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Stress-Strain Analysis of the Fretting and Non-Fretting Steel Wire: An Experimental and Simulation Study

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Fretting wear is one of the main degradation mechanisms produced in steel wire and it is widely used for the lifting and handling of equipments. The main objective of the present work is to analyse the mechanical properties of the fretting and non-fretting wire. Statics tensile tests were performed on non-fretting wire and pre-damaged artificially fretting wire subsequently, after that tensile stress (σ_T), tensile strain (ε_T), and breaking load (B_L) were measured for both wires and their basic mechanical properties were compared. For the analysis wire diameter values varies from 7 mm to 9 mm and artificially pre-damaged wire having reduced diameters varies from 5.8 mm to 8.1 mm were used. From these tests the basic mechanical properties values of maximum tensile stress, tensile strain, modulus of elasticity (E), breaking load (B_L) 1610 N/mm^2, 12.08%, 78854.3 Mpa and 56.73 KN respectively were obtained, for pre-damaged artificially fretting wire. On the other hand, for the non-fretting wire, the values of maximum tensile stress, tensile strain, modulus of elasticity, and breaking load have been obtained as 1171.5 MPa,16.40 %,63289.4 MPa and 58.7 KN respectively.

Keywords: *Breaking Load, Fretting Wear, Tensile Stress, Tensile Strain, Wear Scar, Wire*

1.0 Introduction

Wire ropes are used for numerous mechanical, mining, and civil engineering works in different industries. Since they were first used in the thirteenth century, wire ropes have undergone a few changes. Numerous scholars have worked on the wire rope wear analysis, wire-strand arrangement, and rope-strand arrangement[1,2]. The wire rope used for hoisting applications and it is composed of strands, with the outer strand including mix of wires. Smaller and larger diameters of strands are used according to the flexibility and type of applications.

The failure load of wire rope is significantly reduced due to the axial tensile force and bending load during movement around a sheave or drum, and occasionally twisting load as a result of load rotation during movement of wire rope during its application[3]. A wire rope may have longitudinal, torsional, or a combination of both types of fretting during application. A Scanning Electron Microscope (SEM) is used to investigate the wear mechanism, and a three-dimensional white light interferometer is used to quantitatively analyzed wear scars. The analysis of fretting in wire ropes under continuous applied stress was investigated by cruzado *et*

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al.,[4,5]. They found that wire ropes have equal effects for load and wire rope cross-angle. They also stated that rope distortion, including strand loss and mechanical damage are caused for degradation of the rope, which results in fatigue, corrosion, and abrasion in the wire.

Shen *et al.,*[6] reported that the wear rate is significantly decreased by employing grease, particularly for the partial slip region into which grease pull down the coefficient of friction and prevents oxidation to conserve hardness which was reported by[6]. Wang *et al.,*[7] carried out their investigation by using a fretting-fatigue test setup for the normal contact load, and the impact of strain amplitude on the fretting-fatigue performance of steel wires considering low cycle fatigue. According to Wang *et al.*[8], the number of cycles, rotational displacement amplitude, and normal contact force all have a significant influence on the torsional fretting of wire ropes. Furthermore, Wang *et al.*,[8] investigated how displacement amplitude affects the fatigue behaviour of steel wires during the fretting of two different cyclic strain in low-cycle fatigue. Also, authors have found that the stress state and tangential force have significant effect on the fretting process.

Cruzado *et al.,*[9] accomplished their studies on the fatigue life on steel wire rope by using theoretical as well as experimental approaches. The effect of fretting on the thin steel wires fatigue life has been examined by authors by using theoretical method, named as innovative theoretical Bending Over Sheave (BOS), by using Finite Element Wear (FEW) method. Cruzado *et al.*,[10] employed a finite element fretting wear simulation model for both circular and elliptical shapes of wear scars in the wire rope. The primary parameters for the simulation were considered as mesh size, number of cycles for their analysis. Peterka *et al.*,[11] have reported that weaker wires started to separate from the strand and warp, which caused the weak spots and failure of the wire rope.

Wang *et al.*[12] performed a quantitative examination of fretting-fatigue damage in various types of corrosive media by using a modified version of archard's wear coefficient. They found that when the pH of a corrosive medium rises then wear coefficient of steel wire reduces. Authors have reported that, in acidic and alkaline conditions, steel wires show the lowest and greatest anti-wear qualities respectively. The wear profile and surface roughness of the wire were measured by chen *et al.*,[13] by using a light interferometer. For the wire rope, they have shown that the Coefficient of Friction (COF) has a linear relationship with contact pressure. Wang *et al.,*[14] reported that slippage and wire contact are vital for internal wire wear, furthermore, they stated that the wire ropes mostly fail because of the fretting fatigue on the wire rope.

By means of the finite element modelling approach and ABAQUS/CAE geometric model, Wokem *et al.*,[15] investigate the fatigue life span of the wire rope. Ren *et al.*,[16] carried out an investigation for fracture in wire rope for the single and alternating load. They also discovered the effects of environmental media on mechanical wear, plastic wear, and corrosion of wire. Wang *et al.*,[17] investigated the torsion angle impact on the fretting fatigue behaviour of steel-wire and they reported that an increase in torsion angle, it increases the size of wear scar, deflection angle, and also friction coefficient of the wire. Zhan *et al.*,[18] reported that, due to crossing angle, different contact area and contact stress, affects the fatigue life of steel wires. According to their findings, crossing angles close to 18° produce a greater contact area, and lesser contact stress which results in lower coefficients of friction.

Wang *et al.*,[19] reported that coupled longitudinal and torsional fretting of wire increases the wear- scar size, relative slip, hysteresis loop area and friction coefficient. zhang *et al.*,[20] have utilized the Finite Element Method (FEM) to get the relative slip and contact stress between spiral strands as well as between the ropes and friction lining. According to the authors' findings, contact stress peaks throughout the contact route and it is also influenced by the load's lifting speed. According to Peng *et al.*, [21], the coefficient of friction between wires increases under dry conditions along with an increase in weight, but it reduces as sliding velocity increases. However, they have shown that the coefficient of friction under lubrication is essentially unaffected by sliding velocity and contact stress. Chang *et al.*,[22] examined and reported that fretting of wear responsible for the degradation of wire ropes. Further wear-scar on wire rope also affects the mechanical properties due to which necking and pits on the surface of wire created. Authors have reported that there is temperature growth near the wear scar of the wire before breaking of the rope. They reported that breaking load inversely proportional with an increase in wire wear depth.

According to the above literature survey, it was found that researchers have studied the fretting and wear scar of the wire based on their experimental, analytical and simulation works. As per the authors best knowledge no research work has been reported for the effect of fretting on different mechanical properties of the steel wire. Therefore, the objectives of the present work are to analyse steel wire rope (unused) termed as 'non-fretting' wire with different diameters with three values (for present work) 7, 8 and 9 mm and its tensile test have been performed by using a standard Universal Testing Machine (UTM). Based on the experimental data various mechanical properties have been evaluated and presented.

To investigate the effects of fretting on steel wire and its mechanical properties, artificially fretting on the wire have been created and after that its reduced diameters have been measured with help of digital vernier scale of above non-fretting wires, which are reduced to 5.8, 6.3 and 8.1 mm, respectively. The tensile tests have been performed in the laboratory at about 28° C and as per testing standards for both types of wire under the same operating conditions. Furthermore, simulation studies have also been carried out with use of ANSYS software for both types of wire and a comparison of results between experimental and simulation works have been made.

2.0 Experimental Set-up and Methodology

To explore the effects of the test load, breaking tensile tests were performed for both types of wire samples via a Universal Tensile Machine (UTM) (Manufactured by INSTRON limited high Wycombe, Model No. 8801) as shown in Figure 1(a). For these three different diameters of non-fretting wire 7 mm, 8 mm and 9 mm and fretting wire having diameters 5.8 mm, 6.3 mm and 8.13 mm have been taken as shown in Figure 1(b). Figure 1(c) shows the line diagram of UTM.

The tests were performed in the laboratory with temperature in the range of 20-25 ∘C as per the ASTM-E8/E8M standard[23].

This test (Tensile) includes three major stages, first one is elastic deformation and after that, the second one is plastic deformation and finally in third stage is fracture failure in the process of breaking of tensile specimen. Additionally, the variation of the (a) tensile stress (b) tensile strain and (c) modulus of elasticity and (d) breaking load have been analysed and noted down and all the above mechanical properties have been compared with unused steel wire.

2.1 Von Mises Criteria Evaluation

By carrying out a straightforward tension test, it is simple to get this crucial and unique parameter for each material. The von mises yield criterion is used to determine yielding when examine the failure using the von mises stress, which is not actually a stress but rather a number used as an indicator. The formula represents the von mises stress theory. For calculating the safety factor against failure, it is appropriate. It is typically applied to ductile materials,

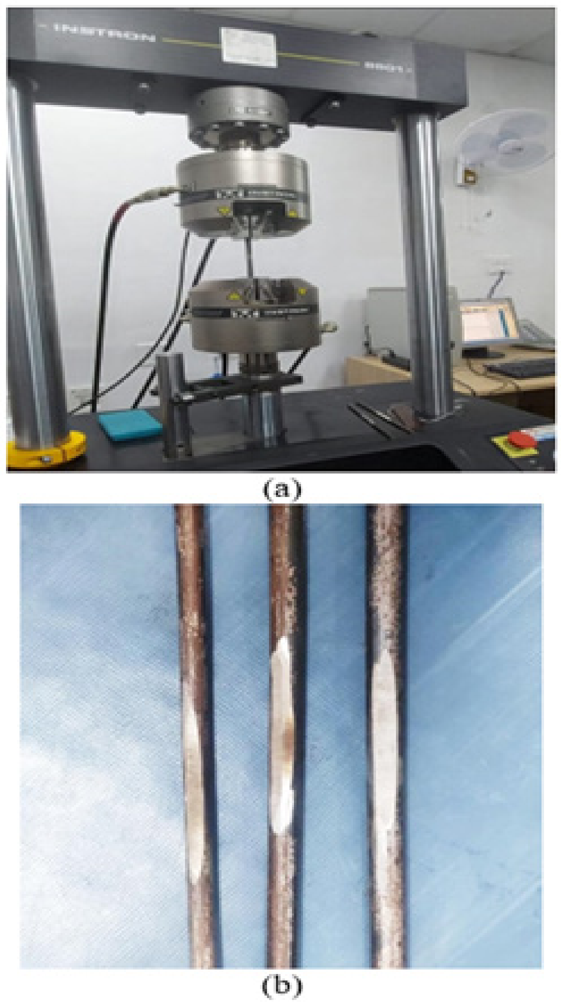


Figure 1. **(a)** Testing of steel wire on UTM. **(b)** Artificial fretting of Steel wire.

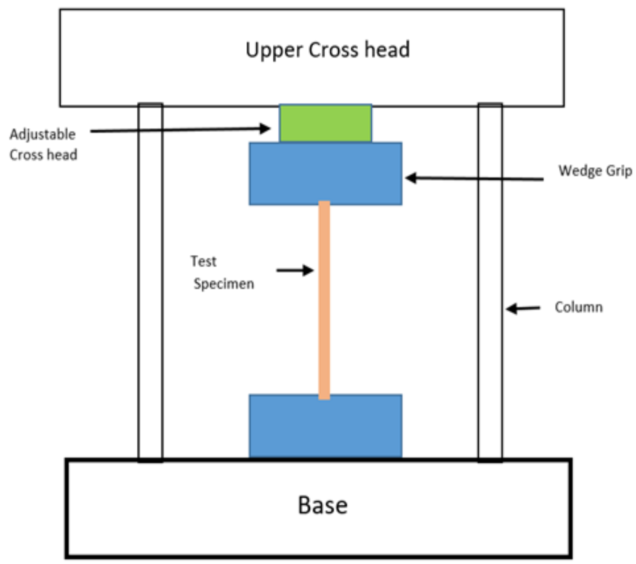


Figure 1. **(c).** Line diagram of UTM.

which must be examined to see if they meet the von mises criterion.

$$N = \frac{\sigma_y}{\sigma'} \tag{1}$$

2.2 Stress Evaluation

Stress can be evaluated by the Equation (2)

$$\boldsymbol{\sigma = F / A} \tag{2}$$

Where σ is the stress
F is the applied force
A is area of the surface.

2.3 Strain Evaluation

Strain (Ɛ) can be evaluated by the Equation (3)

$$\textbf{Strain} = \frac{X}{L} \tag{3}$$

Where,
X represents change in dimension of wire
L represents the original dimension of wire

2.4 Longitudinal Strain Evaluation

Longitudinal strain is defined as the ratio of change in length (Δl) to the original length (L), and mathematically it is expressed as by Equation (4)

$$\text{Longitudinal Strain} = \frac{\Delta l}{L} \tag{4}$$

Where,
Change in length is Δl

Figures 2(a) to (c) show the images captured by the microscope for non-fretting and fretting steel wires, respectively. Figure 2(d) shows the line diagram and details of the test specimen which have been used in the present work.

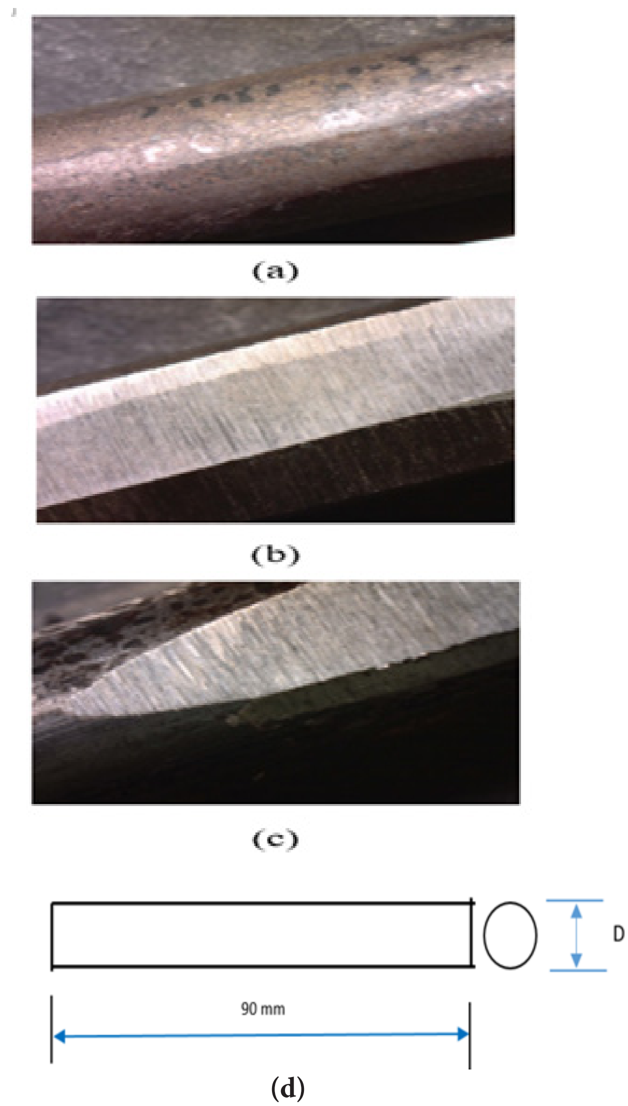


Figure 2. Images obtained from microscope **(a)** Non-fretting steel wire **(b)** and **(c)** Artificial fretting of steel wire. **(d)** line diagram of test specimen.

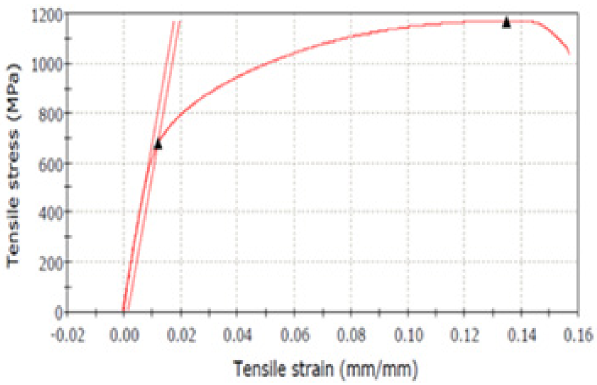
3.0 Result and Discussion

3.1 Analysis of Steel Wire of Diameter 7 mm for with and without Fretting

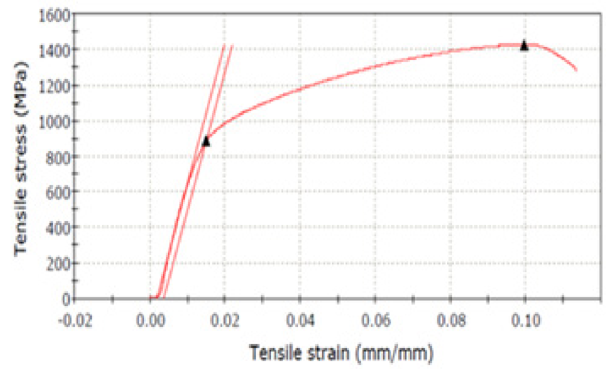
Figure 3 depicts the stress-strain curve of steel wire having diameter (D) = 7 mm without fretting and after fretting condition.

Figure 3(a) shows the stress-strain curve for the steel wire of (D) = 7 mm, from this figure, it can be seen that, in the curve, there are two points which shows the yield point and ultimate stress (ultimate strength) point or ultimate strength point respectively. After the ultimate stress point necking of wire is started and at the end the wire was broken.

Yield point is the point (or value) for the material which shows that at this point the material starts to deform plastically. The ultimate strength of the material is the point up to that a material can withstand the maximum



(a)



(b)

Figure 3. **(a)** Stress-strain curve of steel wire (D) = 7 mm without fretting **(b)** Stress-strain curve of fretting condition steel wire of (D) = 7 mm.

Table 1 (a). Fretting and non-fretting wire rope parameters (used for the present analysis)

Material of wire	Steel
Diameter of unused steel wire (D)	7, 8 and 9 mm
Diameter of fretting steel wire (Df)	5.8, 6.3 and 8.1 mm
Lay length of the wire (Ly)	90 mm

Table 1 (b). Test results for 7 mm non-fretting wire (unused) wire

S. No	Wire Diameter (D)	Wire Length (Lw)	Tensile stress at Max Load (T)	Breaking Load (B_L)	Modulus of Elasticity (E)	Tensile strain at Max Load (ε_T)
Units	(mm)	(mm)	(MPa)	(KN)	(GPa)	(%)
1	7 mm	90 mm	1171.50	45.08	63.289	13.4

Table 1 (c). Test results of mechanical properties for 7 mm fretting wire

Performance Analysis (With Fretting): 7 mm						
S. No	**Wire diameter after fretting (Df)**	**Wire Length (Lw)**	**(T)**	**(B_L)**	**(E)**	
Units	**(mm)**	**(mm)**	**(MPa)**	**(KN)**	**(GPa)**	**(%)**
1	Reduced Dia= 5.8 mm	90 mm	1427.82	40.37	78.854	9.96

Table 1 (d). Mechanical properties comparison of D= 7 mm with and without fretting

S. No	Wire Condition	Wire Diameter (D) (mm) After Fretting	Wire Length (L) (mm)	T, (MPa)	E, (GPa)	(ε_T), (%)
1	**Without Fretting**	Original Dia.= **7**	90 mm	1171.50	63.289	13.4
2	**With Fretting**	Reduced Dia. (Df) = 5.8	90 mm	1427.82	78.854	9.96

Table 1 (e). Chemical composition of steel wire

Element	Percentage (%)
Iron (Fe)	98.4
Carbon (C)	0.86
Silicon (Si)	0.02
Manganese (Mn)	0.7
Sulphur (S)	0.001
Nickel (Ni)	0.01
Phosphorous (P)	< 0.001

stress value. Table 1(b) which has been tabulated data obtained from experimental results, for the 7 mm wire the ultimate strength is 1171.50 MPa obtained.

Figure 3(b) has been plotted for the stress-strain curve for the fretting steel wire of diameter 5.8 mm. For this diameter value of fretting steel wire, the ultimate strength is 1427.82 MPa obtained.

Table 1(d) shows the comparison of mechanical properties of wire 7 mm along with the (Df) = 5.8 mm fretting wire. It can be seen from Table 3, that fretting wire has less value of strain as compared to non-fretting wire. The reason for this that fretting wear reduces the material strain, which can endure before the failure due to the cumulative effects of damage, stress concentration, fatigue, and material weakening of wire.

Furthermore, it can be seen from Table 1(d) that fretting wear of wire leads to a reduction in the strain, a material can undergo before failure when compared to a non-fretting wire (undamaged) wire. Fretting wear can lead to surface damage, including microcracks, scratches, and material removal at the contact points. This damage can act as stress concentrators and reduce the material's tensile strength so fretting wire have higher value of tensile stress.

3.2 Analysis of Steel Wire of D= 8 mm for with and without Fretting Condition

Figures 4(a) and 4(b) represent the stress-strain curve for the non-fretting wire and fretting steel wire of diameter 8 mm and 6.3 mm, respectively. From Figure for 8 mm wire diameter value of the ultimate strength is 923.83 MPa, while for the 6.3 mm fretting steel wire value of the ultimate strength is 1609.55 MPa.

From Table 2, it is visible that the fretting wire has higher values of Modulus of Elasticity (E) as compared to the non-fretting wire it is due to that fretting wear can introduce residual stresses into the material near the contact points. These residual stresses can influence the modulus of elasticity.

3.2.1 Performance Analysis with Fretting Condition of 8 Mm Wire

Table 3(a) represents the overall comparison of the mechanical properties of wire 8 mm along with the fretting wire of diameter 6.3 mm. It can be seen from Table 3(a) that non-fretting wire has higher value of strain as compared to fretting wire. Furthermore, it can also be seen that modulus of elasticity for the fretting wire is more over the non-fretting wire. The reasons for these phenomena have been explained in previous section for the Table 1(d).

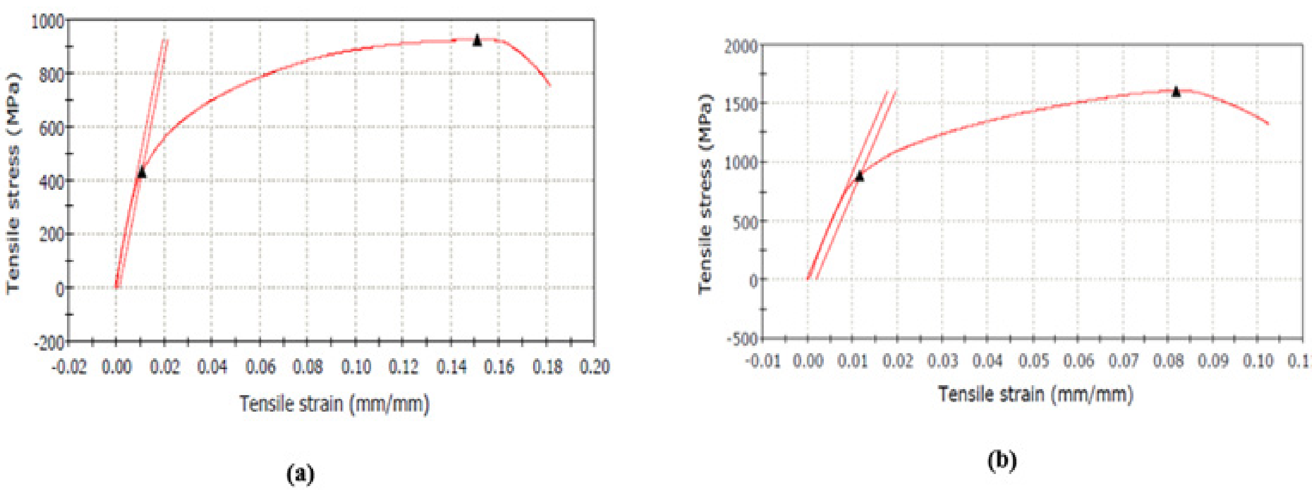


Figure 4. **(a)** Stress-strain curve of steel wire D = 8 mm without fretting **(b)** Stress-strain curve of D= 8 mm with fretting.

Table 2. Test results for 8 mm wire

Performance Analysis (Without Fretting): 8 mm					
S. No	**Wire Diameter (D) (mm)**	**Wire Length (Lw) (mm)**	**T, (MPa)**	**E, (GPa)**	**(ε_T), (%)**
1	8	90	923.83	45.793	15.11
2	Reduced Dia= 6.3	90	1609.55	90.469	8.20

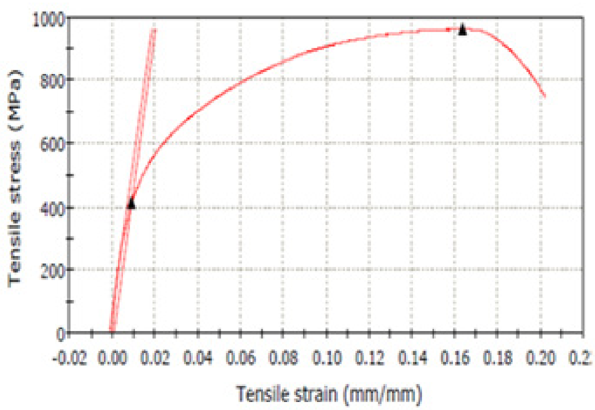
Table 3 (a). Performance comparison of Steel Wire D=8 mm with and without fretting

S. No	Wire Condition	Wire Diameter (mm) After Fretting	Wire Length (Lw), (mm)	T, (MPa)	E, (GPa)	(ε_T), (%)
1	**Without Fretting**	Original Diameter = 8	90 mm	923.83	45.793	15.11
2	**With Fretting**	Reduced Diameter (Df)= 6.3	90 mm	1609.55	90.469	8.20

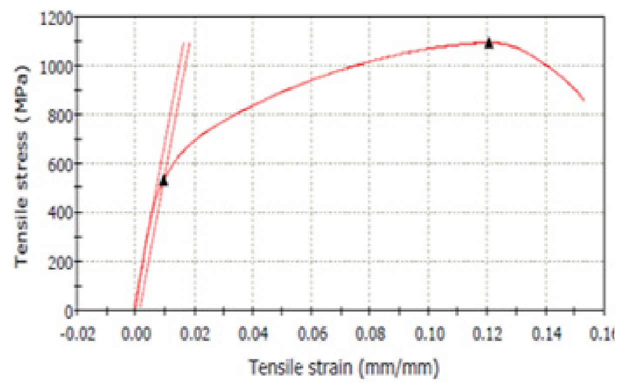
3.3 Analysis of 9 mm Wire for with and without Fretting Conditions

Figures 5(a) and 5(b) show the stress-strain curve for the (D) = 9 mm and fretting wire of diameter 8.1 mm, respectively. From Figure 5(a) and Table 3(b) it can be seen that, for the 9 mm wire diameter value have ultimate strength of 961.79 MPa, while for the (D) = 8.1 mm for fretting steel wire have value of the ultimate strength 1092.95 MPa.

Table 4 represents the overall comparison of the mechanical properties of wire (D)=9 mm along with the fretting wire of diameter 8.1 mm.



(a) Stress-strain curve of Steel Wire of diameter (9 mm) without fretting



(b) Stress-strain curve of Steel Wire of diameter (9 mm) without fretting

Figure 5. **(a)** Stress-strain curve of D= 9 mm for without fretting **(b)** Stress-strain curve of Steel D= 9 mm with fretting.

Table 3 (b). Test results for (D)= 9 mm wire

Performance Analysis (Without Fretting): 9 mm					
S. No	Wire Diameter (mm)	Wire Length (Lw) (mm)	T, (MPa)	E, (GPa)	(ε_T), (%)
1	9 mm	90 mm	961.79	48.784	16.40

Table 4. Performance comparison of Wire D=9 mm with fretting condition

S. No	Wire Condition	Wire Diameter (mm) After Fretting	Wire Length (mm)	T, (MPa)	E, (GPa)	(ε_T), (%)
1	**Without Fretting**	Original Dia (D) = 9	90 mm	961.79	48.784	16.40
2	**With Fretting**	Reduced Dia (Df) = 8.1	90 mm	1092.95	64.283	12.08

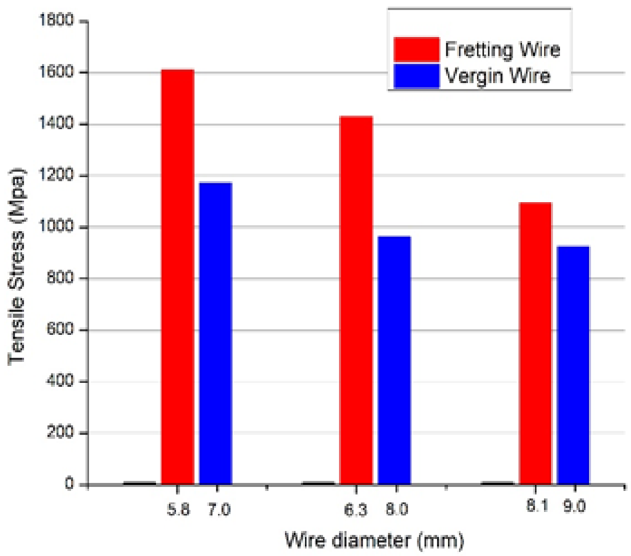


Figure 6. Tensile stress comparison of non-fretting wire along with the fretting wire.

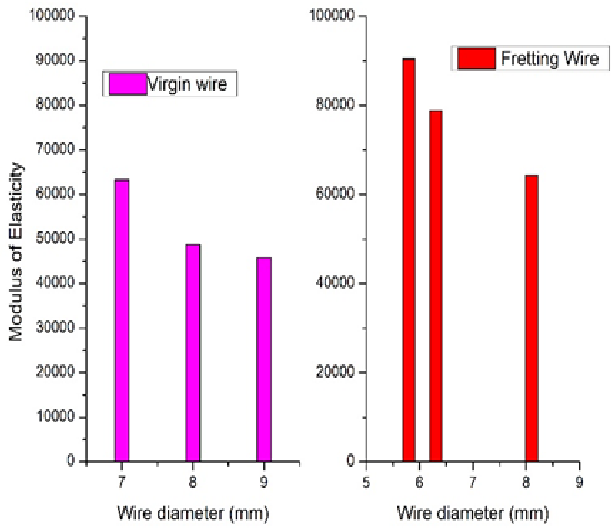


Figure 7. Modulus of elasticity comparison of non-fretting wire along with the fretting wire.

It can be seen from this table that non-fretting wire having a higher value of strain over the fretting wire. Furthermore, it can also be observed that modulus of elasticity for the fretting wire is more over the non-fretting wire.

Figures 6 to 8 show the tensile stress, modulus of elasticity, and strain comparison for the fretting and non-fretting steel wire of all diameters that have been used for the present analysis. It can be seen from Figure 6 that the stress is becoming less for the non-fretting wire, and it is obvious that with the decrease of the wire diameter, there is an enhancement in the stresses of the wire and the ability to withstand the plastic deformation of the wire rope decreases.

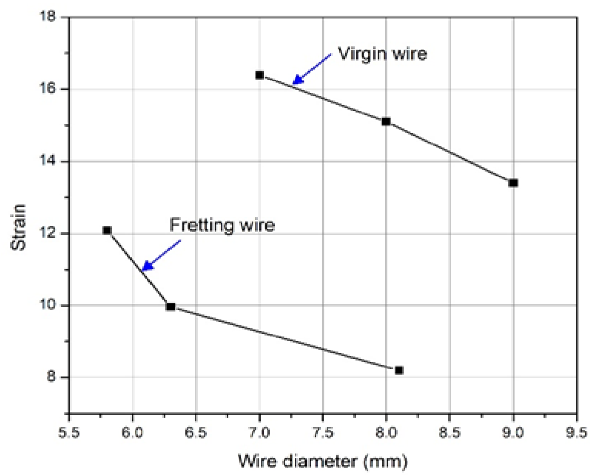


Figure 8. Effect of wire diameter (D) on strain for non-fretting wire with the fretting wire.

4. Simulation based Analysis

4.1. Analysis of Steel Wire of D=7 mm without fretting

Figure 9 shows the geometric modelling of the steel wire in ANSYS, for the modelling parameters have been selected, similar to the wires which has been used for the present experimental works i.e. it have lay length (Ly) value of 90 mm and (D)=7 mm.

Figure 10 depicts the selection of material data and input of necessary material properties from the software.

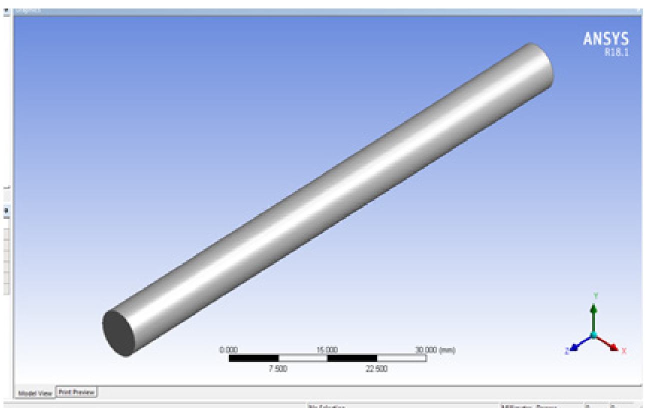


Figure 9. Geometry modelling of steel wire for without fretting condition of D=7 mm.

Figure 11(a) represnts the meshing phase of the wire, after modelling and selection of material properties as it comes in the following step for the analysis.

Figure 11(b) depicts the deformation on steel wire occurred after the application of tensile force, which have been obtained after the simulion process in the ANSYS.

Figure 11(c) shows the von mises stress produced on the wire after the applied of tensile force, which have been obtained by ANSYS simultion and presented here.

4.2. Analysis of Wire for with Fretting Condition Df= 5.8 mm

Figure 12 shows the geometric modelling of frettiing condition wire in the ANSYS software. For the present analysis the frettiing have been considered at the middle of wire as shown in Figure 12.

Figure 13 shows the meshing generation of wire with fretting condition of Df=5.8 mm.

Figure 14(a) shows the application of tensile force and due to this generation of stress on fretting wire.

4.3 Analysis of Wire for without Fretting Condition of Diameter 8 mm

Figure 15(a) shows the deformation of the 8 mm wire without fretting. Figure 15(b) shows the stress analysis by the simulation of the 8 mm wire without fretting.

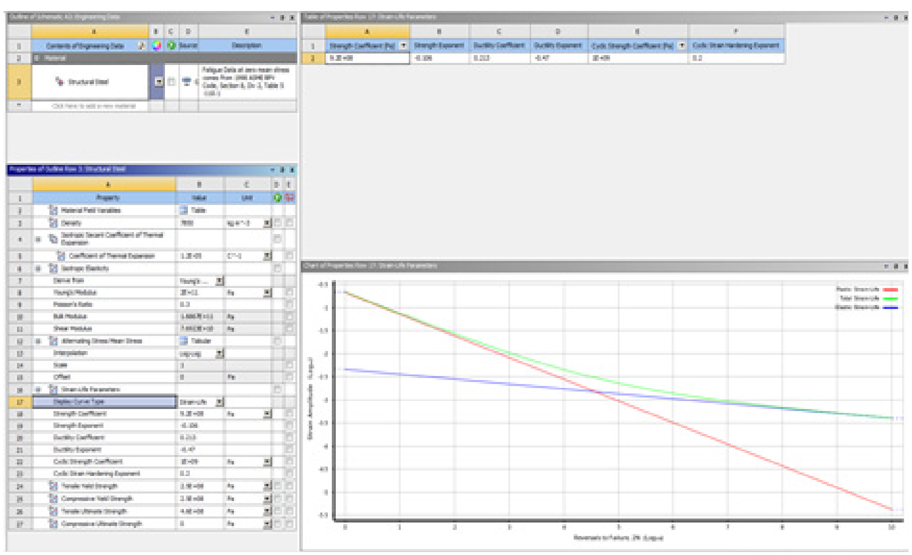
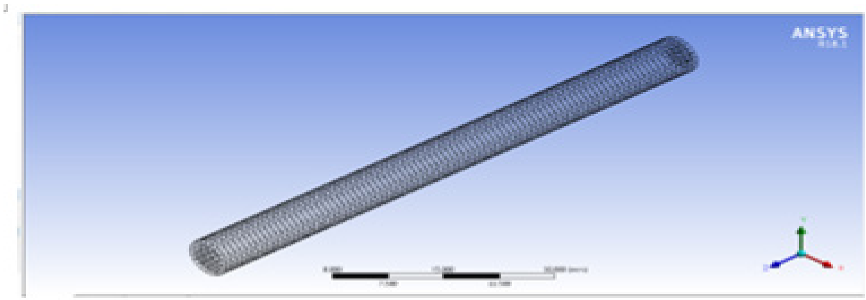
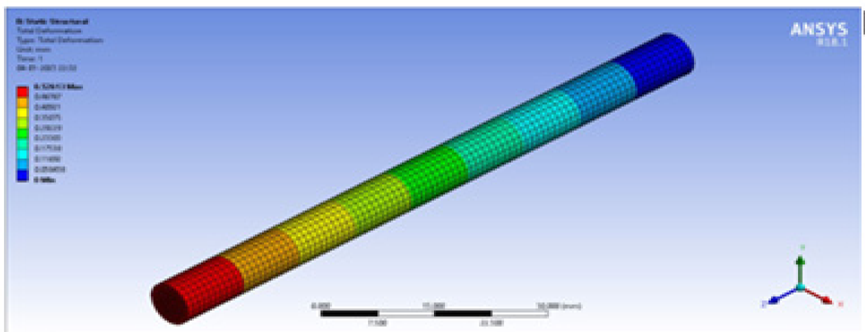


Figure 10. Material data chosen for without fretting steel wire of D=7 mm.



(a)



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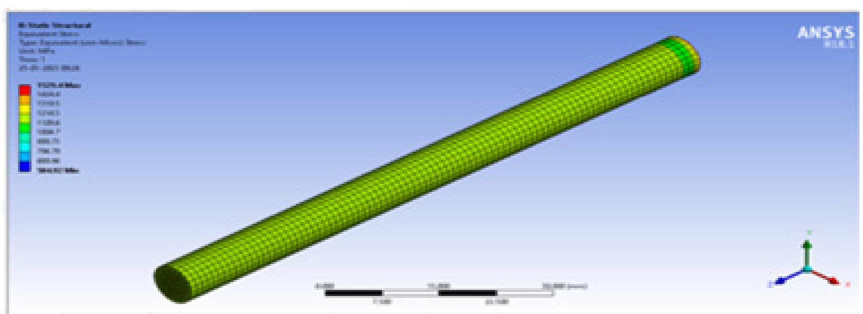


(c)

Figure 11. **(a)** Meshing of without fretting wire (D=7 mm) **(b)** Deformation of wire (D=7 mm) **(c)** von mises stress of wire (D=7 mm).

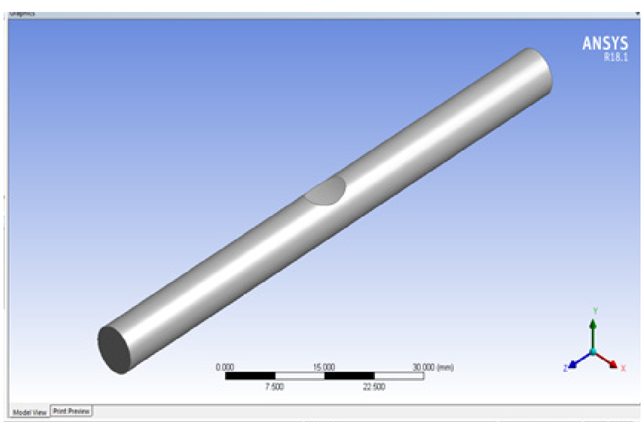


Figure 12. Geometry modelling of fretting wire Df= 5.8 mm.

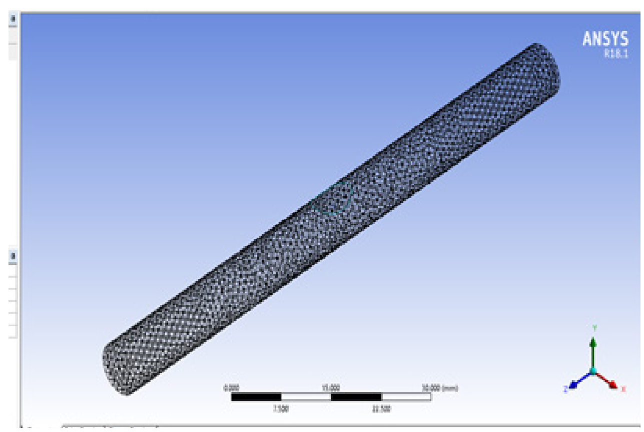
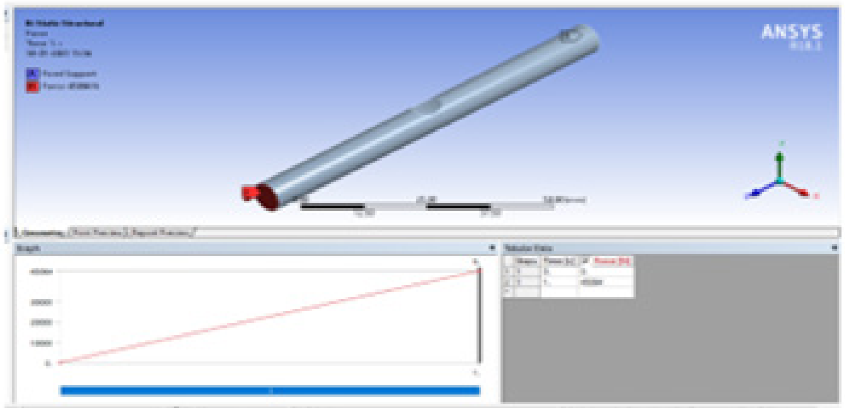
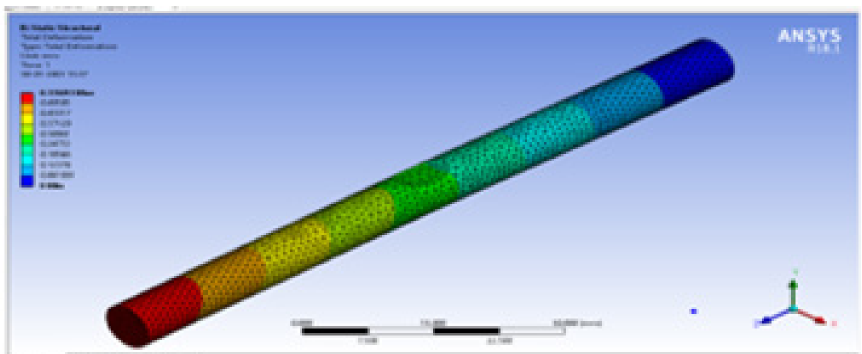


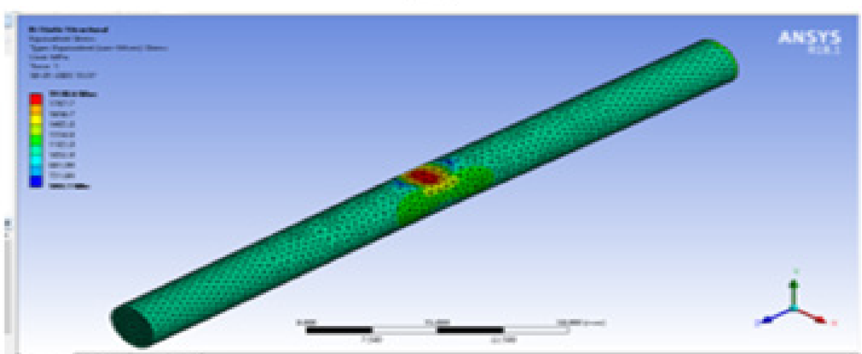
Figure 13. Meshing of wire with fretting condition Df=5.8 mm.



(a)



(b)



(c)

Figure 14. **(a)** Application of force on fretting wire Df=5.8 mm **(b)** deformation of the fretting steel wire Df= 5.8 mm **(c)** Stress on fretting wire Df= 5.8 mm.

4.4 Analysis of Wire for Fretting Condition for Df= 6.3 mm

Figure 16(a) shows the generation of deformation on fretting wire having Df =6.3 mm. Figure 16(b) shows the generation of stress on the fretting condition wire for Df =6.3 mm.

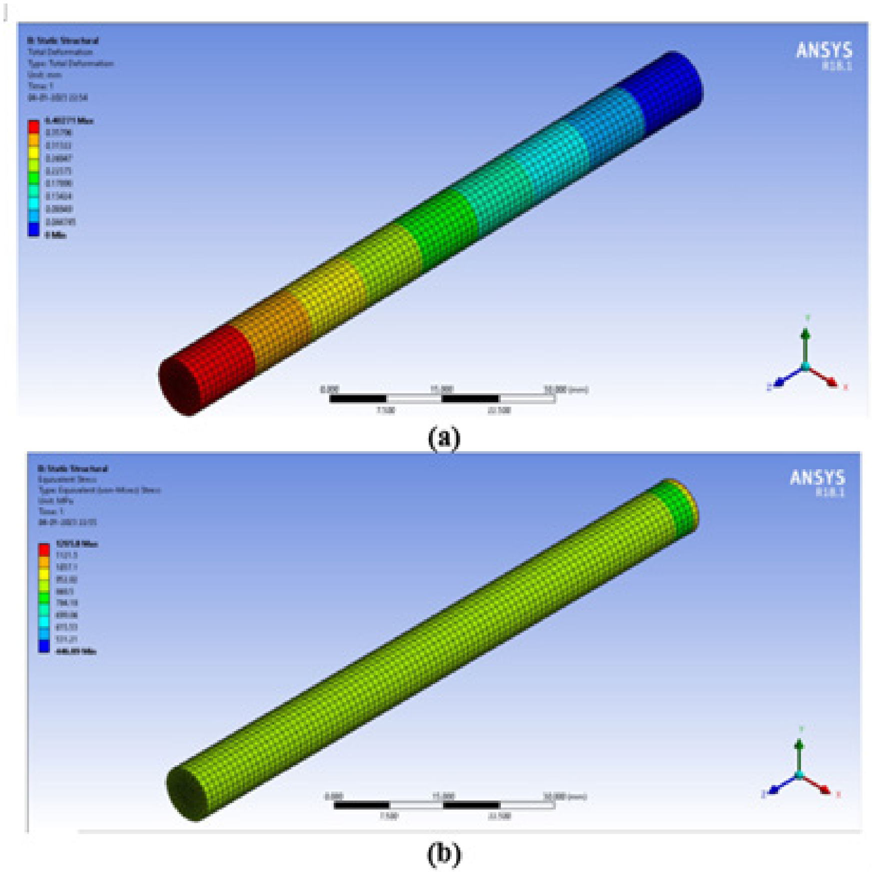
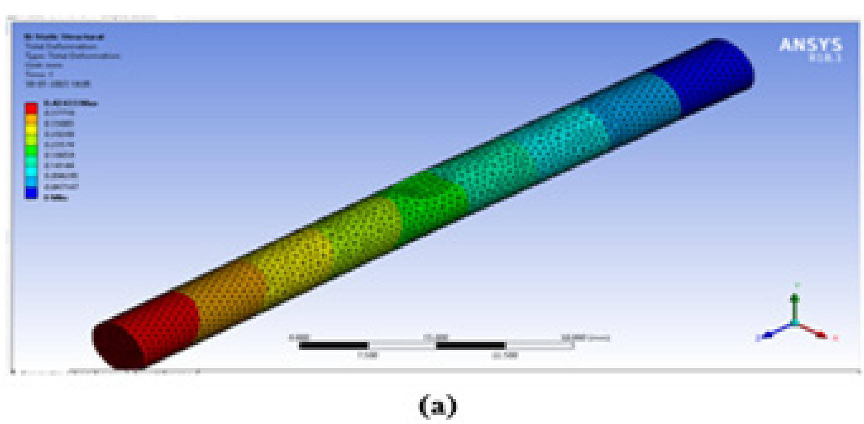


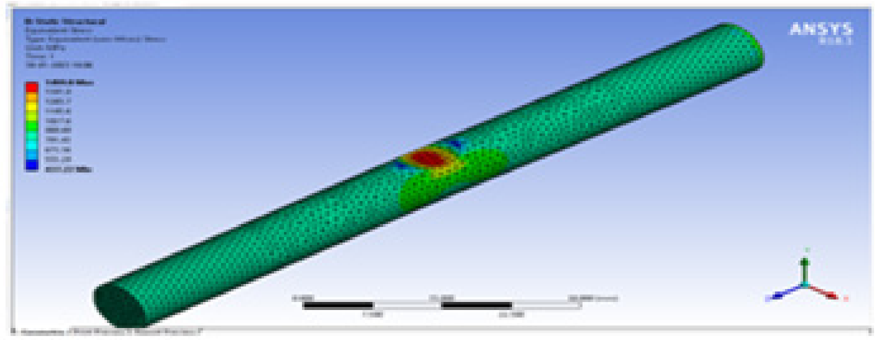
Figure 15. **(a)** Analysis of deformation on wire without fretting (D=8 mm). **(b)** Von mises stress analysis on wire without fretting (D=8 mm).

4.5 Analyis of Steel Wire without Fretting of Diameter 9 mm

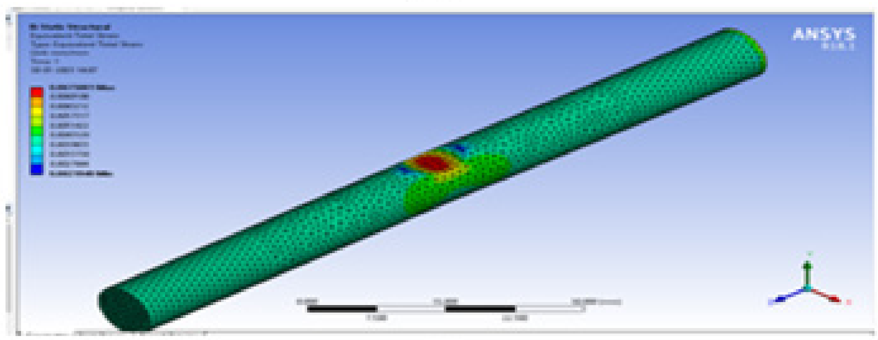
Figure 17(a) shows the stress generation on the steel wire having D =9 mm. Figure 17(b) shows the stress (von mises) on the wire without freting.

4.6 Analyis of Wire with the Fretting





(b)



(c)

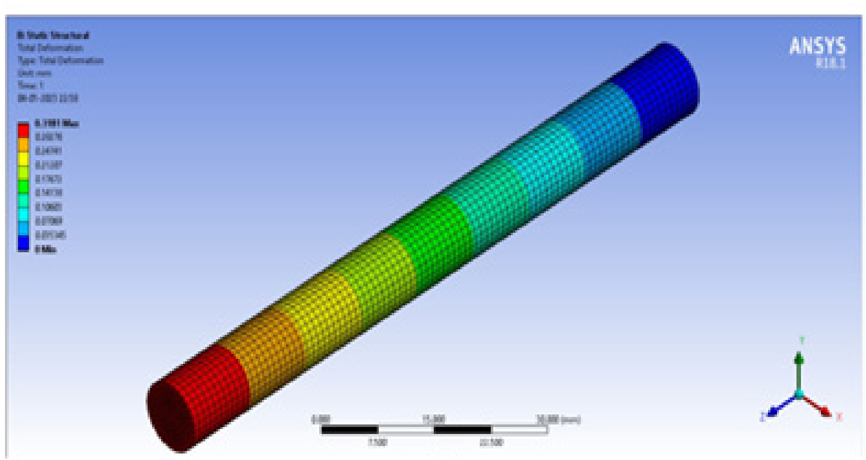
Figure 16. **(a).** Deformation analysis of fretting wire (Df =6.3 mm) **(b)** Von mises stress generation on fretting wire (Df =6.3 mm) **(c)** Total strain generation on fretting wire (Df=6.3 mm).

Condition for D=9 mm

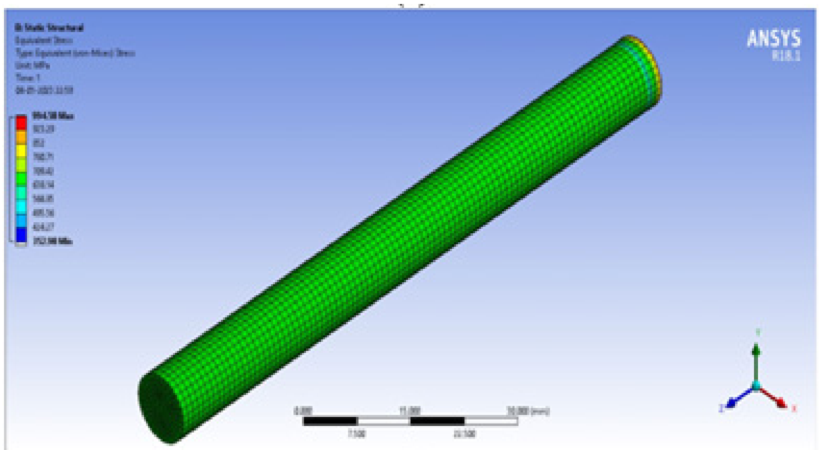
Figure 18(a). shows the generation of deformation on the wire with fretting condition for Df =8.1 mm.

5. Conclusions

In the present work experimental and simulation studies have been performed for the mechanical properties of fretting and non-fretting steel wires. Based on experimental results tensile tests were performed in

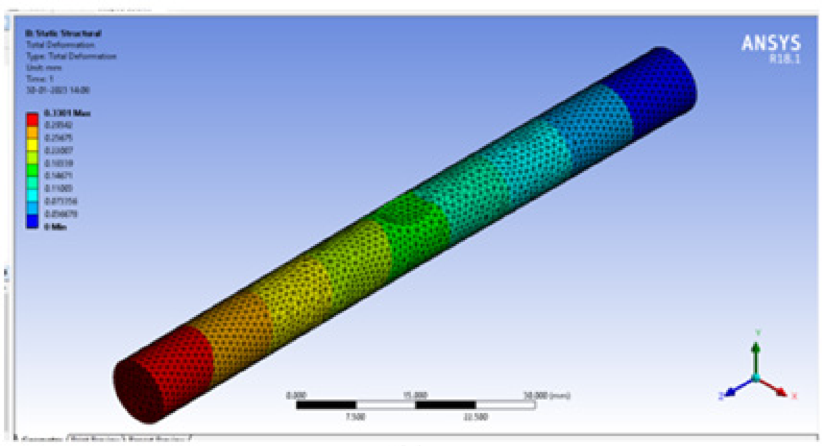


(a)

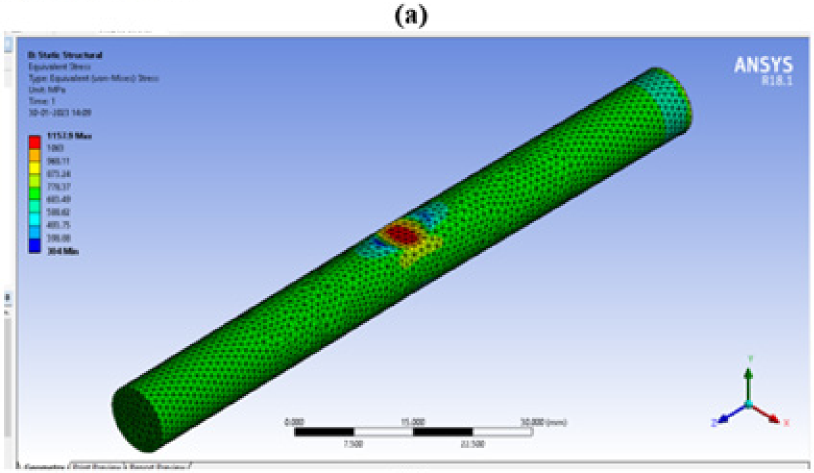


(b)

Figure 17. **(a).** Analyis of deformation on wire for without fretting condition (D=9 mm). **(b)**Analyis of Von mises stress on wire for without fretting condition (D=9 mm).



(a)



(b)

Figure 18. **(a)** Deformation on wire with fretting condition (Df = 8.1 mm) **(b)** Vonmises stress of wire with fretting condition (Df = 8.1 mm).

UTM on the fretting and non-fretting steel wires and their tensile stress, tensile strain, and breaking load were measured. For this non-fretting wire having diameters 7, 8 and 9 mm, and after artificially fretting of these wires their reduced diameters of 5.8, 6.3 and 8.1 mm have been taken.

The tensile tests were performed in UTM and for simulation work ANSYS software have been used. The effect of fretting, on wire and its effects on different mechanical properties have been investigated and presented. The main conclusions of present work are as follows:

- For steel wire of 7 mm for without fretting condition maximum tensile stress (σ) isobtained 1171.50 (MPa) furthermore for the wire with fretting condition (Df=5.8 mm) maximum tensile stress value reached to 1427.82 (MPa) these results are obtained through experimental works.
- For steel wire of 7 mm having without fretting condition, modulus of elasticity (E) is 63289.42 (MPa) while for the same wire with fretting condition (Df=5.8 mm) maximum (E) reached to 78854.32 (MPa), these results are obtained through experimental works.
- For steel wire having 8 mm maximum tensile stress (σ) is obtained 923.83 (MPa), furthermore, for the fretting wire of 8 mm maximum tensile stress (σ) value is 1609.55 (MPa) these results are obtained through experimental works.
- For steel wire 8 mm for without fretting condition, the (E) is obtained as 45973.29 (MPa) while for this wire with fretting condition wire highest (E) is obtained as 90469.12 (MPa) these results are obtained through experimental works.
- For steel wire of 9 mm without fretting (σ)is obtained 961.79 (MPa) while for the same wire with fretting condition (σ) is obtained as 1092.95 (MPa).
- For steel wire of 9 mm for without fretting condition, (E) is obtained as 48784.28 (MPa) while for the fretting wire maximum (E) is obtained as 64283.53 (MPa).

So, it can be concluded from the present work, that due to the fretting of wire it has higher values of stress **(σ)** and modulus of elasticity (E) as compared to non-fretting wire.

The fretting leads to higher localized stresses and stiffness, contributing to the increase in material's modulus of elasticity, which effects on wire life include reduced fatigue life, increased wear and surface damage, accelerated crack initiation and propagation, and a loss of ductility, all of which significantly shorten the steel wire operational lifespan.

Based on present simulation works, results obtained from ANSYS all mechanical properties and its values are close to the experimental results.

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Nomenclature

A	Area of the surface
B_L	Breaking Load
D	Diameter of wire
Df	Diameter of fretting wire
E	Modulus of elasticity
Σ	Stress
F	Force
X	Change in dimension of wire
L	Original dimension of wire
Lw	Length of Wire
Ly	Lay length of the wire
σ_T	Tensile stress
σ_y	Yield strength
Ɛ	Strain
ε_T	Tensile Strain
Δl	**Change in length of wire**

CAE	Complete Abaqus Environment
SEM	Scanning electron microscope
FEW	Finite element wear
BOS	Bending over sheave
COF	Coefficient of friction
FEM	Finite Element Method
UTM	Universal Testing Machine