Design and Development of Quick Shifting Mechanism for Four Speed Gear Box

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Abstract: Design and Development is an essential task in today's developing market. Product design is an important part of technology; it is one of the first step in many to creating a new product. In todays competitive world and a global era, design and development of product plays a very vital role. The development process starts from origin of product and it ends with is use. Thus in the development of any product, it should be optimized and well planned. In this paper, the design of quick shifting mechanism for four speed gear box is done by using 3-D modeling software like solid works. The finite element analysis is done for checking quality in regards to stress analysis.

Keywords: Designing, 3-D modeling, FEA analysis.

I. INTRODUCTION

Product design and development is the essential task in today's developing market. It consists of designing of product from the database requirements and developing them in corresponding to the fit and functionality and required quality characteristics available in the company. In the study, the design development process of quick shifter and gear box components are done by using 3-d model software like solid works. The principal aim of designing the gear box is, transmission of power according to variable needs from input source of power to the desired output. The present world is moving in the direction of globalization. To keep it as per with global market, each countries follows different standards. The important objective of this standard is to construct the product available in every nook and corner of the world, with the same specification without a single change. At the time of working, whenever we require sudden and frequent changes of torque and speeds at output, traditional gear boxes makes it challenging to handle it construction. So we design a quick shifting mechanism for four speed gear box, to achieve frequent and desired changes at output. The study involves the development process of quick shifter that includes two dimensional drawings, 3-D modelling, manufacturing processes, material selection and stress analysis etc.

II. CONTRIBUTION BY THE PREVIOUS RESEARCHERS:

Here different papers are studied based on the approaches used by the different researchers and modifications are made to provide more reliability in the proposed system.

Ujjayan Magumdar, SujitbMaity (2018) presented the indicated gearbox is a mechanical device that is used to provide the conversion of speed and torque from the rotating power source to the output shaft. As the shaft speed increases, the torque transmitted decreases and vice versa. Multi-speed gearboxes are used in applications that require frequent changes to speed/torque at the output shaft. The gearbox works on the principle of fitting teeth, which results in the transmission of movement and force from the input source to the output[1].

Heel Patel, Harsh Patel(2018)the gear is a rotating machine parts having different toothed parts and meshes cut teeth to transmit torque. The gears are mainly type like spur gear, helical gear, double-helical gear, bevel gear, Crown gear, hypoid gear, worm gear, rack and pinion, epi cyclic gear etc[2]

Francesca Cura(2017)presented the procedure can process a given load spectrum based on the Miner damage rule and calculate the equivalent tangential Force values, including all dynamic effects life. In this paper shows a practical example of the bending strength based on a recorded flight mission, referring to a gear box for aerospace use. The results on the equivalence force and global dynamic factor values are compared with those calculated by the classical ISO standard formula based on the corresponding experimental data.[3]

Neeraj Patel &AniketWankhede (2017) presented the proper design of the gearbox has an important place in power transmission applications. The traditional methods used in its design do not have the ability to automate the process. Therefore, an attempt to automate the preliminary design of the gearbox has been made in this paper. The software automates the preliminary design of the gearbox and urges helical gears to be developed. In the software KISS soft applies the problem of the objective function of minimizing the volume of the gear train. The design optimizes the action of the two-stage gearbox by using KISS soft achieved by easily supplying the requested design parameters.[4]

Muhammad Irfan (2017) a study on the mechanism modeled by the mechanical system was carried out. The full gear shifting process in stages, which gives the opportunity to capture the nature of the body, solve the complexities of the
Detailed kinematic description. [5]

III.METHDOLOGY

A development methodology is the process by which an engineering team will build a given product. For a better

development of product, there is an essential requirement is that, the "structured methodology". Hence the following generalized methodology is adopted for study an development of four speed gear box with quick shifting mechanism. The generalized methodologies are as discussed below :

a) Idea Generation –

This is a preparatory phase which involves the review of the literature and theoretical study of Design and Development of 4-speed Gear box. At the same time it is equally important to interact with the other manufacturers of 4-speed Gear box product. Which uses the different technology in the same field so that existing 4-speed Gear box design can be modified or a complete new design will be proposed to take benefit of the latest developed technology and removing the obstacles related to existing one. The purpose of this project is for mass production and cost reduction.

b) Product Specification -

The basic aim behind the development of gear box is for reduce mass production and cost reduction. With effectively provide service to customer and for betterment of their application area. This phase includes selection of material, collecting information about required components and actual working of system.

c) Feasibility study -

Here we analysis and evaluation of a proposed project to determine if it

(1) Is technically feasible,

(2) Is feasible within the estimated cost, and

(3) Will be profitable

(4) Check design will be make easy for maintenance and assembly.

d) Design and Drawing -

It will start with the design criteria's for individual system component. This includes design of shaft, Gears, and other system components also bearing calculation and selection. It includes selection of proper elements for easy and fast response. After that assembly of gear box is made with help of CAD Software, assembly helps in finding collision or interference between the components. After assign all the components, we study the nature of movement of the components inside our product. We are designing 3D model with the help of 2D and 3D software like AUTO-CAD, Solid-Works, and CATIA.

e) Failure Analysis -

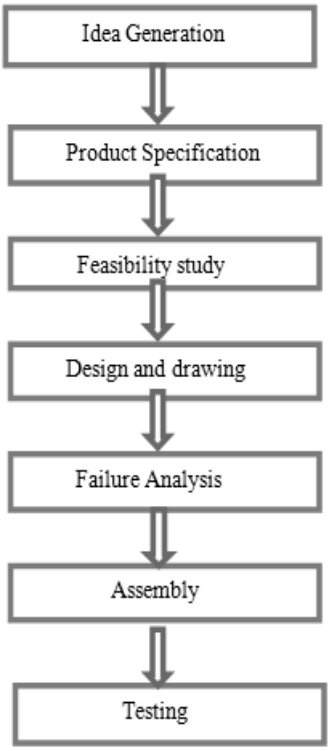
Failure analysis is the process of collecting and analyzing data to determine the cause of a failure, often with the goal of determining corrective actions or liability. Here we are analysis the gear and shaft by analysis software like ANYSIS.

f) Assembly -

After manufacturing of the component assembly of that part is done so that whole experiment setup will be done so that the whole experimental setup will be used for its technical evaluation.

g) Testing -

The experimental test were conducted to check the actual performance of setup the working of all components like gears, shafts and other components to make a statement about good working condition of setup. After completion of manufacturing and assembly it will tested by proper method and results are finding.



IV. FUNCTION STUDY

This is the descriptive study of whole gear box, its components i.e. shaft (Driving and Driven), gears, bearing, and casing etc. For designing a quick shifter and to achieve the desired output, there is an essential requirement is that, to study all the major and relative components which deals with gear box. Thus it is an attempt to study the, design specifications of driving and driven shaft, manufacturing process, and material selection etc. The quick shifter mechanism is an arrangement which is fitted in output shaft i.e. driven shaft to achieve a desired speed variation

V. WORKING OF QUICK SHIFTING MECHANISM

It cosists of input drive shaft which is keyed to a motor, on this shaft, the four gears of different sizes are keyd. This drive gears are connected to driven gear which is loosly running with each other. Inside of driven gear, shifting gear mechanism is arranged, in which connector is placed which holds the required position by means of spring action. Thus by linear movement of shifting gear shaft, we get different speed ratios. Whenever we operate shifting lever, the motion is transmit to C-Connector so it oscillate and whose motion is given to shifting gear shaft via flat pin in order to move in transverse motion, there is a connector which is placed on the gear shifting shaft who also move in linear direction in order to make intact of input gear and output gear in order to achieve required speed ratio. The another gears are connected and rotate at same speed with loose running. here connector is used to get required speed ratio by moving and shifting in linear direction.

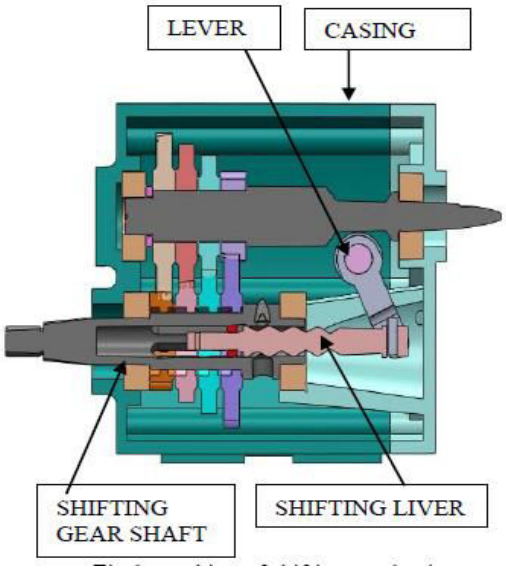


Fig 1: working of shifting mechanism

VI. MATERIAL SELECTION

Material selection is one cardinal concern in mechanical engineering. Material selection plays very vital role in the field of engineering. Material selection is nothing but the process of selecting or choosing the best material which have the potential to perform both in industrially and commercially. There are many factors which should be considered for selecting any material and that are as- Availability, Cost, Mechanical Properties, Manufacturing Consideration.

It is very important to select a material for both gear and shafts, as they specify the weight and maximum stresses in the respective componenets. To select best material for shaft, which is used in quick shifting mechanism the following are the factors which must be considered during material selection process.

- Mechanical Properties
- Manufacturing properties
- Environmental Properties
- Economic Aspect

Table 1: Materials suitable for Shafts

Material	Yield(MPA)	Cost(Rupee/ Kg)
EN31 STEEL	550	71
EN8 STEEL	415	55
MILD STEEL	42	45
C 45	700	65

Table 2: Materials suitable for gears

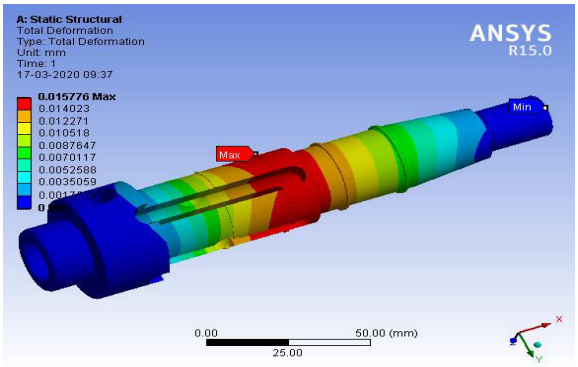
Material	Yield Strength (MPA)	Density ($Kg/m3$)	Cost(Kg)
EN31 STEEL	550	7500	71
EN8 STEEL	415	7500	55
AISI 9310 STEEL	690	7500	120
CAST IRON	350	7850	80
CAST STEEL	550	7500	100
C-45	700	7850	65

VII. CAE ANALYSIS

Objective: Analysis of FOUR speed gear box shaft by calculating the axial and radial force.

Table 3-Different loads Condition on Shafts

Sr.No	Axial Load (N)	Radial Load
1	323.8	117.80
2	237.36	86.39
3	197.08	71.96
4	169.54	61.70



Different Strength of shaft:

Fig 2: Deformation plot

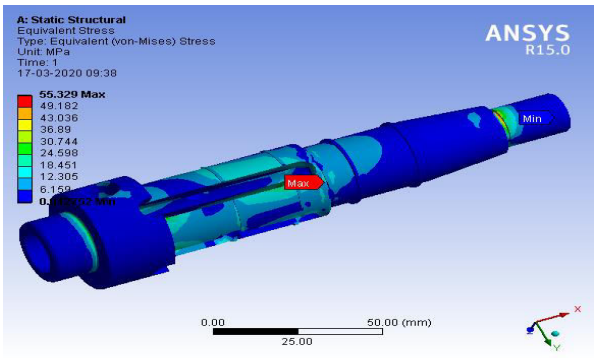


Fig 3: Equivalant stress diagram

Fig 4: actual quick shifter component

VIII. CONCLUSION

This paper shows the gearbox design with quick shifter mechanism which gives the effective results in the field of production. The gearbox with quick shifter allows the satisfactory performance which meets the assorted requirements which were specified. Problems like production and value optimization is overcome and it's used for betterment of their application area. The Gearbox designed is lightweight and compact. Gearbox will be used efficiently for very low to medium power applications. The gearbox seems to be suitable for light load carrying machineries. this paper shows the the gearbox methodology, relevant criteria, stress, strain analysis which gives the satisfactory performance for lifting purpose.

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