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RESEARCH ARTICLE

Design and Finite Element Analysis of Industrial Radial Flow Impeller.

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Abstract

This paper is concerned with the finite element analysis and modal testing of an industrial radial flow impeller. The goal is to determine and verify the vibration and stress characteristics of the impeller using analytical techniques. The static structural of the impeller with tapered blades was built using Cero. The convergence properties of the FE model was then verified by mesh refinement and mass distribution methods. Next, a pre-test plan was performed before conducting a modal test in order to select the material on the impeller. Analysis testing using modal analysis techniques was used to measure the vibration properties of the impeller, components. The natural frequencies graph was then compared with the same results obtained from static structural and showed good agreement. Finally, a parametric study was conducted on disc thickness, blade thickness, leading edge profiles and blade mistuning. It was found that the effect of varying disc thickness on the lower modes of the impeller was not significant. However, significant natural frequency shifts were observed for the higher modes. It was also concluded that varying the blade leading edge position had a marked effect on the natural frequencies while the lower modes were somehow insensitive to the variation of trailing edge position.

Introduction:-

In this chapter, we introduce the components in the centrifugal pump and range of the pump types produced by Granados. This chapter provides then reader with a basic understanding of the principles of the centrifugal pump and pump terminology. The centrifugal pump is the most used pump type in the world. The principle is simple, well-described and thoroughly tested, and the pump is robust, effective and relatively inexpensive to produce. There is a wide range of variations based on the principle of the centrifugal pump and consisting of this are basic hydraulic parts. The majority by Granados are centrifugal pumps.

Which cost to minimize, first cost or life-cycle cost, however, is an important consideration from a life cycle viewpoint, we must take into account power consumption and operation and maintenance costs. These considerations call for optimizing efficiency, reliability (the mean time between failures) and maintainability (the mean time to repair). In general, designing to optimize these categories result in increased costs. Often, these considerations are not very important and we can design for minimum first cost. In appropriate cases, the engineer should initiate a dialog with the client concerning available options. For example, designing a boiler feed pump that operates continuously would probably call for maximizing efficiency. Efficiency considerations would not be so important, however, for a drainage pump that is only required to operate occasional.

Methodology of Flow Charts:-

The geometry is generated with the aim of subdivision into multiple blocks. First, the impeller is generated, One impeller channel is meshed and is then rotationally copied the necessary number of times. For the first pump, the impeller is completely two- dimensional. The impeller mesh is made with hexahedra and wedge cells. For the second pump, the impeller channel is much more complex. The mesh is made in a completely understructure way, mainly using tetrahedral, but other cell forms like pyramids, hexahedra and wedges also occur. The inlet channel is meshed for both pumps with prisms. The volute in both pumps is too complex for a structured grid. The meshing is done in an unstructured way, mainly using tetrahedral. For the first pump the cross section is rectangular.

Introduction of Impeller Analysis

- Reverse Engineering of impeller model.
- Electrical energy convert to mechanical energy
- Pump is a mechanical device generally used for raising liquids from a lower to a higher one.
- Material change, blade change thickness change to (power, load) reduction.

Geometry Properties:-

Standard Material	Cast iron
Standard Thickness	3mm,
Standard Blade	5 Blade

Table 4.1 Standard For Impeller

3D Model and Boundary Conditions:-

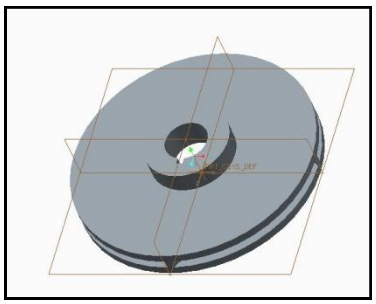


Fig 5.1 Industrial Radial Flow Impeller

Apply the Boundary Conditions

Pressure =0.15mpa

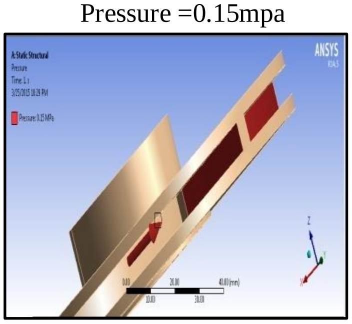


Fig 5.2 Applying Pressure

Moment=3.896 N.m

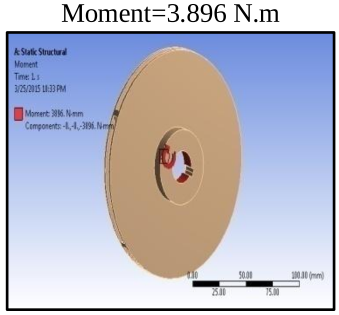


Fig 5.3 Moment of impeller

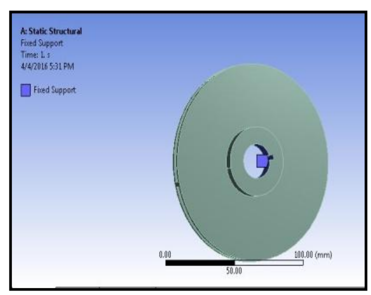


Fig 5.4 Fixed Support

Condition:-

Material	Thickness	No of Blades
Cast iron	3mm	4 blade
Steel	4mm	5 blade
		6 blade

Table 5.1 Condition

Step of Procedure

- STEP 1 (Geometry)
  Geometry select of impeller model

- STEP 2 (Material Properties)
  Steel, Aluminum Alloy, Stainless Steel
- Choose menu path Main Menu>Processor> Material Props>-Constant – Isotropic.
  The Isotropic Material properties dialog box appears.
- STEP 3 (Mesh)
  Element quality measured by MESHING
- Choose menu path Main Menu>Preprocessor>-Meshing-Mesh>-Areas-Mapped. The Mesh Areas picking box appears. Click on Pick All.
-

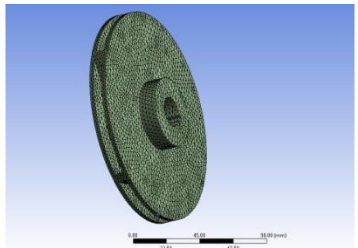


Figure 5.5 Mesh View

- STEP 4 (Statics Load)
  Boundary Condition→
  Pressure (0.15mpa): Moment (3.89.m) : Fixed support

Result For Analysis:-

Cast iron:-

6.1.1) 4blade, 3 mm thickness

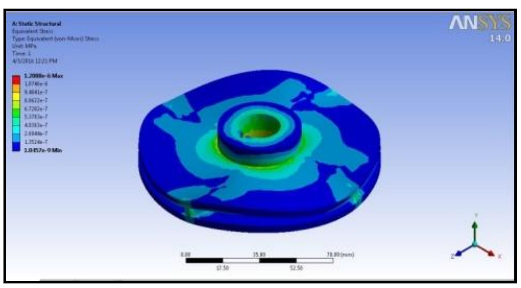


Fig 6.1 Equivalent stress

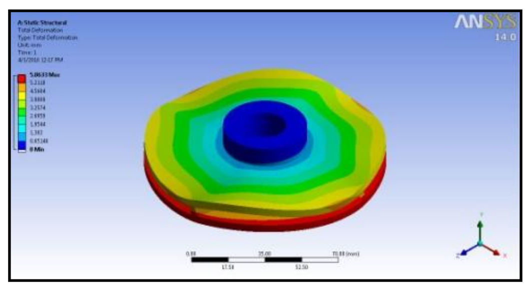


Fig 6.2 Total deformations

6.1.2) 4blade, 4 mm thickness

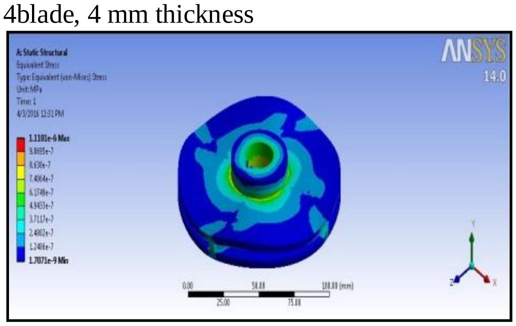


Fig 6.3 Equivalent stress

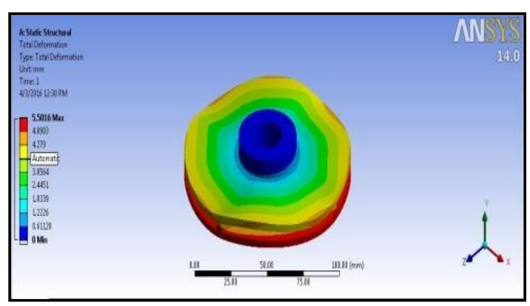


Fig 6.4 Total deformations

6.1.3) 5 blade, 3mm thickness

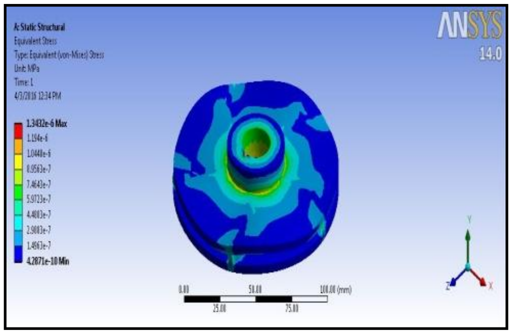


Fig 6.5 Equivalent stress

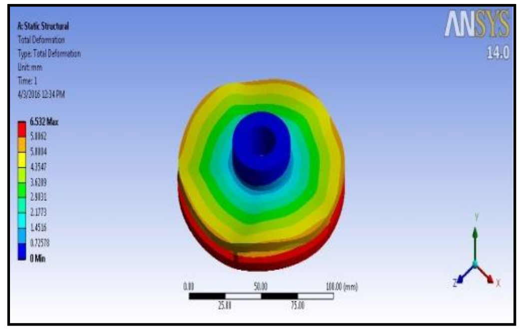


Fig 6.6 Total deformations

6.1.4) 5 blade, 4mm thickness

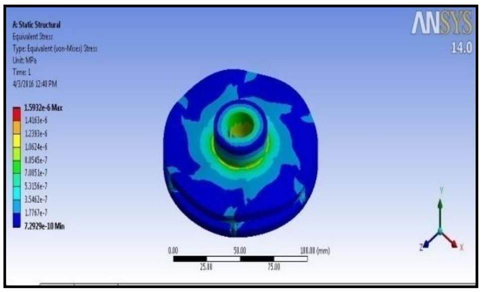


Fig 6.7 Equivalent stress

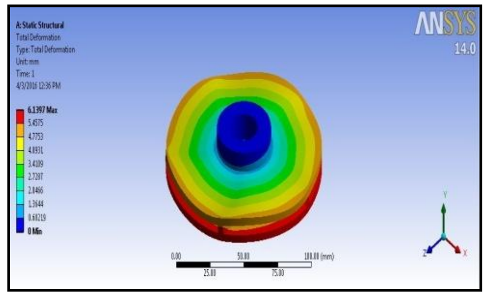


Fig 6.8 Total deformations

6.1.5) 6blade, 3mm thickness

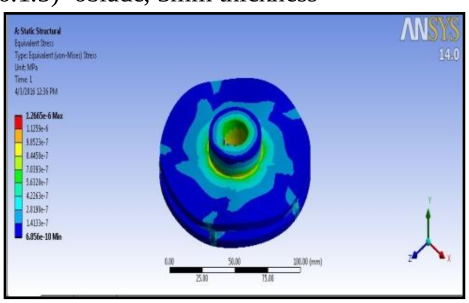


Fig 6.9 Equivalent stress

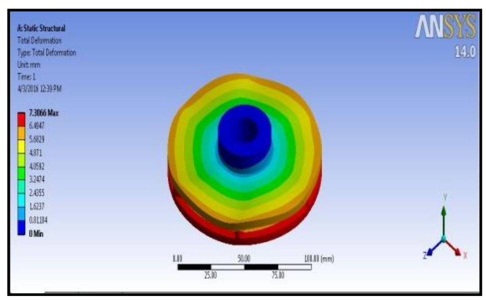


Fig 6.10 Total deformations

6.1.6) 6blade, 4mm thickness

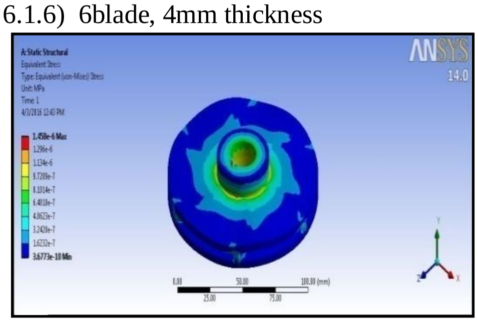


Fig 6.11 Equivalent stress

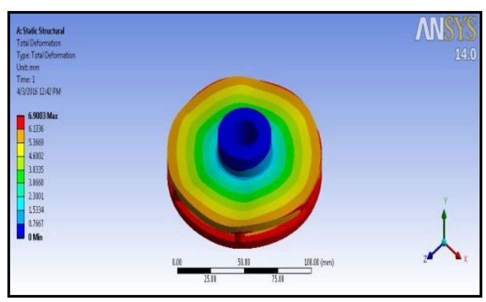


Fig 6.12 Total deformations

Structural steel:-

6.2.1) 4 blade, 3 mm thickness

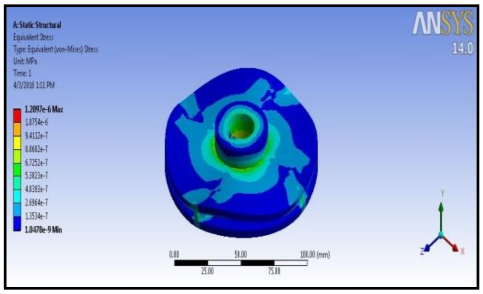


Fig 6.13 Equivalent stress

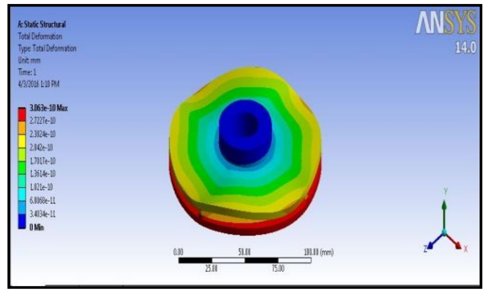


Fig 6.14 Total deformations

6.2.2) 4 blade, 4 mm thickness

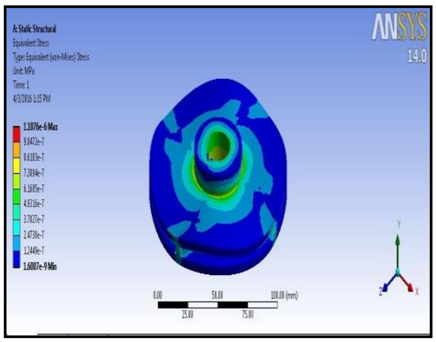


Fig 6.15 Equivalent stress

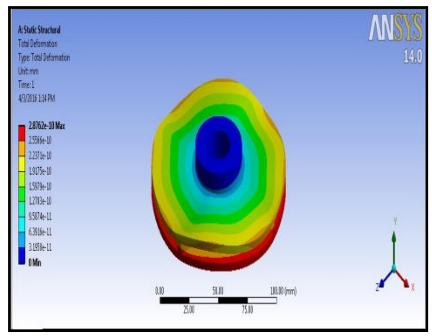


Fig 6.16 Total deformations

6.2.3) 5blade, 3 mm thickness

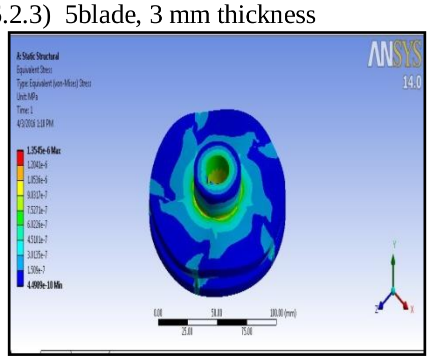


Fig 6.17 Equivalent stress

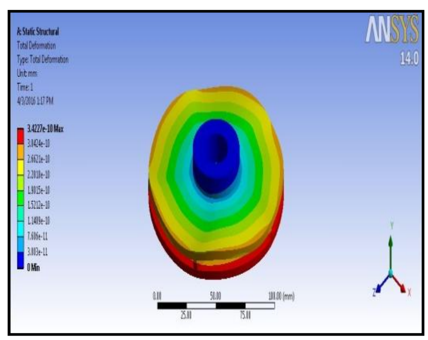


Fig 6.18 Total deformations

6.2.4) 5blade, 4mm thickness

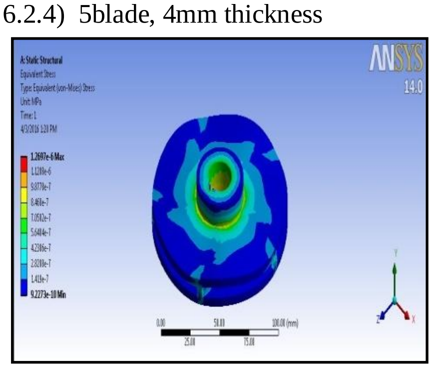


Fig 6.19 Equivalent stress

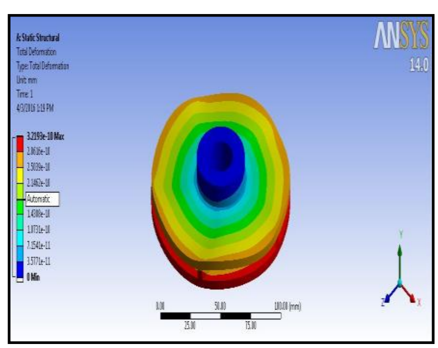


Fig 6.20 Total deformations

6.2.5) 6blade,3 mm thickness

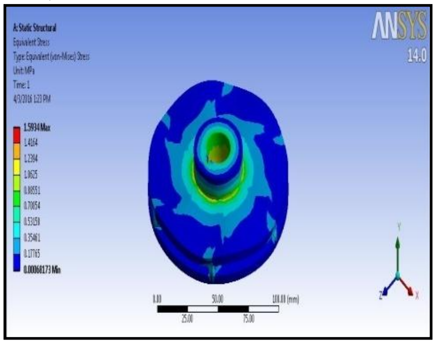


Fig 6.21 Equivalent stress

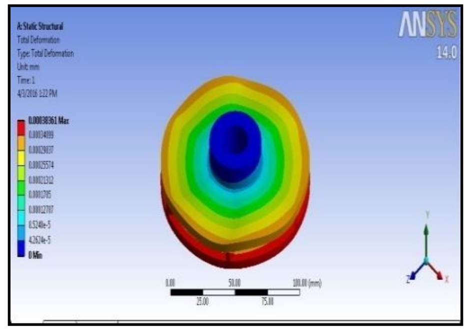


Fig 6.22 Total deformations

6.2.6) 6 blade, 4mm thickness

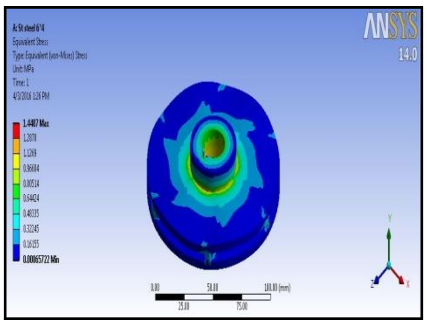


Fig 6.23 Equivalent stress

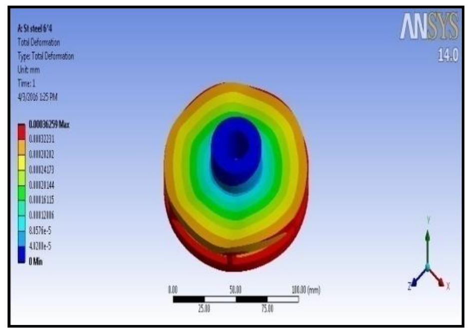


Fig 6.24 Total deformations

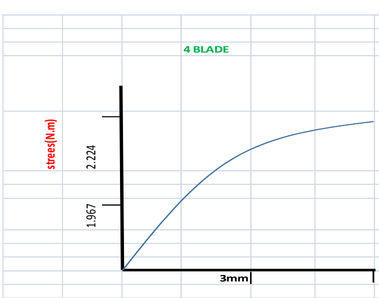
Comparisons:-

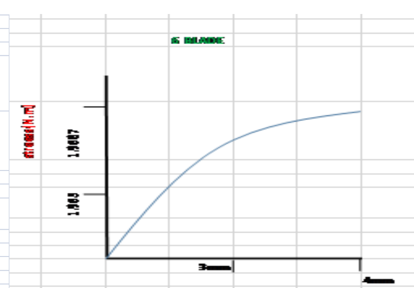
	No of Blade	4 BLADE		5BLADE		6BLADE	
	Blade in thickness	3mm	4mm	3mm	4mm	3mm	4mm
	Equivalent Stress(mpa)	max=2.2244	max=1.967	max=2.2816	max=1.922	max=1.9687	max=1.9653
		min=0.0052459	min=0.0060249	min=0.0079728	min=0.0058169	min=0.0027066	min=0.004322
CAST IORN							
	Total Deformation(mm)	max=0.0011481	max=0.0011338	max=0.0013469	max=0.0013138	max=0.0015889	max=0.0015462
		min=0	min=0	min=0	min=0	min=0	min=0
	Equivalent Stress(mpa)	max=2.2309	max=1.9707	max=2.2978	max=1.9097	max=1.9647	max=1.9607
		min=0.004969	min=0.0062202	min=0.077318	min=0.0061	min=0.0021556	min=0.0043852
STEEL							
	Total Deformation(mm)	max=0.0006386	max=0.000633058	max=0.0007501	max=0.0007318	max=0.00088518	max=0.00086125
		min=0	min=0	min=0	min=0	min=0	min=0

Fig 6.25 Comparisons table

Difference between Charts

Cast Iron





Structural Steel

Discussion and Conclusions:-

1.Mass of the impeller, keeping same thickness of impeller is 4blade=3mm, 4mm(thickness), 5blade=3mm, 4mm (thickness) and 6blade=3mm, 4mm(thickness) components decreases in the sequence of cast iron, and steel, due to density.

2. Equivalent stress is least for, less for Cast iron and high for steel.

3. Total and directional deformation for Cast iron less than steel

Future Scope Of Work

In future scope for work, the fan can be simultaneously designed by simulation checking for both flow and structural performance. Also now-a-days materials like steel and stainless steel are replacing aluminium these can be thought of as alternative, unless proving their reliability.

Reference:-

1. Takemura T and Goto A 1996 Journal of Turbo machinery
2. Goto A 1997 Prediction of diffuser pump performance using 3D viscous stage calculation FEDSM
3. 340 ASME Fluids Engineering Division Summer Meeting.
4. Sedlar M and Mensik P 1999 Investigation of rotor/stator interaction influence on flow fields in radial
5. Sideris M and Van den Braembussche R 1987 Journal of Turbomachinery
6. Miner S, Beaudoin R and Flack R 1989 Journal of Turobomachinery
7. Liu C, Vafidis C and Whitelaw J 1994 Journal of Fluids Engineering
8. Cugal M and Bach'e G 1997 Performance prediction form shutoff to runout flows for a complete stageof a boiler feed pump using computational fluid dynamics FEDSM97-3334 ASME Fluids Engineering
9. Division Summer Meeting
10. Gugau M, Matyschok B and Stoffel B 2001 Experimental and 3D numerical analysis of the flow field in a turbocharger compressor Proceedings: Fourth European Turbomachinery Conference SGE,