Failure Analysis and Design Modification of Drive Axle for ATV Car

[1]Jenish Patel, [2]Dhairya Raval,

[1]PG Scholar, [2]Assistant Professor,

[1]Mechanical Engineering Department,

[1]Silver Oak College of Engineering & Technology, Ahmedabad, India

Abstract : This Paper focuses on the problem of the drive-axle failure within a student built All-terrain vehicle, designed and fabricated by team of students racing for participation in BAJA SAE INDIA ATV championships, with the intent to not only solve the failure for the current case study, but, to also derive a universal approach to solution of such problems in any all-terrain vehicle within the world. The approach to solution begins with a definition of the problem and its key parameters. Further, simulation of the failure conditions is performed to identify shortcomings of the failing design. Thereafter, the solution is derived with the support of standard design calculations and an iterative approach. The processes incorporate iterative material selection and re-design. Thereafter, from the various possible solutions, the optimal solution was identified via FEA tools.

***IndexTerms* – ATV, Drive axle, FEA,**

I. INTRODUCTION

All-Terrain vehicles are off-road vehicle. They are designed and built for the special application. They are capable to move on any paved and gravel surface .Various types of All terrain vehicles are fork lift, tractors, ATV Cars. In this paper we have emphasized on the failure analysis of drive axle which is the main component of transmission system. The purpose of drive axle is to transmit power generated by the engine to the wheel. One end of Drive axle is connected to differential and another end is connected to the wheel. Constant velocity joint has been provided at the both ends to transmit the power at the different angles. Drive axle of most on road vehicles is subjected to torsional and bending loads. For Off road Vehicle it depends upon the design of Vehicle.

Fig.1 Assembled View of Drive Axle [1]

At a basic level, axles are classified into the following types:

- Drive axle
- Dead axle
- Lift axle
- Full-floating axle
- Semi-floating axle

- Dead axle is commonly used axle for the all types of trucks and all terrain vehicles depending upon the application. The rear axle of a front-wheel drive car is usually a dead axle. They are independent from the suspension system of vehicle. Hence, There is negligible bending load acting over it.

II. CAUSES OF FAILURE OF DRIVE AXLE

Failure analysis is the process of collecting and analyzing data to determine the cause of a failure and how to prevent it from recurring. Failure analysis and prevention are important functions to all of the engineering disciplines. A component or product fails in service or if failure occurs in manufacturing or during production processing. In any case, one must determine the cause of failure to prevent future occurrence, and/or to improve the performance of the device, component or structure. It is possible for fracture to be a result of multiple failure mechanisms or root causes.[3] Failure analysis can provide the information to identify the appropriate root cause of the failure.[5].Without suspension system drive axle is subjected to the repetitive load such as bending Some of the off-road vehicles have drive shaft which is independent from the suspension system. Hence, on the paved surfaces they are subjected to torsional stress as compared to the bending stress.[6]

2.1 AXLE MODEL SELECTION

Table1.Axle Dimensions

Material	**Diameter**	17mm
Carbon steel 4140	**Plunge Length**	2.92”
	Wheel Track Change	2.79”
	Ground Clearance	12”
	Max. Axle articulation angle	31°

3.3 FINITE ELEMENT ANALYSIS

The model of shaft was prepared using 3D technique in SOLIDWORKS. Then model is then transferred in .iges format and exported into the ANSYS 15.0 for analysis of half-shaft. Finite element analysis is applied in engineering is a computational tool for performing engineering analysis it includes the use of mesh generation techniques for where a complex geometrical parts has been discretized into small elements depending upon the application. Discretization may be simply described as process by which the given body is subdivided into equivalent systems of finite elements. The meshing is adequately done to obtain the accurate results while computation. Model is meshed with element type tetrahedron shape with element size of 1mm where number of elements are 66636 and number of nodes are 110397.

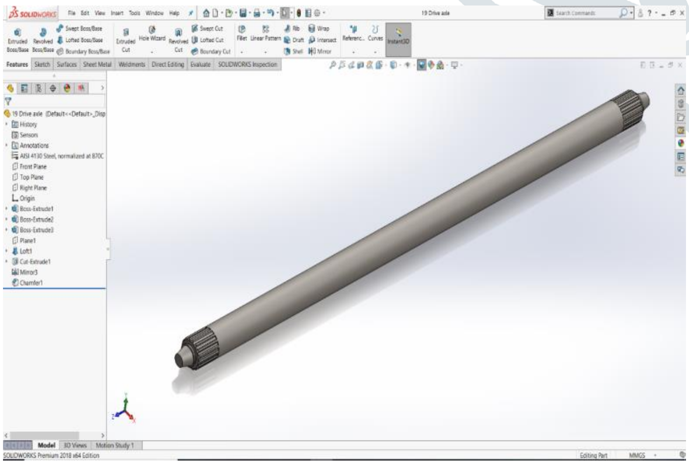

Fig.2 Cad model of Drive Axle

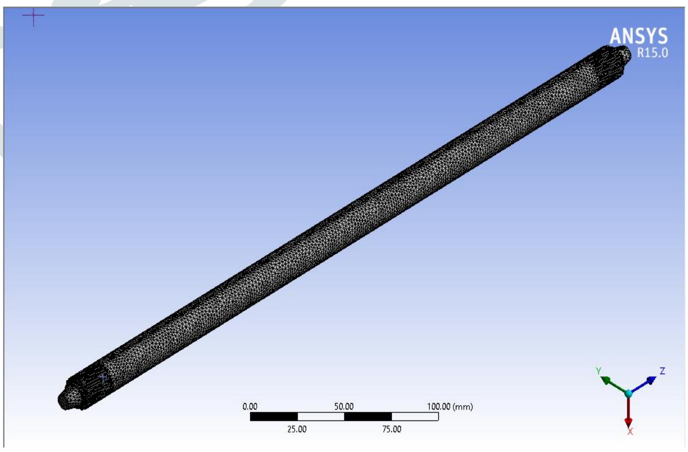

Fig.3 Meshing of Drive Axle

Loading and Boundary Conditions

Preliminary stage of any static analysis is to decide the loading and boundary conditions. The torque is transmitted to and from the half-shaft via splines on both ends of the component, so they are subjected to torsion and shear stress. The gearbox reduction was 11.63:1 and CVT min. reduction was 3:1, so overall reduction with efficiency 85% was 23.93:1 which was further multiplied by engine torque 19.86N-m at 2800 rpm with efficiency 85% of transmission gave maximum torque output of 685.93 N-m at wheels. This torque was then used to verify the torsional strength of half-shaft. The outer end of shaft was fixed, while the 685.93 N-m of torque was applied to inner end.

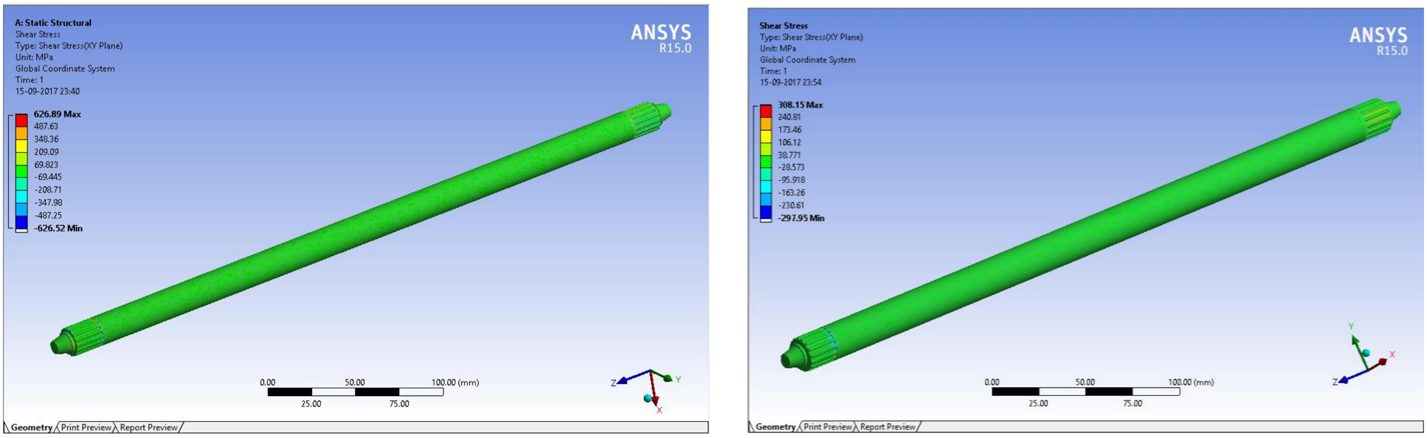

Fig.4 Shear stress Comparison

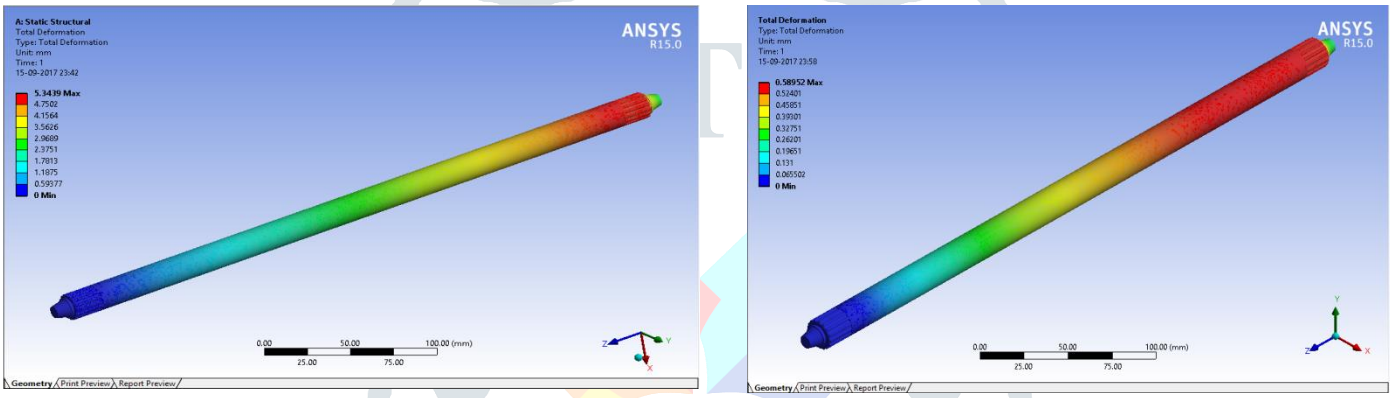

Fig.5 Total Deformation Comparison

IV. RESULTS AND DISCUSSION

The results of ANSYS shows that the maximum stress operated in the component is at end of slip joint spline of male part . The max Shear stress is of 308.15MPa and maximum deformation is 0.5895mm both this value is within the safety limit.

4.1 Comparison of Deformation and Stress

Table .2 Comparison of Deformation and Stress

Drive Axle	Shear Stress (MPa)	Total Deformation (mm)
Existing Drive Axle	626.89	5.3439
Modified Axle	308.15	0.5895

References

[1] Chirag Patil, Sandeep Imale, Kiran Hiware, Sumeet Tiwalkar, "International Journal of Engineering Sciences & Research Technology", Jawaharlal Nehru Engineering College, Aurangabad, IJESRT, ISSN: 2277-9655

[2] A.Tlaisi, A. Akinturk, A.S.J. Swamidas, M.R. Haddara, "Crack detection in shaft using lateral and torional vibration measurement and analyses", ASME Turbo Expo 2012, GT2012-69921

[3] B. James Prasad Rao, D. V Srikanth, T. Suresh Kumar, L. Sreenivasa Rao, "Design and Analysis of Automotive Composite Propeller Shaft Using FEA", ScienceDirect, ICMRA 2016

[4]. Minoru Seto, Shizuoka (JP), Yamaha Hatsudoki Kabushiki Kaisa (JP), ATV TRANSMISSION, Patent No.: US 6,533,060 B1, Date of Patent: Mar. 18, 2003

[5] Bipin Wankhede, Prashant Awchat, Tejpal Parshiwnikar, "Failure Analysis of Automotive Front Wheel Drive Shaft", G. H. Raisoni Academy of Engg. & Tech., Nagpur, Journal of Information, Knowledge and Research in Mechanical Engineering, ISSN: 0975-668X

[6] Subrata Kr Mandal, Palash Kr Maji, S Karmakar, "Analysis of and Intermediate Rear Axle Shaft Failure", Central Mechanical Engineering Research Institute, Durgapur, Advances in Automobile Engineering, ISSN: 2167-7670.

[7] Minoru Seto, Shizuoka (JP), Yamaha Hatsudoki Kabushiki Kaisa (JP), ATV TRANSMISSION, Patent No.: US 6,533,060 B1, Date of Patent: Mar. 18, 2003