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DESIGN ANALYSIS ON EFFECT OF GROOVE GEOMETRY ON TRAIN BREAKS

Dr M Naveen Kumar

Professor, Department of Mechanical Siddahartha Institute of Technology and Sciences, Narapally, Hyderabad, Telangana, India

Abstract:A moving train contains energy, known as kinetic energy, which needs to be removed from the train in order to cause it to stop. The simplest way of doing this is to convert the energy into heat. The conversion is usually done by applying a contact material to the rotating wheels or to discs attached to the axles. The material creates friction and converts the kinetic energy into heat. The wheels slow down and eventually the train stops. The material used for braking is normally in the form of a block or pad. The vast majority of the world's trains are equipped with braking systems which use compressed air as the force to push blocks on to wheels or pads on to discs. These systems are known as "air brakes" or "pneumatic brakes". The existing air brake system of Railway coach has the following drawbacks due to excessive brake force on the brake blocks - thermal cracks on wheel tread, brake binding and reduced life of brake block. The aim of the project is to overcome the above said drawbacks by reducing the effective brake force on the brake blocks without affecting the existing designed (Braking Function) requirements. The modeling is done in computer aided design software solid works. To validate the strength of train brake, transient thermal analysis will be done on the train brake. in thermal to find out the thermal characteristics can be analyzed. The analysis is done by applying materials steel alloys of wheels and brake pads are composite materials and modification's will be done on geometry and above analysis will be done to provide optimistic design.

Key words: train wheel, brakes, thermal behavior, steel alloys, composite materials, catia v5,software, ansys.

1.INTRODUCTION TO RAILWAY WHEEL

Since the time of first steam engine to present day the railway systems has evolved considerably. From the primitive slow moving engines of the past to the high speed engine of today, trains have gone through a great deal of research and development, to keep the pace with the changing needs of society, which has kept it competitive, and in many cases economical, to the other transportation systems.

Increasing demand of high speed and heavy loads has led to occasional accidents due to wheel defect and failure A railway wheel performs three tasks, aiding in train movement, supporting the car load and also act as brake drum. In this service life it encounters both mechanical and thermal stresses. Thermal stresses are observed under severe drag braking, causing yielding and wheel failure. Fig.1 shows the railway wheel profile which has been used for modeling and analysis.

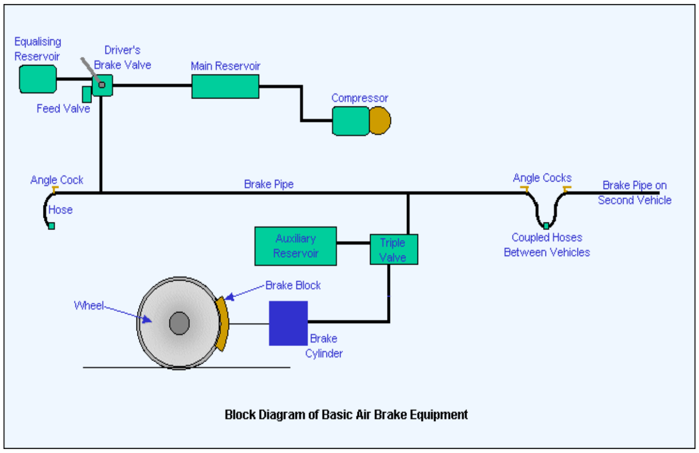
1.2 INTRODUCTION TO BRAKES

A brake is a device that decelerates a moving object such as a machine or vehicle by converting its kinetic energy into another form of energy, or a device which prevents an object from accelerating.Most commonly brakes use friction convert kinetic energy into heat, but in regenerative braking much of the energy is converted instead into useful electrical energy or potential energy in a form such as pressurized air, oil, or a rotation flywheel

1.2.2Air Brake System

The vast majority of the world's trains are equipped with braking systems which use compressed air as the force to push blocks onto wheels or pads on to discs. These systems are known as "air brakes" or "pneumatic brakes". The compressed air is transmitted along the train through a "brake pipe". Changing the level of air pressure in the pipe causes a change in the state of the brake on each vehicle. It can apply the brake, release it or hold it "on" after a partial application. The system is in widespread use throughout the world.

COMPONENTS OF AIR BRAKE SYSTEM



Block Diagram of Basic Air Brake Equipment

1.3 Advantages of air brake system:

Air brake system has the following major advantages over vacuum brake system.

- Speed of the train increased.
- Load of wagon/coach increased.
- Shorter braking distance.
- Better reliability and safety.
- Availability of optimum and uniform brake power. Compact and easy maintenance

2.LITERATURE SURVEY

Syed M.Badruddin studied the behaviour of elasto-plastic and residual stresses due to severe drag braking and reduced the tensile residual stresses in

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regions of stress concentration by modifying the wheel profile. Attempt is made to reduce the tensile residual stresses by modifying the fillet profiles. Three new designs with modifications in fillet profiles are tested.

Care is taken to avoid significant change in the wheel weight in the new designs.

Pramod Murali Mohan was carried out the analysis of railway wagon wheel to study thermal and structural behaviour when the wheel was subjected to thermal, structural and combined loading. That was intended to outline a simple first stage analysis of railway wheel and the analysis result depicts the behaviour of wheel for varying loading conditions. He observed that excessive braking of the wheel leads to thermal overloading which results in fatigue, crack propagation leading to fracture and wear.

P.Rambabu suggested the need to optimize the wheel through several considerations such as material properties, shape, design features etc. He had done the modal analysis for three types of materials for the wheel and frequencies are calculated for different materials by using the analysis software ANSYS. He has suggested the materials which will suites for the design of the wheel.

Rolling contact fatigue damage in railway wheels operating under high axle loads by **P J Mutton** includes surface initiated cracking and sub-surface shelling. Surface initiated cracking the shallow (3-5mm depth) shelling behaviour has been reduced through increase in material strength and improved management of the wheel-rail interface in order to control contact stress and creep age levels.

3.Design

CATIA offers a solution to shape design, styling, surfacing workflow and visualization to create, modify, and validate complex innovative shapes from industrial design to Class-A surfacing with the ICEM surfacing technologies. CATIA supports multiple stages of product design whether started from scratch or from 2D sketches. CATIA is able to read and produce STEP format files for reverse engineering and surface reuse

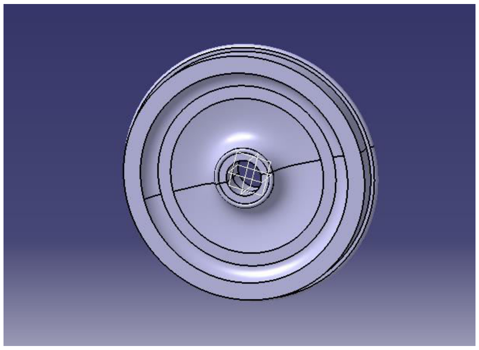


Fig1: train wheel

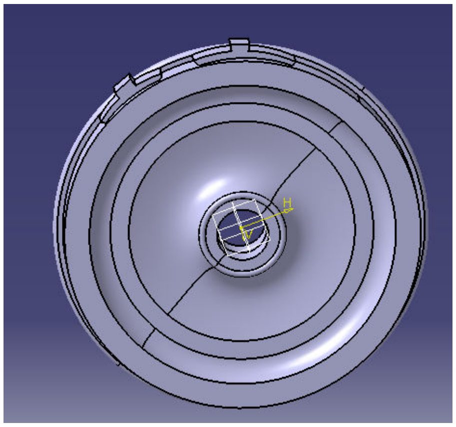
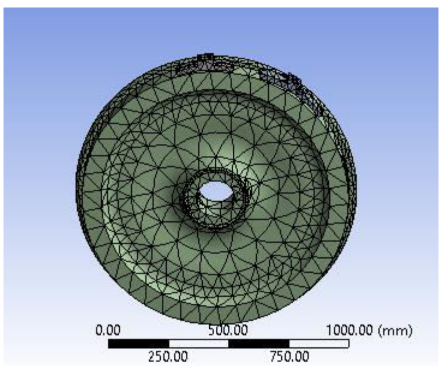


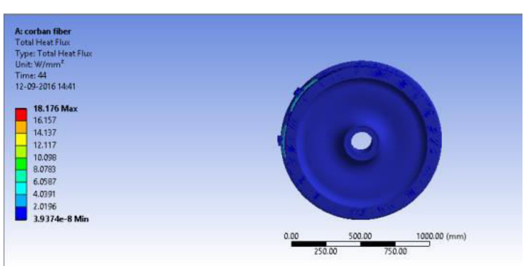
Fig2: train wheel and brakes

4. Ansys result:

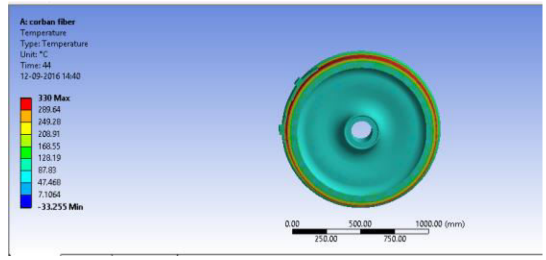


Silicon carbide:

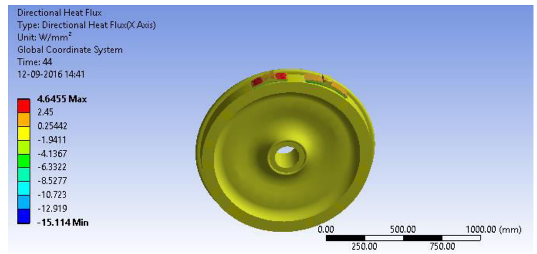
Temperature:



Heat flux:

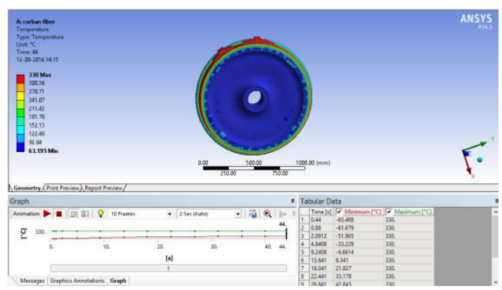


Directional heat flux:

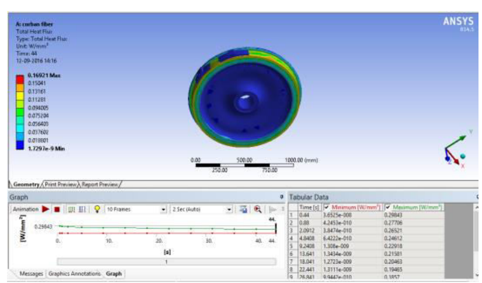


Carbone fiber epoxy:

Temperature:



Total heat flux :



Directional heat flux:

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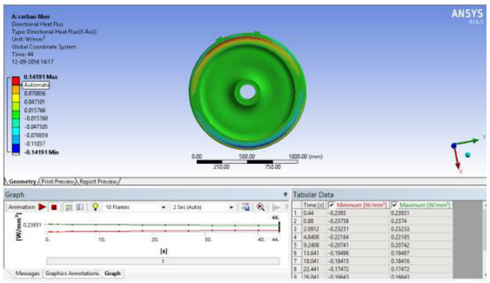

5.RESULT

The analysis of Train wheel has been done by using ANSYS.Then the model is saved in IGES format and the analysis has been done using ANSYS.Through the ANSYS software transient thermal analysis entire model has been achieved. The results obtained for

By using SILICON CARBIDE :

Type	Maximum	Minimum
Time set up	4.4 s	4.4e-002 s
Temperature	330. °C	33.255 °C
Total heat flux	18.176 W/mm²	3.9374e-008 W/mm²
Directional heat flux	4.6455 W/mm²	-15.114 W/mm²

By using CARBON FIBER /EPOXY RESIN:

Type	Maximum	minimum
Time set up	4.4 s	4.4e-002 s
Temperature	330. °C	63.195 °C
Total heat flux	0.16921 W/mm²	1.7297e-009 W/mm²
Directional heat flux	-0.14191 W/mm²	-0.14191 W/mm²

6.CONCLUSION

By observing the above results Silicon carbide has more heat flux and directional heat flux than Carbide fiber. The following drawback due to existing break force on the break blocks thermal cracks on wheel thread .The break binding and reduced the life of break block. The modification is done in the project to overcome the above said troubles by reducing the minimum thermal effective of breaks without existing design requirements.

The maximum temperature of silicon carbide is better than carbon fiber. By the comparison of both break materials, thermal performance of silicon carbide is better than carbon fiber epoxy.Hence modification carried out in this project is justified

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