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# Static Analysis of Back Rear Axle Crown Wheel Of Tourus Model Tipper

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## ABSTRACT

Now a days entire world depends upon automobiles. In an automobile motion is transferred from engine to rear wheel through various mechanical links. But differential gear box plays a vital role in the automobile for transferring motion from engine to rear axle. Normally single differential gear box is used for light weight vehicles but heavy load vehicles two or more rear axles with differential gear boxes are used for transferring maximum amount of power from engine to rear axles. So here it is focused on the mechanical design and analysis of double axle differential gear box as it transmits the power. This work develops a view to get familiar with the technologies as well as application of theories into practical work done by industries. My research contains the design with the help of CATIA/HYPER MESH and material selection of the double axle differential gearbox. For better efficiency, improvement of power transmission rate is an important phenomenon. In the present work, it is proposed to find the effect of deformation, strength variations in the Back Rear crown wheel by static analysis of differential gear box of Ashok Leyland tipper (Taurus 2516/2 model) design on the predicted stress by using ANSYS/CATIA Software. By identifying the true design features, the extended service life and long term stability can be assured.

**Keyword:** Central Differential Gear Box, CATIA and ANSYS

## INTRODUCTION

When a vehicle takes a turn either left or right, the outer wheels must travel more distance than the inner wheels. In an automobile the front wheels can rotate freely on their front axle. However both rear wheels are driven by the engine through gearing. Therefore some sort of automatic device is necessary so that two rear wheels are driven at slightly different speeds.

**Constructional details:**

**WHY DO YOU NEED A DIFFERENTIAL?**

You would not need a differential is your car would always be travelling over a straight line. Unfortunately, driving such a car has certain difficulties - like having to go around the world to return where you started from.

When you need to turn, then you have to address the issue that left and right wheels will have to rotate at a different speed.The difference between the paths travelled by the left (outside) and the right (inside) wheels will be

$$2\pi(R-r)$$

Since both sets of wheels travel over this distance at the same time, the speed differential between the left (outside) and right (inside) wheels is

$$V_o - V_i = \frac{2\pi(R-r)}{T}$$

Where R is outer radius, r is inner radius and T is the travel time. The dimensionless velocity differential between the outside and the inside wheels can then be approximated by

$$V_{diff} = \frac{V_o - V_i}{V_{avg}} = \frac{R-r}{R_{avg}} = \frac{t}{R_{avg}}$$

Where t is the wheel base and $R_{avg}$ is the distance from the centre of rotation to the centre of the wheel axle.

The speed differential between the two wheels is a problem for the driven wheels. One possible solution is to have only one wheel driven. Unfortunately, in this instance, I stick with the F-SAE competition rules and require you to have at least two wheels driven.

**Selection of particular model. (Taurus 2516/2(6x4))**

Among all types of ashok layland models this Ph D work is related to model Taurus 2516/2(6x4) the detail specification and materials used in this model is as follows

**Materials used in gear manufacturing process**

The various materials used for gears include a wide variety of cast irons, non ferrous material and non-metallic materials the selection of the gear material depends upon i) type of service ii) peripheral speed iii) degree of accuracy required iv) method of manufacture v) required dimensions and weight of the drive vi) allowable stress vii) shock resistance viii) wear resistance.

1. Cast iron is popular due to its good wearing properties, excellent machinability and ease of producing complicated shapes by the casting method. It is suitable where large gears of complicated shapes are needed.
2. Steel is sufficiently strong and highly resistant to wear by abrasion

3. Cast steel is used where stress on gear is high and it is difficult to fabricate the gears
4. Plain carbon steels find application for industrial gears where high toughness combined with high strength
5. Alloy steels are used where high tooth strength and low tooth wear are required
6. Aluminum is used where low inertia of rotating mass is desired
7. Gears made of non-metallic materials give noiseless operation at high peripheral speeds.

In the model Taurus 2516/2 Ashok Leyland the differential gear box should be made up of steel G45 Material and their design specifications

| | **Pinion(mm)** | **Gear(mm)** |
|---|---|---|
| Pitch cone diameter | $D_p$=55mm | $D_g$=200mm |
| No. of teeth | $T_P$=6 | $T_G$=39 |
| Module | M=5mm | M=5mm |
| Pitch angle | $\theta_p = 13.299^0$ | $\theta_g = 76.7^0$ |
| Cone distance | $A_0$=55mm | $A_0$=55mm |
| Face width | b=60 | b=60 |
| Addenda | ha=M=8mm | Ha=M=8mm |
| Dedenda | hd=1.26M=10mm | Hd=1.2M=10mm |
| Clearance | C=0.2M=2mm | C=0.2M=2mm |

**HOW TO DESIGN:**

Here to make such a model using PROE or CATIA Software only. While generating the model the designer should keep in mind there are no specific dimensions. All the dimensions should be chosen by the company designers according to their own choice. Then analysis will do by using ANSYS/CATIA soft ware by meshing using HYPERMESH Software

**Introduction to ProE/CATIA**

Pro/ENGINEER (Pro-E)/CATIA is a feature based, parametric solid/Wireframe modeling program. As such, its use is significantly different from conventional drafting programs. In conventional drafting (either manual or computer assisted), various views of a part are created in an attempt to describe the geometry. Each view incorporates aspects of various features (surfaces, cuts, radii, holes, protrusions) but the features are not individually defined. In feature based modeling, each feature is individually described then integrated into the part. The other significant aspect of conventional drafting is that the part geometry is defined by the drawing. If it is desired to change the size, shape, or location of a feature, the physical lines on the drawing must be changed (in each affected view) then associated dimensions are updated. When using parametric modeling, the features are driven by the dimensions (parameters). To modify the diameter of a hole, the hole diameter parameter value is changed. This automatically modifies the feature wherever it occurs - drawing views, assemblies, etc. Another unique attribute of Pro/E or CATIA is that it is a solid modeling program. The design procedure is to create a model, view it, assemble parts as required, then generate any drawings which are required. It should be noted that for many uses of Pro/E or CATIA, complete drawings are never created. A typical design cycle for a molded plastic part might consist of the creation of a solid model, export of an SLA file to a rapid prototyping system (stereo lithography, etc.), use of the SLA part in hands-on verification of fit, form, and function, and then export of an IGES file to the molder or toolmaker

**INTRODUCTION TO FEM**

The basic idea in the Finite Element is to find the solution of complicated problem with relatively easy way. The Finite Element Method has been a powerful tool for the numerical solution of a wide range of engineering problems. Applications range from deformation and stress analysis of automotive, aircraft, building, defense, and missile and bridge structures to the field of analysis of dynamics, stability, fracture mechanics, heat flux, fluid flow, magnetic flux, seepage and other flow problems. With the advances in computer technology and CAD systems, complex problems can be modeled with relative ease. Several alternate configurations can be tried out on a computer before the first prototype is built. The basics in engineering field are must to idealize the given structure for the required behavior. The proven knowledge in the typical problem area, modeling techniques, data transfer and integration, computational aspects of the Finite Element Method is essential. In the Finite Element Method the solution region is considered as built up many small, interconnected sub regions called finite elements.

Most often it is not possible to ascertain the behavior of complex continuous systems without some sort of approximations. For simple members like uniform beams, plates etc., classical solutions like machine tool frames, pressure vessels, automobile bodies, ships, air craft structures, domes etc., need some approximate treatment to arrive at their behavior, be it static deformation, dynamic properties or heat conducting property. Indeed these are continuous systems with their mass and elasticity being continuously distributed. To overcome this, engineers and mathematicians have from time to time proposed complex structure is defined using a finite number of well defined components. Such systems are then regarded as discrete systems. The Discretization method could be finite difference approximation, various residual procedures etc.

**Steps Involved In FEM**

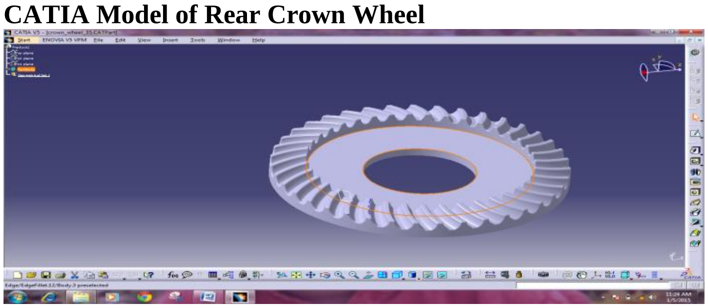
The method is based on stiffness analysis. Stiffness is defined as the force required for unit displacement and is reciprocal of flexibility. In this method the structure is assumed to be built up of numerous connected tiny elements. From this comes the name “Finite Element Method”. Extremely complex structures also can be simulated by proper arrangement of these elements.

Finite Element Method allows accurate modeling through the use of variety of beam plate and solid elements simultaneously. The method being essentially convergent in nature, solutions of engineering accuracy can easily be expected. The broad steps in the finite element method, when it is applied to structural mechanics are as follows.

1. Divide the continuum into a finite number of sub regions (or elements) of simple geometry such as line segments, triangles, quadrilaterals. (Square and rectangular elements are subset of quadrilateral), tetrahedrons and hexahedrons (cubes) etc.
2. Select key points on the elements to serve as nodes where conditions of equilibrium and compatibility are to be enforced.
3. Assume displacement functions within each element so that the displacements at each generic point are depending upon nodal values.
4. Satisfy strain displacement and stress – strain relationships within a typical element
5. Determine stiffness and equivalent nodal loads for a typical element using work or energy principles.
6. Develop equilibrium equations for the nodes of the discredited continuum in terms of the element contributions

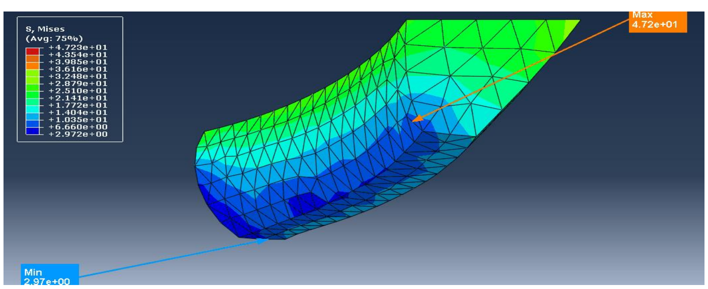
## RESULTS AND DISCUSSIONS

**CATIA Model of Rear Crown Wheel**

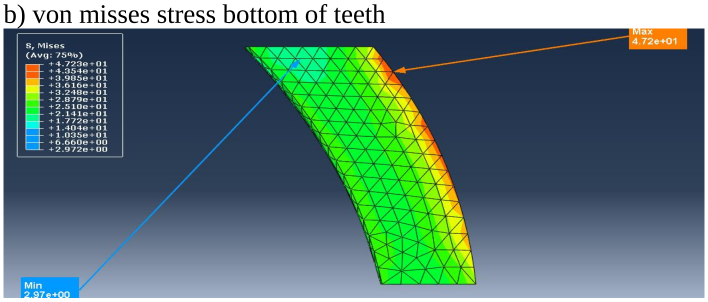


Results of Static analysis of crown wheel teeth

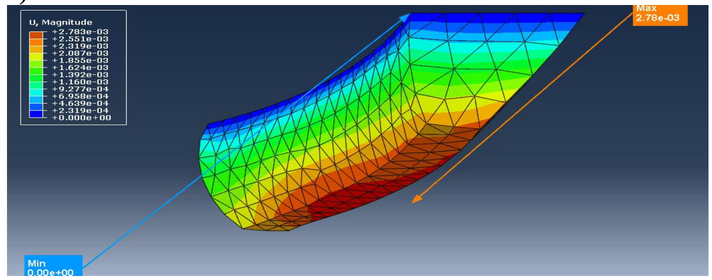
a) Von misses stress top of teeth



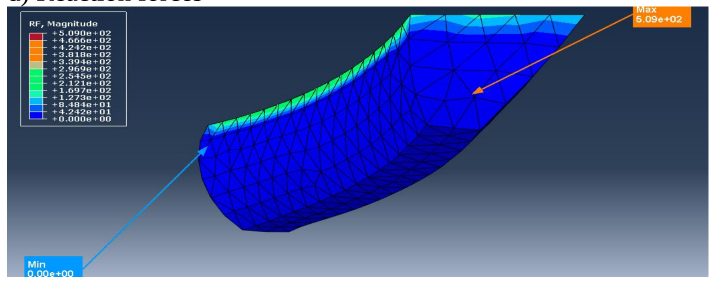

b) von misses stress bottom of teeth




c) Deflections




d) Reaction forces




**RESULTS OF CROWN TEETH FOR STATIC ANALYSIS**

MATERIAL: G-45 STEEL

PROPERTIES AND LOAD APPLIED

| | | | |
|---|---|---|---|
| MOUDULUS OF ELASTICITY | **2.1X10$^5$ N/mm$^2$** | DENSITY | **7200Kg/m$^3$** |
| POISSIONS RATIO | **0.3** | LOAD | **22.16KN,** |
| SURFACE AREA | **1142.372mm$^2$** | Pressure | **19.39N/mm$^2$** |

| | |
|---|---|
| MAX VON MISSES STRESS: | **47.23N/mm$^2$** |
| MAX DEFORMATION: | **0.02783mm** |
| MAX.REACTION FORCES: | **509N** |

## CONCLUSIONS

The above calculated von misses stresses of crown wheel teeth in static analysis is 47.23N/mm2, which is less than actual stress of the gear material i.e., 52N/mm2 and deformations are very less which was 0.02783mm, reaction forces on each teeth is 500N only. Therefore design is safe in condition

## REFERENCES

1. Power Transmission and Gearing Papers,On the Kinematics of the Closed Epicyclic Differential Gears,R. J. Willis,[+] Author and Article Information,J. Mech. Des. 104(4), 712-71(Oct01,1982)(8pages)doi:10.1115/1.3256415History: Received June 18, 1981; Online November 17, 2009
2. Journal of Mechanical Engineering Research and Technology,Volume 2, Number 1 (2014), pp.151-154
3. Case Study: Effect of Core Hardness on Impact Strength of the Crown Wheel,Paper #:2014-28-0003 Published:2014-04-28,DOI:10.4271/2014-28-0003,Citation: Rao, Y.,"Case Study: Effect of Core Hardness on Impact

Strength of the Crown Wheel," SAE Technical Paper 2014-28-0003, 2014, doi:10.4271/2014-28-0003. Author(s):Yathish Rao,Affiliated:,AAM Services India Pvt. Ltd.

4. DeltonBooks,http://www.deltonbooks.com,Design and Analysis of Spiral Bevel Pinion for Bolero Pickup Differential Gear Box,Mr. Santosh S Bagewadi, Dr. S. N. Kurbet & Prof.I.G.Bhavi B.L.D.E.A'S P.G.H College of Engg & Technology, Bijapur,Basaveshwar Engineering College, Bagalkot
5. RESEARCH PAPERS,A Method for Thermal Analysis of Spiral Bevel Gears,R.F. Handschuh and T. P. Kicher,[+] Author and Article Information,J. Mech. Des. 118(4), 580-585 (Dec 01, 1996) (6 pages)doi:10.1115/1.2826932History: Received May 01, 1995; Revised May 01, 1996; Online December 11, 2007.
6. . PRATIK PATEL was done project on design and analysis of single differential gear box in 2009 at GANPT UNIVERSITY, KHERVA in which he was concentrated only design of shafts and bearings he should not done analysis in the differential gear box
7. Shaik ashfakh was done on the project in design and material optimization of a differential gear box used in heavy vehicles in 2012.
8. Comments on "Power transmitted through a particular branch in mechanisms comprising planetary gear trains and other fixed or variable transmissions" G. Mantriota Dipartimento di Meccanica, Matematica e Management, Politecnico di Bari, Viale Japigia, 182, 70126 Bari, Italy
9. Design And Analysis Of Automobile Central Differential Having Two Different Side Gear by Amir Khan and Sankalp Verma Department of Mechanical Engineering, Shri shankaracharya institute of technology,bhilai, Chhattisgarh , India .
10. Design and Structural Analysis of Differential Gear Box at Different Loads by C.Veeranjaneyulu and U. Hari Babu Address for Correspondence Department of Mechanical Engineering, QIS College of Engineering &Technology, Ongole, and Andhra Pradesh. IJAERS/Vol. I/ Issue II/January-March, 2012/65-69
11. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN(e) : 2278-1684, ISSN(p) : 2320–334X, PP : 59-66 www.iosrjournals.org Design, Manufacturing & Analysis of Differential Crown Gear and Pinion for MFWD Axle by S. H. Gawande, S.V. Khandagale, V. T. Jadhav, V. D. Patil, D. J. Thorat (Department of Mechanical Engineering, M.E.S. College of Engineering, Pune, India)
12. Evaluation of Stress Cycles of Differential Bevel Pinion 2011-01-0717, Published:
13. 2011-04-12,DOI:,10.4271/2011-01-0717, Citation: Penumatsa, V. and Chirravuri, B., "Evaluation of Stress Cycles of Differential Bevel Pinion," SAE Technical Paper 2011-01-0717, 2011, doi:10.4271/2011-01-0717.

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