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Title: **DESIGN AND FATIGUE ANALYSIS OF PNEUMATIC TRAIN BRAKING SYSTEM BY USING ALUMINUM SILICON CARBIDE AND CARBON EPOXY**

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DESIGN AND FATIGUE ANALYSIS OF PNEUMATIC TRAIN BRAKING SYSTEM BY USING ALUMINUM SILICON CARBIDE AND CARBON EPOXY

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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. By applying a contact material to the rotating wheels or to discs attached to the axles. The material creates friction and sudden apply load like force, pressure. 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 two 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 - structural 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 requirements. The design using computer aided design software catia v5 software. The analysis is applying different materials steel alloys of wheels and brake pads are composite materials. Dynamic and fatigue errors and performance analysis using ansys.

Key words: train wheel, brakes, structural behavior, steel alloys, composite materials, catiasoftware, ansys.

1. INTRODUCTION TO RAILWAY WHEEL:

A moving train contains vitality, known as motor vitality, which should be expelled from the prepare so as to make it stop. The transformation is normally done by applying a contact material to the pivoting wheels or to plates joined to the axles. The wheels back off and in the long run the prepare stops. The material utilized for braking is regularly as a square or cushion. Envision a vehicle that is a mile long. It is long to the point that the front of the vehicle may be climbing a review while the back is diving, or maybe the front and back are turning left while the center is turning right. This same vehicle is more than 300 times as long as it is wide. Next, envision that it measures more than 8 million pounds (3,700,000kg) or 4000 tons. Locally available the vehicles are TVs, foodstuffs and risky material. Presently imagine the vehicle is going at 70 MPH and the administrator needs to stop.

This is a mind boggling and testing issue, yet a circumstance that happens a large number of times each day. The vehicle obviously is a commonplace cargo prepare. This short paper will acquaint the peruser with the standards of how prepare brakes finish this amazing undertaking. Each power unit (train) has an air compressor that provisions air for the whole prepare's breaking framework. The brake pipe conveys the packed air from the control unit to whatever remains of the prepare. Not at all like truck brakes (and traveler prepare brakes so far as that is concerned) this single wellspring of air conveys both the air that powers the brakes and also the flag control them.

1.2 INTRODUCTION TO BRAKES

A brake is a gadget that decelerates a moving article, for example, a machine or vehicle by changing over its active vitality into another type of vitality, or a gadget which keeps a question from quickening. Most regularly brakes utilize grating believer active vitality into warm, yet in regenerative braking a significant part of the vitality is changed over rather into helpful electrical vitality or potential vitality in a frame, for example, pressurized air, oil, or a pivot flywheel.

1.2.2Air Brake System

Most by far of the world's trains are outfitted with stopping mechanisms which utilize compacted air as the power to push pieces onto wheels or cushions on to plates. These frameworks are known as "compressed air brakes" or "pneumatic brakes". The compacted air is transmitted along the prepare through a "brake pipe". Changing the level of pneumatic force in the pipe causes an adjustment in the condition of the brake on every vehicle. It can apply the brake, discharge it or hold it "on" after an incomplete application. The framework is in boundless use all through the world. Noticeable all around brake's least complex shape, called the straight air framework, compacted air pushes on a cylinder in a barrel. The cylinder is associated through mechanical linkage to brake shoes that can rub on the prepare wheels, utilizing the subsequent grinding to moderate the prepare. The mechanical linkage can turn out to be very intricate, as it uniformly conveys compel from one pressurized air barrel to 8 or 12 wheels. The pressurized air originates from an air compressor in the train and is sent from auto to auto by a prepare line made up of funnels underneath every auto and hoses between autos. The foremost issue with the straight air stopping mechanism is that any division amongst hoses and pipes causes loss of pneumatic stress and subsequently the loss of the power applying the brakes. This lack could without much of a stretch reason a runaway prepare. Straight air powered brakes are as yet utilized on trains, despite the fact that as a double circuit framework, more often than not with every bogie (truck) having its own particular circuit.

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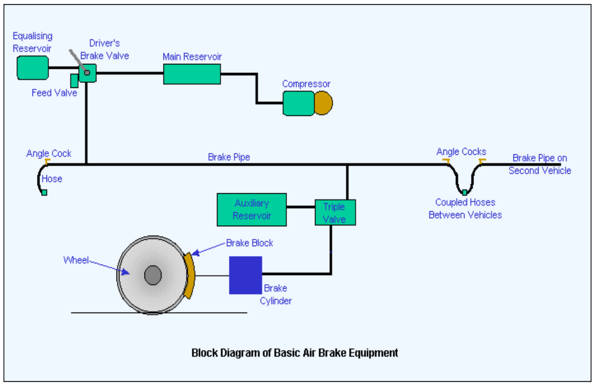

Fig 1.1 COMPONENTS OF AIR BRAKE SYSTEM

1.3 Advantages of air brake system:

Air powered brake framework has the accompanying real focal points over vacuum stopping mechanism.

- Speed of the prepare expanded.
- Load of wagon/mentor expanded.
- Shorter braking separation.
- Better unwavering quality and security.
- Availability of ideal and uniform brake control.
- Compact and simple support.

Chapter 2

2.LITERATURE SURVEY

2.1 INTRODUCTION

Point of this section is to examine about literary works distributed on the examination of the railroad wheel by various specialists prior and furthermore to know the extent without bounds works. A decent number of distributions are accessible on this subject which shows the significance and need of examination of the railroad wheel.

2.2 DISCUSSION

Syed M.Badruddin [1] considered the conduct of elasto-plastic and lingering worries because of serious drag braking and diminished the pliable remaining worries in locales of stress fixation by adjusting the wheel profile. Endeavor is made to lessen the ductile leftover worries by adjusting the filet profiles. Three new outlines with adjustments in filet profiles are tried. Care is taken to stay away from critical change in the wheel weight in the new plans. Worries from the temperatures are acquired for the three cases. Yielding is seen in all the three cases. Yielding is started in inside-edge filet and outside-center point filet locales. Remaining anxieties are gotten for the wheel. Tractable distracting and spiral remaining anxieties are found in inside-edge filet and outside-center point filet districts individually. These ductile lingering stresses are basic in the weakness life of a wheel, particularly since they are in districts of high anxiety fixation. Elastic remaining burdens acquired for the new outline are contrasted and those worries in the old plan. A punishment work is utilized for the examination of stresses. The likelihood of utilizing punishment work, as a mean of examination of stress variety with configuration change, is shown in this work. He diminished the elastic remaining worries by changing the filet profiles of the haggle by giving another plan for the railroad wheel. Pramod Murali Mohan [2] was done the investigation of railroad wagon wheel to consider warm and basic conduct when the wheel was subjected to warm, basic and joined stacking. That was planned to plot a basic initially arrange examination of railroad haggle investigation result portrays the conduct of wheel for differing stacking conditions. He watched that exorbitant braking of the wheel prompts warm over-burdening which brings about weariness, split engendering prompting crack and wear. With a specific end goal to avert harms, measures are to be taken for steady wheel checking procedure and examination of leftover worries keeping in mind the end goal to forestall crack. Attributable to the harms, wheel re-profiling must be done. With a specific end goal to anticipate wheel cracks caused because of warm loads best strategy is to test the leftover worry of wheel edge of various material to decide the suitable level. This alongside escalated look into via doing vibration examination, transient investigation alongside rail and pivot would keep the wheel harm at the underlying stage. P.Rambabu [3] proposed the need to advance the wheel through a few contemplations, for example, material properties, shape, outline highlights and so on. He had done the modular investigation for three sorts of materials for the haggle are figured for various materials by utilizing the examination programming ANSYS. He has proposed the materials which will suites for the outline of the wheel. New determinations are being forced on railroad wheel wear and unwavering quality to expand the time between wheel re-profiling operations, enhance wellbeing and decrease add up to wheel set life cycle costs. In parallel with these prerequisites, changes in railroad vehicle missions are likewise happening. These have prompted the need to work moving stock on track with low and in addition high sweep bends; increment velocities and pivot stacks and fight with an abatement in track quality because of a diminishment in upkeep. These progressions are prompting an expansion in the seriousness of the wheel/rail contact conditions. He proposed that there is a requirement for supplanting conventional plain carbon steel with compound steel, which will diminish wear rate up to some degree. Concentrate for better and financial compound steels is expected to enhance wheel life. Likewise study ought to be led in wheel profile for expanding the wheel life. Research ought to be focused on wheel tread since it is the part which will be dependably in contact with rail. M.Bozzone [4] explored the relative movement between wheel-set and rails through the pursuit of balance designs. The contact focuses between the haggle rail are found and he took a shot at the heap changes between the haggle. Specifically this examination, given the two autonomous position factors of the wheel-set, decides the contact focuses on the haggle the rail, the relative ordinary versos and the staying four ward position organizes.

Chapter 3

3.Design

CATIA (Computer Aided Three-dimensional Interactive Application) (in English typically articulated/kəˈtiə/) is a multi-stage CAD/CAM/CAE business programming suite created by the French

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organization Dassault Systems coordinated by Bernard Charles. Written in the C++ programming dialect, CATIA is the foundation of the Dassault Systems programming suite.

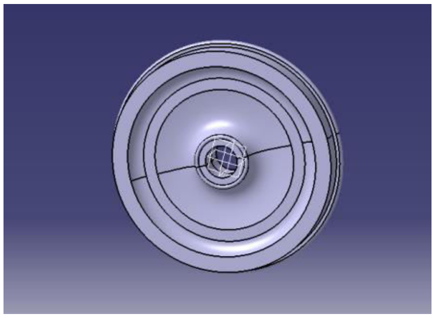


Fig1: train wheel

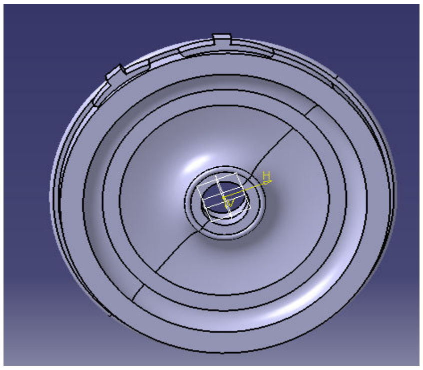


Fig2: train wheel and brakes

Chapter 4

4.Ansys result:

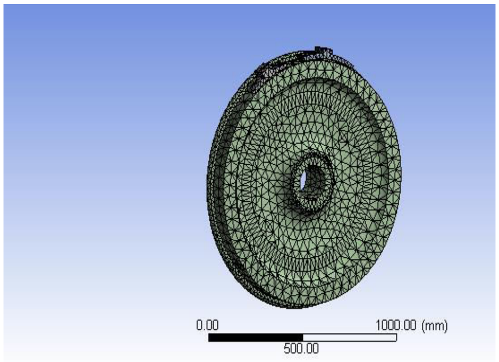
ANSYS is universally useful limited component investigation (FEA) programming bundle. Limited Element Analysis is a numerical strategy for deconstructing an unpredictable framework into little pieces (of client assigned size) called components. The product actualizes conditions that represent the conduct of these components and comprehends them all; making an exhaustive clarification of how the framework goes about overall. These outcomes at that point can be exhibited in organized or graphical structures. This kind of investigation is commonly utilized for the plan and advancement of a framework unreasonably complex to break down by hand. Frameworks that may fit into this class are excessively intricate due, making it impossible to their geometry, scale, or overseeing conditions. ANSYS is the standard FEA showing instrument inside the Mechanical Engineering Department at numerous universities. ANSYS is additionally utilized as a part of Civil and Electrical Engineering, and also the Physics and Chemistry offices. ANSYS gives a financially savvy approach to investigate the execution of items or procedures in a virtual situation. This sort of item advancement is named virtual prototyping.

•**Material Data**

High speed steel:

Density	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
8.16e-006 kg mm^-3	1.9e+008	0.27	1.3768e+008	7.4803e+007

4.1 Mesh:



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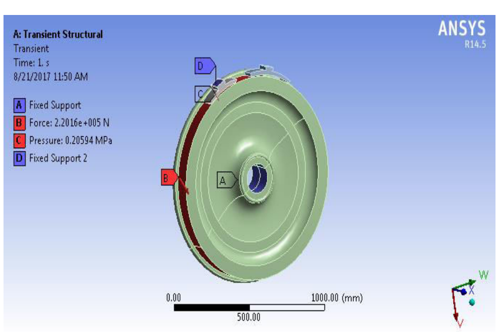
4.2 Dynamic analysis:

Transient dynamic investigation (at times called time-history examination) is a strategy used to decide the dynamic reaction of a structure under the activity of any broad time-subordinate burdens. You can utilize this kind of investigation to decide the time-changing relocations, strains, stresses, and powers in a structure as it reacts to any blend of static, transient, and symphonious burdens. The time size of the stacking is with the end goal that the latency or damping impacts are thought to be imperative. On the off chance that the idleness and damping impacts are not vital, you may have the capacity to utilize a static investigation.

4.3 Apply loads on the model

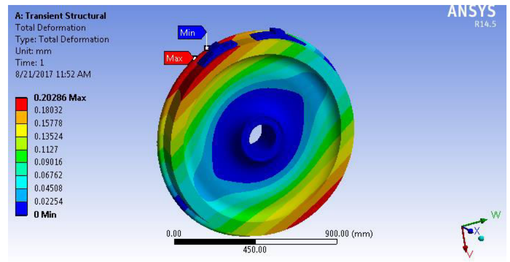
A transient analysis, by definition, involves loads that are functions of time. To specify such loads, you need to divide the load-versus-time curve into suitable load steps. Each "corner" on the load-time curve may be one load step.Allows you to apply complicated boundary conditions. To access the function editor, choose Solution

> Define Loads >Apply > Functions > Define/Edit.

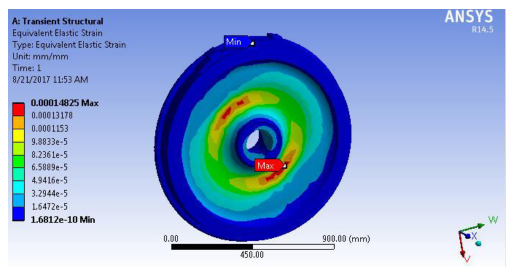


Results:

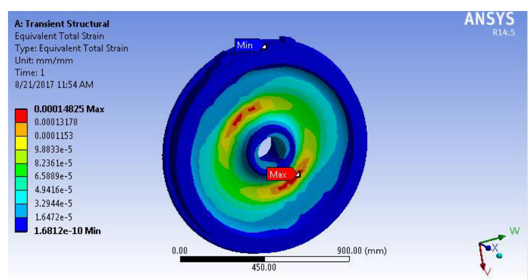
Total Deformation:



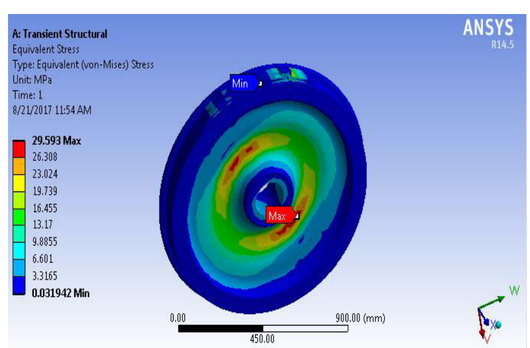
Equivalent Elastic Strain



Equivalent Total Strain



Equivalent Stress



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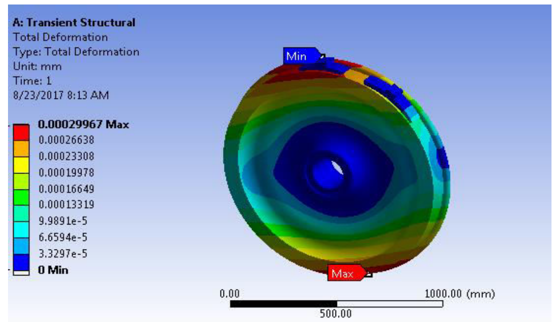
Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Maximum Principal Elastic Strain*	*Equivalent Total Strain*	*Equivalent Stress*
Results					
Minimum	0. mm	1.6812e-010 mm/mm	-1.6592e-011 mm/mm	1.6812e-010 mm/mm	3.1942e-002 MPa
Maximum	0.20286 mm	1.4825e-004 mm/mm	1.5031e-004 mm/mm	1.4825e-004 mm/mm	29.593 MPa

- **Material Data**

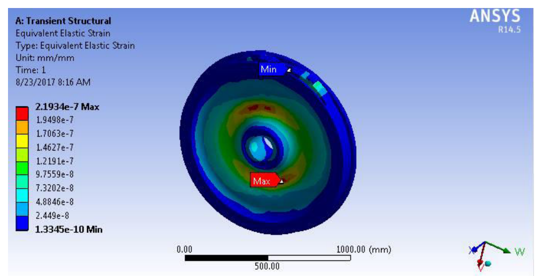
Aluminum silicon carbide

Density	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
2.95e-006 kg mm^-3	2.3e+008	0.154	1.1079e+008	9.9653e+007

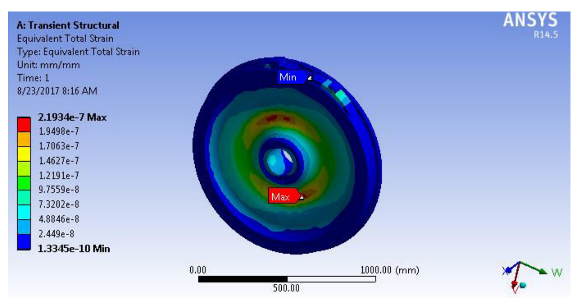
Total Deformation:



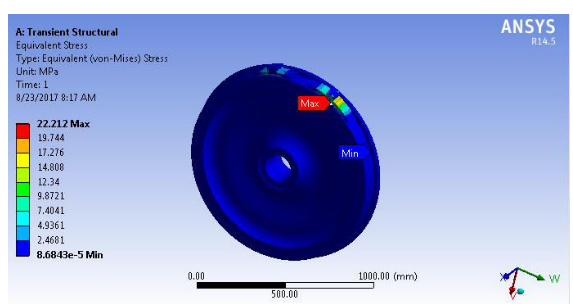
Equivalent Elastic Strain:



Equivalent Total Strain



Equivalent Stress



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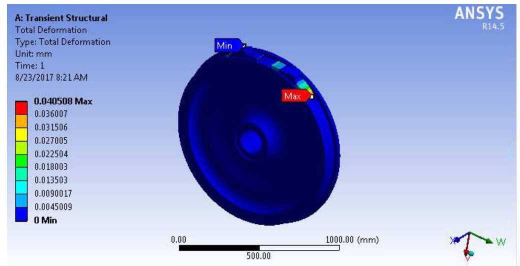
Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Maximum Principal Elastic Strain*	*Equivalent Total Strain*	*Equivalent Stress*
			Results		
Minimum	0. mm	1.3345e-010 mm/mm	-7.2536e-011 mm/mm	1.3345e-010 mm/mm	8.6843e-005 MPa
Maximum	2.9967e-004 mm	2.1934e-007 mm/mm	2.2239e-007 mm/mm	2.1934e-007 mm/mm	22.212 MPa

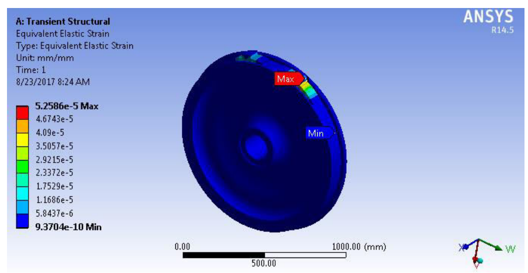
- **Material Data**
  - Carbon epoxy

Density	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
1.8e-006 kg mm^-3	4.5e+005	0.3	3.75e+005	1.7308e+005

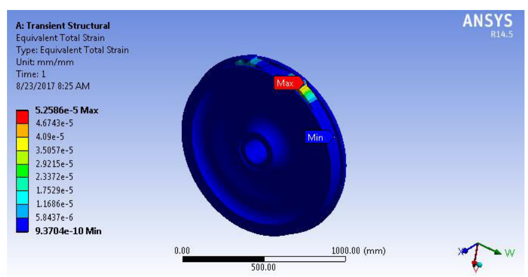
- **Total Deformation**



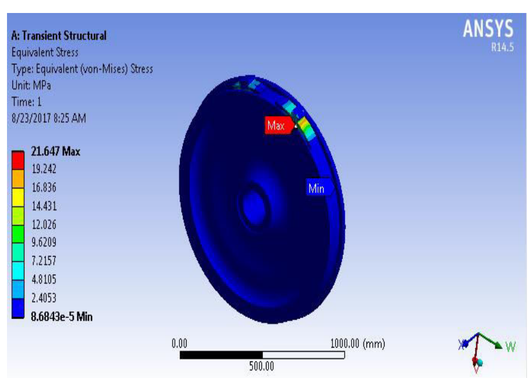
Equivalent Elastic Strain



Equivalent Total Strain



Equivalent Stress



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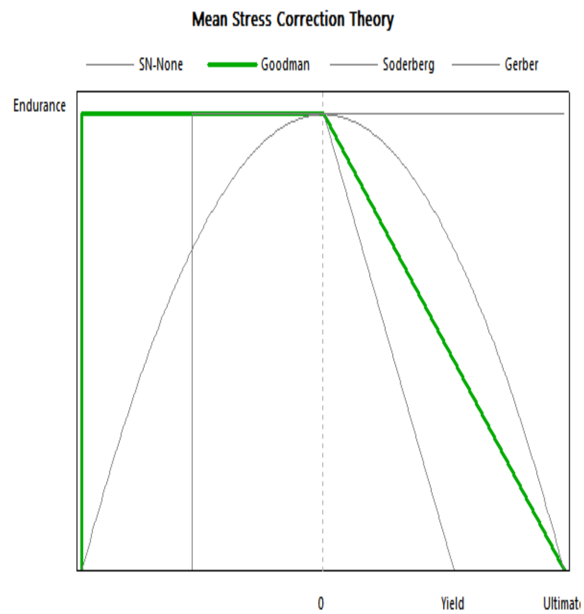
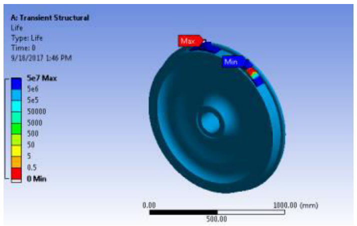
Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Maximum Principal Elastic Strain*	*Equivalent Total Strain*	*Equivalent Stress*
Results					
Minimum	0. mm	9.3704e-010 mm/mm	3.6339e-010 mm/mm	9.3704e-010 mm/mm	8.6843e-005 MPa
Maximum	4.0508e-002 mm	5.2586e-005 mm/mm	4.8647e-005 mm/mm	5.2586e-005 mm/mm	21.647 MPa

Fatigue Analysis:

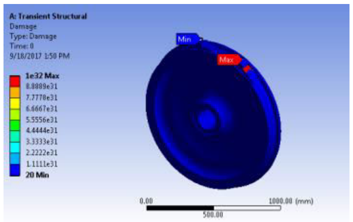


Aluminum silicon carbide:

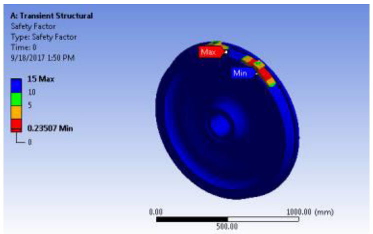
Life:



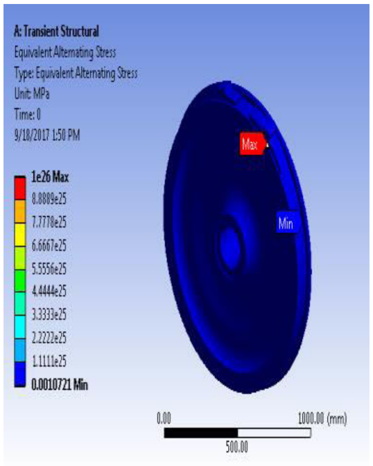
Damage:



Safety factor:



Equivalent Alternating Stress



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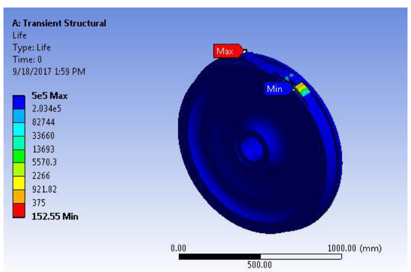
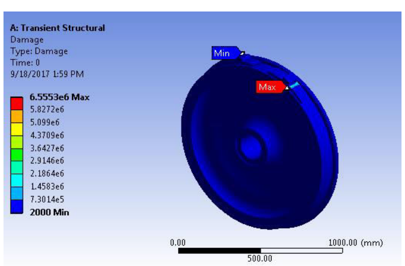
Object Name	Life	Damage	Safety Factor	Equivalent Alternating Stress
Design Life		1.e+009 cycles		
Minimum	0. cycles		0.23507	1.0721e-003 MPa

High speed steel:

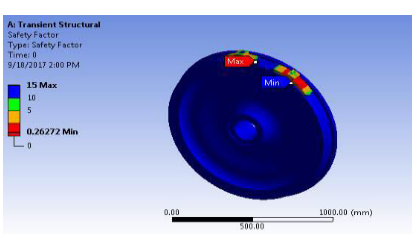
Life



Damage



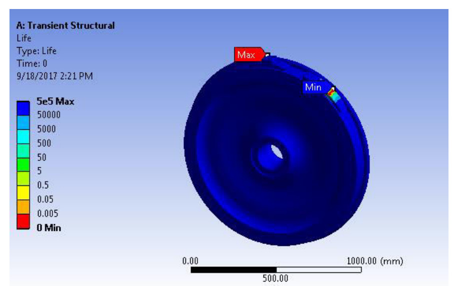
Safety Factor



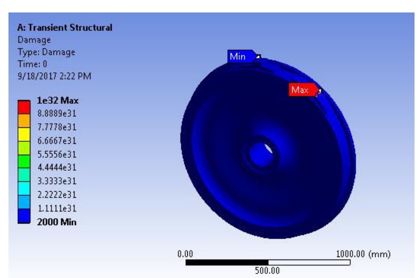
Object Name	Life	Damage	Safety Factor	Equivalent Alternating Stress
Design Life		1.e+009 cycles		
Minimum	152.55 cycles		0.26272	1.0721e-003 MPa

Carbone epoxy:

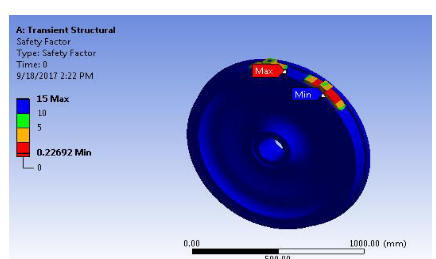
Life:



Damage



Safety Factor



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Object Name	*Life*	*Damage*	*Safety Factor*	*Equivalent Alternating Stress*
Design Life		1.e+009 cycles		
Minimum	0. cycles		0.22692	1.0721e-003 MPa

Results and discussion:

Investigation on Train brake is finished. As per the outcomes organized it has been presumed that among the three materials of Aluminum silicon carbide, Carbon epoxy and High speed steel.

• Low misshapening got in Carbon epoxy 4.0508e-002 mm material contrasting with existing HSS materials and other taken material so more withstand an incentive for Carbon epoxy.

•Carbon epoxy have low anxiety when contrasted and HSS Hence Carbon epoxy is superior to HSS materials the outline is protected and vonmises stresses are inside a definitive quality of the material. By leading dynamic Analysis.

• Equivalent Total Strain dispersion of Aluminum silicon carbide is less when contrasted with existing material HSS.

•Aluminum silicon carbide likewise Low disfigurement contrasting with existing HSS materials implies contrasting and existing material more withstand esteems.

CONCLUSION

In this work we proposed that by fluctuating the prepare brake material to Carbon epoxy and Aluminum silicon carbide Metal Matrix Composite the anxieties incited are diminished and crawl because of brake loads is likewise decreased .Hence by this work we recommended that Carbon epoxy and Aluminum silicon carbide is most appropriate composite material for prepare brake it expands the life time frame.In fatigue analysis Aluminum silicon carbide composite material gives better results than other materials. For Aluminum silicon carbide composite material min152.55 life of cycles and maximum life of 5e+007 cycles are obtained at 6spkoes alloy wheel.

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