow contour in single wire.

A flow of sea water from inlet to outlet is been shown and their behaviour is been seen.

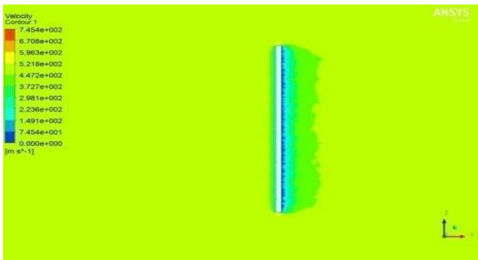

Fig 7.6: Damages in Wire rope

The corroded agent in Sea water makes the wire to corrode and thus leads to failure of wire ropes.

9.1CONCLUSIONS

This work deals with evaluation of numerical results with experimental approach of IWSC. In this approach, procedure for generating the IWSC in CAD software and finite element analysis software is briefly presented in this project the method holds promise in solving more complex analysis of strands and ropes behavior. And also the importance of coefficient of friction is also discussed

REFERENCES

1) Gnanavel, B., K., Gopinath, D., Parthasarathy, N., S., Effect of Friction on Coupled Contact in a Twisted Wire Cable, Int.ernatinal Journal of Applied Mechanics, vol.77, no. 1, pp. 1-6, 2010.
2) Argatov II, Gómez X, Tato W, Urchegui MA. Wear evolution in a stranded rope under cyclic bending: implications to fatigue life estimation. Wear 2011; 271:2857–67.
3) Ahmed Frikha, Patrice Cartraud, Fabien Treyssède, Mechanical modelling of helical structures accounting for translational invariance. Part 1: Static behaviour, International Journal of Solids and Structures.
4) Beretta S, Boniardi M. Fatigue strength and surface quality of eutectoid steel Wires Int. J Fatigue 1999; 21:329–35.
5) Brighenti Roberto, CarpInt.eri Andrea, Vantadori Sabrina. Influence of residual stresses on fatigue crack propagation in pearlitic cold-drawn steel wires. Mater Sci Forum 2011; 681:229–35.
6) Cruzado A, Harteltb M, Wasche R, Urcheguic MA, Gómeza X. Fretting wear of thin steel wires. Part 1: Influence of contact pressure. Wear 2010; 268:1409–16.