A STUDY ON THE STRENGTH OF A 3D PRINTED AUTOMOTIVE TRANSMISSION SYSTEM

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1.0 ABSTRACT

In this project work, advanced manufacturing processes were considered to design and produce complex models using the 3D printing technology. While manufacturers are now replacing assemblies, subdivisions and parts with 3D printed components to reduce cost, material, and weight, it is also crucial to consider the performance behavior and optimization of these preferred components (Altimemy & Caspara, 2020). The study involves a 3D printed differential gearbox system using Additive Manufacturing technology. At the design stage, the fracture behavior and the stress analysis (Loaded and Unloaded) of the designed spur gears were modeled, and the selections of the Printing parameters were dynamically chosen in relation to the performance as simulated with the Slicing tool. This study featured the low noise of operation as compared to Steel gears produced through conventional means. Moreover, other results showed that the correlation of the 3D Printing process parameters and the dynamic performance of polymer gears would be a significant research in the field of 3D Printing and gear manufacture to consider.

Keywords: 3D printing, Spur gear, Fused Deposition Modeling, Additive Manufacturing, Polymer gears

2.0 INTRODUCTION

The advent of additive manufacturing (AM) has developed the face of product fabrication by supporting in-sourcing and promoting personal manufacturing businesses. This has transformed not only the manufacturing industry but also the medical and distribution industries (Faradia, et al., 2011). Designing a solid product used to be a particularly time-consuming process, with many lengthy mock-ups, molding, and injection processes before a serviceable product could be made. However, Additive manufacturing allows complete parts to be manufactured from three-dimensional (3D) models.

3.0 PROBLEM DEFINITION

Conventionally, gears are manufactured using cast iron, steel, nylon, bronze whose manufacturing cost is high due to mold casting, quenching processes etc. In such situation, it cost highly for producing the random requirement. 3D printing technology can be implemented where customized designs can be manufactured in short time without going to conventional manufacturing process. So there is need to design a 3D printed spur gear which can be made quickly and easily, with moderate strength, durability and performance.

4.0 ANALYSIS AND DISCUSSION

4.1 Stress Result

The deformation in spur gear was 0.005mm and the polymers exhibited the following characteristics:

1. Low elastic modulus
2. Significant linear expansion coefficient
3. Shrinkage at the stiffening
4. Parts dimensional instability

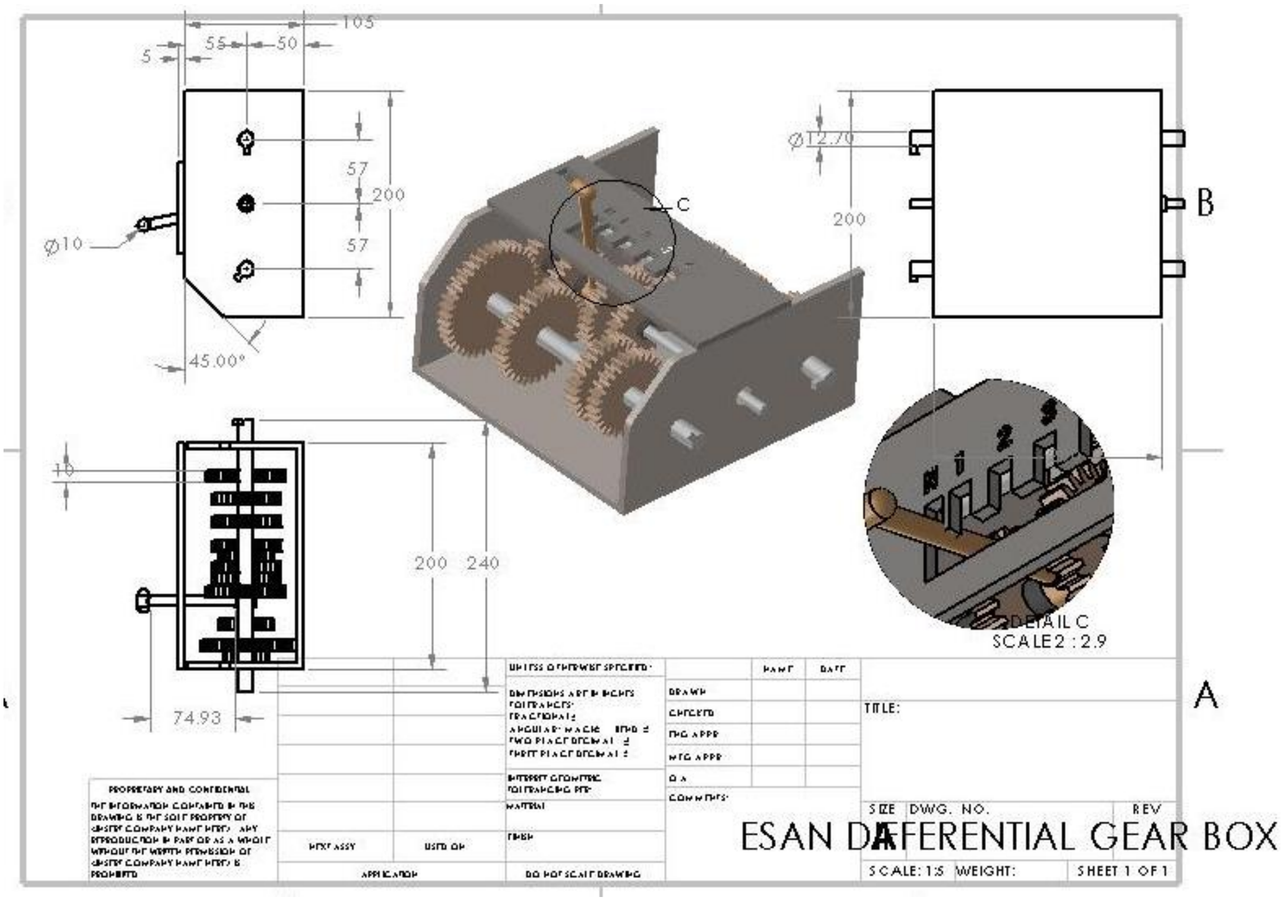

Fig 4.0 Automotive Transmission Design
Source: self

Materials	Density (g/cc)	Tensile strength (MPa)		Young's modulus (GPa)
		Yield	Ultimate	
PLA	1.29	44.8	50.1	3.76
ABS	1.05	40.7	41.4	2.10
NYL12	1.42	45.4	79.4	5.31
PC	1.20	63.3	60.6	2.36

Table 4.0: Mechanical Properties Of The 3D Printed Material During Simulated
Source: self

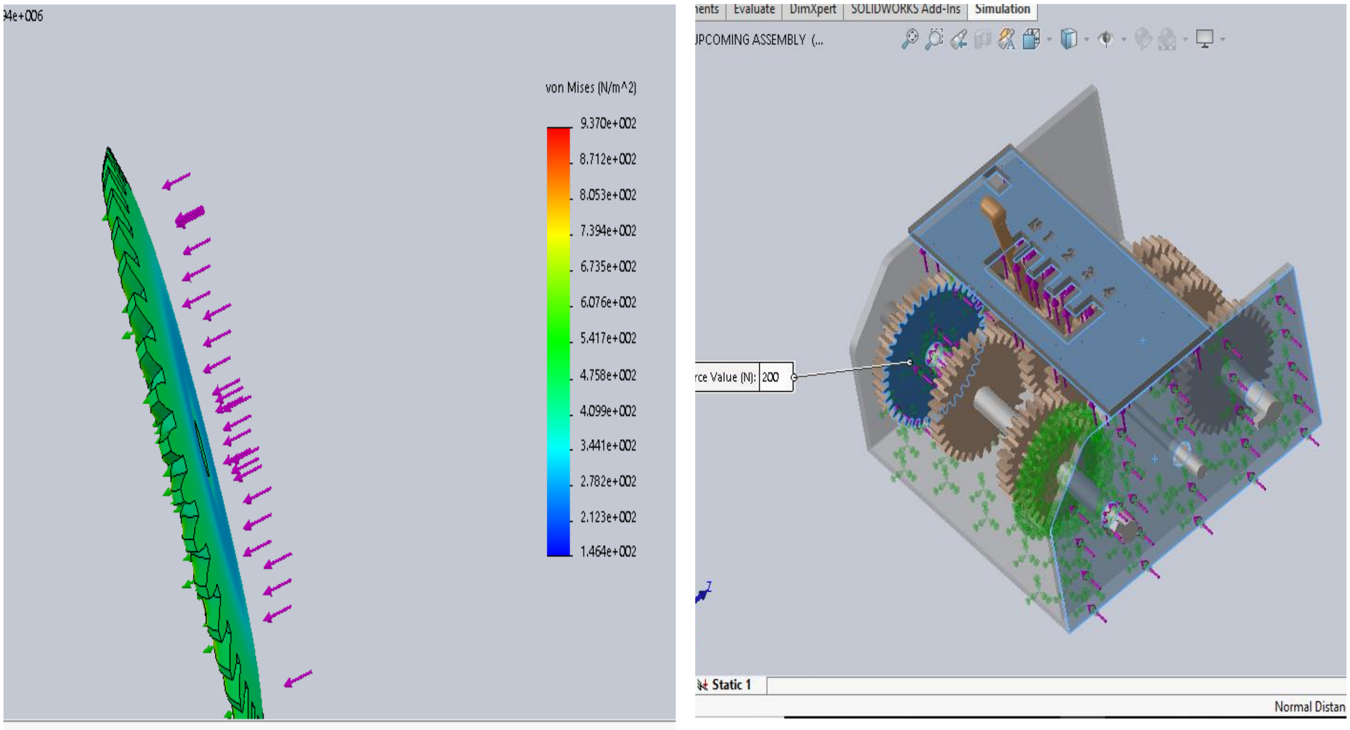

Fig 4.2 Simulation of Automotive Transmission Design

4.2 Manufactured 3D Printed Spur Gears Using PLA (Polymer)

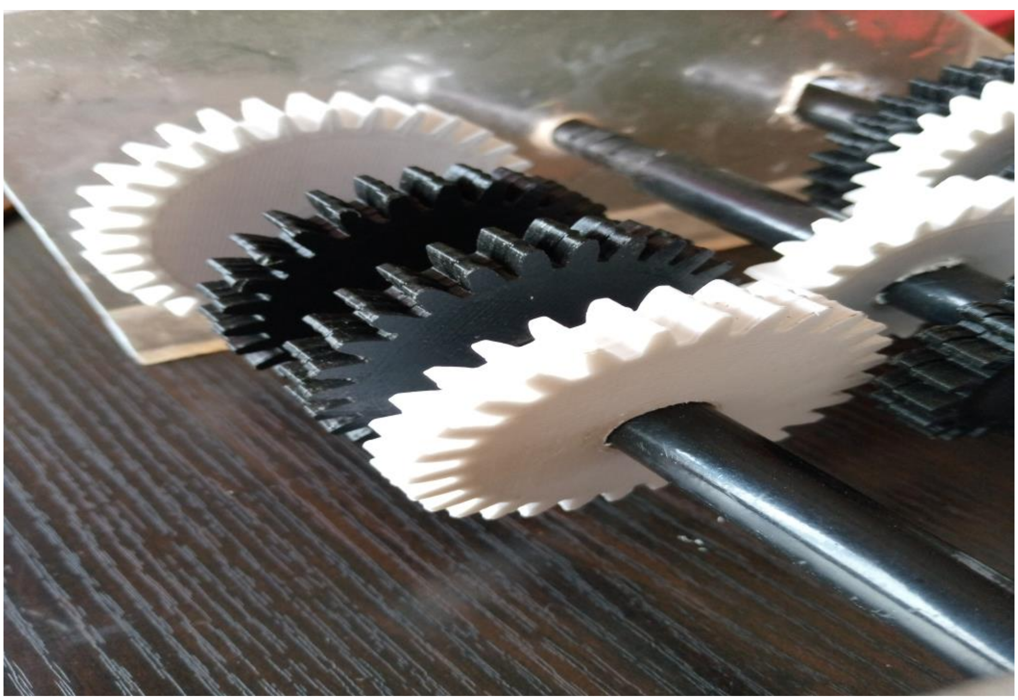

Fig 4.3 Printed Automotive Transmission During Experimental Session
Source: self

5.0 CONCLUSION

The FEA results shows that Nylon is strong when subjected to tensile or compressive loading. Moreover, the printing parameters have been optimized to increase the performance of the 3D printed polymer gears. The results suggest an optimized setting of the 3D printer as follows: printing temperature is equal to 250 °C, a printing speed of 70 mm/s, a bed temperature of 25 °C and the infill percentage is 80%. The operational time of the resultant 3D printed polymer gear was increased with the gears produced using the default print settings. In the future experimental research it’s also planned to vary the 3D printed gears test samples layer thickness, as well as the infill percentage of manufactured prototypes.

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