ISSN : 2455-9679
SJIF Impact Factor : 6.008

IJRTSM
INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"A REVIEW ON DESIGN AND ANALYSIS OF DIFFERENTIAL GEARBOX USING ANSYS"

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ABSTRACT

Crown gears (wheel and pinion), differential (box), and sun gears. At present, every part of the differential is thought of and modelled in a static state. Assembling and modelling are both accomplished with SolidWorks. Provide complete and accurate part drawings. The primary focus of this project is on the mechanical design and contact analysis of the gear assembly in the gear box as it transfers power at torques between 150 N-m and 2000 N-m. This research takes a look at the design and analysis of an open differential for a top-tier automotive. Static analysis was carried out in Ansys after a SolidWorks-created 3D model of a differential gear was developed. Aluminum alloy, Cast iron, and Nickel Chrome steel were chosen as the three materials to examine. torques of 150 N-m, 500 N-m, 1000 N-m, and 2000 N-m are provided to ensure the robustness of the differential gear model.

Key Words: *Crown gears, differential gear box and sun gears.*

I. INTRODUCTION

A differential is an apparatus that, most commonly but not always employing gears, transmits torque and rotation across three shafts. It can be used in one of two ways, both of which account for the vast majority of its applications. It works similarly to the other type of this found in most cars in that it takes two values as input and returns the sum, difference, or average of those numbers. The differential in cars and other vehicles with wheels allows the wheels to revolve at various speeds while still providing the same amount of torque to each wheel. The vehicle's wheels turn at different speeds when travelling around bends. The job of a differential is to provide torque to a set of wheels while allowing them to turn at different rates. In vehicles that do not have differentials, such as go-karts, the two driving wheels are frequently positioned on the same axle and driven by a basic chain drive differential. Because the turning radius of the inner wheel is smaller than that of the outer wheel, turning without a differential causes the inner wheel to spin or the outer wheel to drag. Every part of the drivetrain is put under stress (or possibly failure) as a result of the vehicle's shaky and unreliable handling.

Advantages of gears

- The gear drives may produce a high velocity ratio.
- It can handle enormous weights due to its strong mechanical strength.
- When compared to other drives, the power transfer rate is high.
- It can transfer electricity with a little central distance.
- It may also be utilized to slow the speed, resulting in higher torque production.
- The cost of maintenance is inexpensive since it simply needs oil.
- These drives may transfer motion between shafts that are parallel, intersecting, or non-intersecting.

ISSN : 2455-9679
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- Because there is no sliding in these drives, the velocity ratio remains constant.
- They endure a long time, thus the gear drives are small.

II. LITERATURE REVIEW

R. Karthick et. al. (2018) The primary objectives of this study are to mechanically construct a differential gear box and to conduct a gear box analysis. Materials such as structural steel, stainless steel, aluminium alloy, and magnesium alloy were used in the analysis. Performing static analysis with ANSYS Workbench 16.0. Differential gearboxes are often made of cast iron. Gray cast iron, magnesium alloy, aluminium alloy, and structural steel are employed in their place on this project. as a result of getting picked for static The analysis has determined the total deformation, equivalent elastic strain, and equivalent stress. Data comparisons show that magnesium alloy deforms at a lower rate than other materials, making their use less risky. Magnesium alloy's lower weight and greater strength also make it the best theoretical choice when compared to other materials.

Sonali A. Mote et. al. (2018) In this study, we investigate the relationship between bending and contact stresses using both an analytical approach and the finite element method. The helical gear's 3-D solid model is made with the help of the aforementioned application. For this purpose, the bending stress and contact stress are calculated using the Ansys software. The driving motivation behind this study is to investigate the stresses caused by the gear tooth profile. The results of the theoretical study and the finite element analysis are compared to guarantee precision. Estimated stress is used to determine the module of equipment that can easily support the given loading conditions.

N. Siva Teja et. al. (2017) The primary focuses of this paper are on the mechanical design of a differential gear box and an analysis of a gear box. We analysed both aluminium alloy and grey cast iron samples. Modern gears and shafts are often made of cast iron or cast steel. Therefore, in this essay, we look into the possibility of using aluminium in the differential gear box of SUVs.

V. Naga Prasad Naidu et. al. (2017) At present, the entire differential is conceptualised and modelled in a static state. Assembly and modelling are accomplished with Pro/Engineer. Full component drawings are required. Focusing on the mechanical design and contact analysis of the gear assembly in the gear box while it transfers power at 2400 rpm is the primary objective of this project. Analyses are also performed on the gears' material variations, which include cast iron and aluminium alloy. The study is conducted to identify the best material for the gears in the gear box at higher speeds by evaluating stress, displacement, and weight reduction. The. Modeling is accomplished with Pro/Engineer. The Cosmos software is utilised for logical purposes.

Shashank Pandey et. al. (2017) In this analysis, solid work modelling was used to determine the effect differential gears have on the vibration of the entire system and what frequencies will result in the longest gear life. According to this study, the gear housing is also affected by vibration in the gear box's housing. Gears provide a buffer zone and a transmission medium for other gears. And it supports moving parts and shields them from the elements. The differential is a reduction gear that connects the propeller shaft to the pinion, which turns the ring gear of the differential. This means that vibrations are inevitable, and that it's crucial to evaluate the differential gear housing's reaction to them and pinpoint their fundamental frequencies. Ansys 14.0 is utilised in this vibration analysis as the computational method and validation tool.

M. Keerthi et. al. (2016) In this research, the spur gear is modelled in "SOLIDWORKS" and then brought into "ANSYS" for structural analysis and modal analysis. With static analysis, the deformation and Von-Mies stresses can be found. With modal analysis, the fundamental frequencies and mode shapes can be found. The Lewis equation was used to figure out and confirm the results. Different gear materials, like structural steel, grey cast iron, aluminium alloy, and epoxy E glass UD, are looked at and compared to each other. The results are then compared. In terms of stress, deformation, and weight, composite spur gears are almost the same as their counterparts made of structural steel, grey cast iron, and aluminium alloy. So, if the results keep getting better, composite materials may one day be used instead of cast steel gears in car gear boxes.

ISSN : 2455-9679
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Neeraj Patel et. al. (2016) This study elucidates a more sophisticated method of gearbox design that makes use of state-of-the-art design software. Inputs that more accurately reflect real-world driving conditions have been provided by defining the load spectrum within the software. As a result, the designer may obtain more accurate information regarding criteria such as strength, equivalent stress, deformation, safety factors, and others.

Rahi Jain et. al. (2016) In this study, we look at the stress on the teeth of the spur gear that touch each other to find the maximum contact stress in the gear teeth. Results from a finite-element study (FEA). In this study, 15NiCr1Mo15 and SCM415 were used to make the spur gear. After the spur gears are designed in Creo Parametric, the.iges file is exported and sent to ANSYS for analysis. FEA uses ANSYS 14.0 because the finite element method (FEM) is the easiest and most accurate way to do stress analysis. Since a gear's efficiency goes down when it gets bent, this is also true for 15NiCr1Mo15 and SCM415. The results of the finite element analysis show that the maximum stresses caused by bending and contact are very small and well below the safe limit. There aren't many differences between how 15NiCr1Mo15 and SCM415 gears deform.

M. S. PATIL et. al. (2015) Finite element analysis of vibration in the gearbox case is a topic of study in this project (FEA). The natural frequency of the gearbox housing will be calculated using ANSYS software for the purpose of this article. The purpose of this project is to conduct a modal and stress analysis of the tata indigo cs car's differential gearbox case. The theoretical modal analysis should be verified by comparing the results of the FFT analysis with the practical findings. An exhaustive finite element analysis of the casing was chosen as the major motivation for the work, rather than using empirical formulas or iterative techniques. The experimentally measured operating frequency is compared with the calculated natural frequency of a limited-capacity casing using ANSYS R15. The vibration characteristics of the differential gearbox shell with integral gears have been thoroughly analysed. Modal analysis of the gearbox case is performed using ANSYS Work bench R15.0 software for finite element analysis. The derived natural frequency, the experimental validation results, and the FEA results in this example are all found to be in good agreement with one another. The expected natural frequencies of the modes are within 2% of the observed mode.

III. PROPOSED METHODOLOGY

General Procedure of Finite Element Method

The original design is then seen as a mixture of the finite elements coupled to a wide variety of connections known as nodal factors or nodals, which are tiny finite factors in the finite detail technique. Part by part is how the finite detail technique works. Because the real model is unknown as a field variable, such as the displacement, pressure, temperature, pressure, or speed of the spectrum, it is internally approximated by a simple function. Node field value phrases are used to express these interpolation models, or approximation characteristics. The nodal values of the variable field are often generated via a field equation that might take the form of a matrix equation. The approximating functions display the variable area during assembly of the product when nodal values are measured. The general problems by the technique of the finite elements are explained step by step.

The step-by-step process can be defined as follows for static structural applications:

Step 1: - Design model explanation (domain). The primary step in the process of finite elements is to separate the result area structure into subdivisions or elements.

Step 2: - Selected the correct form of interpolation. Since the explanation of a difficult structure (field vary) cannot be accurately predicted under any specific load conditions, we assume that the unknown solution can produce an appropriate result within a component. The expected outcome must be straightforward and certain convergence requirements must be fulfilled.

Step 3: - The start of stiffness matrices and load vectors (feature matrices). With the supposed version of displacement, both equilibrium situations and the correct variation control should be applied to the stiffness material..

Step 4: - Assembly of element equations to achieve equilibrium.

ISSN : 2455-9679
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The individual matrices of the elements of rigidity and loading vectors must be constructed correctly since the structure consists of a great number of finite elements as

[K]φ = P……………………………. (1)

When [K] is denoted a mounted stiffness matrix, age is known as the knot-displacement vector and P is the full shape vector or nodal pressure [K].

Step 5: - System equation solution to detect displacement nodal values (subject variable). The standard balance equations must be changed in order to take account of the limiting conditions of the problem.

The vector ' т ' can be resolved very problem-free in linear problems. However, the response must be received in a series of ladder, each with the amendment of the [K] and β "or the weight vector P, in the case of non-linear problems.

Step 6:- Detail strains and stresses are calculated. If requested, by utilizing the essential equations of stable or structural mechanics, the detail lines and stresses can be calculated. The phrases in brackets in the above steps apply the overall FEM step by step

Convergence uses

A finite definition technique is a methodology that uses numbers to solve the challenging issue. Additionally, the solution must converge to the specific structural structure. It is hence readily applicable. If the stated displacement function is met in three instances, the solution will converge to the right outcome since the mesh is finer.

Continuous displacement must be a requirement. This issue may be solved simply by using polynomials for displacement-related versions.

The data may be rigorously represented with the help of the shift function. This occurs when nodes are moved about like a stiff frame, the dimension should not be shown, and there should be no nodal powers in the end. This may often be ensured by the regular sentences employed in displacement sentences.

The element's voltage must be kept within by the moving component. Assuming that we can understand the frame or shape while breaking the circumstance down into ever-smaller pieces. Due to the components' tiny size (dimensions 1, 2, and 3), the stresses in each part often entail continuous technical pressures.

IV. CONCLUSION

A gearbox or transmission changes the speed and torque of a rotating power source so that it can be used by another machine. In British English, "transmission" means the whole transmission system, which includes the gearbox, clutch, prop shaft (for rear-wheel drive), differential, and final drive shafts. In American English, though, a gearbox is any device that changes the relationship between speed and torque. A transmission, on the other hand, is a specific type of gearbox that can be "shifted" to change the speed-to-torque ratio on the fly, like in an automobile. Most of the time, the transmission is used in cars to connect the power from the engine to the wheels. Such motors require a high rotating speed to operate, making them unsuitable for sluggish travel or frequent stops. When the transmission slows the wheels down to match the faster engine speed, torque increases. Transmissions also find use in stationary machinery, pedal bicycles, and other devices where modifying the rotational speed and torque is essential.

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