Modelling And Simulation Of Automobile Braking System

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Abstract: Disc brakes are exposed to large thermal stresses during routine braking and extraordinary thermal stresses during hard braking. In this thesis consists of modeling and analysis of both solid and vented type rotor disc brakes. The main objective of the project is to conduct thermal analysis and static analysis on the both rotors to study the heat and temperature distribution and stresses on disc brake rotor. The results were compared for better rotor and both results provide better understanding on the thermal characteristic of disc brake rotor and assist the automotive industry in developing optimum and effective disc brake rotor. Modeling is done in SOLID WORKS and analysis is done in ANSYS

Keywords: Disc Brake; Static Analysis; Modal Analysis; Solid Works; ANSYS

I. INTRODUCTION

A brake is a tool which inhibits motion. Its opposite component is a snatch. The relaxation of this text is dedicated to diverse sorts of vehicular brakes. Most typically brakes use friction to convert kinetic power into warmth, though other strategies of energy conversion may be hired. For example regenerative braking converts an awful lot of the electricity to electric strength, which may be saved for later use. Other methods convert kinetic electricity into capability power in such stored paperwork as pressurized air or pressurized oil. Still other braking strategies even rework kinetic energy into distinctive forms, for instance by transferring the strength to a rotating flywheel.

Fig: disc brake

The goal of this paintings is to fashion the EGlass/Epoxy composite spring while now not change in stiffness for car mechanical machine and analyze it. This could be accomplished to understand the following.

- To the update fashionable metallic springs with Eglass/Epoxy composite leaf spring at the same time as not modification in stiffness.
- To realize full-size weight loss inside the mechanical machine by commutation metal spring with composite spring.

DISC BRAKES

The disc brake or disk brake is a device for slowing or stopping the rotation of a wheel at the same time as it is in movement. A brake disc (or rotor in U.S. English) is normally fabricated from cast iron or ceramic composites (including carbon, Kevlar and silica). This is hooked up to the wheel and/or the axle. To stop the wheel, friction fabric inside the shape of brake pads (mounted on a device called a brake caliper) is pressured robotically, hydraulically, pneumatically or electromagnetically against both aspects of the disc. Friction reasons the disc and attached wheel to gradual or stop. Brakes (each disc and drum) convert friction to heat, but if the brakes get too warm, they’ll cease to work because they cannot use up enough warmthness. This condition of failure is called brake fade.

DISCS

A move-drilled disc on a present day motorbike

The layout of the disc varies somewhat. Some are actually strong forged iron, but others are hollowed out with fins or vanes joining together the disc's two touch surfaces (normally protected as a part of a casting system). This "ventilated" disc design enables to burn up the generated heat and is usually used at the greater-closely-loaded the front discs.
CERAMIC COMPOSITES

Ceramic discs are used on occasion in high-overall performance vehicles and heavy cars. The first development of the modern-day ceramic brake turned into made by British Engineers working inside the railway enterprise for TGV programs in 1988. The objective was to reduce weight, the range of brakes consistent with axle, in addition to offer solid friction from very excessive speeds and all temperatures. The end result changed into a carbon fibre strengthened ceramic procedure which is now utilized in various bureaucracy for automobile, railway, and plane brake programs.

II. LITERATURE REVIEW

Braking is a procedure which converts a car’s kinetic strength into mechanical electricity which need to be dissipated in the form of heat. During the braking phase, the frictional warmth generated at the interface of the disc and pads can result in excessive temperatures. The frictional warmth generated at the rotor floor can have an effect on excessive temperature rise which, in turn, ends in unwanted results along with thermal elastic instability (TEI), premature wear, brake fluid vaporization (BFV) and thermally excited vibrations (TEV). In this undertaking, solid and ventilated type disc brake rotor of a car, taken an research into using numerous substances is completed so that it will improve the braking performance and provide greater balance to the automobile. Modelling of the disc brake rotor is finished the use of CATIA V5R18, which facilitates collaborative engineering throughout various disciplines. The thermal and structural analysis of disc brake rotor is carried out using ANSYS 14.Five, which is a devoted finite detail bundle used for figuring out the temperature distribution, variant of the stresses and deformation across the disc brake profile. A evaluation is made between 3 exceptional materials used for each strong and ventilated kind disc brakes and the best material for making disc brake and kind of disc brake have been recommended based on the importance of Vonmises stresses, temperature distribution and deformation.

INTRODUCTION TO CAD

Computer-aided design (CAD) is using laptop structures (or workstations) to aid within the advent, change, analysis, or optimization of a layout. CAD software is used to increase the productiveness of the clothier, improve the great of layout, improve communications via documentation, and to create a database for production. CAD output is frequently within the form of digital documents for print, machining, or other manufacturing operations. The term CADD (for Computer Aided Design and Drafting) is also used.

INTRODUCTION TO SOLID WORKS

SolidWorks (stylized as SOLIDWORKS) is a strong modeling computer-aided layout (CAD) and laptop-aided engineering (CAE) computer application that runs on Microsoft Windows. SolidWorks is published with the aid of Dassault Systèmes.

According to the writer, over 1 million engineers and architects at extra than 165,000 corporations were the use of SolidWorks as of 2013. Also in line with the organization, financial year 2011–12 revenue for SolidWorks totalled $483 million.

III. 3D MODELS OF DISC BRAKE

CASE 1: PLANE DISC BRAKE

CASE 2: DISC BRAKE WITH DRILLED HOLES

CASE 3: DISC BRAKE WITH SLOTS

CASE 4: DISC BRAKE WITH SLOTS AND DRILLED HOLES

INTRODUCTION TO FEA

Finite element evaluation is a technique of solving, normally approximately, certain problems in engineering and science. It is used specially for troubles for which no precise solution, expressible
in a few mathematical shape, is available. As such, it is a numerical in preference to an analytical technique. Methods of this type are wanted due to the fact analytical strategies cannot cope with the real, complicated troubles which can be met with in engineering. For instance, engineering electricity of substances or the mathematical principle of elasticity may be used to calculate analytically the stresses and lines in a bent beam, but neither will be very successful in locating out what's going on in a part of a car suspension device for the duration of cornering.

IV. INTRODUCTION
ANSYS is well-known-reason finite detail evaluation (FEA) software bundle. Finite Element Analysis is a numerical method of deconstructing a complicated system into very small pieces (of person-exact length) called factors. The software implements equations that govern the behaviour of these factors and solves all of them; creating a comprehensive clarification of ways the machine acts as a whole. These outcomes then can be offered in tabulated, or graphical forms. This kind of analysis is typically used for the layout and optimization of a machine some distance too complex to analyze by hand. Systems that may match into this category are too complicated due to their geometry, scale, or governing equations.

DISC BRAKE STANDARD
Rotor disc dimension = 240 mm (240*10^-3 m)
Rotor disc fabric = carbon ceramic matrix
Pad brake place = 2000 mm2 (2000*10^-6 m)
Pad brake material = asbestos
Coefficient of friction (wet) = zero.07-zero.Thirteen
Coefficient of friction (dry) = 0.Three-zero.Five
Maximum temperature = 350 0c
Maximum strain = 1 MPa (106 Pa)

TANGENTIAL FORCE BETWEEN PAD AND ROTOR(inner face), FTRI
FTRI = μ1.FRI
Where, FTRI = Normal pressure among pad brake and rotor(inner)
μ1 = Coefficient of friction = zero.5
FRI = P max/2 * A pad brake area
So, FTRI = μ1.FRI
FTRI = (0.Five)(zero.Five)(1*106N/m2)(2000*106N/m2)
FTRI = 500 N.

Tangential force among pad and rotor (outer face), FTRO.
In this FTRO is same to FTRI because identical ordinary force and equal cloth.

BRAKE TORQUE (TB)-
With the assumptions of equal coefficient of friction and regular forces FR on inner and outer faces:
TB = FT.R
Where, TB = Brake torque
μ = coefficient of friction
FT = general ordinary forces on disc brake rotor
   = FTRI+FTRO
FT =1000 N
R = Radius of rotor disc
So, TB = (a thousand)(a hundred and twenty*10^-3)
TB = a hundred and twenty N.M

BRAKE DISTANCE (X)-
We realize tangential braking pressure acting at the point of touch of the brake, and
Work carried out = FT.X................................Equation A
Where, FT = FTRI+FTRO
X = Distance travelled by way of the automobile (in meter) before it come to relaxation
We realize kinetic strength of the car.
Kinetic power = (mv^2/2)........................Equation B
where, m = mass of automobile
   v = velocity of car
In order to deliver the automobile to rest, the workdone in opposition to friction must be same to the kinetic power of the car.
Therefore equating (Equation A) and (Equation B)
FT.X = (mv^2/2)
Assumption v = one hundred kg/h = 27.77 m/s
M = 132 kg. (dry weight of vehicle)
So we get  x = mv^2/2 FT
X = 132*(27.Seventy seven)^2/(2*a thousand)
X = 50.89 m
Heat generated (Q) = M.CP.ΔT   J/S
Flux (q) = Q/A W/m2
Thermal gradient (K) = q/okay K/m

CARBON CERAMIC MATRIX-
Heat generated \( Q = M \cdot C_p \cdot \Delta T \)

Mass of disc = 0.5 kg

Specific warmth capability = 800 J/kg°C

Time taken to stop the vehicle = 5 sec

Developed temperature difference = 15 °C

\[ Q = 0.5 \cdot 800 \cdot 15 = 6000 \text{ J} \]

Area of disc = \( \pi \cdot (R^2 - r^2) = \pi \cdot (0.122^2 - 0.55^2) \)

= 0.0357 m²

Heat flux = warmth generated / 2d / place = 6000/5/0.03573 = 33.585 kw/m²

Thermal gradient = warmth flux / thermal conductivity

= 33.585·103 / forty

= 839.364 mV.

V. STRUCTURAL ANALYSIS OF DISC BRAKE

CASE I-PALNE DISC BRAKE

Open ANSYS>Open work bench 14.5>select static structural >double click on it.

Select engineering data> window will be open in that enter required material properties> update project and return to the project.

Select geometry > right click on it >select import geometry> select file>ok

Imported Model from solid works

Select model>right click on it> select edit> window will be open in that select mesh>right click on it>select generate mesh

Meshed Model

Loads

Select static structural >right click on it>insert> Displacement > select area> apply.

Select static structural >right click on it>insert> FORCE> select area> enter magnitude> apply.

Right click on solution> insert > Deformation >Total>

Right click on solution> insert> Strain> Equivalent (Von-mises)>

Right click on solution> insert> Stress> Equivalent (Von-mises).

Right click on solution> insert > Solve.

VI. MATERIAL – ALUMINUM ALLOY

DEFORMATION

STRESS

STRAIN

STATIC ANALYSIS RESULT TABLE
FATIGUE ANALYSIS RESULTS

THERMAL ANALYSIS RESULTS TABLE

VII. CONCLUSION

Friction causes the disc and attached wheel to slow or stop. Brakes convert friction to heat, but if the brakes get too hot, they will cease to work because they cannot dissipate enough heat. This condition of failure is known as brake fade.

Disc brakes are exposed to large thermal stresses during routine braking and extraordinary thermal stresses during hard braking.

By observing the static analysis results the stress values are less for the ceramic material by the design model is case: 3 models i.e., disc brake with slots.

By observing the fatigue analysis the safety factor more for ceramic material by the model is case: 3.

By observing the dynamic analysis the stress values are less for ceramic material and stress values are increases by increasing the time and loads

So it can be concluded the disc brake with slots model is better design for disc brake and ceramic material is the better material for disc brake.

VIII. FUTURE SCOPE

Further investigation should be carried out using design of experiments methods in order to find the optimal design of the disc brake components for reducing the brake squeal.

There are two main categories of damping shims: single-layer and multi-layer shims. The single-layer shim that is used in the present brake system is investigated numerically. It is recommended to carry out studies on the influence of multilayer shims in controlling squeal in disc brake systems.

We can use functionally graded materials to increase the strength of the disc brake.

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