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STATIC AND DYNAMIC DEFORMATION OF RAILWAY WAGON WHEEL AND TRACK WITH VERIEGATED MATERIALS

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1. Abstract

The main objective of this project is to increase the hardness of the railway wheel there by resulting in reduced wear rate and increased life expectancy. The various elements which are responsible for the wheel hardness are first studied and then are manipulated in order to obtain an increased amount of hardness.The profile of a wheel influences its life, wear rate and the heat dissipation capacity. The wear rate is influenced by the frictional forces acting on it. Its heat dissipation capacity is influenced by its surface area or the area in contact with external surroundings. Finally the life of the wheel is determined by its strength, toughness and the wheel hardness. The wheel hardness must be greater than its ductility. This is because if the wheel is more ductile than hard, then there will be a permanent deformation over its contour owing to the constant loads acting on it through the axle.

Materials used: These mainly include carbon, molybdenum, sulfur, manganese and a few others such as nickel and chromium.

Keyword's : AUTO CAD, PRO-E, CATIA & ANSYS.

2. Examination Of Wheel And Track

2.1. Parasitic Motion Of A Vehicle

Railway vehicle wheels are guided by the rails between its gauge face. These vehicles have only a single degree of freedom of motion. Wheel tread is conical. If it were cylindrical, then the wheels will run on one side of the rail only and the rail will wear out very fast. IT will become very difficult then for the wheel to steer in curves. As the Wheel tread is conical, the movement of the wheel takes the path of a sine curve and the wheel motion is sinusoidal.

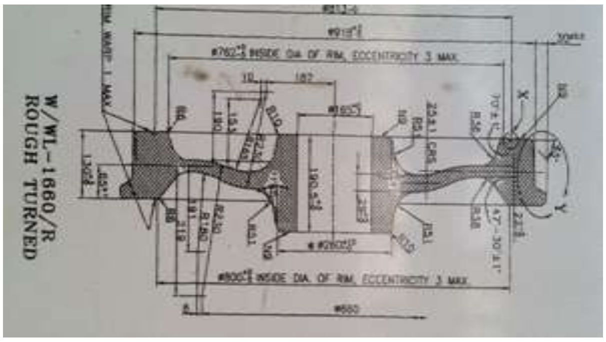

Fig1. Sectional view of a wheel

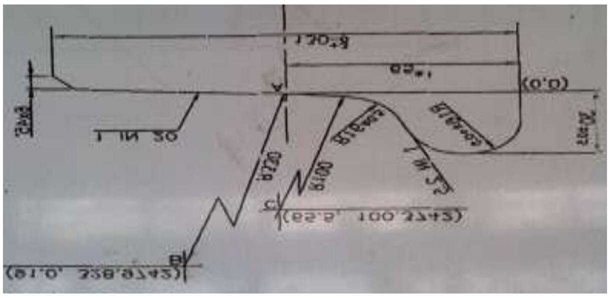

Fig 1.2. Wheel dimensions (sectional view)

Axis	Linear Oscillation	Rotational Oscillation
X	Shuttling	Rolling
Y	Lurching	Pitching
Z	Bouncing	Nosing(yaw)

Table1: Motions during linear and rotational oscillations

Maximum speed of the vehicle is always kept at 10 to 15 percent lower than the hunting speed to allow time for the track and vehicle imperfections to be identified and rectified during service. If the track imperfections and the vehicle imperfections are not identified timely and rectified then the critical speed of the vehicle falls and hence the maximum speed for the vehicle. This is the reason why maintenance schedule is prescribed for the vehicles and track recording cars are run at a periodical interval and track maintenance cycle prescribed. If this is followed systematically, there can be no case for derailments at all and absolute safety can then be ensured.

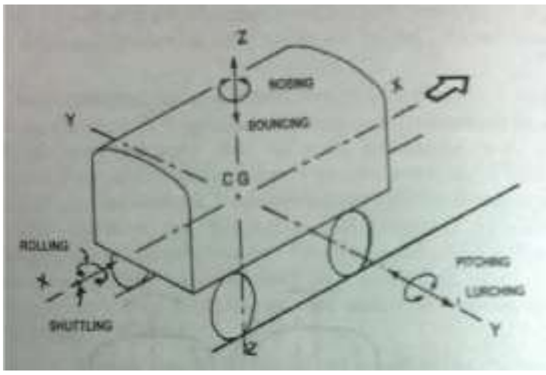

Fig2.2.motion along all the three axes.

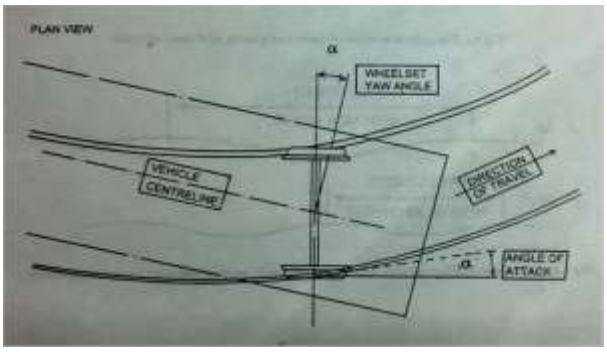

Fig2.3. Angle of Attack

For a poorly maintained vehicle on a well maintained track, the critical speed is always much lower than the safe maximum speed for that vehicle.

2.2. Curves

The Curve forms an indispensable component of railway alignment. Unlike straight track, curved track has specified requirements in respect of cross levels and alignment. A clear understanding of the forces to which the vehicles and the passengers are subjected to should therefore be acquired.

a) Radius
b) Cant
c) Equilibrium cant
d) Cant deficiency
e) Cant excess
f) Rate of change of cant
g) Rate of change of cant deficiency
h) Cant gradient

2.3. Angle of Attack

The effect of angle of attack on the Y/Q ratio has also been studied recently by YOKOSE in experiments using model wheel sets. The effect of increasing positive angle of attack is to reduce marginally the critical value

3. Alloying Elements For Steel Manufacture

This chapter gives you the functional properties of the various alloying elements that are generally used in manufacturing of alloy steels. Their functions are as follows:

3.1. Wheel Composition: (In %)

Element Composition

Carbon -	0.6	Manganese -	0.57
Silicon-	0.3	Sulphur -	0.01
Phosphorous-	0.02	Nickel -	0.22
Chromium-	0.13	Molybdenum-	0.05
Titanium -	0.3	Iron Remaining	

4. Analysis

Life Of The Wheel

The outcome of all considerations is ultimately the life of the wheel. This depends upon the distance travelled by the wheel, its corresponding wear and impact load resisting capacity. The other major consideration which must be taken into account is the wear and deformation of the wheel during its rest position during which static load from the axle acts on it.

4.1. Verification of Residual Stresses

a) Impact test
b) Re-test
c) Product Analysis
d) Element Percentage variation

Carbon	-	0.02 to +0.03
Manganese and silicon	-	0.03 to +0.03
Phosphorous and sulphur	-	0 to +0.005
Chromium and nickel	-	0 to +0.05
Copper and vanadium	-	0 to +0.02

4.2. Other Testing Methods

a) Ultrasonic Tests
b) Magnetic Particle Tests

4.3. Disadvantages of the existing system:

1. The load carrying capacity is considerably lower and can be improved greatly.
2. The stresses developed are higher as compared to harder wheels.
3. There is a possibility of higher deformation due to more inherent ductility over hardness(this is maintained within the range of high hardness and low ductility ratio).

4.4 Proposed System: The proposed system consists of a wheel of a different composition which has the following properties:

1. Higher inherent hardness,
2. Greater load carrying capacity
3. Lower deformation under stress.

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5. Results And Discussions

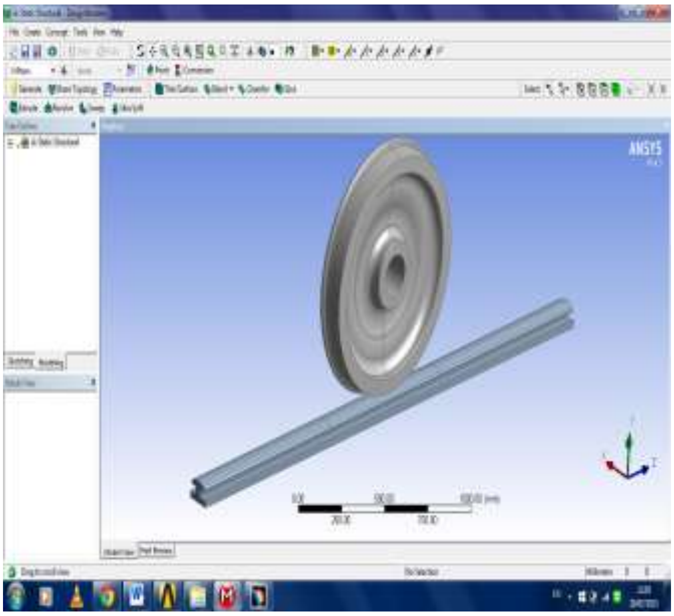


Fig.5.Imported designed step file in to ANSYS workbench design

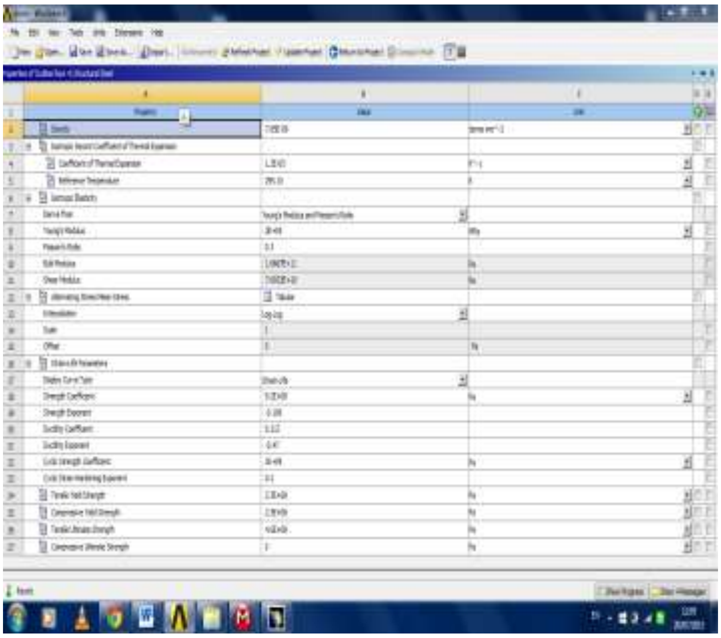


Table 2: Material selected for rail track as structural steel with properties

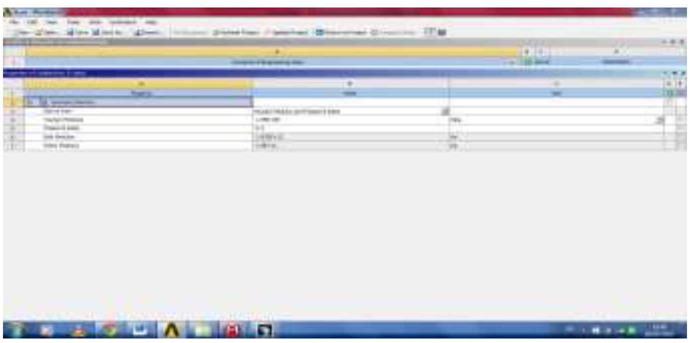


Table3.Composite Material developed for wheel with properties

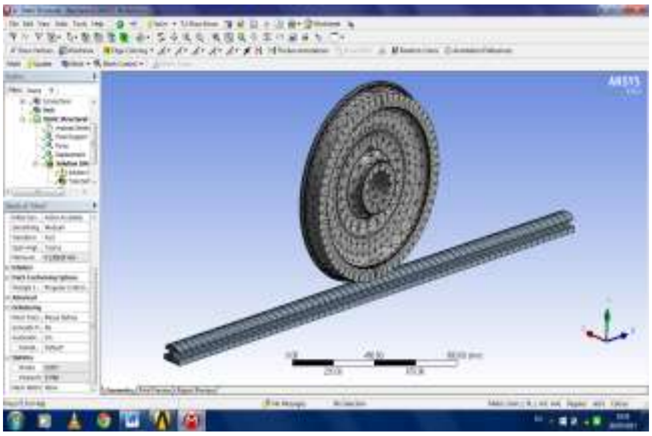


Fig5.1.Meshing with no if elements and nodes

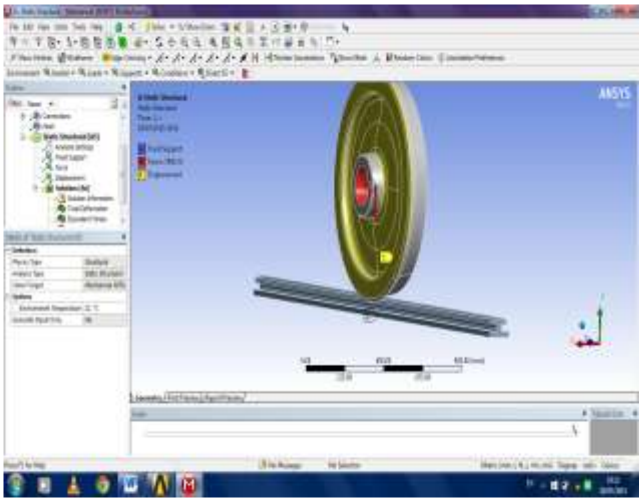
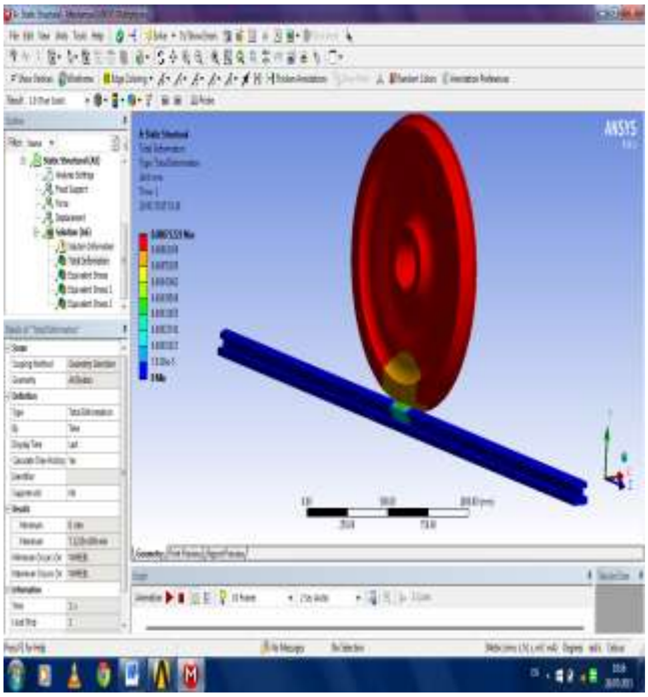


Fig 5.2. Loads & constraints



Case 5.3. (Struct1utral Steel Track With New Composite Wheel)Total Deformation.

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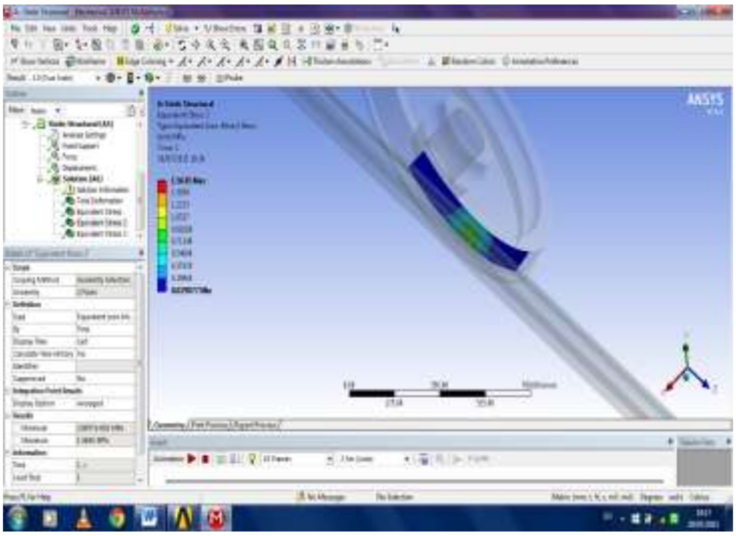


Fig 5.4. Stress On Wheel

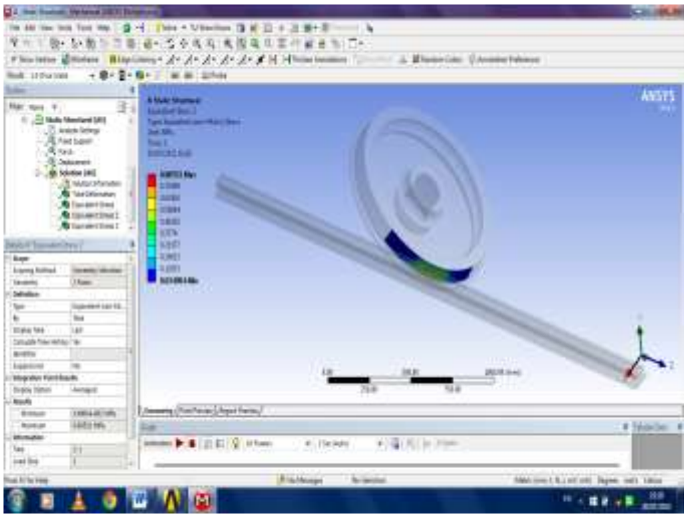


Fig 5.7. Stress On Wheel

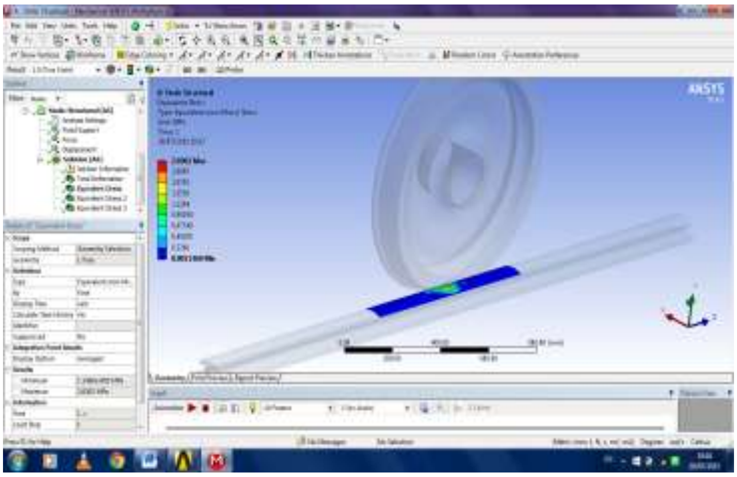


Fig 5.5. Stress On Track

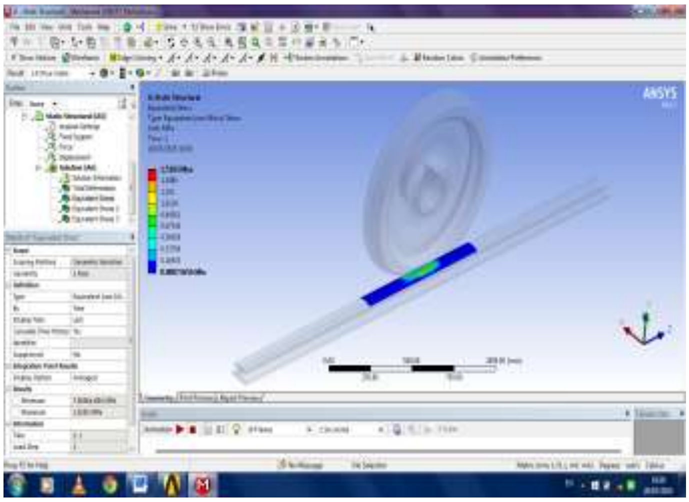
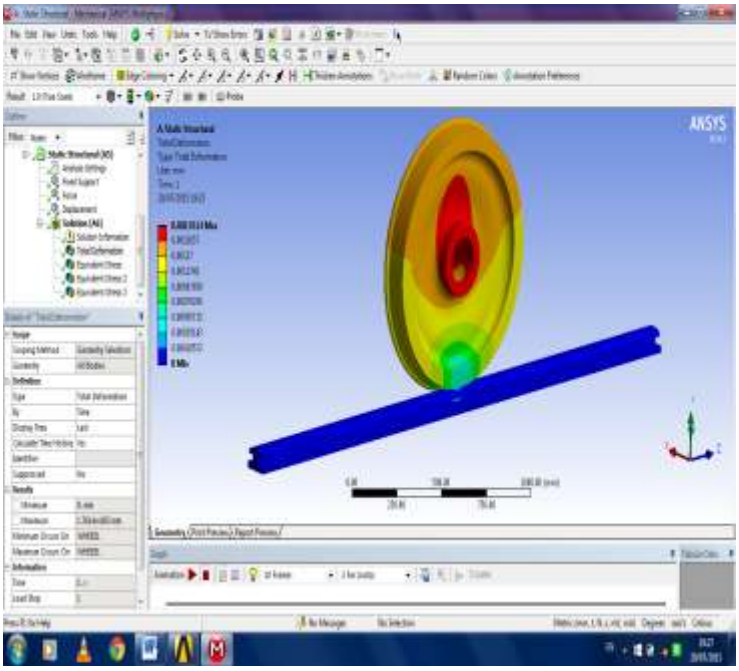
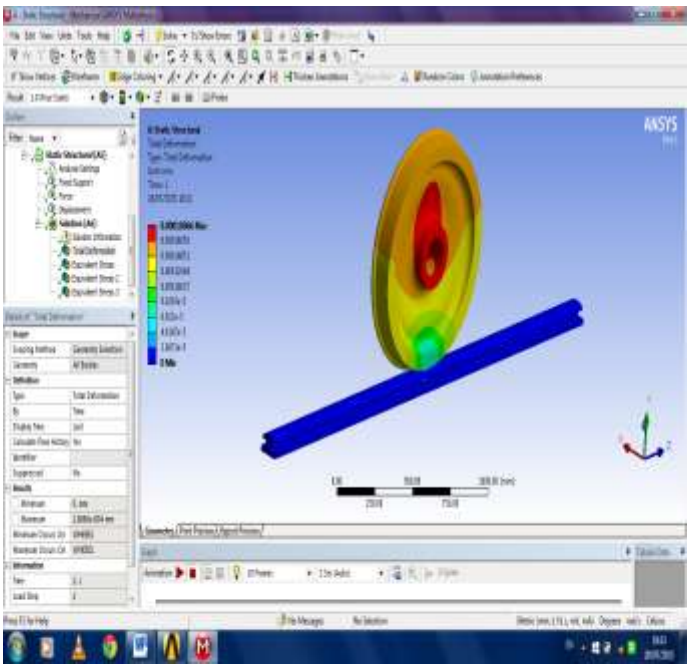


Fig 5.8. Stress On Track



Case 5.6. (Both Rail & Wheel Are Structural Steel)
Total Deformation



Case 5.9. (Both With Composite Material)
Total Deformation

ISSN: 2278 – 7798
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Fig 5.10. Stress On Wheel

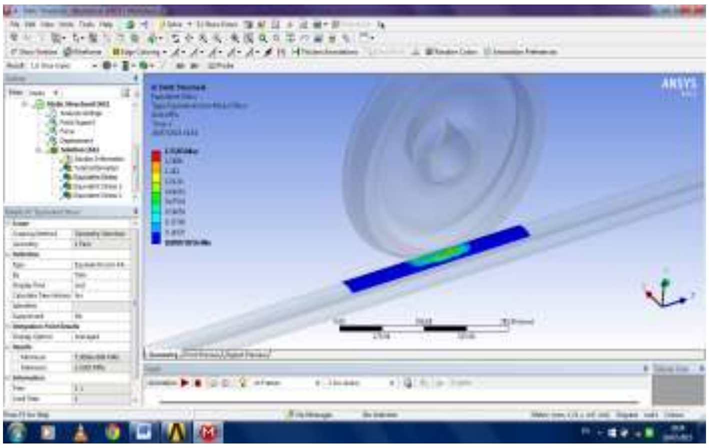

Fig 5.11. Stress On Track

6. Results

S. no	Type of material	Max deformation	Min deformation
1.	Structural steel tack with composite wheel	0.00071223	0
	Stress on wheel	1.5645	0.029077
	Stress on track	2.0302	0.0011468
2.	Both Rail & wheel are structural steel	0.0017614	0
	Stress on wheel	0.88551	0.034904
	Stress on track	1.5183	0.00073656
3.	Both with composite material	0.00073656	0.00019066
	Stress on wheel	0.88551	0.034904
	Stress on track	1.5183	0.00073656

Table 4. Result

Comparing above results minimum and maximum deformation of a Structural steel track with composite wheel is better than remaining results.

7. Conclusion & Future Scope Of Work

Conclusion:

Thus, in this project-"“Static And Deformation Condition Of Railway wheel And Track With Diverse Materials” the present wheel characteristics have been studied along with its analysis and an enhancement is its hardness is made to increase wheel life, stress bearing capacity and the load bearing capacities. The hardness of such a kind of wheel hovers near to that of the rail. Therefore, these wheels can be used in situations (countries) where the Hardness of the track is considerable greater than that of the wheel. The maintenance costs of such wheels also tend to decrease as their life and deformations better optimized as compared to the present wheels.

Future Scope Of Work:

Disadvantages of the existing system:

1. The load carrying capacity is considerably lower and can be improved greatly.
2. The stresses developed are higher as compared to harder wheels.
3. There is a possibility of higher deformation due to more inherent ductility over hardness(this is maintained within the range of high hardness and low ductility ratio).

Considerable increase in the hardness of the wheel improves the load application capacity.

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