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# Design and Analysis of Counter shaft using CATIA and ANSYS

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## ABSTRACT

The Recent advancement in software applications is making a best analysis results for the Mechanical Engineering application studies. This paper mainly involves with the designing and analyzing the countershaft (lay shaft) model by using the software application. This project deals with the stress analysis of a shaft using Ansys. The shaft which is fixed at one end is selected and forces are given at particular points. The reactant forces acts in opposite directions. Torque acts at two points in opposite directions. The reactant forces and bending moments are initially calculated. Based on these parameters, the maximum shear stress, normal stress is calculated. The same values are used then calculated by using ANSYS software. Finally the theoretical and analytical results are compared and verified. Here we selected for part design in CATIA V5R19 and for the analyzing the part model using the is Ansys 16.0 software respectively. Selection of material for the counter shaft is 4340 Alloy steel(Heat treated).

**Keywords:** Countershaft (lay shaft),4340 Alloy steel(Heat treated),Stress, Strain

## I. INTRODUCTION

A Lay shaft is an intermediate shaft within a gearbox that carries gears, but does not transfer the primary drive of the gearbox either in or out of the gearbox. Lay shafts are best known through their use in car gearboxes, where they were a ubiquitous part of the rear-wheel drive layout. With the shift to front-wheel drive, the use of Lay shafts is now rarer.

The driving shaft carries the input power into the gearbox. The driven shaft is the output shaft from the gearbox. In car gearboxes with Lay shafts, these two shafts emerge from opposite ends of the gearbox, which is convenient for RWD cars but may be a disadvantage for other layouts.

For gearboxes in general, gear clusters mounted on a Lay shaft may either turn freely on a fixed shaft, or may be part of a shaft that then rotates in bearings. There may be multiple separate clusters on a shared shaft and these are allowed to turn freely relative to each other.

Transmission and Operation In Automobile Car In the typical manual gearbox for a RWD car, the driving shaft (input) is in-line with the driven shaft (output), but not permanently connected to it. A reduction gear on the driving shaft drives the layshaft. In car transmissions, the term countershaft is also used A number of gears on the layshaft may then be connected, one at a time, to the driven shaft. Selecting each of these gears in turn gives the various ratios of the gearbox All of these gear ratios are reduction gears, the engine speed being higher than the input speed to the final drive of the rear axle.

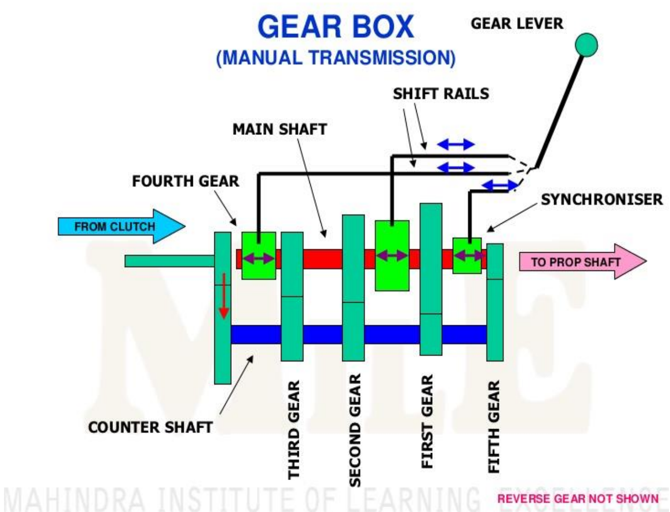


**Figure 1.** Manual gear transmission system

Early gearboxes used sliding gears to engage and disengage the drive. These were difficult to operate and also wore on the main working surfaces of the gears. An early improvement was to use separate dog clutches instead to engage gears, leaving the gears themselves in 'constant mesh'. A later, and more gradual development, was the introduction of synchromesh. This is an all-metal friction clutch in addition to the positive dog clutch, that gradually engages the gears and matches their speed before the dog clutch engages.

The top gear of the gearbox is achieved without these gears, but by coupling the driven shaft directly to the driving shaft through another dog clutch. This gives a 'direct drive' top gear, which has advantages for both efficiency and quietness at cruising speed. A typical gearbox had 2% losses in each gear set, so 4% for intermediate ranges through their two gears, but approaching 0% for the direct-drive top gear.[3] As the direct top gear is not transmitting torque through the gears, it is also quieter.

In theory, it is also possible to provide an overdrive top gear, another indirect gear, but of a speed-up ratio rather than the reduction ratio of the other gears. The direct-drive ratio then becomes the second-to-top or third gear. This arrangement was used on some early cars, but was uncommon. Where overdrive is provided for a RWD car, this is almost always done by adding a separate overdrive gearbox to the output driven shaft of the gearbox, usually outside the gear casing.

Because of the layout of the gearbox, the layshaft is normally mounted low-down in the gearbox casing below the other shafts. The gear lever enters through the top of the casing and so it is more convenient for the sliding components of the dog clutches to be mounted on the driven shaft, rather than the layshaft. The layshaft gear cluster is thus often a simple one-piece component, typically cast iron gears running in bearings on a fixed steel shaft. The bearings may be plain phosphor bronze bushes, or for high-load applications needle rollers. Where large numbers of gear ratios, Seven or more, are to be provided then these will require a third or more gear clusters on the Lay shaft To maintain the proportions of the overall gearbox as more compact, rather than becoming long and thin, these gearboxes may use twin Layshafts. This requires an additional driven gear for each layshaft, but the mechanism is otherwise very similar. The use of multiple layshafts also developed into the multiple clutch gearbox, used for some buses, where each ratio has its own layshaft and separate plate or hydraulic clutches, rather than dog clutches, are used to select between them.

Where a power take-off is required, usually for industrial vehicles to drive winches, hydraulic pumps etc., this is often driven from one end of the layshaft, as this is more accessible shaft than the main shafts, already in use by the drive train.

## II. METHODS AND MATERIAL

The material selection is very important for any design. In this project we taken counter shaft material and model Gear wheels materials are same. The 4340 Alloy steel (Heat treated) is selected.

Properties of 4340 Alloy steel

Density (ρ) = $7.85\mathbf{e}^{-6}$ Kg/mm3

Modulus of Elasticity or

Young's modulus (E)= $210 \times 10^{6}$ Mpa

Poisson's ratio(μ)=0.3

## III. RESULTS AND DISCUSSION

### 1. Part Design

Commonly referred to as a 3D Product Lifecycle Management software suite, CATIA supports multiple stages of product development (CAx), including conceptualization, design (CAD), engineering (CAE) and manufacturing (CAM). CATIA facilitates collaborative engineering across disciplines around its 3DEXPERIENCE platform, including surfacing &

shape design, electrical fluid & electronics systems design, mechanical engineering and systems engineering.

For this project the CATIA is used for only design purpose not for analysis

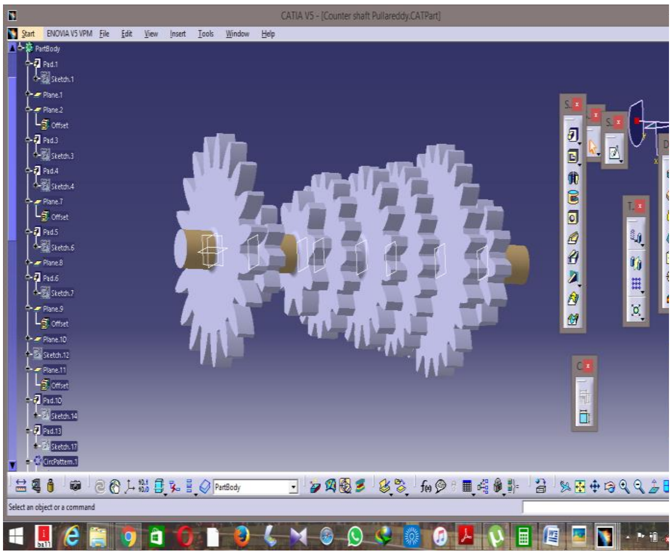

**Figure 2.** CATIA Part model

## 2. Model Analysis

**Input Parameters:**

Density (ρ) = 7.85$\mathbf{e}^{-6}$ Kg/mm3

Modulus of Elasticity /Young's modulus (E)= 210 x $10^6$ Mpa

Poisson's ratio (µ)=0.3

Length of the shaft=832.6mm

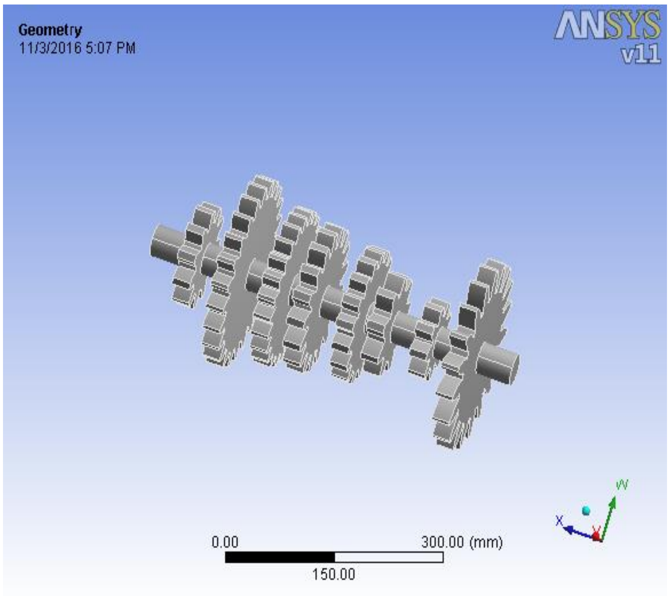


**Figure 3.** Geometric model of counter shaft

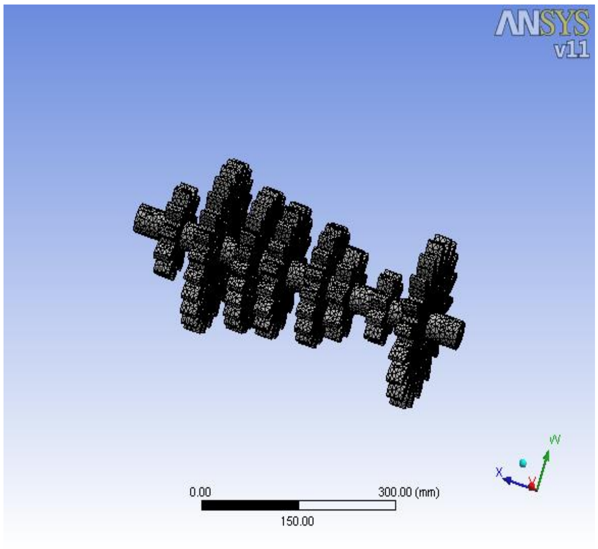


**Figure 4.** Meshing the Shaft

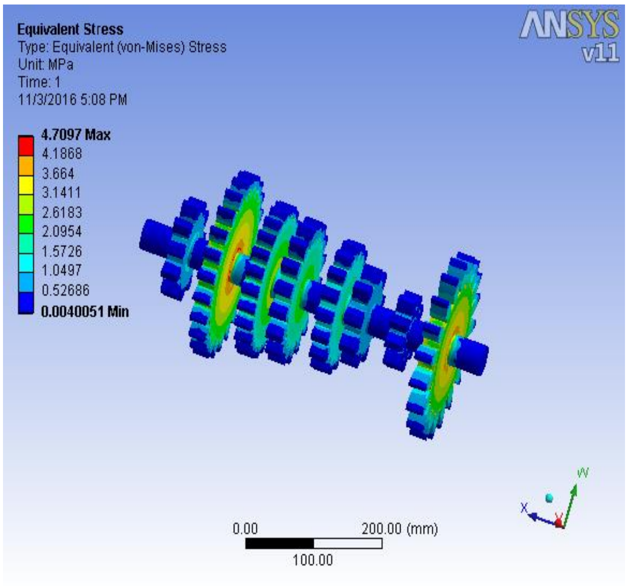


**Figure 5.** Equivalent tress

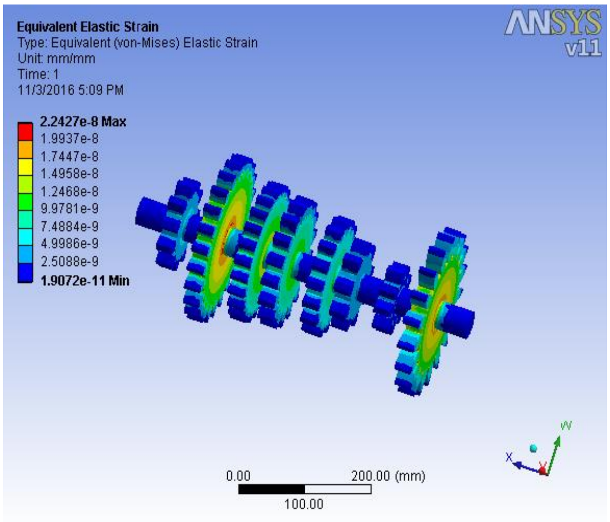


**Figure 6.** Equivalent Elastic strain

### 3. Results

1. The Equivalent stress is 4.7097 Max
2. The Elastic strain 2.2427e$^{-8}$Mpa
3. If one end Z-axis direction is fixed and other end side motion given then the Total deformation is 1.7929e$^{-6}$

## IV. CONCLUSION

As per 4340 Alloy steel standards it has been found that the design is safe and further, the design with selection of other materials and various gear ration can be process for the Gear box applications.

## V. ACKNOWLEDGEMENT

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