Analysis of Brake Rod of Bajaj Pulsar Using Reverse Engineering

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Abstract- *Reverse engineering plays vital role in the branch of the mechanical design and manufacturing based industry. This technique has been widely recognized as an important technique in the product design cycle. In regular computerized manufacturing environment, the operation order usually starts from the product design and ends with machine operation to convert raw material into final product. It is often essential to reproduce a CAD model of existing part using any digitization techniques, when original drawings or documentation are not available and used for analysis and modifications are required to construct a improved product design. In reverse engineering approach the important steps involved, are characterizations of geometric models and related surface representations, segmentation and surface fitting of simple and free-form shapes, and creating accurate CAD models. The chapter presents review on reverse engineering methodology and its application areas related to product design development. The product re-design and research with reverse engineering will largely reduced the production period and costs in product manufacturing industries.In this research paper the methodology of Reverse Engineering has been employed to Brake Rod of Bajaj Pulsar 150cc Motor Bike. This case study describes the generation of 2D model of Brake Rod using photogrammetry technique, development of 3D solid model on SolidWorks and Autodesk Inventor, stresses are analysed at different loads. Finally the results of SolidWorks have been compared with the results of Autodesk Inventor*

Keywords- Functional reverse engineering, subtract and operate ,computer aided reverse engineering

I. INTRODUCTION

The world has witnessed three digital convergences during the past three decades. Each time new technologies break down the barrier between physical and digital forms, new products and new markets has been created. The 1970s ushered in digitized sound using signal processing (1D), which made analog and digital conversion part of a common language in the telecom industry. The 1980s brought digitized fonts and pictures using image processing (2D). The convenience of switching between electronic and paper documents changed the publishing industry and the way to store and share information. The third convergence, beginning in the 1990s, focus on digitizing the physical world using geometry processing (3D). The convergence of physical and digital worlds enabled by reverse and forward engineering technologies should fundamentally change the way products are designed, manufactured, and marketed. By create a digital duplicate of world as easily as taking a digital picture, the biggest breakthrough of the twenty-first century will be in manufacturing industry.

Reverse engineering can be applied to re-create either the high-value commercial parts for business profits or the valueless legacy parts for historical restoration. To accomplish this task, the engineer needs an understanding of the functionality of the original part and the skills to replicate its characteristic details. In the fields of mechanical engineering and industrial manufacturing, reverse engineering refers to the method of creating engineering design and documentation data from existing parts and their assemblies. While in conventional engineering process, transforms engineering concepts and models into real parts, in the reverse engineering approach real parts are transformed into engineering models and concepts. Reverse engineering has a very common a broad range area such as mechanical engineering, software engineering, animation/entertainment industry, microchips, chemicals, electronics, pharmaceutical products etc. Focusing on the mechanical engineering domain, through the application of reverse engineering techniques an existing part is recreated by acquiring its' surface or geometrical features data using contact or non contact digitizing or measuring devices. By using reverse engineering, creation of product takes advantage of the extensive use of CAD/CAM/CAE systems. And apparently provides enormous gains in improving in quality, materials properties, efficiency of re-design, manufacture and analysis. Therefore, reverse engineering is going with substantial business benefits in shortening the product development cycle.

Reverse engineering has been used to produce many mechanical parts, such as seals, O-rings, bolts and nuts, gaskets, and engine parts, and is widely used in many industries (Tut, 2010). The Society of Manufacturing Engineers (SME) states that the practice of reverse engineering "starting with a finished product or process and working backward in logical fashion to discover the underlying new technology" (Francis, 1988). Manufacturers all over the world have practiced reverse engineering in their product development. The new analytical technologies, such as three-dimensional (3D) laser scanning and high-resolution microscopy, have made reverse engineering easier, but there is still much more to be learned. Several professional organizations have provided the definitions of reverse engineering from their perspectives. It has been incorporates in appropriate mechanical design and manufacturing engineering standards and multiple realistic product constraints with broad knowledge in multiple disciplines such as:

Applying knowledge of mathematics, engineering, and science in data analysis and interpretation. Using techniques, instruments, and tools in reverse engineering applications .Conducting appropriate experiments and tests to obtain the necessary data in reverse engineering. Identifying, formulating, and solving issues related to reverse engineering. Understanding legal and ethical responsibilities pertinent to reverse engineering. Assessing and evaluating documents and fostering attainment of objectives of a reverse engineering project.

The part produced through reverse engineering should be in compliance with the requirements contained in applicable program criteria. To achieve a successful reverse engineering process requires. Though it roots back to ancient times in history, the recent advancement in reverse engineering has elevated this technology to one of the primary methodologies utilized in many industries, including aerospace, automotive, consumer electronics, medical device, sports equipment, toy, and jewellery. It is also applied in forensic science and accident investigations.

II. REVERSE ENGINEERING

Reverse engineering is the process of obtaining a geometric CAD model from measurements acquired by contact or non-contact scanning technique of an existing physical model (Liang & Grier, 2000).The characterizes typical procedure of reverse engineering is showing in figure 1.

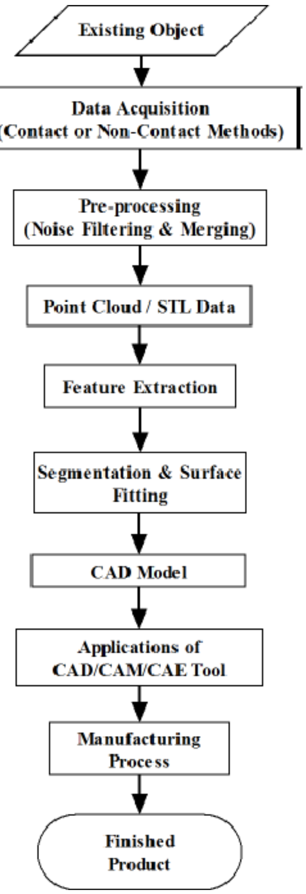


Fig. 1. Basic flow of reverse engineering

It consists of following steps: data acquisition, pre-processing (noise filtering and merging), triangulation, feature extraction, segmentation and surface fitting and application of CAD/CAM/CAE tools .

III. COMPUTER AIDED REVERSE ENGINEERING

Reverse Engineering originally emerged as the answer to provide spares for replacing broken or worn out parts for which no technical data was available. This can be the case if the part was originally imported (without drawings) or the drawings being misplaced or lost. Reengineering or reverse engineering such parts can be a less expensive option compared to re-importing, not only for immediate replacement, but also to create additional spares to maintain the product over a longer period. Computer-based surface models are indispensable in several fields of science and engineering. For example, the design and manufacturing of vehicles, such as cars and aircrafts, would not be possible without sophisticated CAD and simulation tools predicting the behaviour of the product. The point cloud acquisition generally is performed by stationary scanning devices, like laser-range or computer-tomography scanners. After taking multiple scans from various sides or by rotating the object, the sampled points are combined into a single point cloud, from which the surface needs to be reconstructed. The resulting adaptive reconstruction method is based upon the repetitive application of the following steps (Pal et al., 2005):

Starting from an initial bounding point enclosing the original point cloud the hierarchical space partitioning creates a point set by recursively subdividing each individual point into sub-point

The resulting mesh is obtained by subdividing the coarser mesh and adapting its topology at locations where point have been removed

The final data mapping locally constrains the mesh toward the point cloud. All vertices are projected onto local tangent planes defined by the individual points.

Reverse Engineering has been defined as a process for obtaining the technical data of a critical spare component. Computer-aided reverse engineering relies on the use of computer-aided tools for obtaining the part geometry, identifying its material, improving the design, tooling fabrication, manufacturing planning and physical realization. A solid model of the part is backbone for computer-aided reverse engineering. The model data can be exported or imported into CAD/CAE/CAM systems using standard formats such as IGES, STL, VDA and STEP.

IV. FEATURE BASED REVERSE ENGINEERING

Feature-based models have been suitable for manufacturing the mechanical parts with reverse engineering. Also, feature-based models are ideal for industrial design and manufacturing since the model produced can be easily modified. Feature-based and constraint-based methods can be characterized as knowledge-based methods. As researchers, it is useful to exploit design intent and feature relationships that exist in models created for industrial use, because they justify some of the attributes of the object that are obsolete. Such information can be expressed by geometric constraints

V. BASIC STEPS IN REVERSE ENGINEERING

As indicated earlier the main purpose of reverse engineering is to convert a discrete data set into a piecewise smooth, continuous model. In this section various aspects of this conversion are described. The discrete data set typically consists of (x; y; z) coordinate values of measured data points. Concerning the organization of data with follow the following steps are (Várady et al., 1997):

5.1 The Geometry Part Digitization

The first objective of reverse engineering methodology is to digitize the physical model. Digitization is the process of capturing the data of the physical model and converting digital form. It can be achieved by utilizing either contact probing or non-contact sensing techniques. In figure 2 shows the classification of the acquiring 3D data into contact and non-contact methods. After taking multiple scans from various sides or by rotating the object, the sampled points are combined into a single point cloud, from which the surface needs to be reconstructed. The resulting adaptive reconstruction method is based upon the repetitive application of the following steps:

Starting from an initial bounding point enclosing the original point cloud the hierarchical space partitioning creates a point set by recursively subdividing each individual point into sub-point

The resulting mesh is obtained by subdividing the coarser mesh.

The final data mapping locally constrains the mesh toward the point cloud.

All vertices are projected onto local tangent planes defined by the individual points.

5.2 Purpose of Object Surface Acquisition

The measurement point group and STL data are used in two ways:

Analyze own and other product (design)
Confirm the accuracy of own products (Inspection)

Design purpose further divided into:

Generate a 3D mockup to shorten the development period
3D data are not available, use as CAD data to implement analysis.

Inspection purpose is further divided into:

Inspect object dimension
Check the amount of deform material

Define the life of object based on result.Reverse Engineering Digitization Contact Non Contact Non Optical MRI CT Transmissive Reflective CMM-Articulated CMM-CNC Machines Point-to-Point Sensing with Touch Trigger Probes Analogue Sensing with scanning Probes Active Sonar Microwave Radar Passive Optical Shape From focus Coherent

Laser Radar Shape From Shading Moire Effect Shape From Stereo Structured Light Triangulation Shape From Motion Time of Flight

5.3 Post-Processing

Based on the past research on some curve smoothing theories, the vertices of the mesh are repositioned by computing the centroid of the directly connected neighbor vertices. To improve the quality of the generated mesh can be performed an additional optimization step. In a successive step these centroid are again predictable onto the tangent planes of the corresponding data sets according to define theories. Generally, mesh-optimization is a repetitive process, applied several times to obtain the most possible accuracy in surface quality which is help for 3D CAD model.

5.4 Triangulation

Based on past research on triangulation under reverse engineering environment, the mathematic theory and computational algorithms for triangulation have been well developed. The triangular polygon mesh with sufficient geometrical information can be created efficiently for a given set of data points. The fundamental concept in triangulation is Delaunay triangulation. In addition to Delaunay triangulation, there are several mathematic algorithms for triangulation, including marching cubes, Poisson surface reconstruction, moving least squares methods etc. While, some triangulation algorithms may not perfect as per requirements. They have been tending to generate meshes with a high triangle count. In addition, these algorithms implicitly assume topology of the shape to be reconstructed from triangulation, and the parameters setting often influence results and stability.

5.5 Segmentation

One of the most important steps in reverse engineering is mesh segmentation. Segmentation is a complex process in which the original data points are subsets of each individual logically belongs to a primitive surface. Some more efficient non-iterative segmentation methods are using and they are called direct segmentation methods. In general, the segmentation process is involves an estimate of first- and second-order surface properties. The first-order segmentation, which is based on normal vectors, provides an initial subdivision of the surface and detects sharp edges as well as flat or highly curved areas. The second-order segmentation subdivides the surface according to principal curvatures and provides a sufficient foundation for the classification of simple algebraic surfaces. Most of the segmentation algorithms come with surface fitting, which fits a best primitive surface of appropriate type to each segmented region. It is important to specify a hierarchy of surface types in the order of geometric complexity (Várady et al., 1997). As discussed above, feature-based segmentation provides a sufficient foundation for the classification of primary and secondary geometry shown in figure 3 or parametric and non-parametric surfaces. Algebraic surfaces, such as planes, such as sphere, cylinders, and cones, and tori, are readily to be fitted to such regions. Surface Geometries Primary Surface Geometry Secondary Surface Geometry Simple Surface General Free-From Surface Regular Swept Surfaces Edge Blends Vertex Blends Planes Natural Quadrics Tori R-Sweep T-Sweep Rectangular Sweep Irregular Sweep.In addition to primitive non parametric surfaces with a simple kinematic generation, such as sweep surfaces, revolved surfaces, extrusion surfaces, pipe surfaces, are directly compatible to CAD models.

5.6 Solid Modeling

Solid modeling is probably use for shape engineering process in support of reverse engineering using any modeling software such as Auto CAD, CATIA, Pro/E etc. There are two basic representations for solid models are boundary representation and feature-based representation. There have some methods, such as (Várady et al., 1998), proposed to automatically construct boundary representation models from point clouds or triangular mesh with profile curve. It is creating by connecting the point to point in spline manner. Some focused on manufacturing feature recognition for process planning purpose. However, none of the method is able to fully automate the construction process and generate fully parametric solid models.

5.7 Solid Model Export

Re-constructed the 3D model using reverse engineering, the software will have to exported the conventional CAD packages for supporting the design engineering aspect. The conventional solid model exchanges via standards, IGES or STEP, STL, are inadequate since parametric information, sketch constraints and dimensions, including solid features, feature tree, are completely not same through the exchanges. Direct solid model can be exported or imported in some software, such as liveTransfer™ module of Rapidform XOR3 with CAD/CAE/CAM systems using standard formats such as IGES, STL, VDA and STEP.

VI. APPLICATIONS OF REVERSE ENGINEERING

Reverse engineering is a multidisciplinary approach and virtually can be applied to industrial field universally. The prime applications of reverse engineering are either to re-create a copy of part of the original part or retrace the events of what happened. It is widely used in software and information technology industries, from software code development to Internet network security. Thousands of parts are reinvented every year using reverse engineering to satisfy the aftermarket demands that are worth billions of dollars. The invention of digital technology has fundamentally revolutionized it. Compared to the aviation and automobile industries, the applications of digitalized reverse engineering in the life science and medical device industries have faced more challenges and advanced at a more moderate pace. However, some briefly description has been presented with reverse engineering applications as follows:

6.1 In Mechanical Industry

The term engineering is generally used to describe the act of creating something beneficial. Reverse engineering has been associated with the copying an original design for competitive purposes. In the manufacturing world today, however, the concept of reverse engineering is being legally applied for producing new products or variations of old products. The term reverse comes from the concept of bi-directional data exchange between the digital and physical worlds. The primary thrust in the early development of computer-aided design (CAD), engineering (CAE) and manufacturing (CAM) was to create a product in a computer and bring the results out to the real world. CAD was supposed to be able to define a simple part or a complex assembly entirely from its dimensional characteristics. CAE components, such as structural or thermal analysis software, would take this digital representation and analyze it. The CAM software would take this same electronic definition and create the paths to cut the tools for part manufacture. Today, the reverse engineering is applying in surface creation of complex geometry mechanical parts such as turbine blade, gear, car engine, casing, gas kit etc.

6.2 In Aerospace and Ship Hull Craft

Reverse engineering approach has been used by Boeing and other aerospace companies to create digital inventories of spare parts or to convert legacy data into today's CAD environments. Reverse engineering method is a key to the future of aerospace manufacturing as CAD tool. The modern aerospace industry uses reverse engineering for these key reasons (Ping, 2008):

- To create legacy parts that does not have CAD models
- To overcome obstacles in data exchange
- To short out problems arising from discrepancies between the CAD master model and the actual tooling or as-built part
- To confirm the quality and performance by computer-aided inspection and engineering analysis

An industrial application of CAD is presented, which concerns the measurement and reengineering of the shape of a complete ship hull and of ship's parts, which is a frequently recurring task in the shipbuilding and ship repair sector. In order to choose the most appropriate measurement method, several typical aspects of our object of measurement, such as its size, possible obstructions and poor accessibility, have to be taken into consideration (Koelman, 2010).

A proper function of these implants manufactured by reverse engineering requires them to sustain multiaxial statistic stresses and various modes of dynamic loads.It is also used to reconstruct the events just before and immediately after accidents in the aviation, automobile, and other transportation industries. Other fields, such as in fashion Design, in chemical industry, architecture and civil engineering.

VII. ADVANTAGES

- Improve efficiency
- Improve performance
- Longer part life
- Reduce operating and maintenance costs
- Upgraded application of technologies

VIII. DISADVANTAGES

Two main disadvantages: You can never really disassemble an application fully to it's original state before being compiled. Additionally, it can be very difficult to make anything of a disassembled application due to the Obfuscation of the critical and important source code. Essentially, they load a ton of relevant code into the application to throw off reverse engineers and make it even more difficult than it already is to perform the reversal.

REVERSE ENGINEERING OF BRAKE ROD OF BAJAJ PULSAR 150CC MOTOR BIKE USING SOLIDWORKS AND AUTODESK INVENTOR

In this case study the methodology of Reverse Engineering has been employed to Brake Rod of Bajaj Pulsar 150cc Motor Bike. This case study describes the generation of 2D model of Brake Rod using photogrammetry technique, development of 3D solid model on SolidWorks and Autodesk Inventor, stresses are analysed at different loads. Finally the results of SolidWorks have been compared with the results of Autodesk Inventor

1. INVESTIGATIONS OF EXISTING BRAKE ROD:

1.1. Measurement of various Lengths, major Diameter, Thread profile, Chemical composition and Mechanical properties:

Brake Rod is an essential structure element which provides linkage between Brake pedal and Brake shoe assembly. Its one end is fastened with Brake shoe assembly and other end is hinged to the Brake pedal lever. In this part the investigations of the existing Brake Rod have been carried out.The following data was measured during the Investigations of the Brake Rod:-

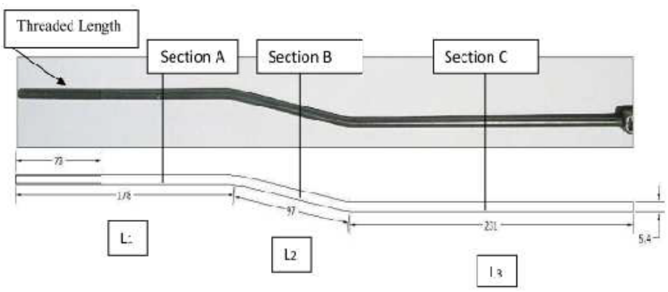


Fig. 1 Digital photograph and 2D sketch

1.1.1. Measurement of Various Lengths in Brake Rod are as follows:-

i) Length (L1) = 178 mm.
ii) Length (L2) = 97 mm.
iii) Length (L3) =231 mm.
iv) Threaded length = 73 mm.

1.1.2. Measurement of Major Diameter of Brake Rod: -

Major diameter of Brake Rod was measured by using Micrometer. The different readings obtained are shown in table below:-

Table1: Measurement of Major diameter

Diameter at section A (mm)			Avg. dia. at A (mm)	Diameter at section B (mm)			Avg. dia. At B (mm)	Diameter at Section C (mm)			Avg. dia at C (mm)	Final Avg. diameter (mm)
5.35	5.36	5.36	5.35	5.45	5.45	5.46	5.45	5.39	5.41	5.40	5.40	5.35+5.45 +5.40 = 5.40

Thus, the final average diameter of Brake Rod of Bajaj Pulsar 150cc Motor Bike using micrometer is found to be 5.4mm.

1.1.3. Thread Profile: Thread Profile is obtained using thread gauge and the Pitch is found to be 1mm.

1.1.4. Chemical Composition: The material applied for the Brake Rod having following chemical composition:

Table 2: Chemical Composition of material of Brake

C	Si	Mn	P	S	Cr	Mo	Ni
0.266	0.105	0.972	0.013	0.005	0.187	<0.005	<0.005

1.1.5. Mechanical Properties: Mechanical properties of Brake Rod material applied are:

Table 3: Mechanical Properties of Brake Rod Material

Tensile Strength	637.65N/mm^2
Yield Strength	519.93N/mm^2
Poisson Ratio	0.3
Elastic Modulus	210Gpa
Mass of component	0.0875712kg
Volume of component	0.00001137m^3
Density	7700kg/m^3

1.2. Photogrammetry Technique of Brake Rod

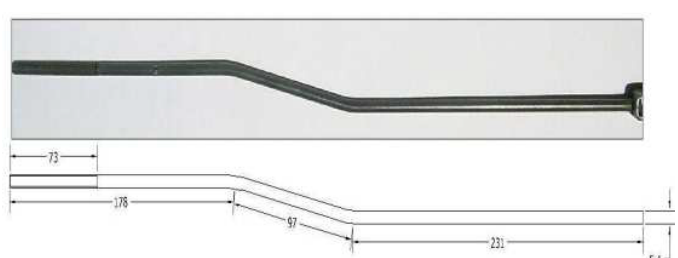


Fig.3 Digital photograph and 2D CAD Drawing of Brake Rod.

Different steps are followed in this technique:-

- Optical photogrammetry technique using Digital Camera :- In this technique, Brake Rod is placed under proper light on a horizontal surface and Digital Camera is fixed at a height of 1metre with proper focal length and 10 photographs are taken.
- One of best Digital photographs is digitally processed in the Computer so that visible edges are properly seen.
- Digital photograph is then imported in the CAD package (AutoCAD). The photograph is carefully traced by using Drawing commands and 2D CAD Model is created.
- The CAD Model is then scaled accordingly with one exactly known dimension (diameter of Brake Rod) i.e. 5.4mm.Then all other dimensions are automatically extracted from the CAD Model.
- Finally the 3D CAD Model is created using SolidWorks software.

1.3. CAD Modeling of Brake Rod

Following steps are required for the development of CAD Model of Brake Rod with the help of available

Digital photograph during Photogrammetry technique:-

- Importing the Digital photograph
- Tracing the outline by using Drawing commands
- Creating the features by SolidWorks.

The first step in reverse engineering process is to import the scanned data, which is in the form of Digital photograph in CAD package (AutoCAD). The photograph is carefully traced by using Drawing commands and 2D CAD Model is created. The CAD Model is then scaled accordingly with one exactly known dimension (diameter of Brake Rod) i.e. 5.4mm.Then all other dimensions are automatically extracted from the CAD Model. Finally the 3D CAD Model is created using SolidWorks software.

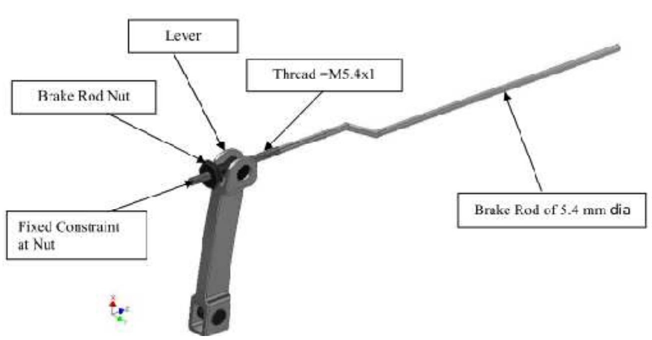


Fig.4 Brake Rod of diameter 5.4mm of Pulsar 150cc Motorbike

1.4. Determination of Axial Load on the Brake Rod:

The axial load that existed on the Brake Rod is studied in detail in this section of reverse engineering. The actual load that existed on the brake rod of the Bajaj Pulsar 150cc was calculated by using Spring Balance. The minimum load required to operate Brake shoe and stop the Motor Bike was measured as 4kg (39.24N) and the maximum applied load found was 8kg (78.48N) when the brake pedal was fully pressed with a condition that the brake pads should be maximum torn out.

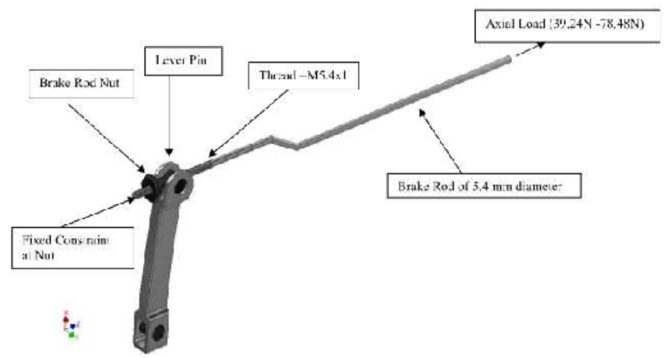


Fig.5 Constraints and Loading condition of Brake Rod of diameter 5.4mm.

II. RESULTS AND DISCUSSIONS

2.1. SolidWorks Results:

2.1.1. Stress Analysis of Brake Rod of Diameter 5.4mm:

The following assumptions are applied to this analysis:

- Linear - stress is directly proportional to strain.
- Constant - all properties temperature-independent.
- Homogeneous - properties do not change throughout the volume of the part.
- Isotropic - material properties are identical in all directions.
- Loading Conditions:

For the stress analysis of the Brake Rod under static boundary condition, the following loading condition is considered:

Condition: - When the nut was tight the middle of the threaded portion of the Brake Rod.

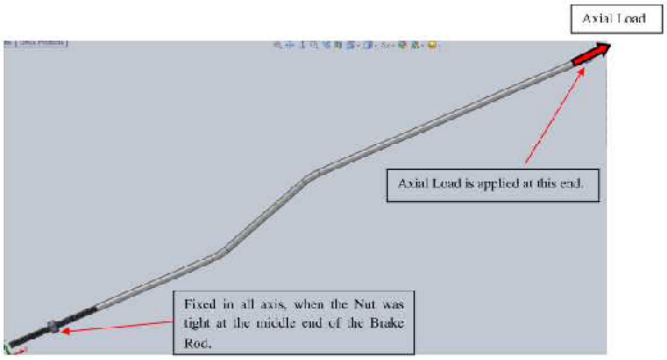


Fig.6 Constraints & loading conditions of Brake

As the Minimum Axial Load acting on the Brake Rod has been calculated as 4kg (39.24N) and the Maximum Load as 8Kg (78.48N) by using Spring Balance, so its analysis has been performed at various Loads ranging from 39.24N to 78.48N Axial Load acting on the Brake Rod in order to study its behavior at various loads.

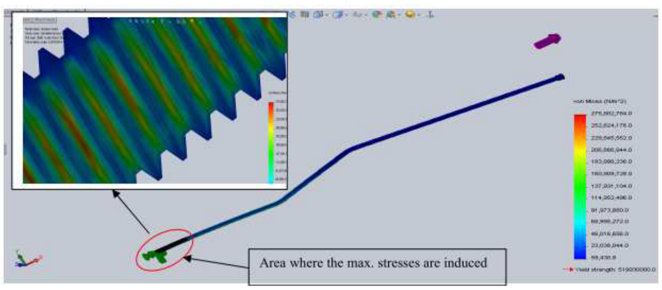


Fig.8 Von Mises stress at Load 39.24N

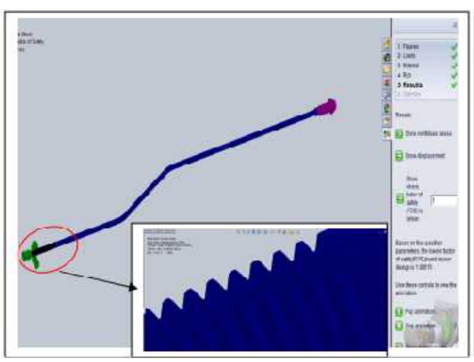


Fig.9 Factor of Safety at Load 39.24N.

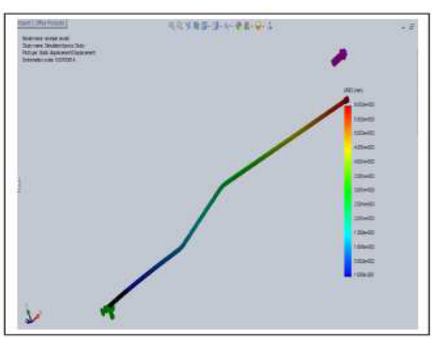
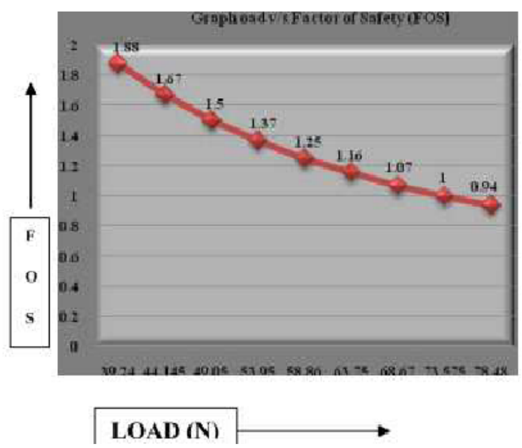


Fig .10 Maximum Displacement at Load 39.24N

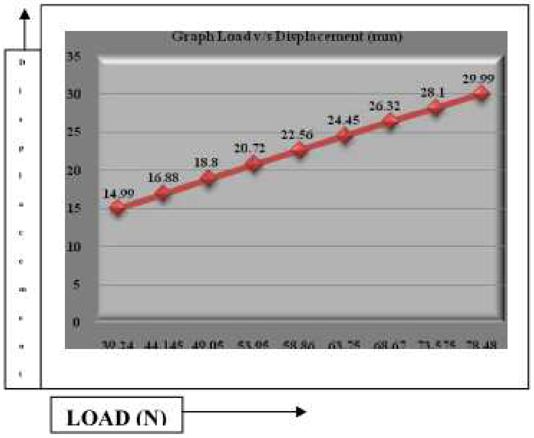
When the nut was tight at the middle of the threaded part of the Brake Rod, the maximum Von Mises stress, Factor of Safety (FOS) and maximum displacement at load 39.24N are 275.80N/mm2, 1.88 and 14.99mm respectively. As the maximum Von Mises stress is less than the yield strength (519.93N/mm2) of the material applied and the Factor of Safety is more than 1, the design of existing Brake Rod of diameter 5.4mm is safe at minimum applied load. The following table shows the results of the analysis at different Loads ranging from minimum axial load to maximum axial load i.e. 39.24N to 78.48N.

Table 5:- Results of analysis of Brake Rod of diameter 5.4mm at various Loads.

Load (N)	Max. Von Mises Stress (N/mm^2)	Factor of Safety	Max. Displacement (mm)
39.24	106.721	4.87	3.919
44.145	120.061	4.33	4.409
49.05	133.401	3.89	4.899
53.955	146.741	3.54	5.389
58.86	160..081	3.24	5.879
63.765	173.421	2.99	6.369
68.67	186.762	2.78	6.859
73.575	200.102	2.59	7.48
78.48	213.442	2.43	7.838



Graph1:- Load v/s Factor of Safety (FOS)



Graph2:-Load v/s Displacement (mm)

2.3. Comparisons: Results of Solid Works and Autodesk Inventor

In this section, the results obtained by SolidWorks are compared with the results obtained by Autodesk Inventor at maximum applied load. From Graph 13, 14 and table11, it has been observed that the maximum value of Von Mises stress of existing Brake Rod of diameter 5.4mm, at maximum applied load, obtained by SolidWorks and Autodesk Inventor is 562.51N/mm2 and 546.01 N/mm2 respectively which is more than the yield strength (519.93N/mm2) of the material of Brake Rod. Also the calculated value of Factor of Safety obtained by SolidWorks and Autodesk Inventor are 0.94 and 0.95 respectively which is less than 1. So, it is clear that the design of existing Brake Rod of diameter 5.4mm is safe at most of the applied load. Also the calculated value of Factor of Safety is more than 1.

Table 6: Comparison of results of SolidWorks and Autodesk Inventor

Parameter	Solidwork Results Brake rod dia. 5.4 mm	Autodesk Inventor Result Brake Rod Dia. 5.4 mm
Max. Von Mises Stress(N/mm^2)	562.51	546.01
Factor Of Safety	0.94	0.95
Max.Displacement(mm)	29.99	29.97

III. CONCLUSIONS

The CAD Model of existing Brake Rod of diameter 5.4mm of Bajaj Pulsar 150cc Motor Bike has been developed by SolidWorks and Autodesk Inventor using the photogrammetry technique. After getting the solid model, stress analysis of Brake Rod has been performed at different loads ranging from minimum value to maximum value of loads. Results of SolidWorks show that at maximum applied load (78.48N), the maximum stresses are induced in the threaded part of the Brake Rod and its maximum value is 562.51N/mm2 which is more than the permissible limit of the yield strength (519.93N/mm2) of the material of the Brake Rod. The Factor of Safety is also calculated, the value of which is found to be 0.94. Since the maximum value of Von Mises stress is more than the yield strength of the material applied of the Brake Rod and Factor of Safety is found to be less than 1, so it has to be redesigned.Again the stress analysis is performed on the modified CAD Model of Brake Rod of diameter 6mm and 7mm. It has been observed that the maximum stress at maximum applied load is less than the permissible limit of yield strength of the material applied of the Brake Rod and the Factor of Safety is found to be more than 1. Also the analysis of existing Brake Rod of diameter 5.4mm has been carried out by Autodesk Inventor. The results of analysis show that, at maximum applied load, the maximum stresses are induced in the threaded part of the Brake Rod. The maximum value of Von Mises stress is found to be 546.01N/mm2. Also the Factor of Safety is calculated, the value of which is found to 0.95. Since the calculated value of maximum Von Mises stress is more than the yield strength of the material (519.93N/mm2) of the Brake Rod and the Factor of Safety is less than 1. Again the stress analysis is performed on the modified CAD Model of Brake Rod of diameter 6mm and 7mm. It has been observed that the maximum stress at maximum applied load is less than the permissible limit of yield strength of the material applied and the Factor of Safety is found to be more than 1.Therefore, the design of Brake Rod of diameter 7mm is safe at maximum applied load. Finally, the results of analysis of SolidWorks and Autodesk Inventor are compared. From comparison it has been observed that the existing Brake Rod of diameter 5.4mm is not safe at maximum applied load. Hence it serves the purpose of Reverse Engineering of the Brake Rod of Bajaj Pulsar 150cc Motor Bike and it also helps to study the behavior of the CAD Model under various loads ranging from minimum value to maximum value i.e. 39.24N to 78.48N.

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