DESIGN AND ANALYSIS OF LOCO WHEEL

B. Yamuna[1],Bakka.Ravi Kiran[2] ,Koppisetty.Ravindra Durga Kiran[3], Talla.Swaroop[4]

[1]Assistant Professor, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad.

[2,3,4] Student, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad.

Abstract

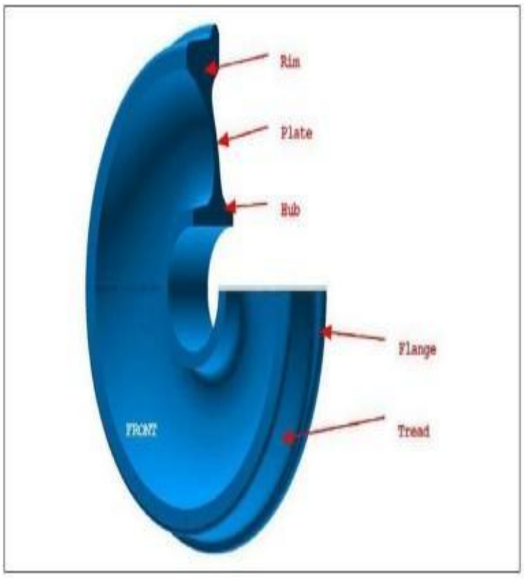
A Railway axle is a rolling stock subjected to continuous cyclic loading & repeated stress causes forced vibrations in the axle. These forced vibrations causes resonance leads to heavy stresses and deformations induced in axle. To minimise these factors, stepped bore axle is modelled in the place of solid wheel axle. To study the response of mass participation factor, stresses and deflections induced in axle, modal and harmonic analysis are performed in ANSYS. Results show that stepped axle is subjected to minimum stresses when axle is in vibration, which has no adverse effect on strength and stability of an axle. Also the effective mass participation factor is least in the stepped bore axle compared to solid axle which reduces the vibration. In Ansys Static, modal and harmonic analysis is carried out for the two models. Comparison is made between these models to predict the safe design under dynamic loading conditions

INTRODUCTION

In recent years, higher train speeds and increased axle loads have led to larger wheel/rail contact forces. Also, efforts have been made to optimize wheel and rail design to improve the performance and reduce the cost. These trends have changed the major wheel rim damage from wear to fatigue. Unlike the slow deterioration process of wear, fatigue causes abrupt fractures in wheels or the tread surface material loss. These failures may cause damage to rails, damage to train suspensions and, in some cases, serious derailment of the train. The fatigue problem of railroad wheels is often referred to as rolling contact fatigue, which is caused by repeated contact stress during the rolling motion. Similar fatigue problems also exist in other mechanical components experiencing rolling contact loading, such as gears and bearings. A detailed overview of the rolling contact problem of railroad wheels were given by Different failure modes have been observed for railroad wheels, such as shattered rim, vertical split rim and thermal cracking. Shattered rim failures are the result of large subsurface cracks that propagate roughly parallel to the wheel tread surface. Thermal cracking usually breaks off a piece of the wheel tread, while shattered rim can destroy the wheel's integrity and thus is more dangerous. The current study focuses on the subsurface crack propagation (shattered rim) analysis. Most of the existing rolling contact fatigue models use a simplified stress calculation technique, such as Hertz analytical solution or simplified finite element analysis with applied Hertz contact pressure. Due to the complex geometry of the wheel/rail contact area, it is more appropriate to use a 3D finite element method to calculate stress response in the mechanical components.

GEOMETRIC REPRESENTATION

Wheel is a circular device that is capable of rotating on its axis, facilitating movement or transportation whilst supporting a load (mass). Common examples are found in transport applications. A wheel, together with an axle overcomes friction by facilitating motion by rolling. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity, or by application of another external force. More generally the term is also used for other circular objects that rotate or turn. The train wheel is made of steel primarily to reduce rolling friction. The wheels on the train ride on a tiny contact patch, the contact area between each wheel and the track is approximately the size of a penny. The train's wheels are not just disks, there is a special ledge on each of them. The role of this ledge is very important; it lowers below rail's level and prevents the train from leaving the track. It is the lowest part of the wheel that is moving in the direction opposite to the train's heading.



MODELING:-

The Wheel and Axle is modeled in modeling software like the CATIA V5 in order to study the stress distribution and temperature distribution in the wheel. The wheel is integrated into five parts namely Rim, Plate, Hub, Flange and Thread. The train wheel has got a very special place in today’s world because it is the only thing which runs on rails. And both rail and wheel are made up of the same material. A Wheelset is the Wheel-Rail assembly of a railroad car. The frame assembly beneath each end of a car or locomotivethat holds the Wheelset is called the bogie. The Wheelset is classified into Wheel Rail. Most wheels have a conical shape of ratio about 1 in 20. The conical shape has the effect of steering the Wheel set around curves, so that the flanges come into play only some of the time. The rails generally slant in at the same rate as the wheel conicity. As the wheels approach a curve, they will tend to follow a straighter path. This causes the Wheel set to shift sideways on the track so that the effective diameter of the outer wheels is greater than that of the inner ones. Since the wheels are joined rigidly by the axle, the outer wheels will travel further, causing the train to naturally follow the curve. The wheel is 943 mm in diameter with a weight of 376 kg. The Axle is 2316 mm in length and weighs over 339 kg. The Wheel and Axle is modeled based on the dimensions provided by the Integral coach factory.

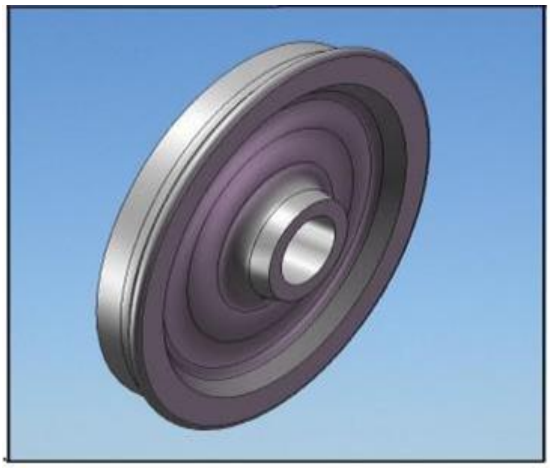
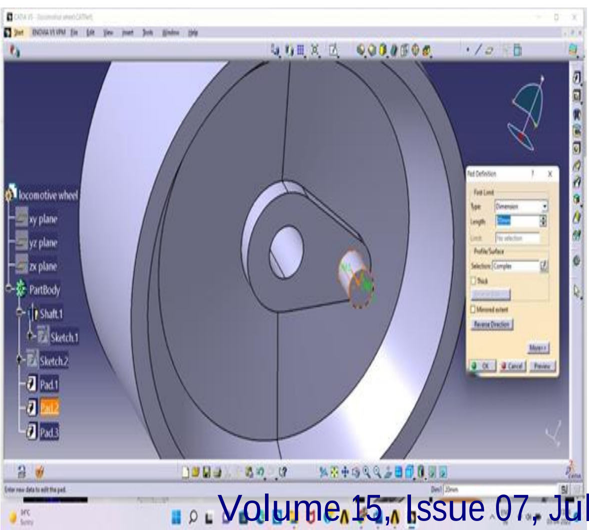
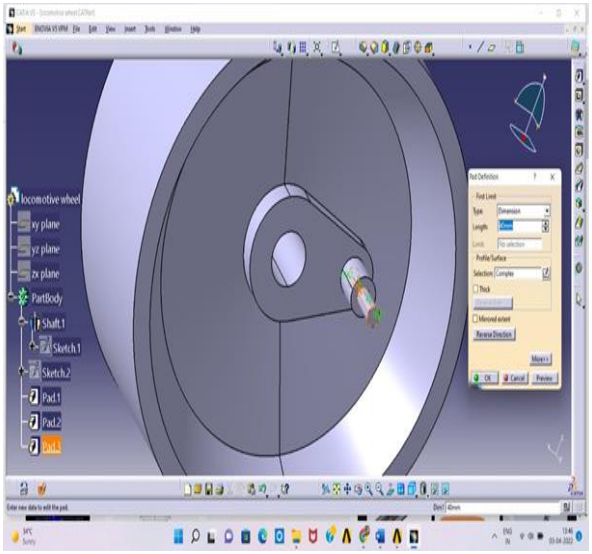


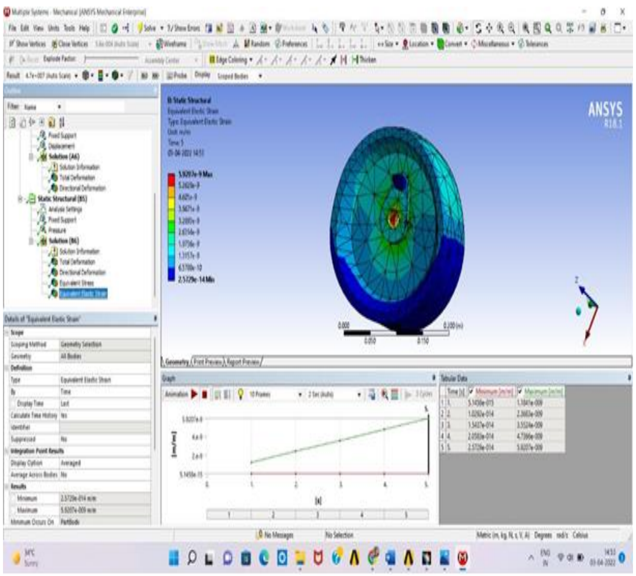
Figure 5.1: Wheel – Isometric View.





Now save the model in igs format

EQUIVALENT ELASTIC STRAIN:



CONCLUSION

Loco wheel is designed and analysed. Material assumed is Mild steel.

Following are the results of analysis:

Max.Displacement :

0.436 m

Total deformation :

4.3395×10^{-10} mm

Directional Deformation :

3.8397×10^{-10} mm

Equivalent Stress :

1143.5 Pa.

Equivalent elastic Strain :

5.9207 x 10^{-9}

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