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# MODELLING AND 3D PRINTING OF HEAVY VEHICLE DISC PLATE

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**ABSTRACT**
Brakes are the most important components of any automobile. Brakes provides the ability to reduce or bring automobile to a complete stop. Process of braking is usually achieved by applying pressure to the brake disc. The main objective of this project is to perform an appropriate design and suitable brake rotor to enhance the performance of high speed heavy vehicle. The design of the brake disc is modelled using the SOLID WORKS. From the design and material change, by changing the material it results it can be concluded that grey cast iron has performed better as compared to stainless steel as this material as anti-fade properties which improves the life of the brake rotor. Then by using the 3D printing technology we are preparing the prototype of the disc plate in the FORGE CREATOR PRO 3D printing software.

**Keywords:**
3D printing, disc brake, rapid prototyping, heavy vehicle breaks, forge creator pro software.

## INTRODUCTION

A disc brake is a type of brake that uses callipers to squeeze pairs of pads against a disc in order to create friction that retards the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed. Hydraulic disc brakes are the mostcommonly used form of brake for motor vehicles but the principles of a
disc brake are applicable to almost any rotating shaft. Compared to drum brakes, disc brakes offer better stopping performance because the disc is more readily cooled. As a consequence discs are less prone to the brake fade caused when brake components overheat. Disc brakes also recover more quickly
from immersion (wet brakes are less effective than dry ones).

The brake disc is the component of a disc brake against which the brake pads are applied. The material is typically grey iron, a form of cast iron. The design of the disc varies somewhat. Some are simply solid, but others are hollowed out with fins or vanes joining together the disc's two contact surfaces (usually included as part of a
casting process). The weight and power of the vehicle determines the need for ventilated discs. The "ventilated" disc design helps to dissipate the generated heat and is commonly used on the more-heavily-loaded front discs. Discs may also be slotted, where shallow channels are machined into the disc to aid in removing dust and gas. Slotting is the preferred method in most racing environments to remove gas and water and to deglaze brake pads. Some discs are both drilled and slotted. Slotted discs are generally not used on standard vehicles because they quickly wear down brake pads; however, this removal of material is beneficial to race vehicles since it keeps the pads soft and avoids vitrification of their surfaces. On the road, drilled or slotted discs still have a positive effect in wet conditions becausethe holes Disc Brakes Are Often Located Within The Wheel or slots prevent a film of water building up between the disc and the pads. Cross- drilled discs may eventually crack at the holes due to metal fatigue. Cross-drilled brakesthat are

manufactured poorly or subjected to high stresses will crack much sooner and more severely.

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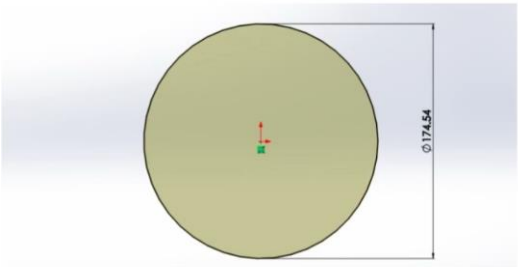
## 3D MODELLING AND PRINTING OF THE DISC PLATE

### 3D MODELLING

The 3D modelling software tools are used for a number of projects, from simulation to manufacturing. A 3D modelling software with great visualisation options can help you get a better overview of your project. A precise overview allows you to adjust and improve your parts efficiently. It is also a good method to correct the last errors.Computer-Aided Design (CAD) software allows building 3D models of parts and assemblies. CAD software has a drafting component that allows you to create 2D drawings of your parts that can be manufactured. Printing or Additive Manufacturing Is a Process of Making Three Dimensional Objects From a Digital File. The Creation of a 3D Printed Object Is Achieved Using Additive. Processes. In an Additive Process an Object Is Created by Laying Down Successive Layers of Material Until the Object Is Created. Each of These Layers Can Be Seen as a Thinly Sliced Cross-Section of the Object. There Is One Exception Though, and It's Called Volumetric 3D Printing. With Volumetric Printing Entire Structures Can Be Formed at Once Without the Need for Layer-by-Layer Fabrication. It's Worth Noting, However, That as of Now, Volumetric Technology Is Primarily in the Research Phase. 3D Printing Is the Opposite of Subtractive Manufacturing Which Is Cutting Out / Hollowing out a Block of Material With for Instance a Milling Machine. 3D Printing Enables You To Produce Complex Shapes Using Less Material Than Traditional Manufacturing Methods.

### DESIGN OF THE DISC PLATE IN SOLID WORKSEXTRUDE

1. Click New (Standard toolbar) and open a new part.
2. Click Extruded Boss/Base (Features toolbar) and select the Front plane.
3. Sketch a corner circle beginning at the origin.
4. Click Smart Dimension (Dimensions/Relations toolbar) and dimension the circle to 174.54mm .
5. Click Exit Sketch (Sketch toolbar) to exit the sketch



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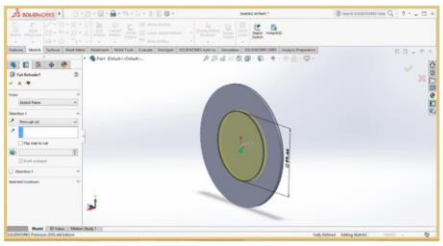
**Extrude Cut:**

1. Click New (Standard toolbar) and open a new part.
2. Click Extruded Boss/Base (Features toolbar) and select the Front plane.
3. Sketch a corner circle beginning at the origin.
4. Click Smart Dimension (Dimensions/Relations toolbar) and dimension the circle to 99.54 mm .
5. Click Exit Sketch (Sketch toolbar) to exit the sketch.

The Extrude cut Property Manager and a preview of the extrusion appear.

1. Under Direction1:
2. Set End Condition to Blind.
3. Set Depth to 4.5.
4. Click to create the extrusion



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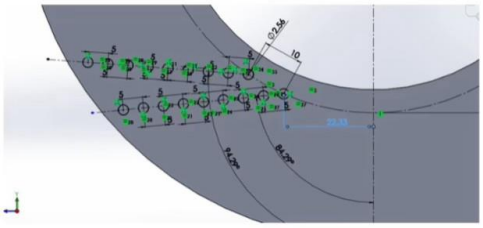

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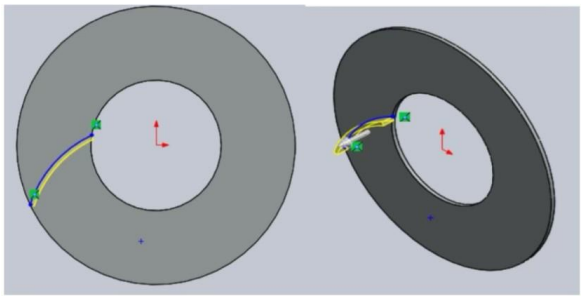
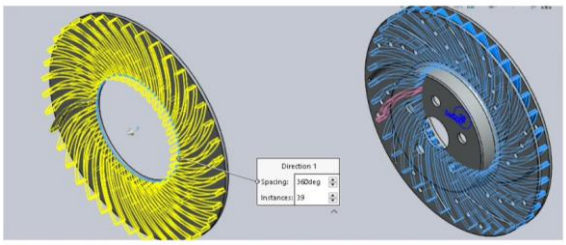
**Extrude Thin:**
we have to draw the shape of teeth profile on the surface with the help of sketcher tool in sketcher module. After we enter into the part module to select the tool of extrude thin for removing the material of required thickness as shown in below.



**Circular Pattern:**
In this pattern we have to give the number of instances for adding the duplicates teeth profile on rotor brakes. In this pattern tool we have to give the instances and spacing on the profile instances which we given the 39 and wecan apply the 360 degree around the axis.



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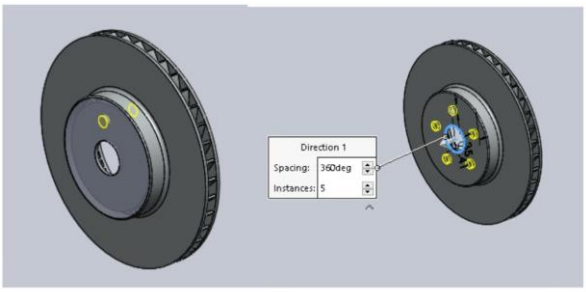
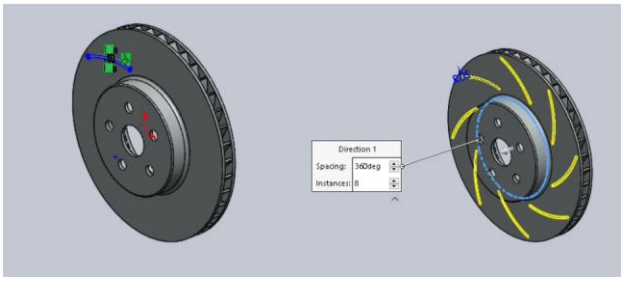
**Hole:**
Hole tool we can apply the remove the material on the surface of brake rotor for the required diameter as shown in below




**Extrude Cut:**
By using extrude, for adding the material to created the shape of brake with thickness of 5mm disc its shown as below




**Final Object Of Rotor Brakes**

**3D PRINTING OF DISC PLATE**

**STEP -1** In the first step we need to select the machine type as the flash forge creator pro and material as the PLA and then supports as the auto mesh it means software meshes the surfaces automatically. Then select theresolution as the standard and shells as 2,3,3 for perimeters shells , top solid layers , bottom solid layersrespectively

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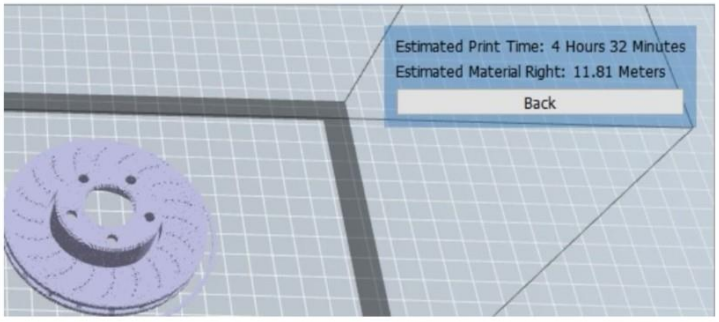
**STEP -2** Then make sure that fill density at-least 60%.. and fill pattern as triangle.
**STEP -3** Then select the temperature as 200C for right extrude and 50C for platform..
**STEP-4** It will take around 4 hour 32 minutes to print the total material and the total extruded material is 11.81 meters.




## LITERATURE SURVEY

- **Piotr GRZES** The aim of this paper was to investigate the temperature fields of the solid disc brake during short, emergency braking. In this paper transient thermal analysis of disc brakes in single brake application was performed. To obtain the numerical simulation parabolic heat conduction equation for two dimensional model was used. The results show that both evolution of rotating speed of disc and contact pressure with specific material properties intensely effect disc brake temperature fields
in the domain of time.
- **Abd Rahim Abu-Bakar, Huajiang Ouyang** This paper studies the contact pressure distribution of a solid disc brake as a result of structural modifications. Before modifications are simulated, four different models of different degrees of complexity for contact analysis are investigated. It is shown that the contact pressure distributions obtained from these four models are quite different. This suggests that one should be careful in modeling disc brakes in order to obtain correct contact pressure distributions. This work could help design engineers to obtain a more uniform pressure distribution and subsequently satisfy customers' needs by making pad life longer.
- **M. Nouby, D. Mathivanan, K. Srinivasan** proposes an approach to investigate the influencing factors of the brake pad on the disc brake squeal by integrating finite element simulations with statistical regression techniques. Complex Eigen value analysis(CEA) has been widely used to predict unstable frequencies in brake systems models. The finite element model is correlated with experimental modal test. The 'input-output' relationship between the brake squeal and the brake pad geometry is constructed for possible prediction of the squeal using various geometrical configurations of the disc brake. distance between two slots, slot width and angle of slot are investigated using design of experiments
- **P. Liu a, H. Zheng a, C. Cai a, Y.Y**, An attempt is made to investigate the effects of system parameters, such as the hydraulic pressure, the rotational velocity of the disc, the friction coefficient of the contact interactions between the pads and the disc, the stiffness of the disc, and the stiffness of the back plates of the pads, on the disc squeal. The simulation results show that significant pad bending vibration may be responsible for the disc brake squeal. The squeal can be reduced by decreasing the friction coefficient, increasing the stiffness of the disc, using damping material on the back plates of the pads, and modify he shape of the brake pads. Rajendra Pohane, R. G. Choudhari FEM model is prepared for contact analysis. A three dimensional finite element model of the brake pad and the disc is developed to calculate static structural analysis, intransient state analysis. The comparison is made between the solid and ventilated disc keeping the same material properties and constraints and using general-purpose finite element analysis. This paper discusses how general purpose finite element analysis software can be used to analyze the equivalent (von-misses)stresses& the thermal stresses at disc to pad interface.
- **H Mazidi, S.Jalalifar, J. Chakhoo**[ In this study, the heat conduction problems of the disc brake components (Pad

and Rotor) are modeled mathematically and is solved numerically using finite difference method. In the discretization of time dependent equations the implicit method is taken into account. In the derivation of heat equations, parameters such as the duration of braking, vehicle velocity, Geometries and the dimensions of the brake components, Materials of the disc brake rotor and the PAD and contact pressure distribution have been taken into account.

- **V.M.M.Thilak, R.Krishnaraj, Dr.M.Sakthivel, K.Kanthavel, Deepan Marudachalam M.G, R.Palani** In this work, an attempt has been made to investigate the suitable hybrid composite material which is lighter than cast iron and has good Young's modulus, Yield strength and density properties. Aluminum base metal matrix composite and High Strength Glass Fiber composites have a promising friction and wear behavior as a Disk brake rotor. The transient thermo elastic analysis of Disc brakes in repeated brake applications has been performed and the results were compared. The suitable material forth braking operation is S2 glass fiber and all the values obtained from the analysis are less than their allowable values.
- **Prashant Chavan, Amol Apte** Gives simplified yet almost equally accurate modeling and analysis method for thermo-mechanical analysis using brake fade test simulation as an example. This methodology is based on use of ABAQUS Axisymmetric analysis technique modified to represent effect of discrete bolting, bolt preloads, and contacts within various components of the assembly.

- **S. P. Jung, T. W. Park, J. H. Lee, W. H. Kim, and W.S Chung** A simple finite element model of a disc and two pads was created, and TEI phenomenon was implemented by rotating the disc with a constant rotational speed of 1400 rpm. The intermediate processor using the staggered approach was used to connect results of two other analysis domains: mechanical and thermal analysis. By exchanging calculation results such as temperature distribution, contact power and nodal position at every time step, solutions of fully coupled thermo-mechanical system could be obtained. Contact pressure distribution of the pad surface was varied according to the rotational direction of the disc. DTV and temperature of the disc were calculated and tendency was verified by earlier study
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## METHODOLOGY

The methodology adopted in this paper is an intensive literature review on the various types of technologies to improve the breaking ability of heavy vehicles with lower cost by reducing weight of the brake parts ..and the one best solution with low investment is 3D printing technology .

## CONCLUSION

The printing of heavy vehicle disc plate will provide a boost for technology management as it can simplify the process of construction and put it in an efficient way. It will also enhance engineering practices though the usage of engineering software which would give out accurate design specifications for the deployment of the brakes. Certainly, 3D printing is still in its earliest stages and a high level of instability will undoubtedly impact the future effect of this way breaking innovation on generation migration and exchange but will be intertwined with the manufacturing industries in the immediate future. 3D printing is undoubtedly going to substitute customary assembling in industry portions that deliver exceptionally mind multifaceted and tailored merchandise. To accomplish more extensive application and appropriation. organisations must work together and advance with a specific end goal to conquer 3D printing's residual difficulties. Hope of accessible materials for 3D printing.

## ACKNOWLEDGEMENT

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more personal note, we thank our beloved parents and friends for their moral support during our project.

## REFERENCE

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2. **Q Cao1, M I Friswell, H Ouyang, J E Mottershead1and S James** This paper presents a numerical method for the calculation of the unstable frequencies of a car disc brake and the analysis procedure. The stationary components of the disc brake are modeled using finite elements and the disc as a thin plate. This approach facilitates the modeling of the disc brake squeal as a moving load problem. Some uncertain system parameters of the stationary components and the disc are tuned to fit experimental results. A linear, complex-valued, asymmetric eigenvalue formulation is derived for disc brake squeal. Predicted unstable frequencies are compared with experimentally established squeal frequencies of a realistic car disc brake.

3. **S. P. Jung, T. W. Park, J. H. Lee, W. H. Kim, and W.S Chung** A simple finite element model of a disc and two pads was created, and TEI phenomenon was implemented by rotating the disc with a constant rotational speed of 1400 rpm. The intermediate processor using the staggered approach was used to connect results of two other analysis domains: mechanical and thermal analysis. By exchanging calculation results such as temperature distribution, contact power and nodal position at every time step, solutions of fully coupled thermo-mechanical system could be obtained. Contact pressure distribution of the pad surface was varied according to the rotational direction of the disc. DTV and temperature of the disc were calculated and tendency was verified by earlier studies.
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