Design Analysis and Performance Evaluation of Intelligent ABS

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ABSTRACT

Anti-lock braking system (ABS) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. It is an automated system that uses the principles of threshold braking and cadence braking which were practiced by skillful drivers with previous generation braking systems. It does this at a much faster rate and with better control than a driver could manage.

ABS generally offers improved vehicle control and decreases stopping distances on dry and slippery surfaces for many drivers; however, on loose surfaces like gravel or snow-covered pavement, ABS can significantly increase braking distance, although still improving vehicle control. Many accidents caused by ignoring right-of-way, driving on the wrong side of the road, inappropriate speed, insufficient distance from other vehicles and so on might have been prevented had the vehicles been able to brake faster, Studies have shown that many drivers do not apply the brakes sufficiently in emergency situations due to lack of experience. That means that the greatest possible braking effect is not attained because the drivers did not press the brake pedal hard enough. Therefore, the brake assist system was developed to support the driver in critical braking situations. The intelligent ABS system uses a speed based brake actuator mechanism that automatically actuates after the preset limit there-by preventing over speeding and proportionate control of the vehicle.

The paper discusses the overall system configuration design analysis of critical components like shaft and disk brake where as also results of testing are discussed.

Keywords : *Intelligent ABS , braking , Over speeding ,Safety.*

1. Introduction

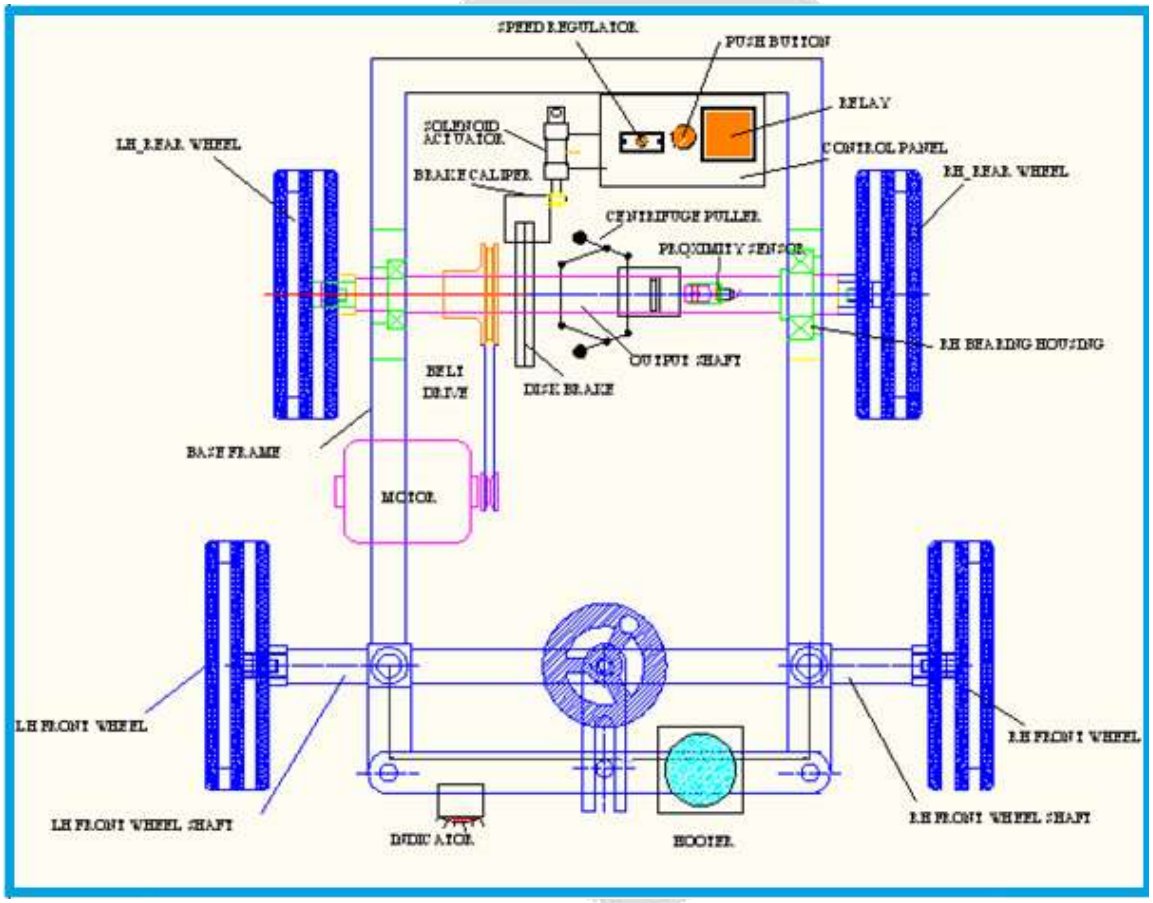
Stopping a car in a hurry on a slippery road can be very challenging. Anti-lock braking systems (ABS) take a lot of the challenge out of this sometimes nerve-wracking event. In fact, on slippery surfaces, even professional drivers can't stop as quickly without ABS as an average driver can with ABS. There are many different variations and control algorithms for ABS systems. The ABS controller knows that such a rapid deceleration is impossible, so it reduces the **pressure** to that brake until it sees an acceleration, then it increases the pressure until it sees the deceleration again. It can do this very quickly, before the tire can actually significantly change speed. The result is that the tire slows down at the same rate as the car, with the brakes keeping the tires very near the point at which they will start to lock up. This gives the system maximum braking power. When the ABS system is in operation you will feel a **pulsing**in the brake pedal; this comes from the rapid opening and closing of the valves. Some ABS systems can cycle up to 15 times per secondWh en the brake is applied within the ABS limit the speed sensor is active , gear pump is started and the hydraulic oil is pumped onto the brake calliper and brake is applied this will try to retard the axle suddenly..this is sensed by the speed sensor, it will cut off supply to the gear pump hence, brake will be off, due to momentum of vehicle axle will again gain speed, sensor will be off now again pump will start and apply the brake….thus the braking will keep on turning 'ON' &' OFF' is quick sucession…which is expected from the ABS to prevent locking of the brake.

Problem Definition & Solution

The above systems as applied to automobiles are extremely costly as they compulsorily need a computer for their implementation More over all these systems are singular problem oriented, hence there is a need of a cost effective low end technology or device that can perform the function of over-speed indication –alarm-and brake control with minimal use of high end technology , suitable for low budget commercial vehicles. The Intelligent ABS braking system is a answer to the above problems where in the following features have been incorporated;.

- Braking –using Disk brake to ensure optimal braking force and minimum braking distance.
- Electro mechanical actuation..making the operation extremely fast thereby safety ensured
- Braking (Nature similar to the anti-lock braking) ie, intermittent and gradual braking.

Schematic of Intelligent ABS System



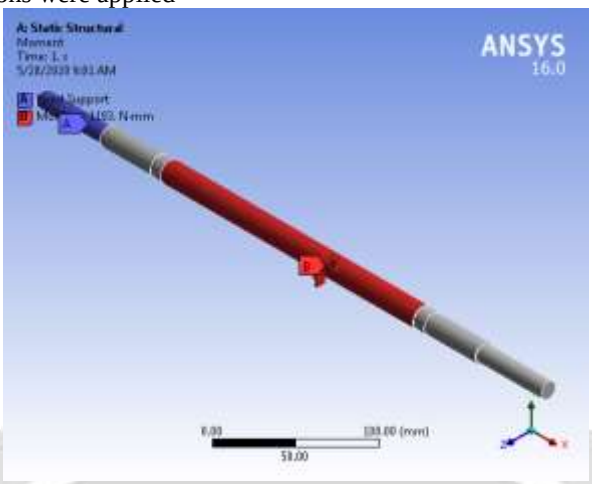
DESIGN & ANALYSIS OF WHEEL SHAFT :

MATERIAL SELECTION : -Ref :- PSG (1.10 & 1.12) + (1.17)

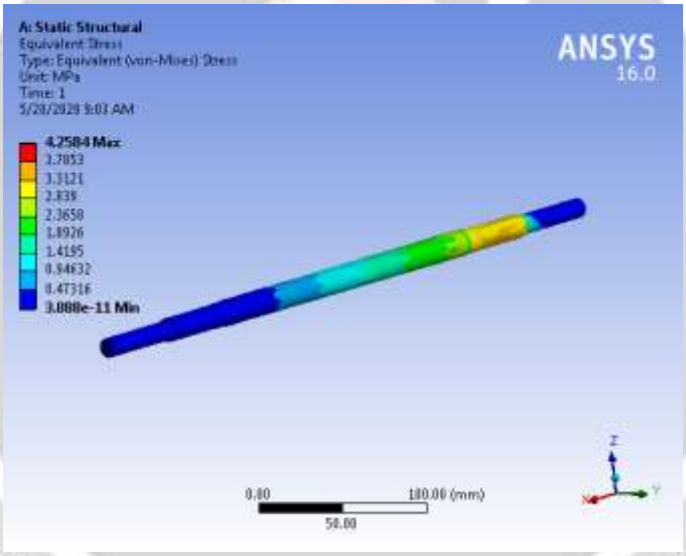
DESIGNATION	ULTIMATE TENSILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
EN24	800	600

$\Rightarrow$fs allowable = 104 N/mm^2
$\Rightarrow$ T design =1.19 Nm
$\Rightarrow fs_{act}$ = 3.53 N/mm^2
As $fs_{act} < fs_{all}$

⇒Wheel shaft is safe under torsional load.
Analysis of Shaft :
The following boundary conditions were applied

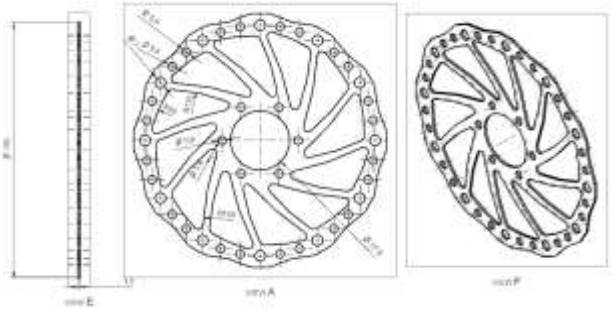


The maximum stress induced in part :



As the maximum stress induced is 4.29 Mpa which is far below allowable stress the part is safe.

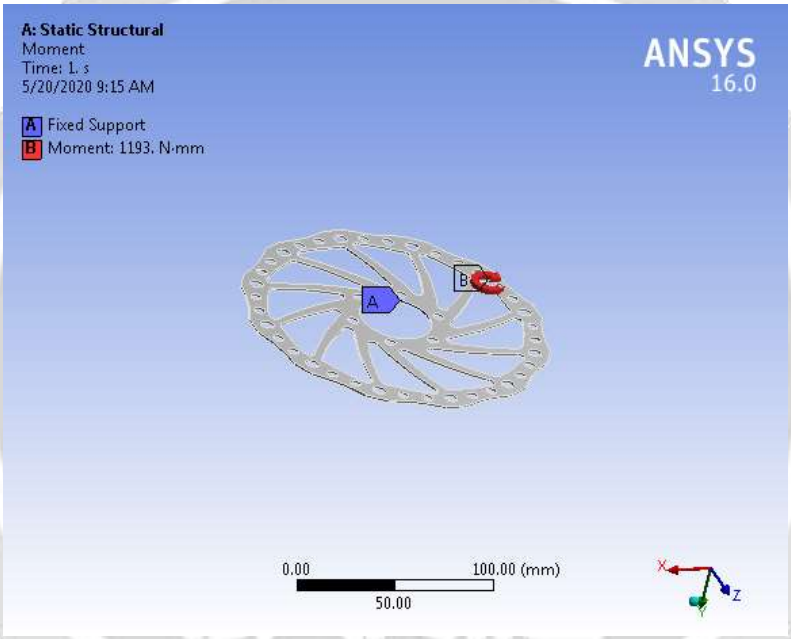
DESIGN & ANALYSIS OF DISK BRAKE :



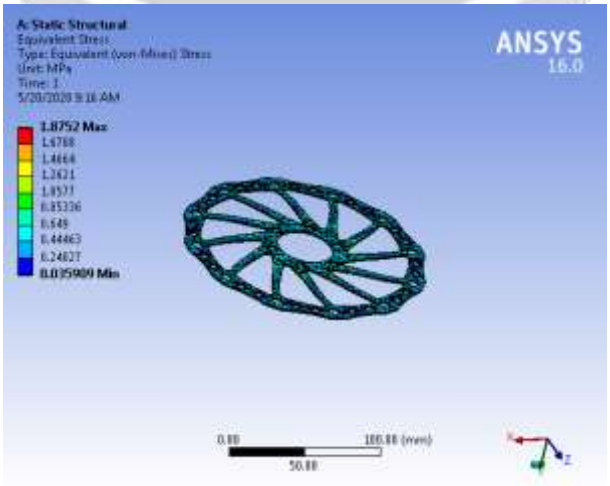
MATERIAL SELECTION : -Ref :- PSG (1.10 & 1.12) + (1.17)

DESIGNATION	ULTIMATE TENSILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
En24	800	600

$\Rightarrow$fs allowable = 104 N/mm^2
$\Rightarrow$ T design =1.19 Nm
$\Rightarrow fs_{act}$ = 0.496301338 N/mm^2
As $fs_{act} < fs_{all}$
$\Rightarrow$Wheel shaft is safe under torsional load.
Analysis of Shaft :
The following boundary conditions were applied



The maximum stress induced in part :



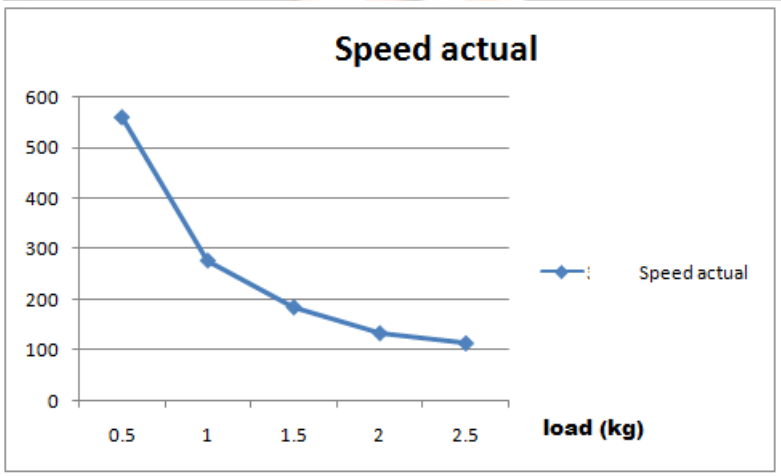
As the maximum stress induced is 1.19 Mpa which is far below allowable stress the part is safe.

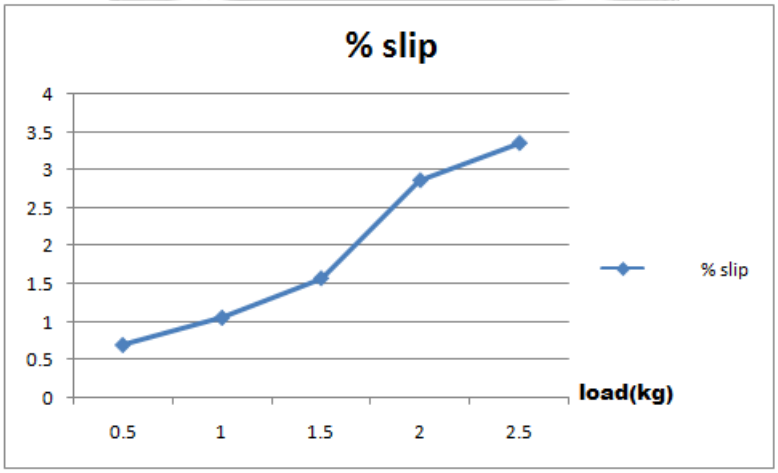
Analysis of the base flange

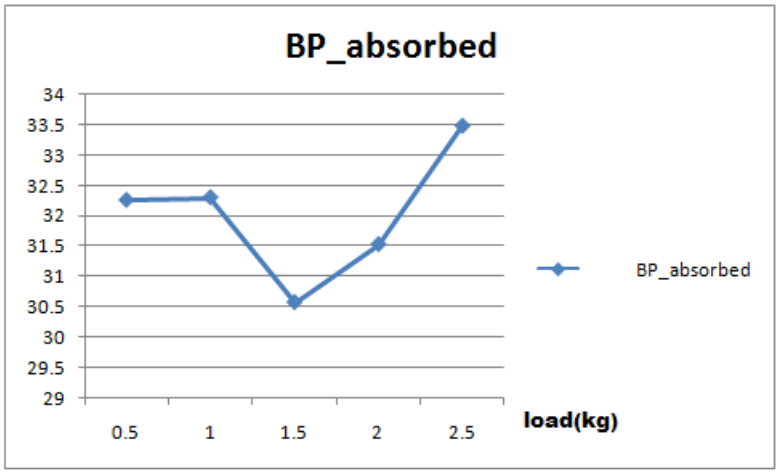
TEST AND TRIAL
INPUT DATA:
TEST AND TRIAL ON PERIMETER BRAKE

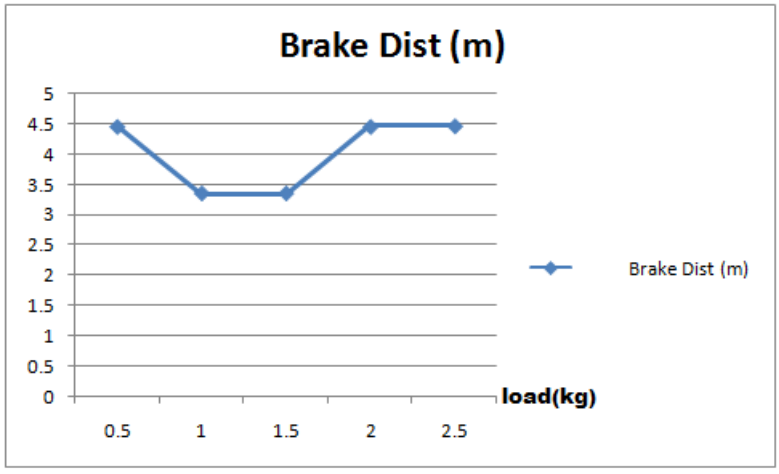
Observation table :

Sr no	IBS Brake load Kg	Wheel Speed actual	Wheel Speed Theo.	Brake Torque	Brake power absorbed	% Slip	BRAKE DISTANCE (m)
1	0.5	560	564	0.55	32.257	0.70	4.46
2	1	278	281	1.11	32.3	1.06	3.35
3	1.5	186	189	1.56	30.57	1.58	3.35
4	2	135	139	2.23	31.527	2.87	4.46
5	2.5	115	119	2.78	33.48	3.36	4.469









RESULT AND DISCUSSION :

1. Design of analysis showed that the part is safe both by theoretical method and also by ansys analysis
2. Output speed drops with increase in load
3. Output torque increases with drop in output speed
4. Output power is maximum at speed range of 700 rpm
5. **Efficiency is optimal at output speed 0f 710 rpm**
6. **The torque limiter slips on application of overload at all spring positions.**

CONCLUSION :

The intelligent ABS system was designed using theoretical method and analysis was done using static structural method on ANSYS Workbench and the values of stress were found to be well below the permissible level hence the intelligent ABS disk brake is safe.The maximum energy absorbing capacity of the IBS brake was found to be 180 watt at speed close to 60 kmph .Percentage slip in case of IBS disk brake system was found to be 3.6 hence the IBS shows better performance of braking as compared to the conventional systemThe Overall conclusion is that the intelligent IBS brake performs better than the conventional brake thereby increasing the safety of the vehicle.

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