International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Reverse Engineering on Two Wheeler Brake Rod: Case Study

M.BN. Fanisam[1], Patil Mitesh[2], Pagare Nitin[3]

[1]Professor, Savitribai Phule Pune University, R.H.Sapat College of Engineering, College Road, Nashik 422005 India

[2, 3]Savitribai Phule Pune University, R.H.Sapat College of Engineering, College Road, Nashik 422005 India

Abstract: ***Reverse engineering is the process of defining and installing a model based on the measurement taken from an exemplar object. The measurement (or data sensing) process is prone to random and systematic error and often fails to sense the object in manner consistent with the intended functionality of the object's design. In this paper an attempt has been made to find out the persisting problem associated with the brake rod of Bajaj Pulsar 150cc motor bike using reverse engineering. The 3D model of the brake rod done by software Unigraphics NX 11.0 and Hyper mesh 14.0 and using FEA techniques. Result obtained of existing and modified brake rod has been performed at various loads ranging from minimum value to maximum value. This result involves various parameters such as stress, displacement and factor of safety. According to the result obtained the modifications have been changed in the existing brake rod.***

Keywords: Reverse Engineering, Data sensing, Brake rod, Modification and Analysis

1. Introduction

Reverse engineering is a process by which the design of a product is analysed or recreated using a physical part as a starting point. During the design process for a new product, clay models and different types of prototypes are made in order to test, evaluate and validate the conceptual design. This process is usually iterative and requires several modifications to the original design. For that reason, reverse engineering can become a valuable solution for extracting the dimensions of handmade models, clay models and prototypes; especially those with freeform shapes. You could also acquire the 3D geometry of an existing object in order to incorporate some of its features in the new product design. In addition to that, 3D scanning solutions also provide a powerful tool for documenting and archiving the different design iterations. The critical steps in reverse engineering are acquiring, accurately and efficiently, the dimensions of the object and extracting the necessary information from the resulting scan in order to create the new design with the right look and functionality.

Reverse engineering is now widely used in numerous applications, such as manufacturing, industrial design, and jewellery design and reproduction For example, when a new car is launched on the market, competing manufacturers may buy one and disassemble it to learn how it was built and how it works. In some situations, such as automotive styling, designers give shape to their ideas by using clay, plaster, wood, or foam rubber, but a CAD model is needed to manufacture the part. As products become more organic in shape, designing in CAD becomes more challenging and there is no guarantee that the CAD representation will replicate the sculpted model exactly.

1.1 Literature Survey

Mohammad Shadabet. al. (2006): presented the applications of the reverse engineering method on the modelling of Pillion step holder of Hero Honda CBZ Motor Bike. The CAD Model of Pillion step holder has been developed by CATIA V5 using the cloud data. The stress analysis of pillion step holder was also done. Results shows that the maximum stress at critical is within the permissible limit as compared to the strength of the material and the deflections in the component is much lesser than the permissible value. Again the stress is performed on the modified CAD Model. It is found that the maximum stress and maximum deflection is still within the permissible limit. It also helps to understand the behaviour of the CAD Model under various loading conditions and further help to modify it.[6]

A.V.Nichat: In this paper, to find out the dimension of pre-existing spline shaft of gearbox using reverse engineering. The geometric data of given part or component has been obtained by using CMM .The 3D mode of spline shaft has been obtained but using CATIA. Then the analysis is to be done in ANSYS, to find out various properties for various load ranging from minimum value to maximum value and the finally for computer aided manufacturing NC part programming is generate by using CATIA.

Dr. S. B. Thakare: In this paper, approach for reverse engineering (re) technique using coordinate measuring machine (CMM) and a design software CATIA is represented A part is physically examined with the help of co-ordinate measuring machine(CMM).Point cloud data of apart is generated through scanning on CMM Point cloud data is then exported to CAD software CATIA to generate CAD model of a part.[2]

1.2 Stages Involved in the Reverse Engineering

Engineering is the profession involved in designing, manufacturing, constructing, and maintaining of products, systems, and structures. At a higher level, there are two types of engineering: forward engineering and reverse engineering.Forward engineering is the traditional process of moving from high-level abstractions and logical designs to the physical implementation of a system. In some situations, there may be a physical part without any technical details,

Licensed Under Creative Commons Attribution CC BY

such as drawings, bills-of-material, or without engineering data, such as thermal and electrical properties.The process of duplicating an existing component, subassembly, or product, without the aid of drawings, documentation, or computer model is known as reverse engineering.

Reverse engineering can be viewed as the process of analyzing a system to:

- Discovering the component or product that needs to be reverse engineered.
- Disassembling or observing the information detailing how the original component operates.
- Applying the technical information generated from the reverse engineering in a tailored version of the original.
- Creating a new product in the market.

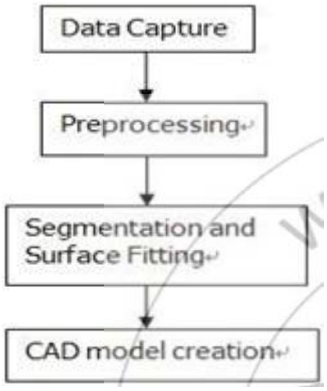


Figure 1: Flow chart of basic phase in reverse engineering

First Stage: In this stage the product or component is identified completely and this stage is also sometimes known as pre-screening. The potential components of these projects include parts, singular items, units, components, sub-assemblies, etc.

Second Stage: The second stage of reverse engineering is known as de-compilation or disassembly of the actual product. This stage consumes maximum amount of time and in this process the engineers makes an attempt to create a characterization of the system by collecting all technical instructions and data of how a product works. The product is completely broken down thus separating every unit complied into its basic state to understand the engineering principles used to construct it.

Third Stage: In the third stage, the engineers make sure that the data collected from the disassembly of the original system is accurately reconstructed. They also verify the validity or accuracy of the designs by creating prototypes, testing the system and experimenting with the outcomes. This stage help in making sure that the reconstructed products works well and helps in creating more need for similar product in the market.

Fourth Stage: The final or fourth stage of the reverse engineering involves the introduction of the reconstructed product in the market. The new product is created through innovative technology derived from the original product but designed with competitive capabilities and features. The reconstructed products can be an adaptation of the original product for its usage with other integrated systems like various platforms of computer operating systems.

1.3 Purpose

- It can be used to clone the product and manufacture it more cheaply that the original which may be a more legally and ethically concerning use of reverse engineering
- It is also used to do better job of fixing it and because that is a business opportunity
- To derive a design, technical specification, functionality or manufacturing methods for particular objects by studying the existing parts
- Some bad features of the products need to be redesign
- To update obsolete material or antiquated manufacturing process with more current less expensive technology
- Reverse engineering commonly used for deciphering file formats for improving in interoperability
- Reverse engineering is needed whenever the documentation is lost or if never existed.[4]

1.4 Areas in which Reverse Engineering is applicable:

- Lost Documentations: Reverse engineering is done because the documentation of a particular device has been lost (or was never written) and the person who builds is no longer available. Integrated circuits often seems to have been designed an obsolete which means that the only way to incorporate the functionally into new technology is to reverse engineering.
- Product Analysis: to examine how a product works, what component it consist of, estimate cost and identify potential patent in figment.
- Digital update/correction: to update the digital version (e.g CAD model) of an object to match „as-build" condition
- Acquiring sensitive data by disassembling and analysing the design of a system component.
- Military or commercial espionage: learning about an enemy's latest research by stealing or capturing a prototype it
- Creation of unlicensed/ un-approval duplicates
- Academic/ learning purpose
- Curiosity
- Competitive technical intelligence
- Learning: learn from others mistakes.

2. Existing System of Brake Rod (Bajaj pulsar 150cc)

Brake rod is a component which is placed in between brake pedal and brake shoe assembly. It"s one end is hinged to the brake pedal lever and another end is fastened with brake shoe assembly. In this area the inquisition of the existing brake rod have been carried out. The following measurements are done from the inquisition:

Licensed Under Creative Commons Attribution CC BY

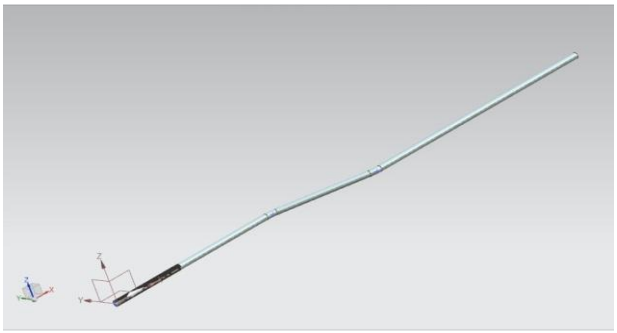


Figure 2: 3D model of existing brake rod

2.1 Enumeration of various geometries' entities of brake rod are as follow:

- length (L1) = 178mm
- length (L2) = 97mm
- length (L3) = 231mm
- threaded length = 73mm
- average diameter = 5.40mm
- pitch of thread profile = 1mm

2.2 Chemical Composition

The material applied for the Brake Rod having following chemical composition:

Table 1: chemical composition of the material of brake rod

C	Si	Mn	P	S	Cr	Mo	Ni
0.266	0.105	0.972	0.13	0.005	0.187	0.005	0.005

2.3 Mechanical Properties: Mechanical properties of Brake Rod material applied are:

Table 2: mechanical properties of the material of brake rod

Tensile strength	637.65 N/mm^2
Yield strength	519.93 N/mm^2
Poisson ratio	0.3
Elastic modulus	210 Gpa
Mass of component	0.0875712 Kg
Volume of component	0.00001137 m^3
density	7700 kg/m^3

2.4 Determination of Axial Load on the Brake Rod

The load that is exerted on brake rod of the bajajpulsur 150cc is calculated using spring balance.the minimum and maximum force required to brake shoe to stop the motor bike is 4kg (39.24N) and 8 kg(78.48N) respectively, when the brake pedal was fully pressed with a condition that the brake pads should be maximum torn out.[1]

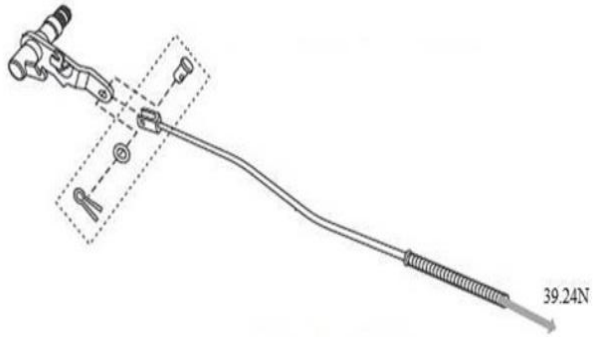


Figure 3: Loading condition of the brake rod of diameter 5.4mm

3. Analysis and Results in Hypermesh14.0

3.1 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.

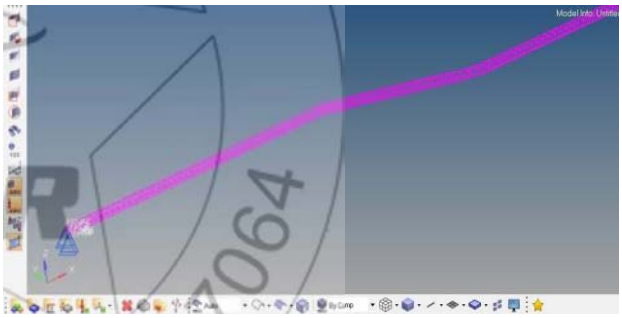


Figure 4: Solid mesh of brake rod

The fig.4 shows the mesh of the Brake Rod which was generated by Hypermesh Software for the purpose of analysis under different loads ranging from minimum value to maximum value. The mesh generated contains tetrahedral geometry elements.[5]

3.2 Results of Analysis of 5.4mm Diameter of Brake Rod:

Condition: when the nut was tight at the middle of the threaded part Brake Rod.

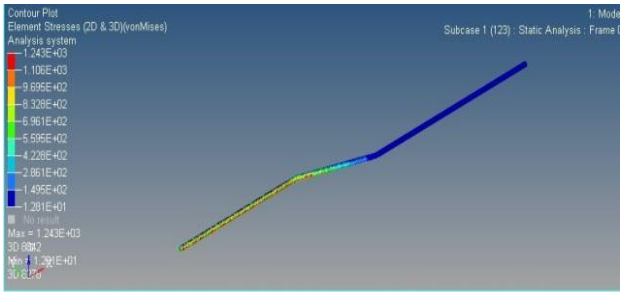


Figure 5: Von Misses stress at load 39.24 N

Licensed Under Creative Commons Attribution CC BY

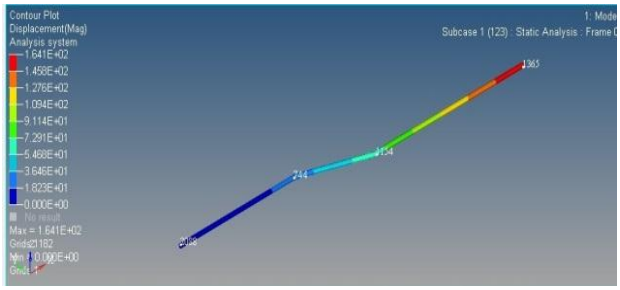
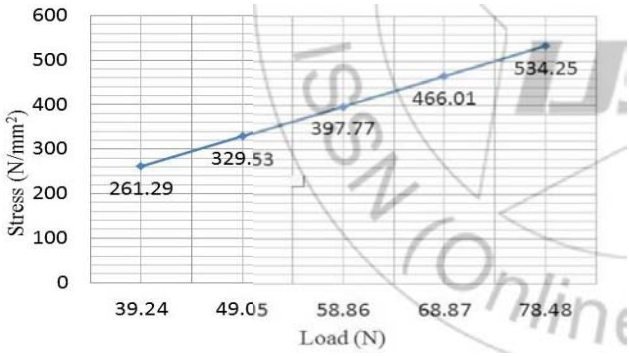


Figure 6: Displacement at load 39.24 N

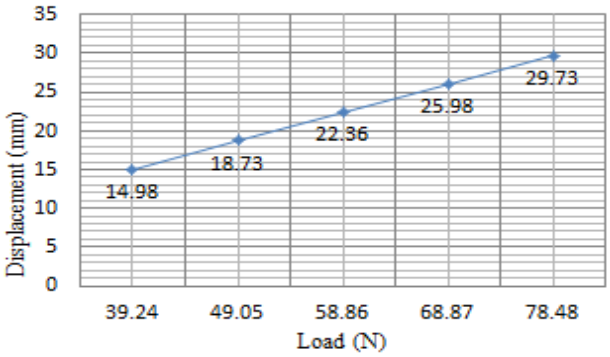
When the nut was screwed at the centre of the threaded part of the Brake Rod of diameter 5.4mm,the maximum Von Mises stress, Factor of Safety and maximum displacement at minimum applied load (39.24N) are 273.01N/mm 2, 1.90 and 184.98mm respectively. As the maximum Von Mises stress is less than the yield strength (519.93N/mm 2) of the material applied and the Factor of Safety is more than 1, the design of modified Brake Rod of diameter 5.4mm is safe at minimum applied load. The following table shows the results of analysis of the Brake Rod at different Loads ranging from minimum axial load to maximum axial load i.e. 39.24N to 78.48N.

Table 3: Results of analysis of Brake Rod of diameter 5.4mm at various Loads.

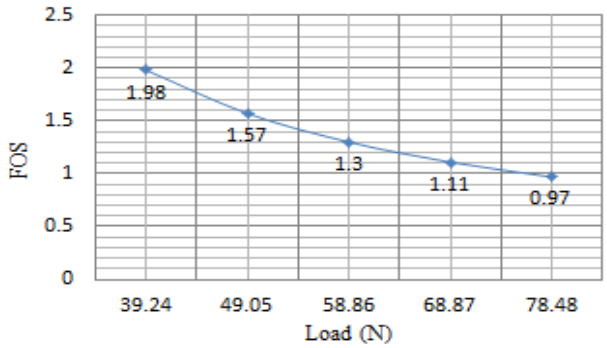
Load (N)	Stress (N/mm^2)	Displacement (mm)	FOS
39.24	261.29	14.98	1.98
49.05	329.53	18.73	1.57
58.86	397.77	22.36	1.30
68.87	466.01	25.98	1.11
78.48	534.25	29.73	0.97



Graph 1: Load v/s Stress



Graph 2: Load v/s Displacement



Graph 3: Load v/s FOS

4. Results of Analysis of Brake Rod of 6mm diameter

When the nut was tight at the middle of the threaded part of the Brake Rod of diameter 6mm, the maximum Von Mises stress, Factor of Safety and maximum displacement at minimum applied load (39.24N) are 121.36N/mm^2, 4.28 and 7.35 respectively. As the maximum Von Mises stress is less than the yield strength (519.93N/mm 2) of the material applied and the Factor of Safety is more than 1, the design of modified Brake Rod of diameter 6mm is safe at minimum applied load.

Table 4: Results of analysis of Brake Rod of diameter 6 mm at various Loads.

Load (N)	Stress (N/mm^2)	Displacement (mm)	FOS
39.24	121.36	7.35	4.28
49.05	152.64	9.23	3.40
58.86	187.92	11.11	2.76
68.87	221.20	12.99	2.35
78.48	254.48	14.87	2.04

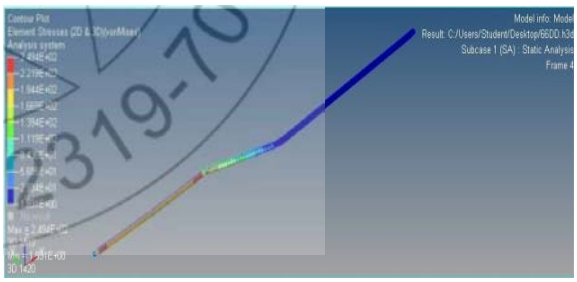


Figure 7: Von Misses stress at load 39.24 N

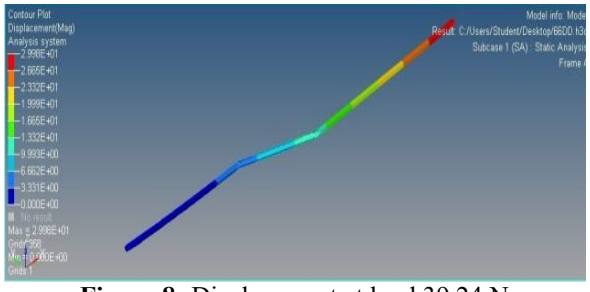
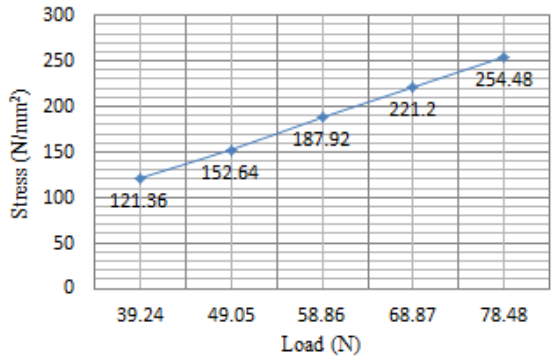
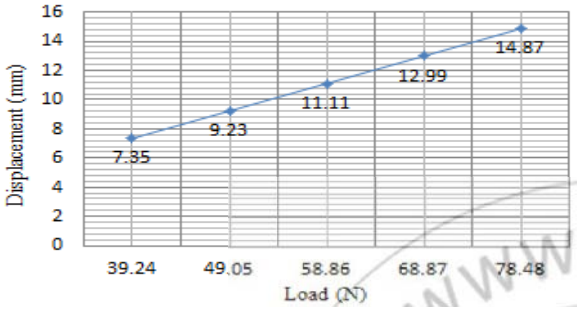


Figure 8: Displacement at load 39.24 N

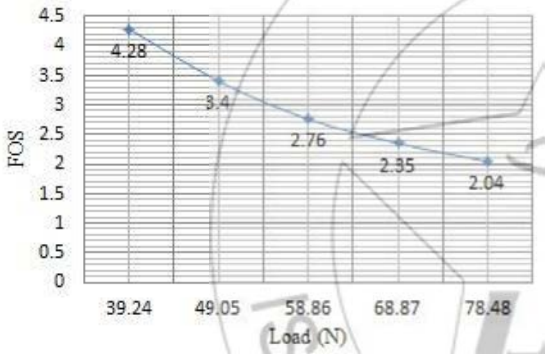
Licensed Under Creative Commons Attribution CC BY



Graph 4: Load v/s Stress



Graph 5: Load v/s Displacement



Graph 6: Load v/s FOS

Results of Analysis of 7mm Diameter of Brake Rod

The following table shows the results of 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 7mm at various Loads.

Load (N)	Stress (N/mm^2)	Displacement (mm)	FOS
39.24	82.56	3.68	6.29
49.05	106.12	4.65	4.89
58.86	129.68	5.63	4.00
68.87	153.24	6.61	3.39
78.48	176.80	7.59	2.94

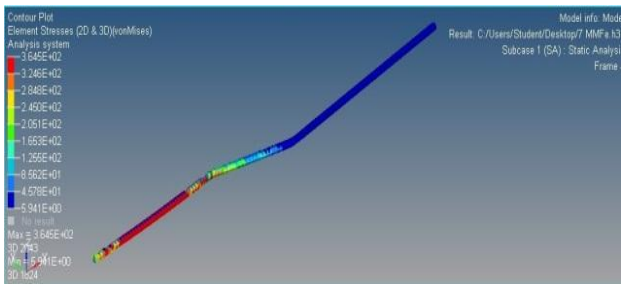


Figure 9: Von Misses stress at load 39.24 N

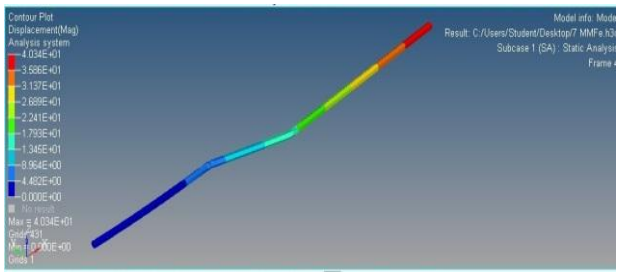
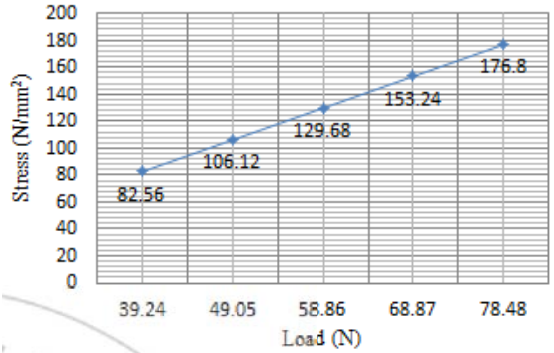
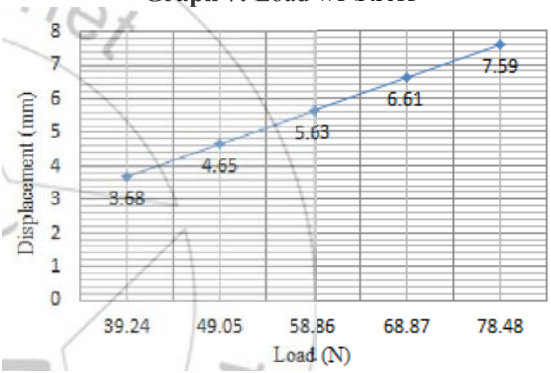


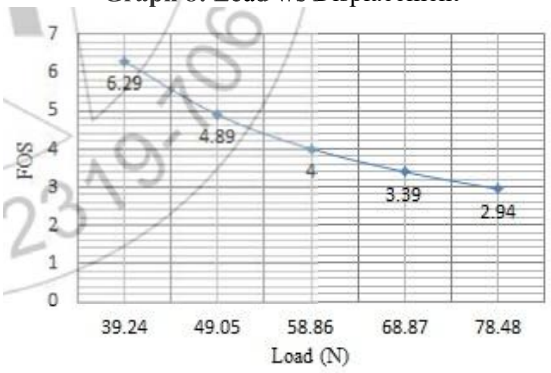
Figure 10: Displacement at load 39.24 N



Graph 7: Load v/s Stress



Graph 8: Load v/s Displacement



Graph 9. Load v/s FOS

5. Result Analysis

Table 6: Result obtained at minimum and maximum load

Parameters	Load (N)	Diameter (mm)		
		5.4	6	7
Stress (N/mm^2)	39.24	273.01	133.12	94.278
	78.48	546.01	266.24	188.56
FOS	39.24	1.90	3.90	5.505
	78.48	0.95	1.95	2.752
Displacement (mm)	39.24	14.98	7.555	3.919
	78.48	29.97	15.11	7.838

Licensed Under Creative Commons Attribution CC BY

6. Conclusions

A cad model of existing brake rod of diameter 5.4mm of Bajaj pulsar 150cc motorbike has been developed by nx6 software and analysis is done in hypermesh14.0 software, at different loads ranging from minimum value (39.24N) to maximum value (78.48N).

From the hyper mesh results of 5.4mm particular diameter it is noticed that maximum stress induced in threaded portion at maximum load (78.48N) is 534.25N/mm^2 which is more than the permissible yield strength (519.93N/mm^2). More over the FOSis also less than one. Due to this above statistical reason redesign of brake rod should be done.

Again analysis is done by taking diameter 6mm and 7mm brake rod. From the result table it has been observed that maximum stress induced in threaded portion is 254.48 N/mm^{2}and 176.8 N/mm^{2}respectively, which is less than the permissible yield strength (519.93 N/mm^2) and the FOS is also more than 1.

From the table no.8 is has been observed that stress induced in threaded portion of 5.4mm diameter brake rod is more than permissible yield strength and factor of safety is also less than 1. So brake rod having diameter 5.4mm is not safe at maximum applied load. Therefore the diameter of existing brake rod should be redesign from 5.4mm to 6mm or 7mm in order to make design safe and for the better safety of rider.

References

[1] Jagdev Singh, "Reverse Engineering of brake rod of motor bike using solid works and autodeskinventor",Journal of engineering research and studies, Vol.III,IssueI/January-march, 2012.
[2] Dr. S.B. Thakare, "Reverse Engineering using CMM and CAD tool", Journal of engineering research and technology", Vol.II Issue 10, October-2013.
[3] F. Belarifi, E. Bayraktar, A. Benamar, "The reverse engineering to optimise the dimensional conical spur gear by CAD", Journal of Achievements in Materials and Manufacturing Engineering. Volume 31/2008.
[4] Dr.A.U. Awate, "Application of Reverse Engineering using CMM for manufacturing intricate component/case study", International journal of pure and applied research in engineering and technology. Vol.I/2013.
[5] Shashank Alai, "A Review of 3D design parameterization using Reverse Engineering", International Journal of Emerging Technology and Advance Engineering, Vol.III Issue10, October 2013.
[6] Mohammad Shadab, Dr.Suhaib and Dr.R.A.Khan., "Reverse engineering of Hero Honda CBZ Motorbike using Catia V5",National Conference on Recent Developments and Future Trends in Mechanical Engineering, 2006.

Author Profile



Prof. M. BN. Fanisam is Assistant Professor, Department of Mechanical Engineering, Gokhale Edu. Soc. R.H.Sapat, College of Engineering, Nashik.



Mr.MiteshPatil, Pursuing B.E. degree in Mechanical, Engineering from Gokhale Edu. Soc., R.H.Sapat College of Engineering, Nashik-422 005



Mr. NitinPagare pursuing B.E. degree in Mechanical Engineering from GokhaleEdu.Soc., R.H.Sapat College of Engineering, Nashik 422005

Licensed Under Creative Commons Attribution CC BY