Numerical Analysis And Comparison Of An Abs Centrifugal Pump Casing With Ductile Iron

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Abstract

Metallic component are been used right from their origin, because of their ability in strength, durability and many other properties. Even non-metallic components have been used for more than 25 years, though they have the capacity to replace the metallic components. It has got restricted in particular fields and high budget projects, the main drawback of these non-metallic components are cost. Our work focuses on replacement of metallic pump components by non-metallic components. It not only reduces the weight of the pump, it also makes sure that it is corrosion free throughout its application. Ultimately cost is also affordable when compared with metallic components. This project focuses on particular part of a pump ie, casing. Casing will be selected for the study, 3D modeling of casing will be carried out, analysis due to pressure is carried out, and prototype will be built using Fused Deposition Modelling (FDM). Results are compared with ductile iron casing.

Key words: centrifugal pump, composite, corrosion free.

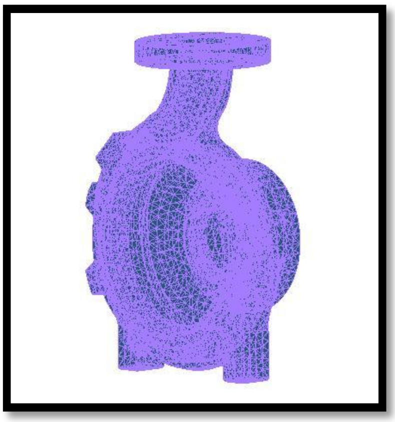
1. Introduction

When a certain mass of liquid is made to rotate by an external source it is thrown away from the centrifugal axis of rotation and a centrifugal head is impressed and which enables it to rise to a higher level. If more liquid is made available at the centre of rotation a continuous supply of liquid passes through revolving wheel of the impeller. Its angular velocity changes which also results in increasing the pressure of liquid. Centrifugal pump has wide range of head and discharge.

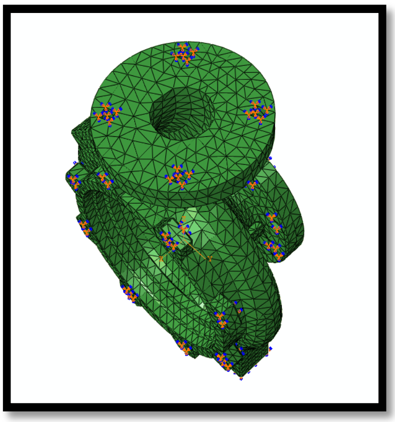
In recent times the casing of centrifugal pumps are made of ductile iron which makes it a metallic component and are prone to corrosion and manufacturing takes a long time. Therefore the metallic component has been replaced by ABS (acrylonitrile butadiene styrene), which is a non metallic component having a better corrosion resistance when compared to ductile iron, manufacturing can be done easily and it also reduces the weight of the pump. L.A Utracki, F.Nordgren And M.Nyquist [1, 2, 3] reported that the addition of ABS TO PC minimises the drawbacks of ABS such as poor flame, chemical resistance and low thermal stability without affecting its material properties and also generates other useful characteristics such as glossiness and low temperature toughness.Pradeep Kumar Uddandapn [4] conducted impact analysis on car bumper by varying speeds using ABS plastic and carbon reinforced poly ether imide by FEA(solid works). He replaced steel by PEI and ABS plastic and came to a conclusion that ABS plastic is better to be utilized than PEI since it has high impact strength. Jagdish Shinhare And S.B Jain [5, 6] studied the main objective to introduce ABS plastic substrate in place of RT duroid for microwave filters. The cost of ABS plastic was less than that of RT duroid and it was tested. The performance of filters was verified over temperature range of -10 degree Celsius to 60 degree Celsius and he concluded that the performance of ABS plastic microwave filters was superior when compared to that of RT duroid and it was of low cost and light weight.

2. Methodology

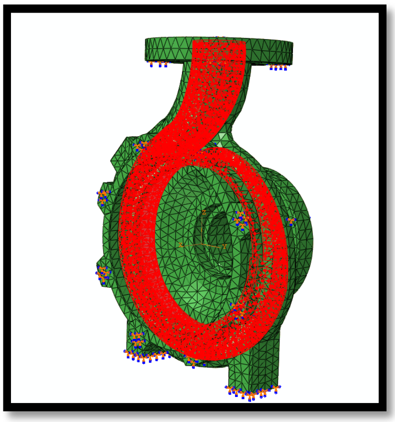
1. 3D modelling of the casing is made and the meshing is done using hyper mesh.
2. Loading condition and boundary condition are applied
3. By selecting the appropriate material properly the pressure input for loading in bar is applied i.e. 2 bar, 4 bar, 6 bar and 8 bar.
4. Linear static analysis is carried out and the results are compared with ductile iron results



Tetramesh Of Centrifugal Pump Casing In Wireframe Mode



Fixities Of Centrifugal Pump Casing



Pressure Application Location Of Centrifugal Pump Casing

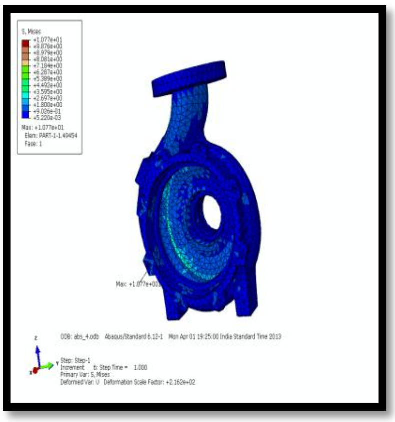
The pressure input for loading is as tabulated below.

S.I NO.	PRESSURE in Bar
1	2
2	4
3	6
4	8

3. Results and discussion

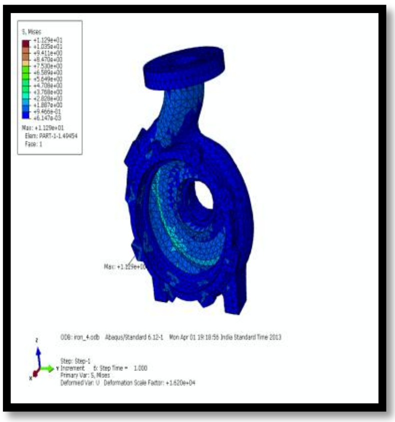
Maximum Stress Plots for 4 bar pressure

Stress Plot Results



Maximum von-mises stress plots (abs material)

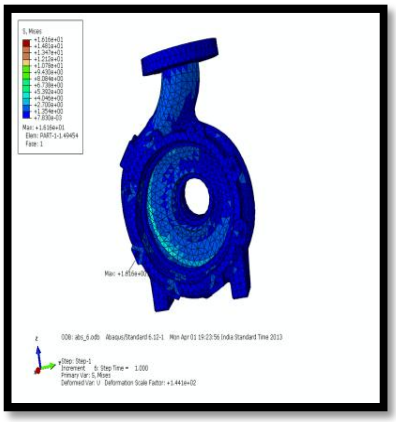
From the above figure it is clear seen that maximum von-Mises stresses(10.77 Mpa) induced are well below the allowable stresses and, are induced at the inner circumference of the casing i.e. the inner fillet region of the casing.



Maximum von-mises stress plots (ductile iron material)

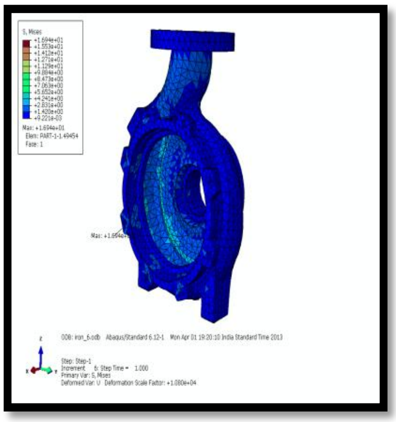
From the above figure maximum von-Mises stress (11.29 Mpa) induced are well below the allowable stresses and the maximum stresses location is same as for the materials, but the maximum stresses are higher then that compared to ABS materials (10.77Mpa) for the same pressure.

Maximum Stress Plots for 6 bar pressure



Maximum von-mises stress plots (abs material)

After increasing the inlet fluid pressure to 6bar from 4bar, the maximum von-Mises stresses induced is 16.16Mpa which is below the allowable stress and, the induced stress location is same as that of 4bar pressure.



maximum von-mises stress plots (ductile iron material)

After increasing the inlet fluid pressure to 6bar from 4bar, the maximum von-Mises stresses induced is 16.94Mpa which is below the allowable stress and, the induced stress location is same as that of 4bar pressure. From the figure in section 5.1 and 5.2 t is clear that the fluid pressure can be increased further.

Maximum Stress Plots for 8 bar pressure

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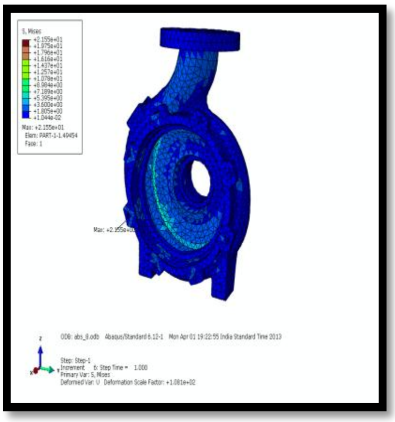
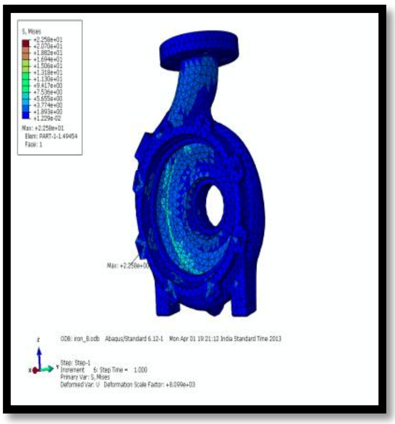


Maximum von-Mises stress plots (ABS MATERIAL)

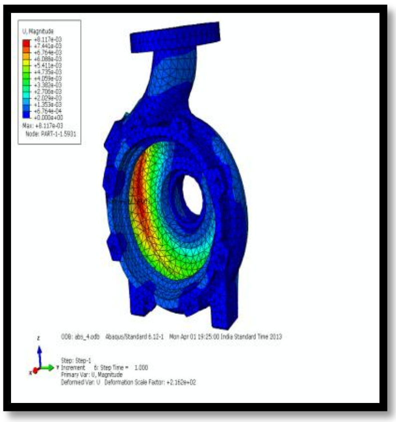
From the above figure it is clear seen that maximum von-Mises stresses (21.55Mpa) induced are well below the allowable stresses and the stress location are same in all the cases.



Maximum von-Mises stress plots (ABS MATERIAL)

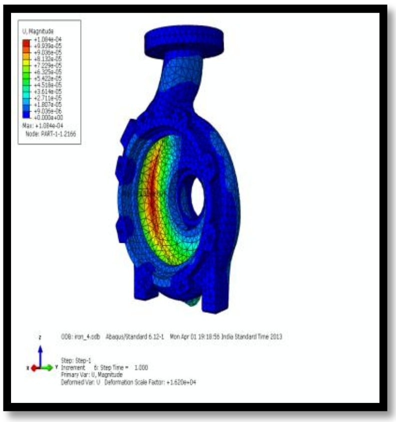
From the above figure it is clear seen that maximum von-Mises stresses (22.50Mpa) induced are well below the allowable stresses and the stress location are same in all the cases

DISPLACEMENT PLOTS
DISPLACEMENT PLOT RESULTS



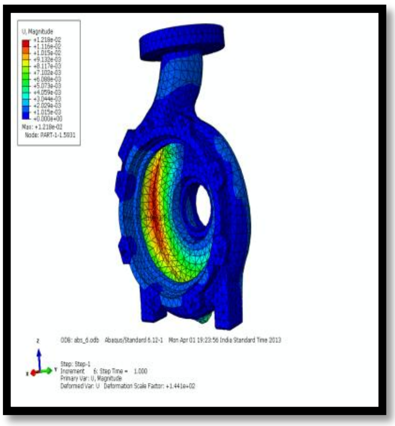
Maximum von-Mises stress plots (ABS MATERIAL)

The maximum nodal displacement found to be 0.117e-3mm for 4bar fluid pressure with ABS as the material.



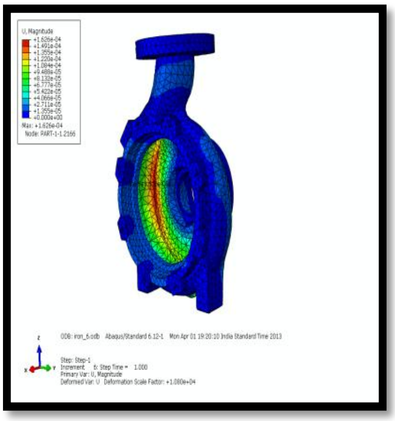
4 Bar Pressure, Ductile Iron Material

The maximum nodal displacement found to be 1.08e-4mm for 4bar fluid pressure with ductile iron as the material.



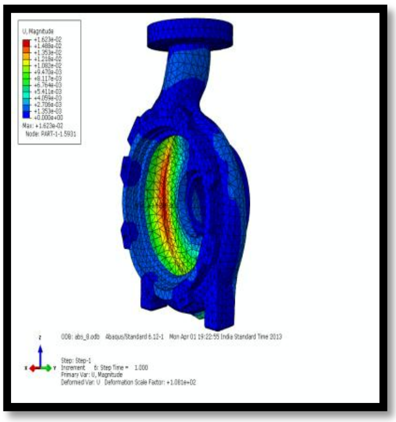
6 BAR PRESSURE, ABS MATERIAL

The maximum nodal displacement found to be 1.218e-2mm for 6bar fluid pressure with ABS as the material. From the above figure it is seen that the maximum displacement induced are comparatively higher.



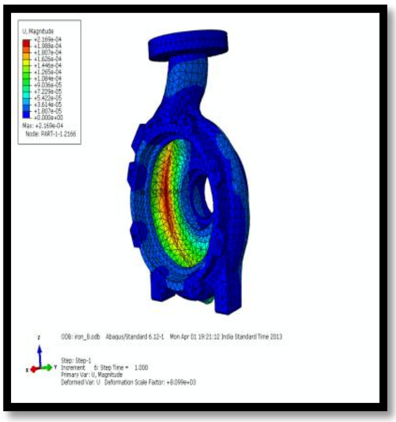
6 Bar Pressure, Ductile Iron Material

The maximum nodal displacement found to be 1.626e-4mm for 6bar fluid pressure with ductile iron as the material. Comparing the nodal displacement of ABS and ductile iron material, it is clear that iron is stiffer.



8 BAR PRESSURE, ABS MATERIAL

The maximum nodal displacement found to be 1.623e-2mm for 8bar fluid pressure with ABS as the material.



8 Bar Pressure, Ductile Iron Material

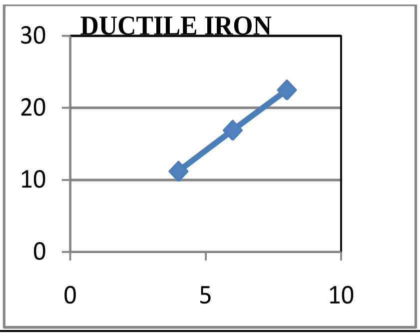
The maximum nodal displacement found to be 2.169e-4mm for 8bar fluid pressure with ABS as the material.

Comparing all the load cases, the maximum nodal displacement for both the material is increasing linearly, but the increase in ABS material is higher then the iron casing.

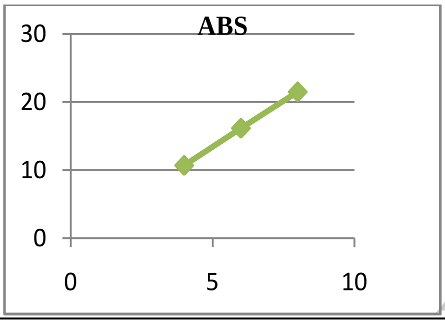
The results are plotted Vs Pressure, i.e. Stress Vs Pressure and Displacement Vs Pressure.

PLOTS:

Pressure Vs Stress



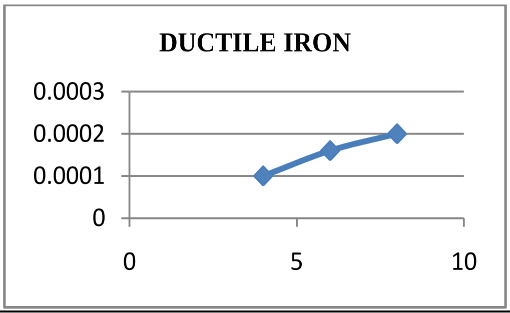
pressure vs stress, ductile iron material



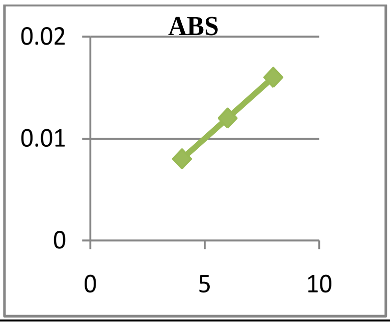
pressure vs stress, abs material

PLOTS:

Pressure Vs Displacement



pressure vs displacement, ductile iron material



pressure vs, displacement abs material

4. Conclusions

As metallic components get prone to corrosion, as it is regularly used with water or other fluids, which in turn leads to weaken the structure, The ABS material is corrosion free. The result obtained shows the ABS material exhibit almost same resistance as ductile iron.

The FEM results from the abacus shows the mirror reflection of ductile iron is ABS material. The obtained results are validated through the test data. The results also put front that ductile iron can be replaced with ABS material.

5. references

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