Modelling And Static Analysis of Shoe Break

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Abstract- *Train is one of the major transportation which makes the things easier at low cost. This train moves by fossil fuel and the consumption of the fuel is depends up on the engine performance and braking system, as the kinetic energy of the train is to be reduced by braking and electric system. This kinetic energy is to be converted into heat by contact material to the rotating wheels or discs which are attached to the axles. The friction which is created and coverts the energy into heat and eventually the train slow down and the braking material is in the form of block or pad.*

The braking systems are used in majority of trains which uses compressed air as the force to push pads on to discs, which are known as "air brakes" or "pneumatic brakes". The electricity is also been used to reduce the speed of the wheels by producing reverse current and because of this brakeage and thermal cracks are reduced. But these are the effective drawbacks which are to be considered to increase the life and performance of the wheels.

In this paper the aim is to overcome the drawbacks by reducing the effect of brake force on the brake block without affecting the existing designed (Braking function) requirements, design of brake pad is done by using CATIA software which is widely used for solid modeling. The material properties of the brake pad are carbon steel, cast iron composites compared the results of both the materials in static analysis are in ANSYS software and cast iron is better than carbon steel.

Keywords- Block Brake, Cast Iron , Carbon Steel ,CATIA V5 ,ANSYS 1

I. INTRODUCTION

A brake is a mechanical device which inhibits motion, slowing or stopping a moving object or preventing its motion. Most commonly brakes use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat, though other methods of energy conversion may be employed.

For example regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat. Still other braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel.

II. TYPES OF BRAKES

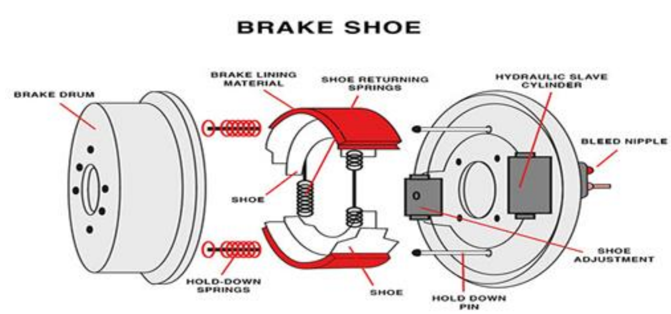
Depending upon the direction of application of braking force, the mechanical brakes are primarily of three types

- Shoe or block brakes – braking force applied radially.
- Band brakes – braking force applied tangentially.
- Disc brake – braking force applied axially.

SINGLE SHOE BRAKE

The force needed to secure contact is supplied by a lever. When a force F is applied to the shoe (see figure 1.3) frictional force proportional to the applied force *Ffr*

= *M* ' *F* DEVELOPS, WHERE *M* ' DEPENDS OF FRICTION MATERIAL AND THE GEOMETRY OF THE SHOE.



DOUBLE SHOE BRAKE

Since in a single shoe brake normal force introduces transverse loading on the shaft on which the brake drum is mounted two shoes are often used to provide braking torque. The opposite forces on two shoes minimize the transverse loading.

EXTERNAL EXPANDING BRAKE

An external expanding shoe brake consists of two symmetrically placed shoes having inner surfaces coated with frictional lining. When the shoes are engaged, non-uniform pressure develops between the friction lining and the drum. The pressure is assumed to be proportional to wear which is in turn proportional to the perpendicular distance from pivoting point.

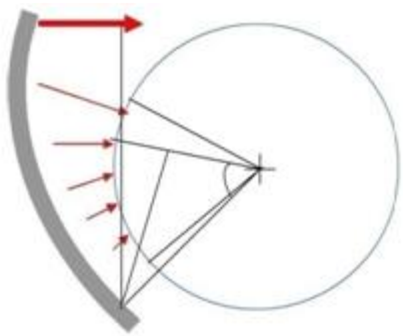


Fig.Internal Expanding Brake

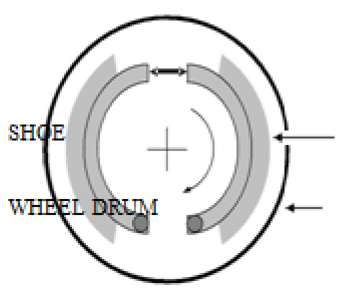


Fig. External Expanding Brake

INTERNAL EXPANDING SHOE BRAKE

Here the brake shoes are engaged with the internal surface of the drum. The analysis runs one of the important member of the expanding shoe brakes is the anchor pin. The size of the pin is to be properly selected depending upon the face acting on it during brake engagement.

AIR BRAKE SYSTEM

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 used to push blocks on to wheels or pads on to discs. These systems are known as "air brakes" or "pneumatic brakes".

Compressor

The pump which draws air from atmosphere and compresses it for use on the train. Its principal use is for the air brake system, although compressed air has a number of other uses on trains

Main Reservoir

Storage tank for compressed air for braking and other pneumatic systems.

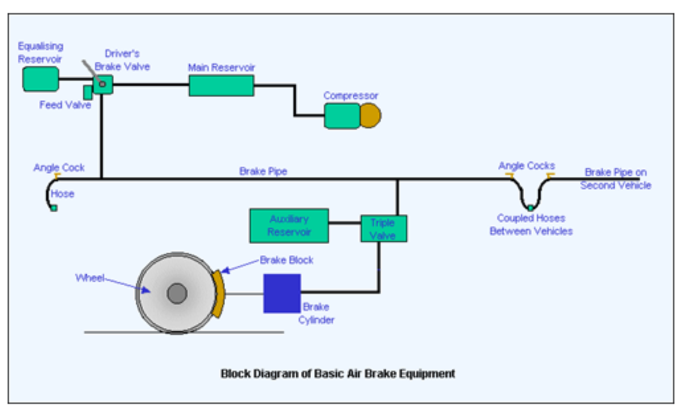
Driver's Brake Valve

The means by which the driver controls the brake. The brake valve will have (at least) the following positions: "Release", "Running", "Lap" and "Application" and "Emergency". There may also be a "Shut Down" position, which locks the valve out of use.

VACUUM BRAKES

Selection of materials for engineering purposes

1. Availability of the materials,
2. Suitability of the materials for the working conditions in service, and
3. The cost of the materials.



CAST IRON

The cast iron is obtained by re-melting pig iron with coke and limestone in a furnace known as cupola. It is primarily an alloy of iron and carbon.

The carbon contents in cast iron varies from 1.7 per cent to 4.5 per cent. It also contains small amounts of Silicon, Manganese, Phosphorous and Sulphur. The carbon in a cast iron is present in either of the following two forms:

Free carbon or graphite, and Combined carbon or cementite.

Following are the values of ultimate strength of cast iron:

- Tensile strength = 100 to 200 MPa
- Compressive strength = 400 to 1000 MPa
- Shear strength = 120 MPa

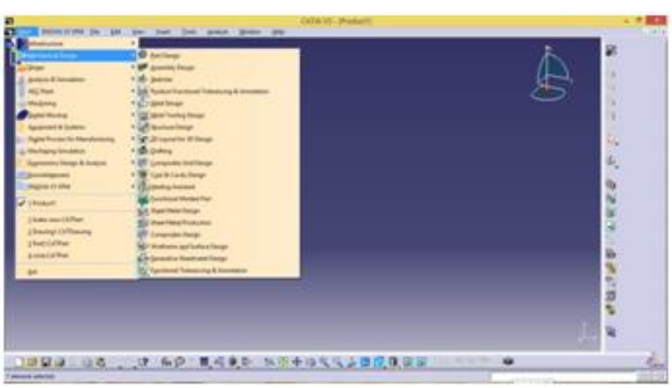
CARBON STEEL

It is an alloy of iron and carbon, with carbon content up to a maximum of 1.5%. The carbon occurs in the form of iron carbide, because of its ability to increase the hardness and strength of the steel.

A carbon steel is defined as a steel which has its properties mainly due to its carbon content and does not contain more than 0.5% of silicon and 1.5% of manganese. The plain carbon steels varying from 0.06% carbon to 1.5% carbon are divided into the following types depending upon the carbon content.

- Dead mild steel — up to 0.15%carbon
- Low carbon or mild steel — 0.15% to 0.45%carbon
- Medium carbon steel — 0.45% to 0.8%carbon
- High carbon steel — 0.8% to 1.5%carbon

GEOMETRIC MODELING USING CATIA



MODELING OF SHOE BRAKE

The shoe brake is modeled by using CATIA. The following figures shows that the final model and different views of a brake shoe.

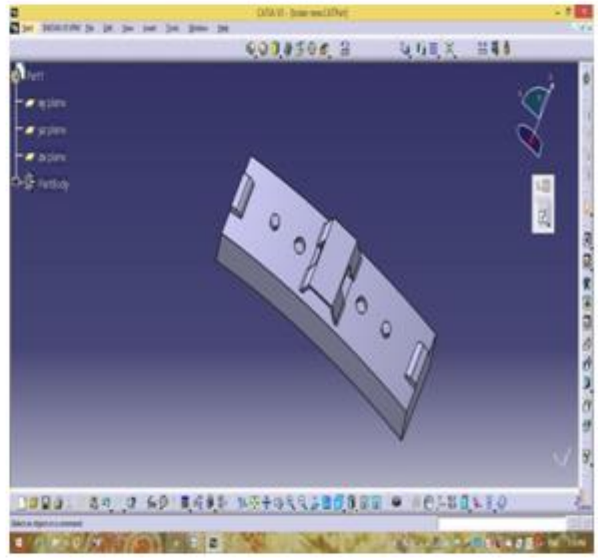


Fig: geometric model of shoe brake

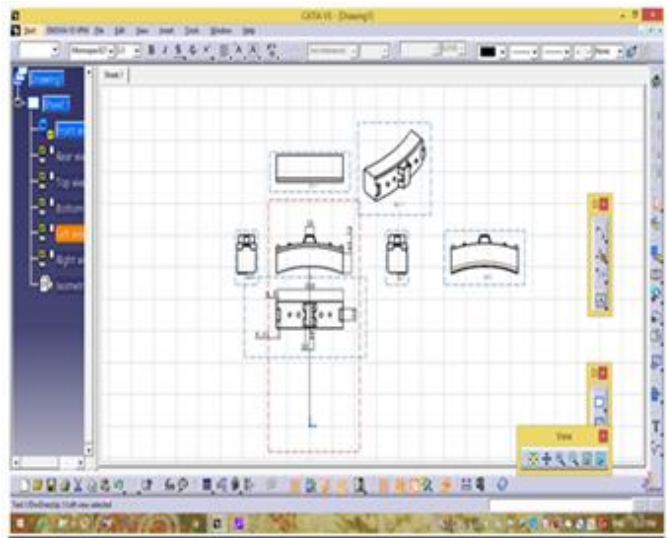


Fig:Views of a block brake

ANALYSIS OF BLOCK BRAKE

Import Geometry

~ Go to – file – import geometry file – then click generate

The block brake already modeled in CATIA software should be imported in ANSYS work bench. The file imported in ANSYS should be in .IGES [Initial Graphics Exchange Specification] format.

STATIC STRUCTURAL ANALYSIS

CAST IRON		CARBON STEEL	
young's modulus	1.29e+11 Pa	Young's modulus	2.0e+011 Pa
Poisson's ratio	0.29	Poisson's ratio	0.295
Density	6800 kg/m^3	Density	7872 kg/m^3
Thermal conductivity	56000 w/m ^0C	Thermal conductivity	54000 w/m ^0C
Thermal expansion	1.06e-0051/^0C	Thermal expansion	1.17e-005 1/^0C
Specific heat	0.46 J/kg ^0C	Specific heat	0.49 J/kg ^0C

~Material properties of CAST IRON and CARBON STEEL
~Apply boundary conditions

There are two boundary condition applied for the block brake model are fixed support and pressure.

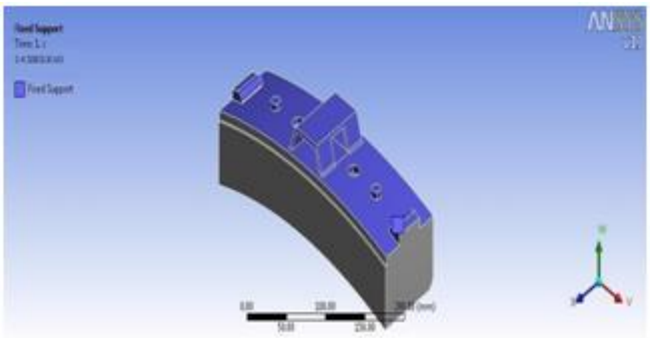


Fig. Fixed support applied for brake

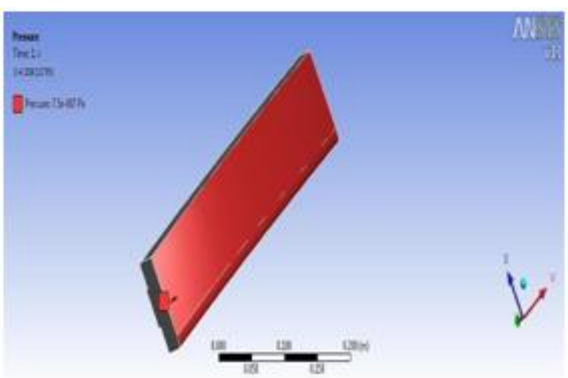


Fig. Pressure applied on Brake

Results obtained for static structural analysis of shoe brake

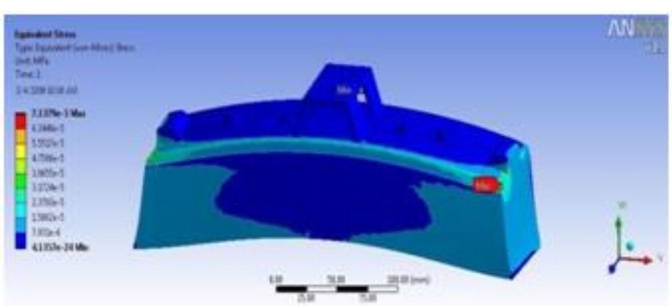


Fig. Von-Mises stress for Carbon steel

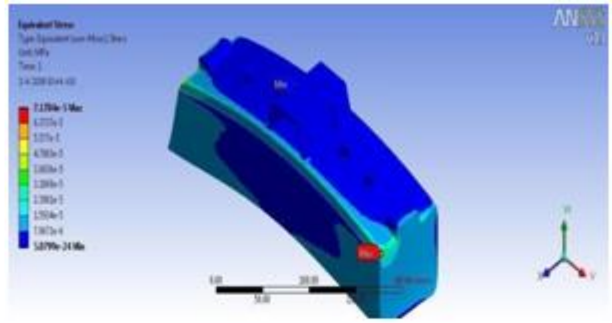


Fig. Von-Mises stress for Cast iron

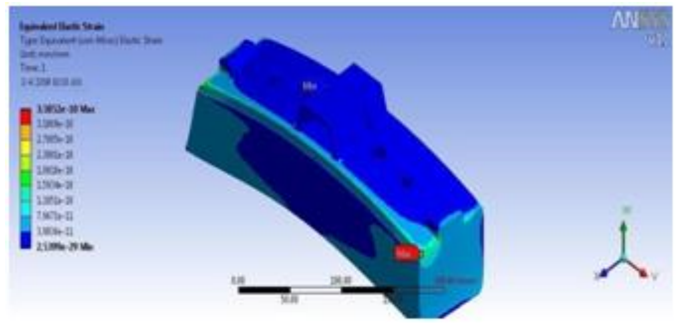


Fig. Von-Mises strain for Carbon steel

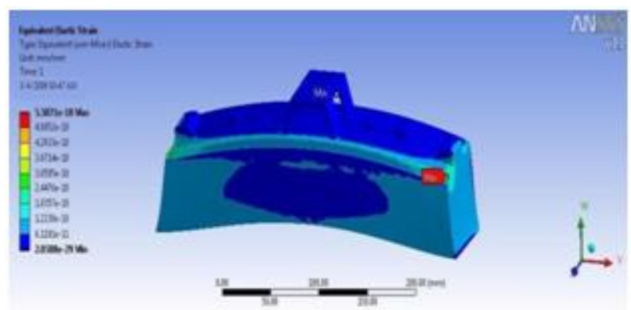


Fig. Von-Mises strain for Cast Iron

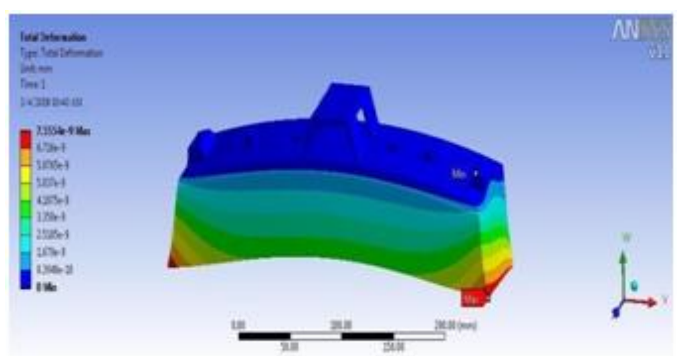


Fig. Total Deformation for Carbon steel

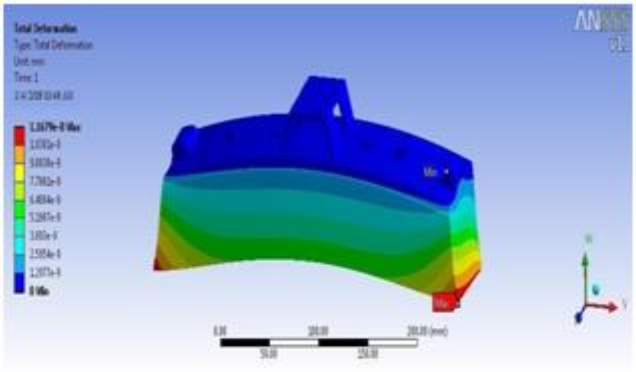


Fig.Total Deformation for Carbon steel

III. CONCLUSION

MATERIAL	STRESS(MPa)	STRAIN	DEFORMATION(mm)
CAST IRON	7.1704e-5	5.5071e-10	1.1679e-8
CARBON STEEL	7.1379e-5	3.5822e-10	7.5554e-9

According to given data we draw the train brake pad in CATIA, after that Analysis has been done by using ANSYS software. It has been concluded that among the two materials of cast iron and carbon steel. Cast iron produces less deformation than carbon steel material, hence cast iron is better than carbon steel materials. More number of materials can be tested in the same way for future scope and that can give more number of results and may improve the braking performance of brake pad

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