

Designing, Modelling and 3-D Printing of Cotter Joint

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Abstract:

In this paper, different modes of failure of a cotter joint are studied. First, we have calculated the dimensions for the different components like a socket, spigot, and cotter when the joint is subjected to a force of 50 KN. After that, the joint is modeled using Creo software. The individual parts are designed separately and then assembled. The assembly is then get converted into the .stl(stereolithography) file. This .stl file is then transferred to another software CURA for the generation of G-code and M-code. At last, the G-code and M-code are utilized for 3-D printing of the prototype of the cotter joint. PLA (Poly Lactic Acid) filament was used as a 3D printing material.

Keywords: 3D printing; Creo; CURA, G-code; M-code; Cotter.

1. Introduction and Literature Review

[1]explained the stress analysis of the different parts of the cotter joint under compressive and tensile forces.[2] focused on applications of cotter joint in different fields of society.[3] provided a set of the database to analyze the different parts of the cotter joints by theory and empirical relations. The rest of the paper is as follows. Section 2 presents the Experimental Set-up, Materials, and Methods. In section 3 an attempt to model the cotter joint using PTC Creo has been executed. The development of G-Codes on CURA and 3D printing has been carried out in section 4. Thereafter, the result(the final prototype in an assembled form) is presented and discussed in section 5. At last section 6 presents the conclusion and future scope.

2. Methodology

It is assumed that each rod is subjected to an axial force of 50kN. The main dimensions of a cotter joint are found and specified.According to the specified dimensions, the cotter joint is designed utilizing Creo software.When the design gets ready, The design is converted into .stl format.The .stl file will

provide usG-codes and M-codes in CURA software, after that we started 3D-printing layer by layer to print the prototype. The experimental setup used for additive manufacturing is shown in fig. 1.



Fig. 1.CAD x ARYA_Prime (Experimental set up)

3. Modeling of Cotter Joint:

Modeling is carried out utilizing PTC CREO 3.0. The parts file are shown in fig. 2-4 for cotter,socket, and spigot respectively. These parts file are converted into .stl file as shown in fig. 5-7.These

stereolithography files then finally transferred to CURA where G-code and M-code are generated. The detailed method for G-code generation is explained in section 4.

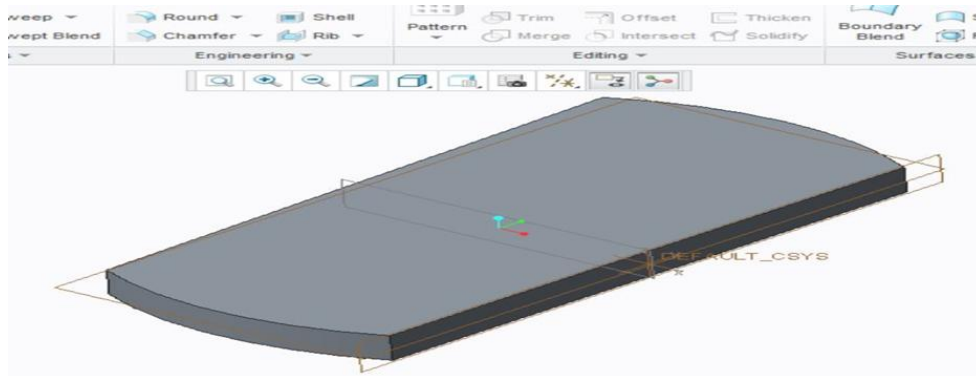


Fig. 2. Cotter part file

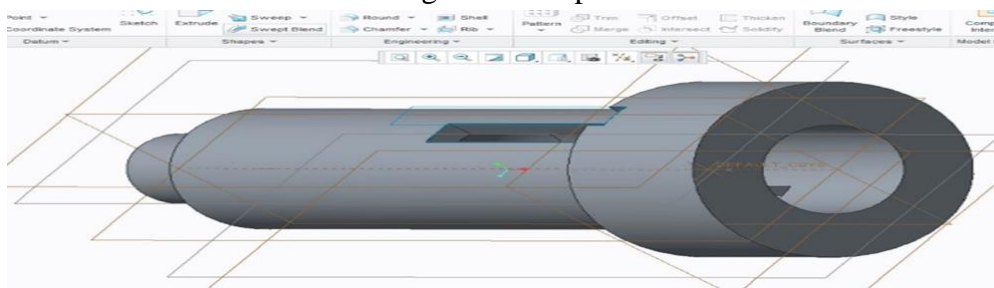


Fig. 3. Socket part file

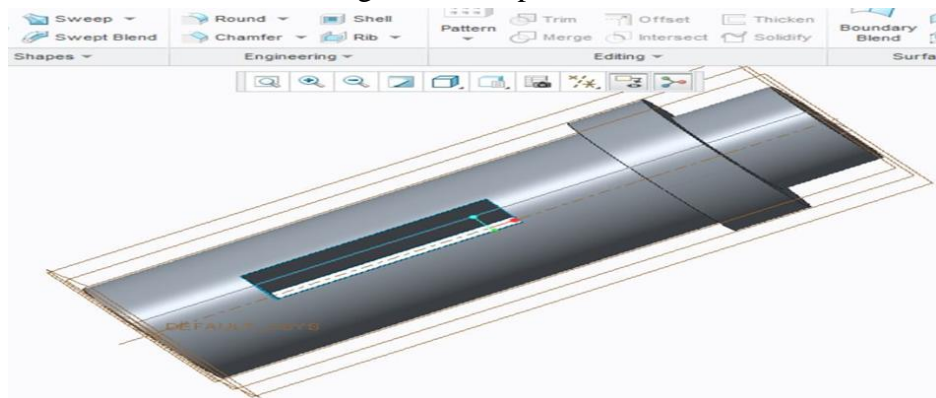


Fig. 4. Spigot part file

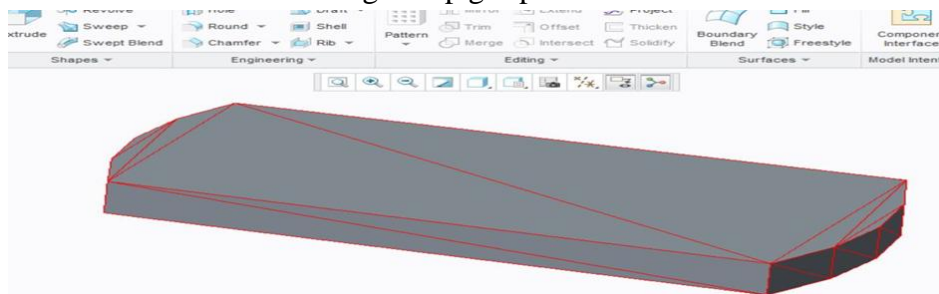


Fig. 5. Cotter .stl file

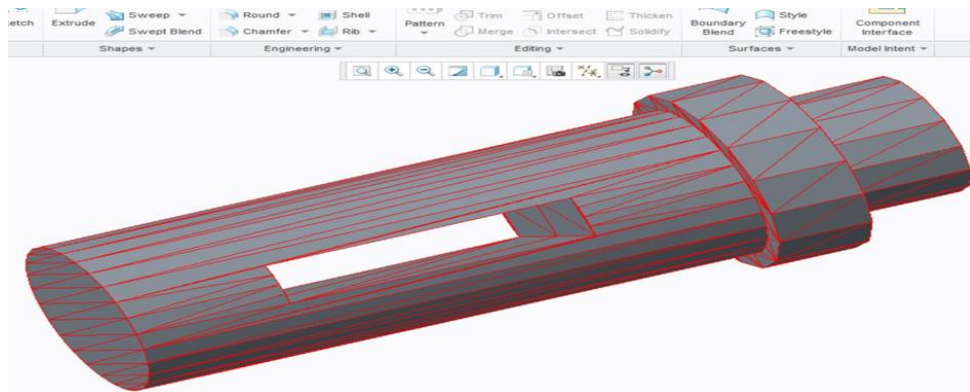


Fig. 6. Spigot .stl file

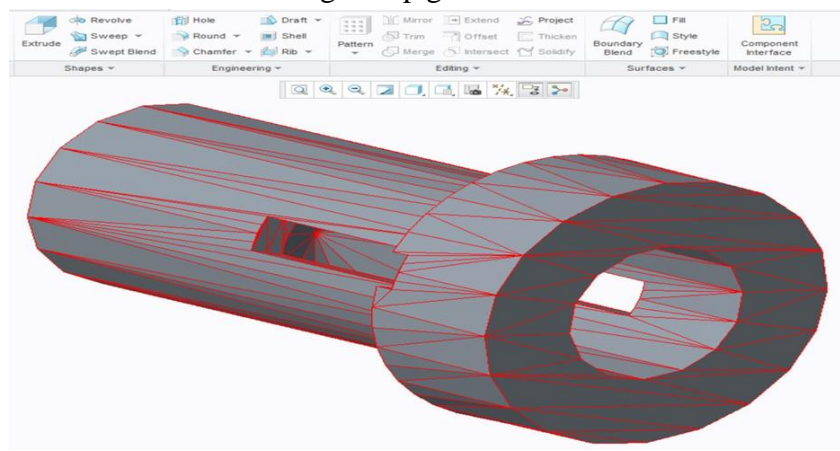


Fig. 7. Socket .stl file

4. Development of G-Codes on CURA and 3D printing:

The .stl file of Cotter Joint prepared in PTC CREO 3.0 is transferred to CURA software where we performed the following steps:

- The type of 3-D printer is selected in CURA.
- Extruder No. 1 is selected for printing the Cotter, Spigot & Socket of the Cotter Joint.
- The .stl file is opened in CURA and the alignment of different parts of Cotter Joint is done on the working table.
- Alignments are done in such a way so that we can get an only outer supporting

structure.

- Infill density of different part is set in the properties as:
 - For Cotter: 20%
 - For Spigot: 20%
 - For Socket: 10%
- Printing speed is set at 45 mm/sec for all the three parts of the cotter joint.
- After defining all the properties slicing is done on CURA.
- G-Code is created on CURA software as shown in fig. 8 and the file is transferred to the 3-D printer.

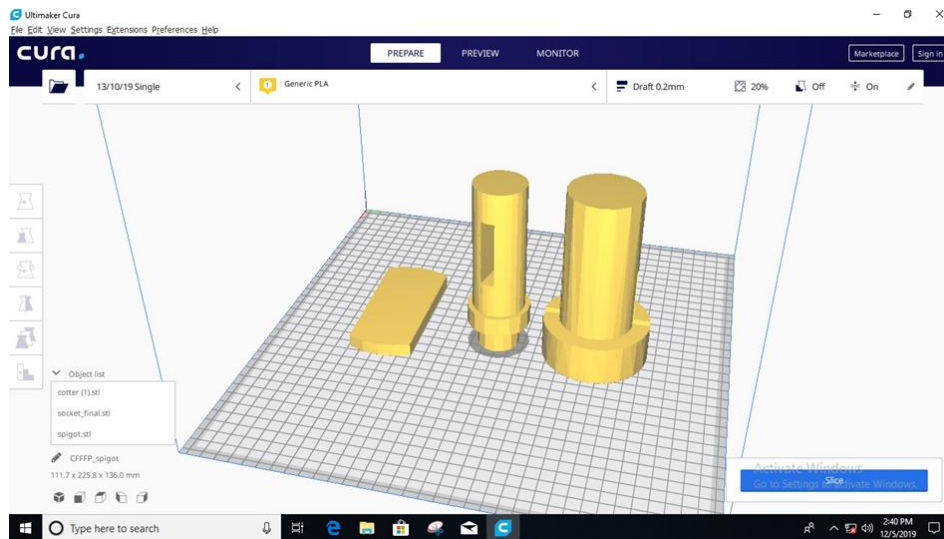


Fig. 8. Development of G-Code on CURA

Steps for rapid prototyping are explained using a block diagram as shown in fig. 9. 3D printing of socket is continuing in Fig. 10 as per the

experimental set up explained in the methodology section. The next section discusses the final product.

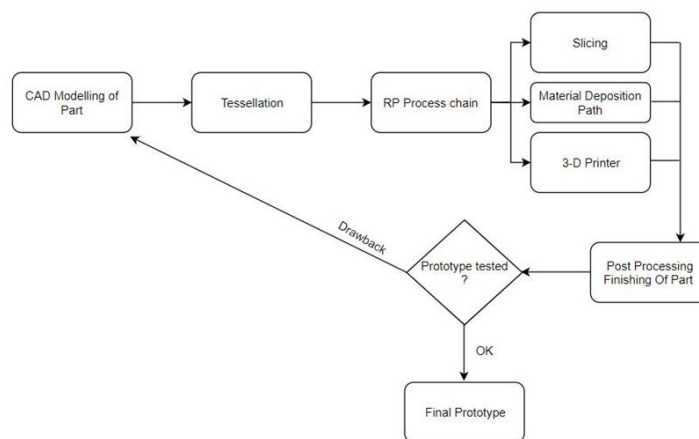


Fig. 9.: Methodology of Rapid Prototyping

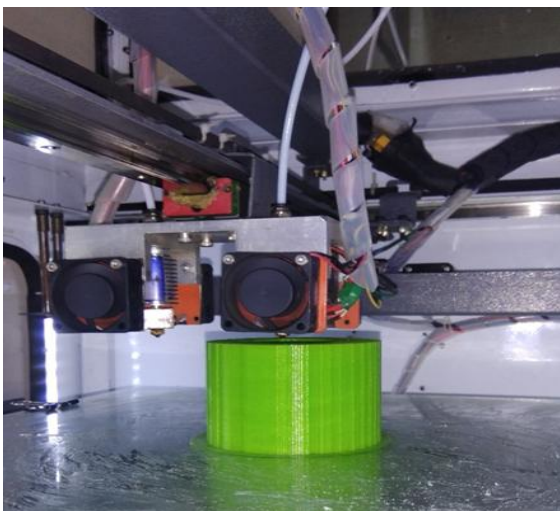


Fig. 10: Printing of Socket

Results and Discussion:

The final prototype is shown in Fig. 11. Assembly in CREO and the Final Prototype Assembly is depicted in Fig. 12.

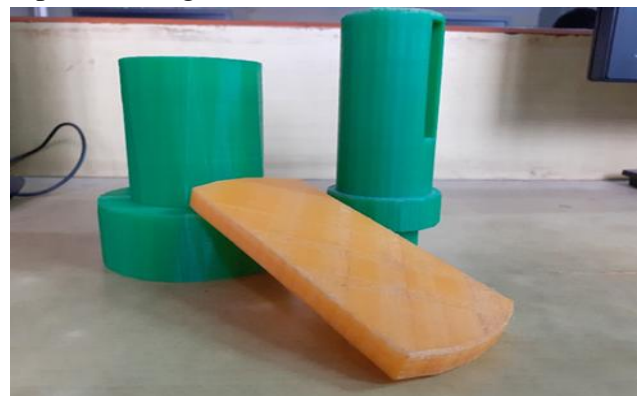


Fig. 11.: Final Cotter Joint Prototypes

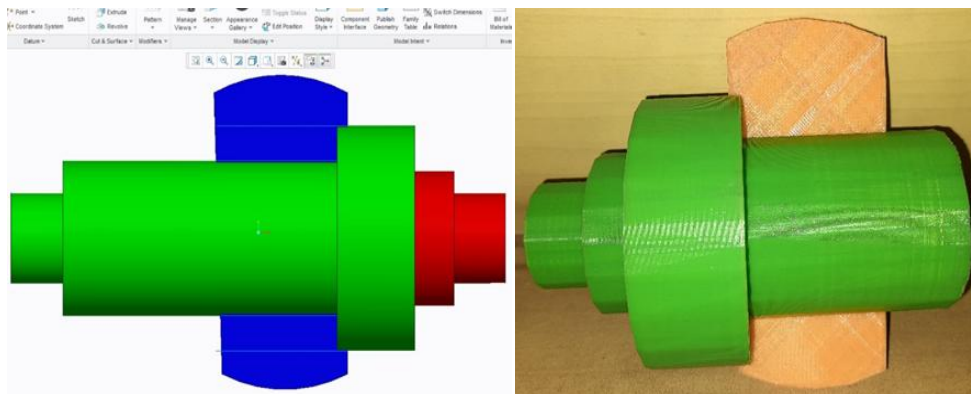


Fig. 12.: Assembly in CREO and the Final Prototype Assembly

Conclusion:

The design of the cotter joint came out to be within the limits of permissible stresses. The parts of the cotter joint i.e. Cotter, Spigot & Socket are created using CAD software PTC CREO 3.0. The .prt file of the parts are converted into .stl file (stereolithography). CURA software converted .stl file into G-Code. This prepared G-Code is used for 3D printing. The process of 3D printing/additive manufacturing of the prototype parts is successfully carried out. The Prototype generated can be used as a reference for the final product to be manufactured and can also be used as a demo model in various designing laboratories and workshops. Additive manufacturing is a very intensive research area, hence there exists lots of future work in the research and development for reducing the cost of not only the final product but the cost of testing as well.

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