A Project Report
Submitted for

Computer Aided Design & Analysis (UME412)

Online Test 2
Analysis of Force Pump Air Vessel

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Acknowledgement

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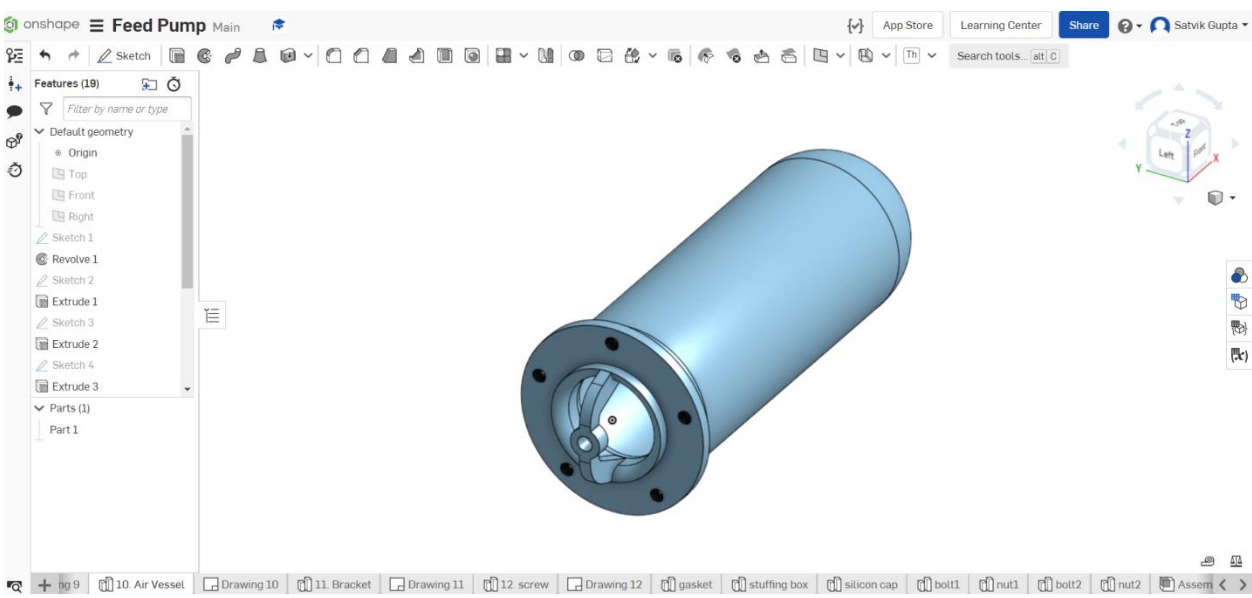
Introduction

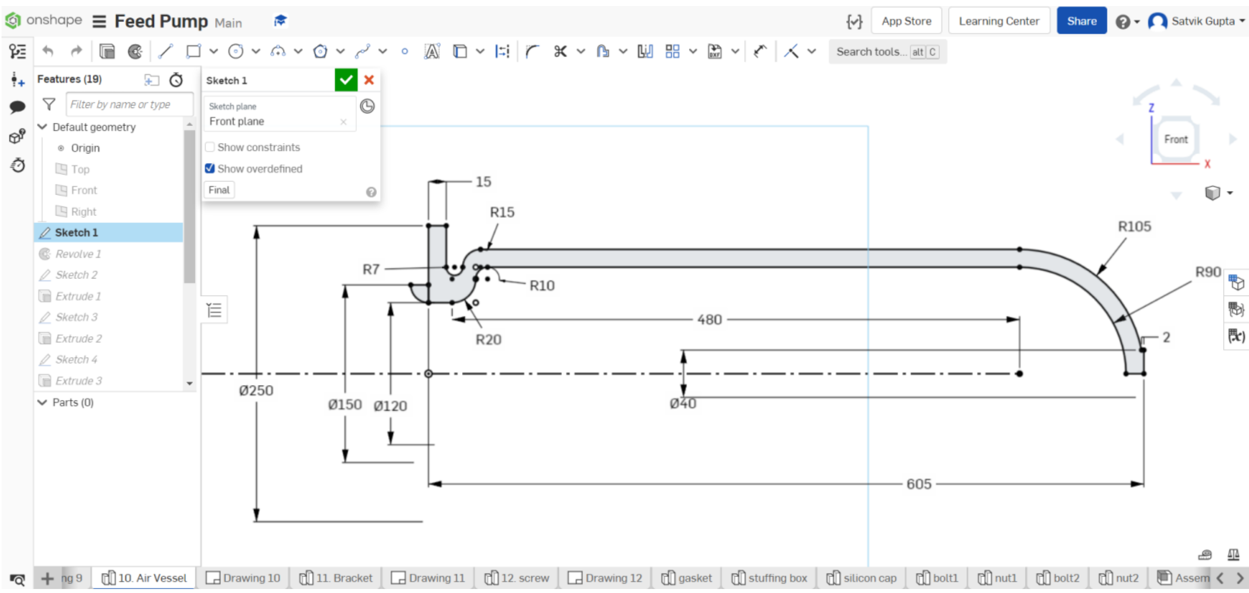
The aim of this project is to do structural analysis of the Air vessel part of the feed pump designed in the Online test 1. In this project we use the online cloud based software and tools PTC Onshape SW. The Air-vessel was designed with the standard dimensions that were provided in the feed pump assembly drawings. The pump has to develop a pressure of 12 bar to pump water to a boiler having a volume of 500 litres. We have to analyze only the “Air Vessel” part using a static structural simulation app add-on to Onshape. Both the ends of the air vessel were sealed for the analysis and to determine the FOS, given CI used has a tensile strength of Syt= 850 MPa a modulus of elasticity of 200 GPa, and a poisons ratio = 0.28. For analysis purposes we use the add-on application Altair SIMSOLID provided in the app store of Onshape. The thickness of the air vessel had to be changed again and again to get the optimum value of stresses generated and to satisfy the FOS demands. The following project report provides a sum up of all the procedures and processes involved for the successful completion of this project.



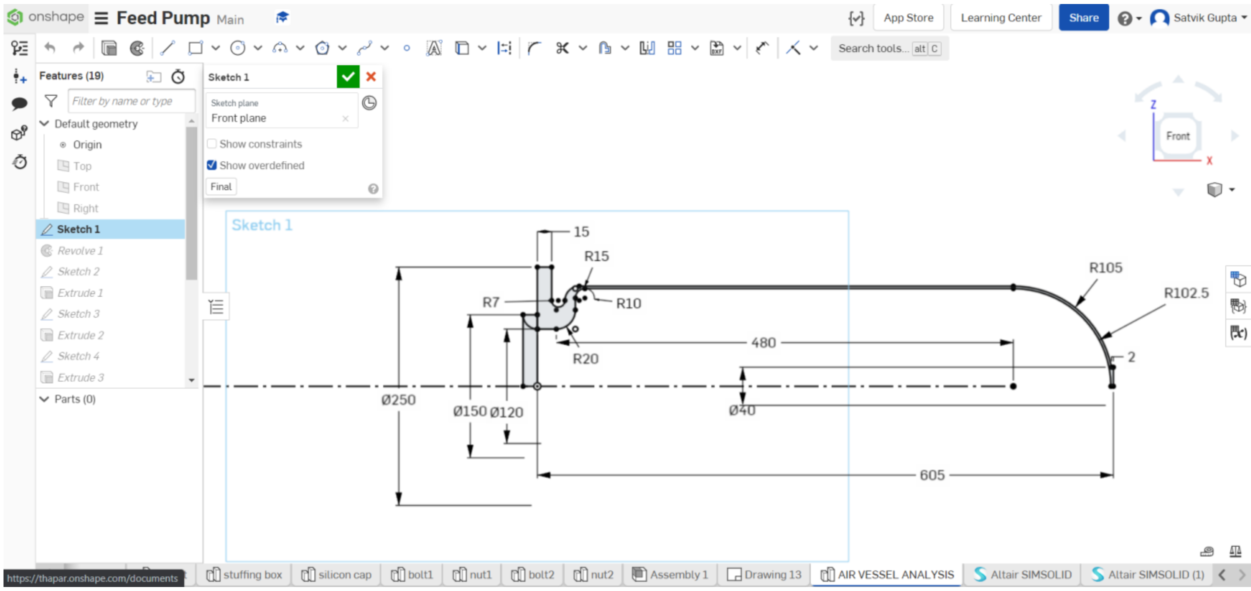
(Fig.1 Initial CAD modeling of the Air vessel in PTC Onshape)

Changes in the Modeling Sketch

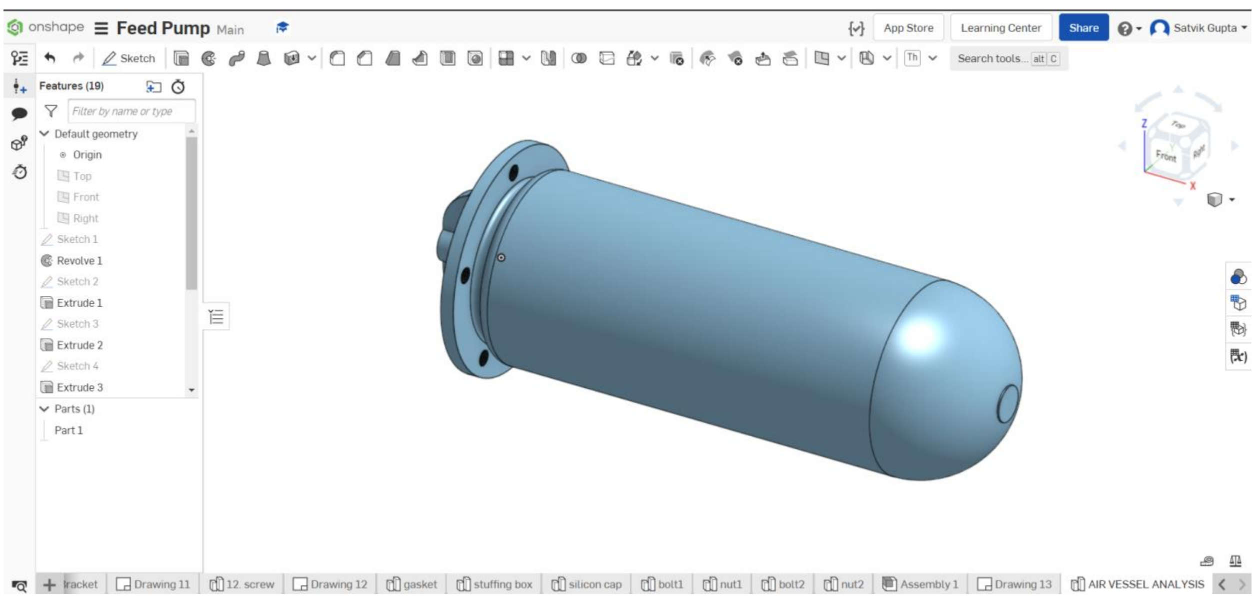
The initial modeling of the air vessel was done in PTC Onshape using the standard dimensions provided in the Feed Pump drawing. The final goal of this project was to reduce the weight, distribute the stresses to provide a FOS which is not having a large varation over the part. To achieve this, we had to do various iterations in the thickness of the air vessel. As, pressure is being applied on the inner and outer surfaces of the air vessel we also had to seal the air vessel from top and bottom. Given below are the intial and final sketches.



(Fig.2 Intial sketch of the air vessel before analysis)



(Fig.3 Final sketch of the air vessel used for analysis)

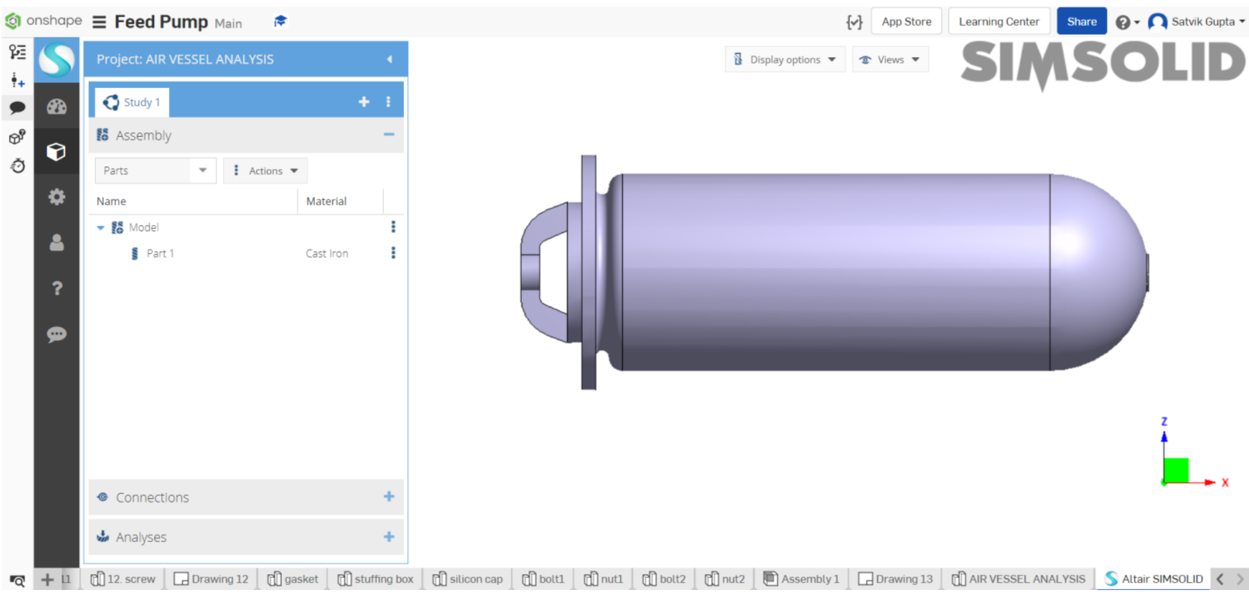


(Fig.4 Sealed ends of the air vessel)

Structural Analysis

1. Assigning the material

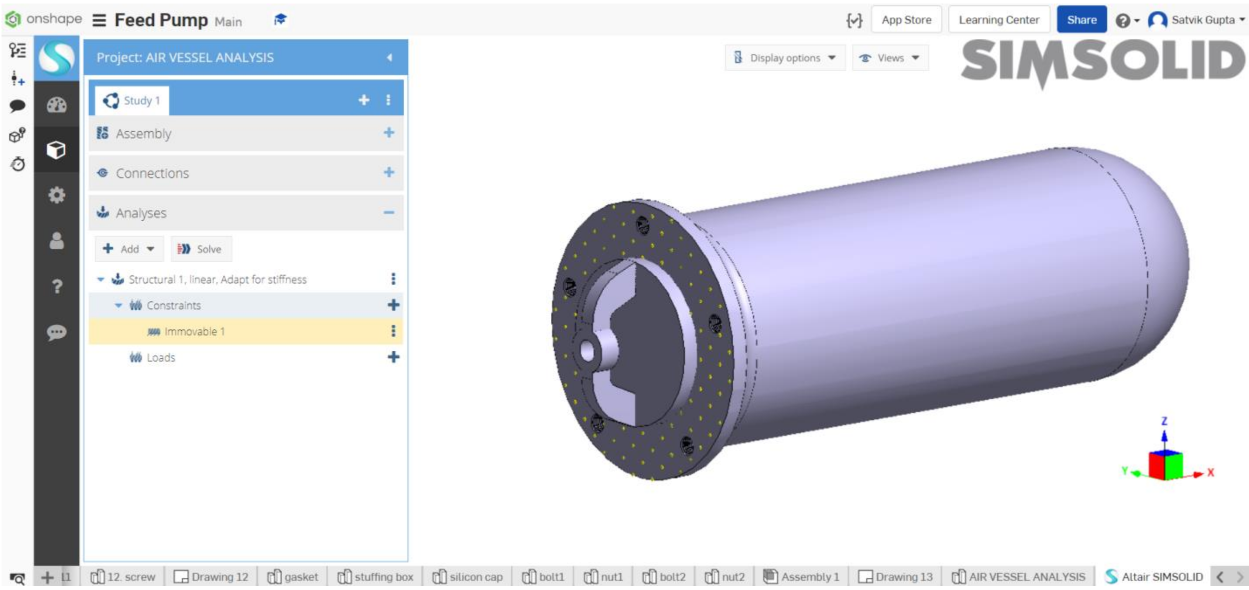
Once we are ready with the CAD model after sealing both the ends. The next step is to open the app ad-on Altair SIMSOLID. Once the app is opened with the air vessel we assign the material to the vessel, Cast Iron in this case with the following properties: a tensile strength of Syt= 850 MPa, a modulus of elasticity of 200 GPa, and a poisons ratio of 0.28.



(Fig.5 assigning the material to the air vessel)

2. Adding Constraints

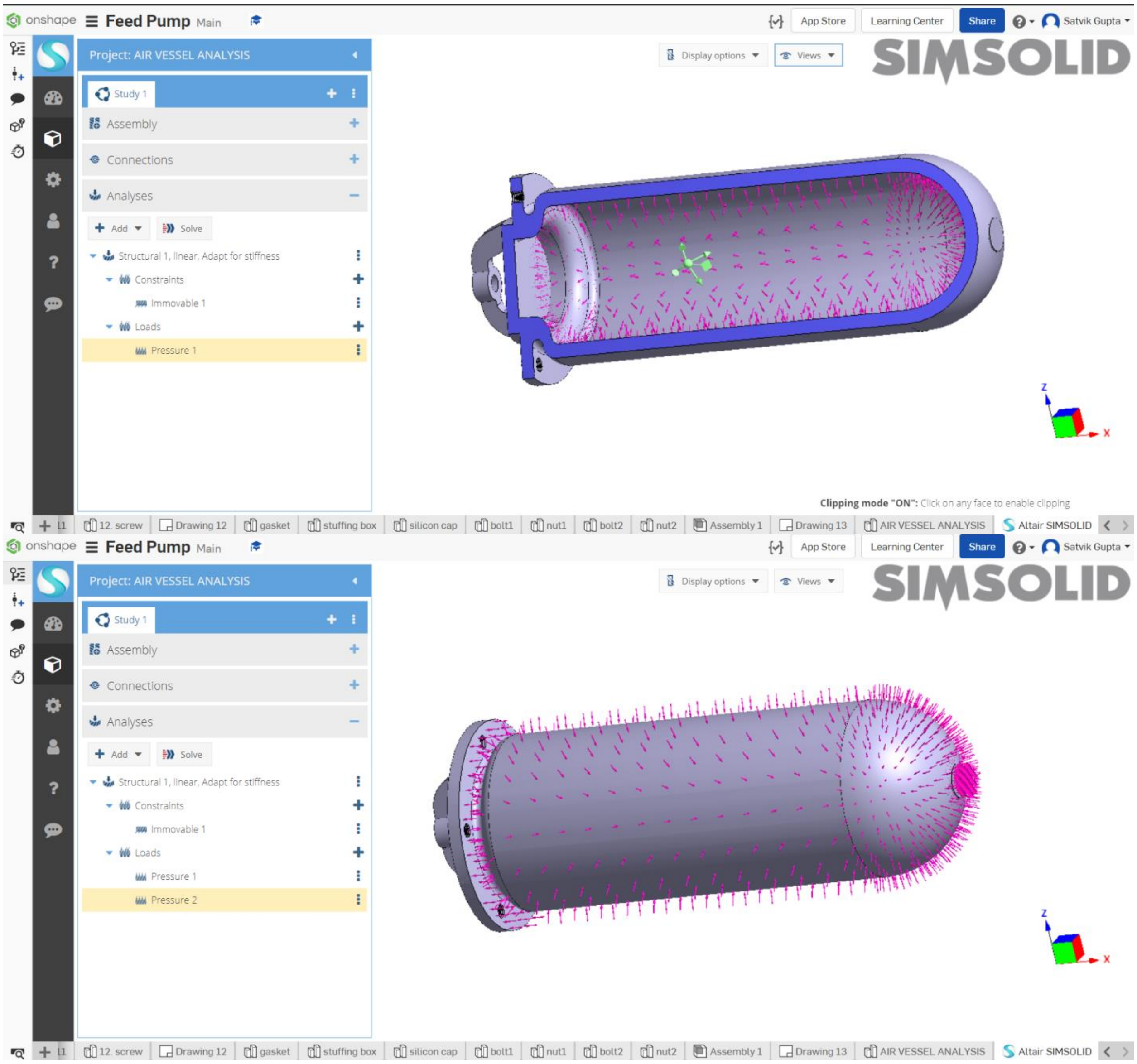
Once the material is assigned to the air vessel, next step is to add constraints to the vessel as per the given requirements. First, we fix the base of the vessel by adding the immovable type constraint from the drop down.



(Fig.6 fixing the base of the vessel- constraint)

3. Applying loads

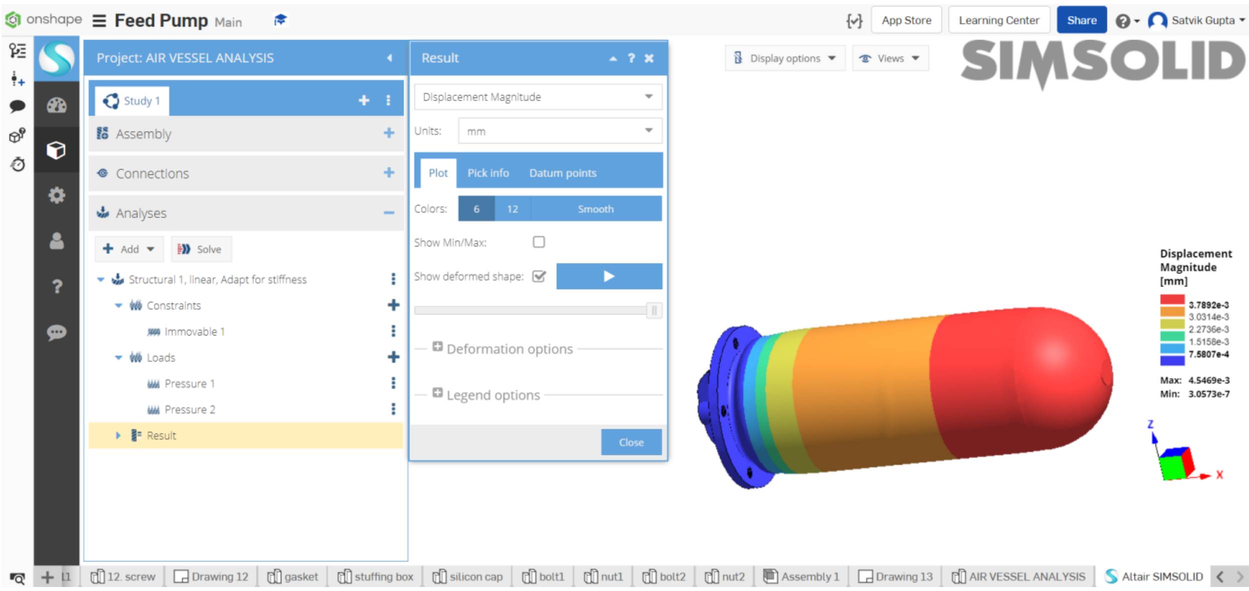
Once the base is fixed, next step is to apply the given pressure loads to the vessel. Atmospheric pressure of 1 bar is applied on the outer surface of the vessel whereas, an internal pressure of 12 bar is applied on the inner surfaces as shown in the figures below.



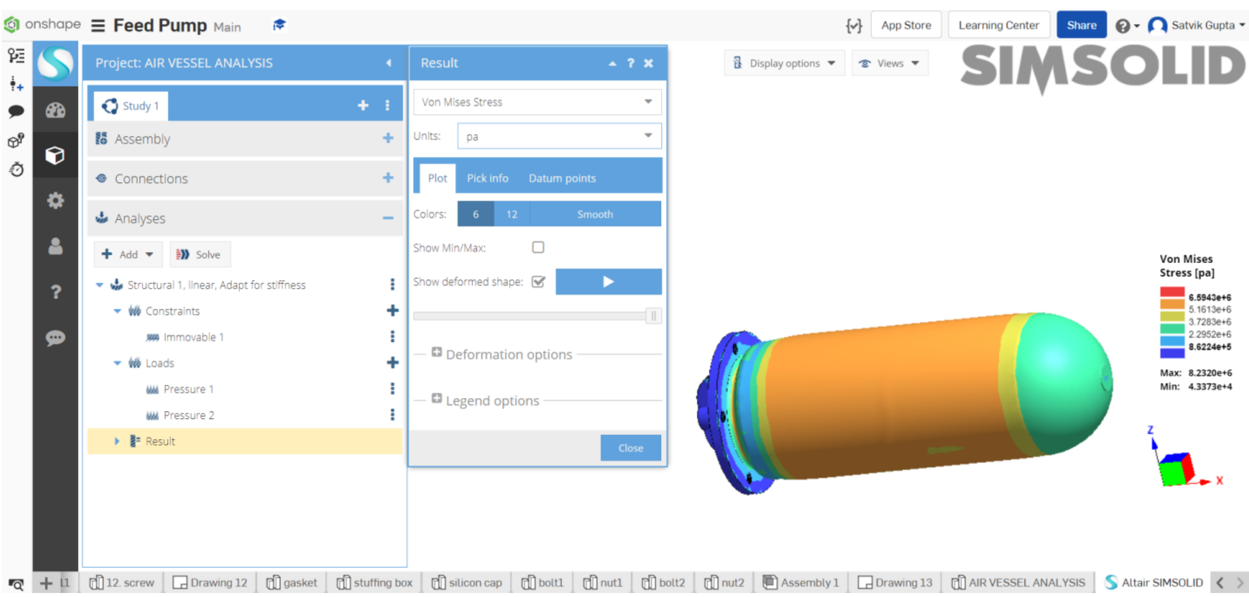
(Fig.8 Applied pressure to internal and external surfaces)

4. Performing Structural Analysis in initial CAD model

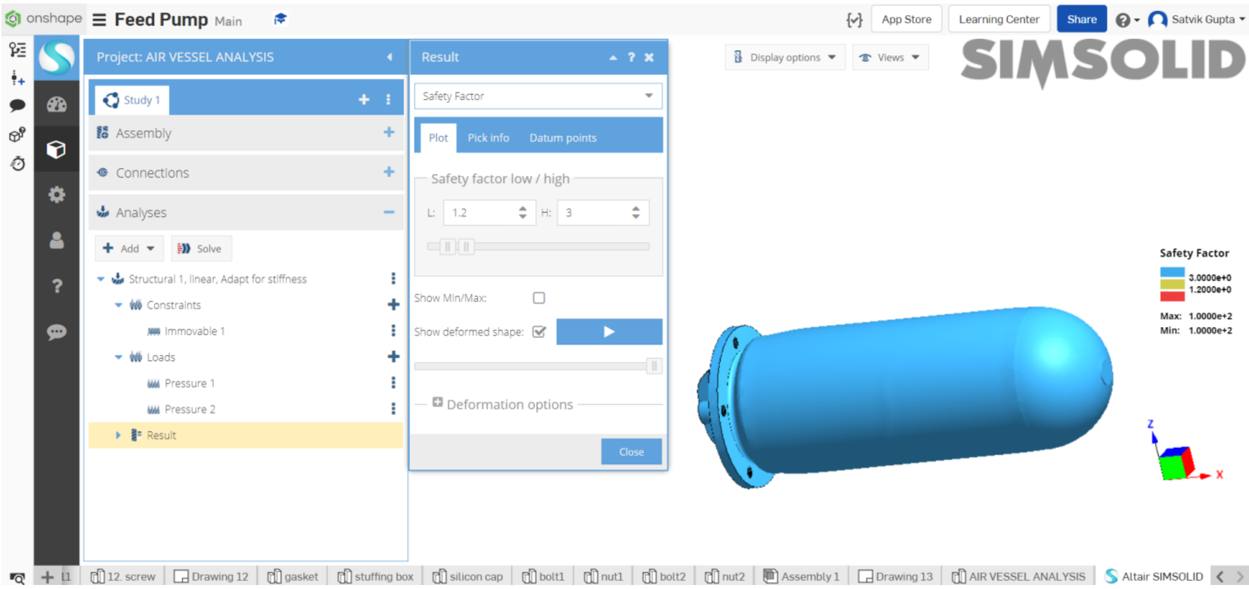
Once the loads and constraints are applied to the initial CAD model we perform the structural analysis. The following figures show the max. and min. values Displacement magnitude, Von Mises Stress and the FOS respectively.



(Fig.9 Displacement magnitude in initial CAD model)



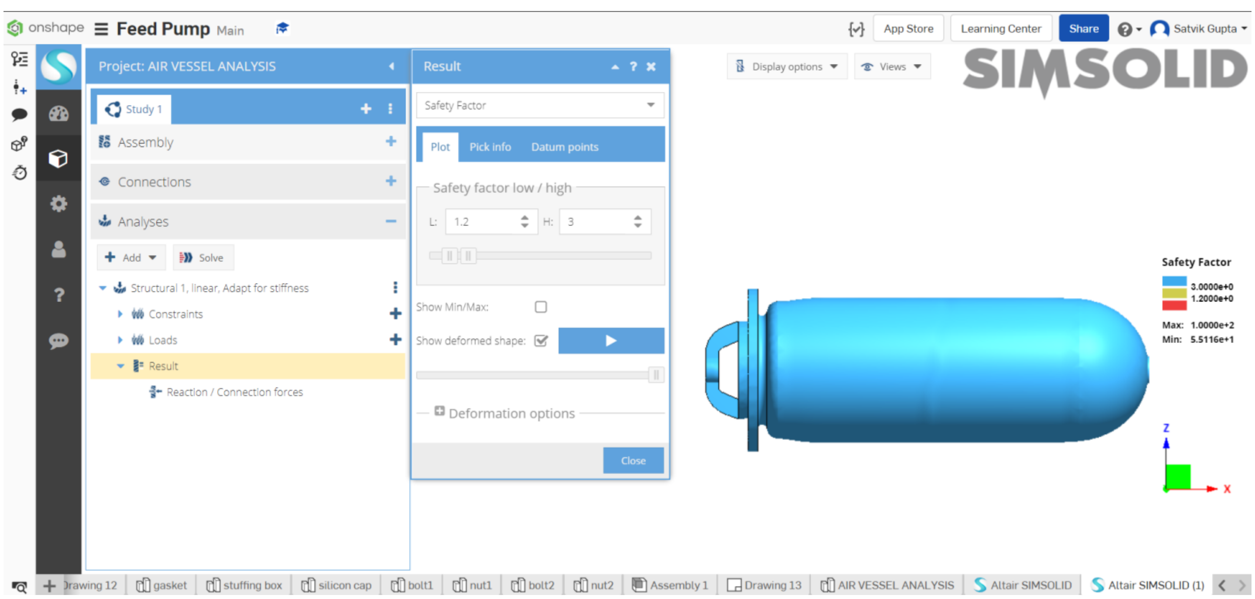
(Fig.10 Von Mises stress developed in initial CAD model)



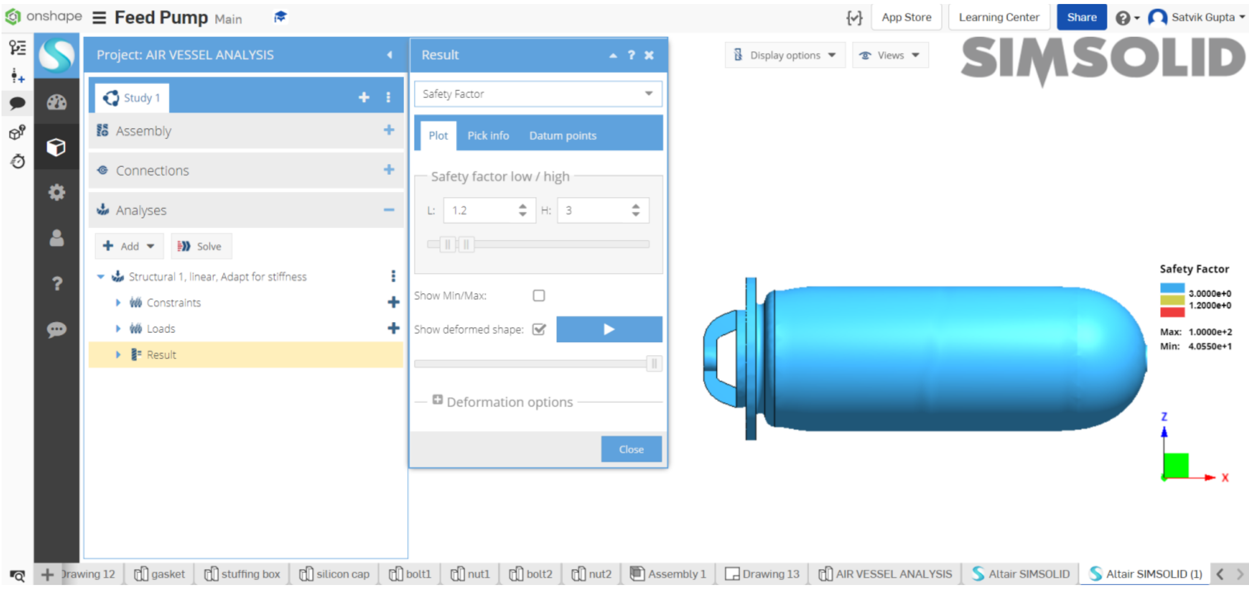
(Fig.11 Factor of Safety in initial CAD model, wall thickness = 15mm)

5. Performing Structural Analysis making iterations in the thickness to get the desired result

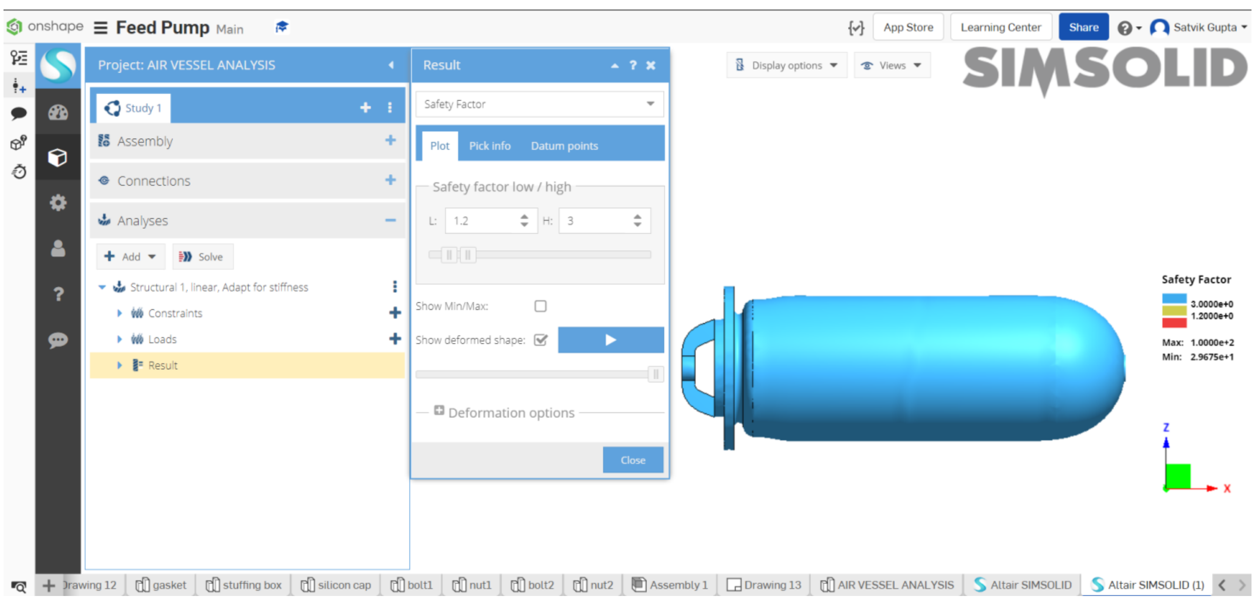
As, is clear from the initial structural analysis that we were not able to get the desired FOS. Hence, now we make successive iterations of 2.5mm to the wall thickness of the air vessel and do the analysis for each iteration.



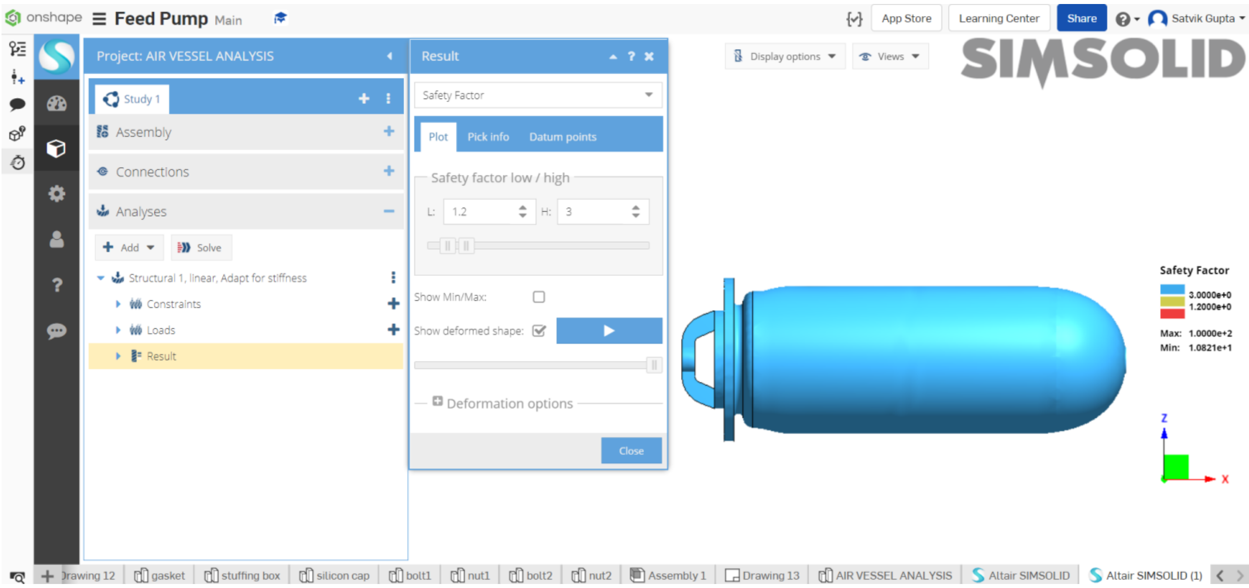
(Fig.12 FOS with wall thickness = 12.5mm)



(Fig.13 FOS with wall thickness = 10mm)



(Fig.14 FOS with wall thickness = 5mm)

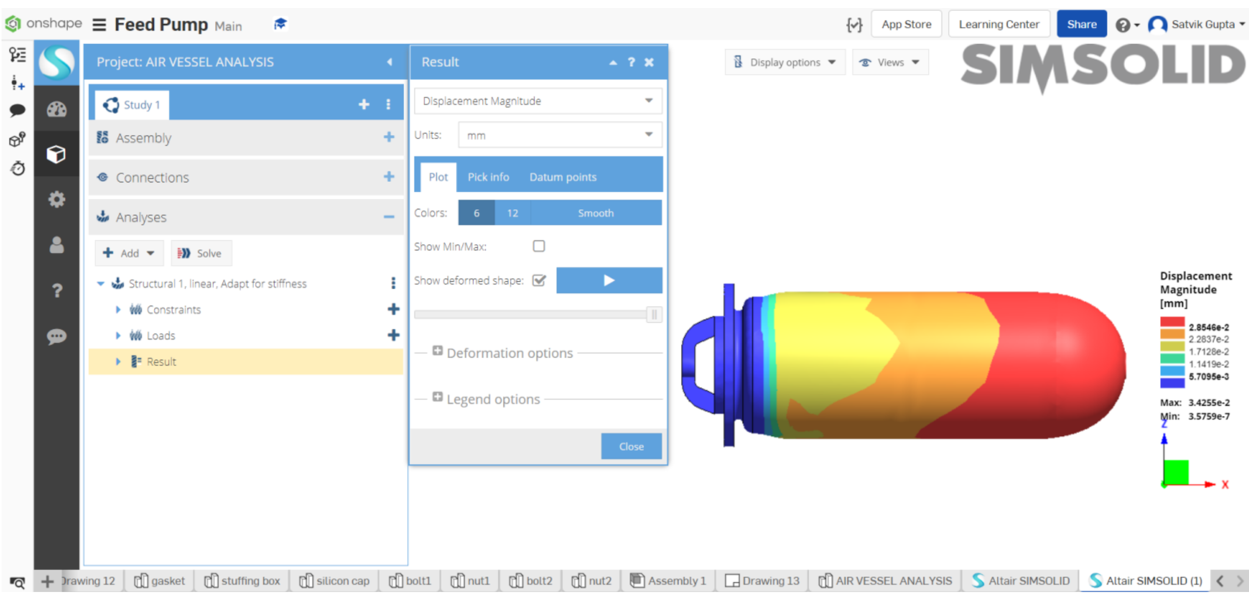


(Fig.15 FOS with wall thickness = 2.5mm)

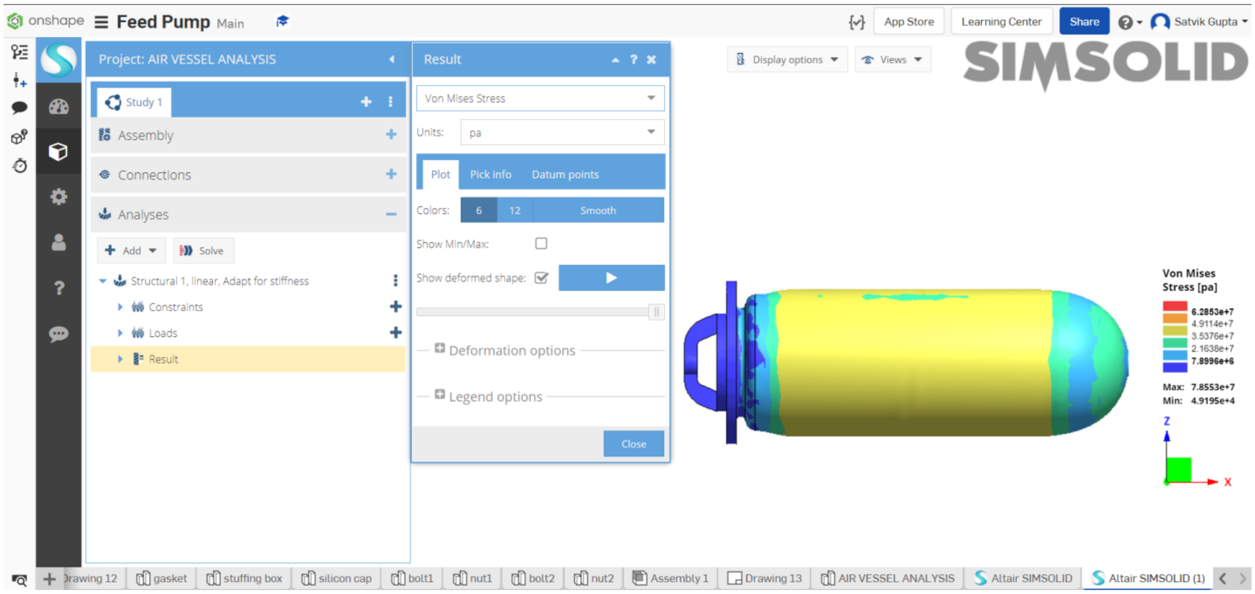
Results

From the above performed iterations we find out that the best possible **FOS** according to the given requirements is around **10.821 at a thickness of 2.5mm** of the air vessel and the stress in almost uniformly varied across the body.

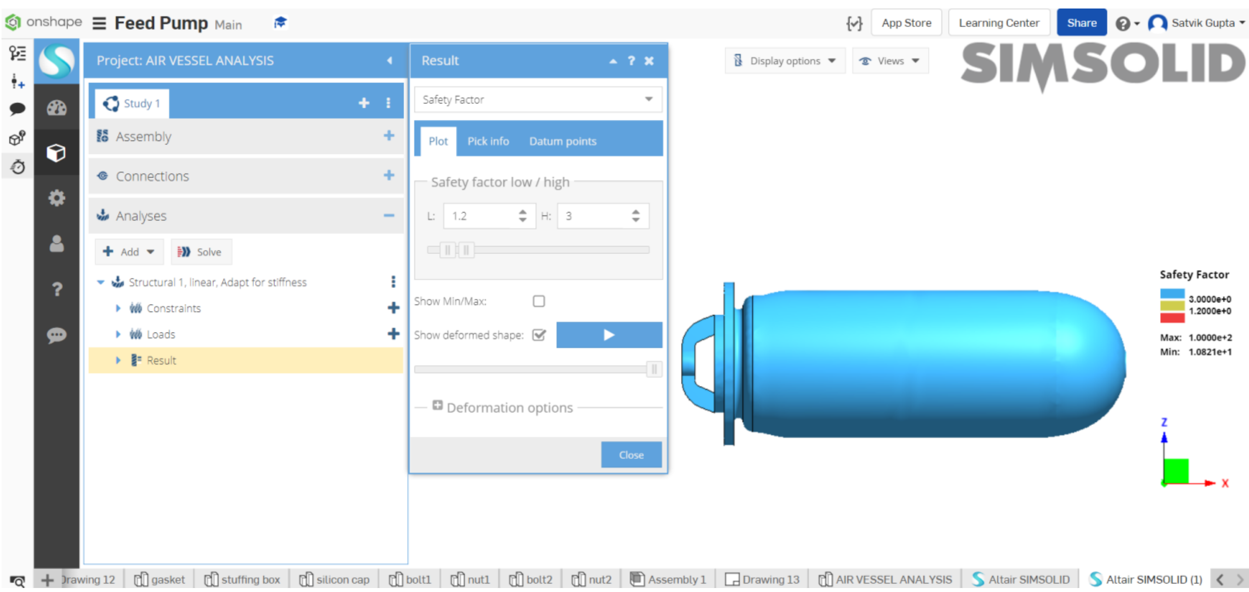
Hence, we perform the final structural analysis on this sketch and find that the **displacement magnitude** is coming in the range of **3.5759e-7 mm to 3.4255e-2 mm.** We also find the final **von mises stress** which comes out to be in the range of **4.9195e+4 pa to 7.8553e+7.**



(Fig.16 Final displacement magnitude)



(Fig.17 Final Von Mises Stress)



(Fig.18 Final FOS with wall thickness = 2.5mm)

Reflections

1. **Your learning's from this project and its use in making you a better mechanical design engineer.**
   After the completion of this particular project I was able to learn about the online simulation tool available in the online cloud based CAD software that is, PTC Onshape SW. The module which we used in this project, Altair SIMSOLID is a good online tool made available online and easy to use. This project is relevant to our engineering branch as just like our previous projects, it imparts some important learning needed by Mechanical engineers like Force analysis and Deformity simulation. We also get to know the importance of weight reduction and FOS.

2. **What is the effect of other components in the assembly on the design of the Air Vessel?**
   There is a very important role of each and every component with respect to each other in an assembly. Though, in the assembly of the feed pump there is no as such involvement of other components with the air vessel in terms of design of the air vessel. Still, all the parts must be designed and made using the standard dimensions and taking a few more considerations such as how much pressure will the air vessel be able to withstand, level of water being filled, material being used, thickness of the vessel, etc.

3. **What other loading conditions are relevant for the Air vessel design which are not considered in this simulation?**
   Other loading conditions that are relevant for the air vessel design which are not considered in this simulation could be fluid conditions. For example, the minimum and maximum temperatures of the fluid, chemical and physical properties of the fluid may alter the material used to design the air vessel, etc.