International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 01 | Jan 2020 www.irjet.net p-ISSN: 2395-0072

Educational Working Model of Automobile Transmission System

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Abstract – *As Automobile systems become more and more complex, it gets more difficult to properly comprehend the basic elements in power transmission in automobile in student's point of view. The purpose of author is to create a educational model of automobile power transmission system which not only explains basic transmission elements in brief but also allows students to observe different speed changing mechanism in running condition. To reduce carbon footprint, instead of using actual Internal Combustion Engine, author has used Electric Brushless DC Motor with attached Pulley. Use of Electric Motor Ensures full control and Safety of students.*

Key Words: Automobile Transmission system, Educational working model, Automobile Power transmission system, BLDC motor with pulley, Educational Model

1. INTRODUCTION

Due to ever happening advancement of technology in automobile industry, the complexities of automobile system layout increases which becomes hindrance in student's basic understanding of subject. The theoretical part covered by the textbooks fails to provide total insight and understanding of the automobile layout. Hence, author proposes idea of special structure containing parts from real automobile which can house and withstand forces applied by weight and vibration of transmission system.

This Paper mainly focuses on the Rear Wheel Drive configuration model of automobile transmission system. Rear-wheel drive (RWD) typically places the engine in the front of the vehicle and the driven wheels are located at the rear, a configuration known as front-engine, rear-wheel-drive layout. Model designed for understanding of students consists three main systems namely Power Generation system, Power transmission system, Actuators. Where in this model Actuator is giving output in form of rotation per minute (RPM) of output rod. The total cost of proposed setup is around 15000 INR with selection of cost effective materials. The model used in paper considers transmission system from Maruti 800 (1997) automobile. Proposed model is 20 kg in weight where majority is of Main transmission system. The power transmission rod is manufactured in CNC lathe machine with tolerance of 0.1 mm

2. System Configuration:

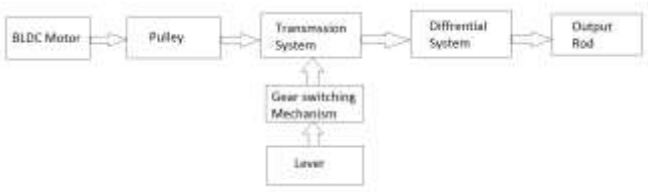

Table -1: Block diagram

3. METHODOLOGY:

3.1 Model :

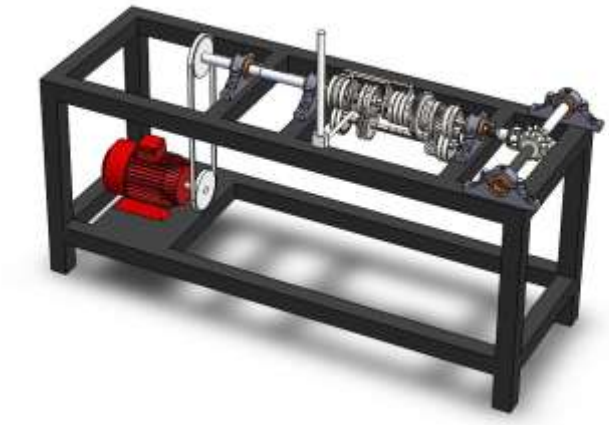

Fig -1: Non-Rendered 3D Model

Fig -2: Rendered 3D Model

3.2 Challenges Faced:

1) Cost Reduction

2) Weight Reduction

3) Since transmission were used from actual automobile, hence they were designed keeping high torque and speed in mind. But since this model is supposed to be for educational purposes, safety standard measures are to be followed. High torque and low operational speed is to required which results in requirement of low speed high torque BLDC motor.

4) Safe removal of Transmission system from vehicle and mounting of heavy system on structure while maintaining safety standards

3.3 Components used:

BLDC Motor, Plummer Block, Shaft, Transmission, Differential, Supporting structure

3.4 Components Selection:

1) BLDC Motor:

Operating Power = 500 W

Operating Voltage = DC 24V

Rated Current(A) = 10 ~ 20

Rated Speed(RPM) = 2750

Rated Torque = 190 N-cm

High Torque Motor is selected in order to drive transmission system.

2) Plummer Block:

Model type: UCP204 Pillow Block Mounted Bearing

No. of bolts: 2 Bolt

Inside Diameter: 20mm

Lock type: Set screw Lock

Material: Cast Iron

Plummer block is used to restrict the rotational motion in structure.

3) Shaft:

The material for shaft used is TATA IS: 1161 with Outside Diameter = 21.3 mm and thickness 2.6 mm due to its availability and price.

3) Transmission system:

Transmission system is synchro-mesh gearbox used in Maruti 800 automobile due to its high load carrying capacity.

4] Differential:

Differential system is directly used of automobile for purpose of student's better understanding.

5] Supporting structure:

The structure is the backbone of assembly. This is constructed by keeping trusses of forces and the weight of equipment in mind. The material used is square cross sectioned IS 4923 TATA Beam of dimension 50*25 mm with thickness 2 mm (YST 310 Grade).

3.5 Static analysis on structure:

Before creation of structure, basic static analysis is done on model using ANSYS

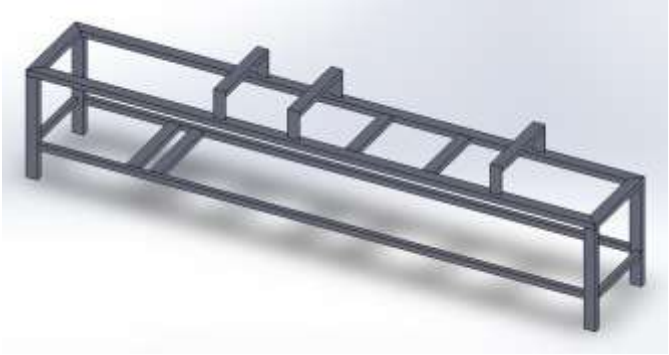

Fig -3: Model of structure in Solidworks

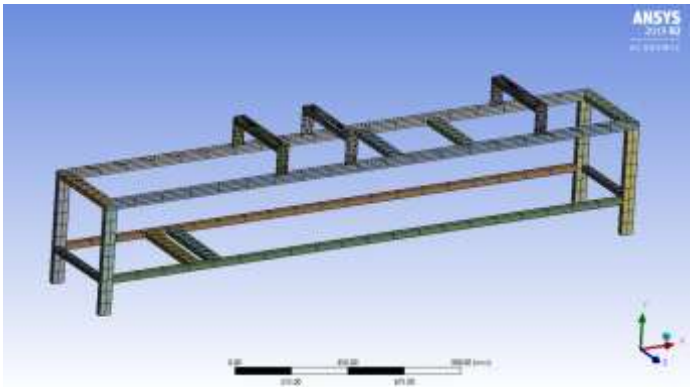

Fig -4: Mesh of structure in ANSYS

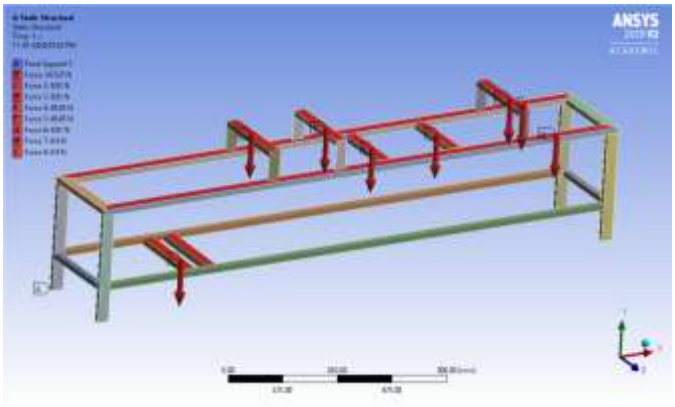

Fig -5: Forces on structure in ANSYS

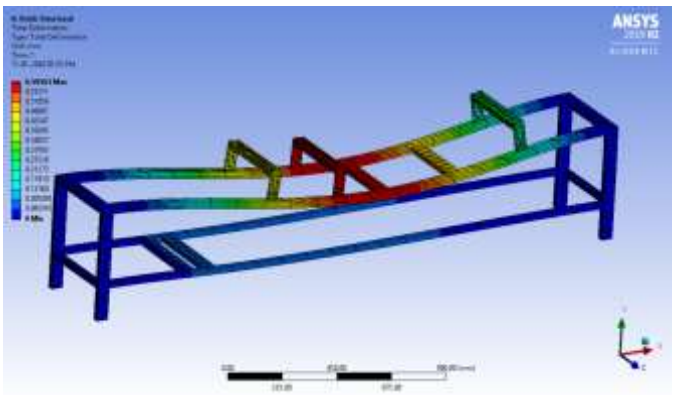

Fig -6: Total Deformation in structure

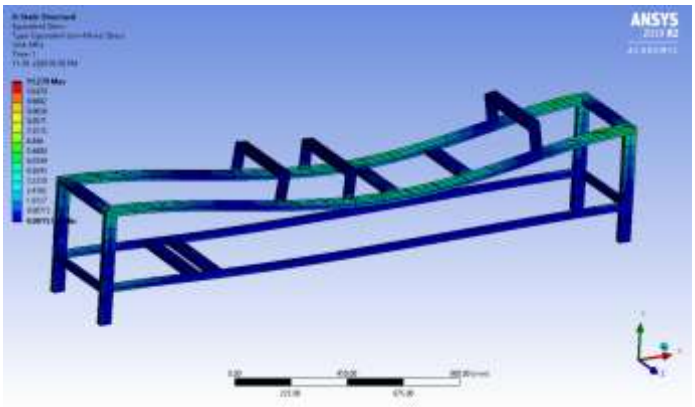

Fig -7: Equivalent (Von-mises) stress in structure

4. RESULTS & DISCUSSION:

As observed in Total Deformation analysis of structure, the maximum deflection is occurring in structure is of 0.59565 mm which is situated at point of synchro mesh gearbox placement. 0.59565 mm deflection is negligible for low speed of operation of 1500 RPM. And due to switching mechanism different RPM can be observed at output shaft at end due to Gear ratios.

Input RPM	Theoretical Gear ratio	Actual Gear Ratio	Error %
1500	3.416(1st)	3.34	2.275
1500	1.894(2nd)	1.86	1.827
1500	1.28(3rd)	1.13	1.327
1500	0.914(4th)	0.92	0.65
1500	3.583(R)	3.4	5.382

Table-2: Table showing output at different gears

5. CONCLUSIONS:

Thus the educational working model of automobile transmission system breaks down complex transmission systems in automobiles in basic easily understandable parts. This will further enrich the knowledge of students by clearing concepts about differential and Gear ratios.

From Table -2, it is observed that exact gear ratios cannot be achieved in transmission due to following reasons:

1) Worn out gears in transmission system

2) Rotational energy is converted to heat due to friction in power transmission rod

3) Human Error in measurement

ACKNOWLEDGEMENT:

I would like to thank Prof. S.B.Salvi for giving e guidance and support for this ambitious project and workshop staff in MGM's Jawaharlal Nehru Engineering College, Aurangabad for giving guidance.

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