FINITE ELEMENT STRUCTURAL & THERMAL ANALYSIS OF LOCK PLATE

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Abstract
In Centrifugal Pipe Casting machine, hot molten metal is injected from one end and the other end remains closed by a covering plate having standard dimension. This covering plate is locked by a worker with the help of a spanner. This covering plate again needs to be opened after completion of casting process for the extraction of the pipe from the mould. This paper discuss mainly focused on the analysis of locking plate and its new design so that the human interference must be reduced to higher extent. Thus large amount of time can be saved which in turn will increase the productivity & reduce the cost of production.

Keyword: Centrifugal Casting, ANSYS, FEM, Thermal Analysis, Structural Analysis etc.

1.0 INTRODUCTION

Centrifugal casting machine is used to mould cast iron pipes which are of great demand in the market. These pipes are used in great extent in various needs of our daily life like water supply pipes, sewage pipes etc. In this tough market, every company is trying utilized their money, their research, their expertise to stand well. The main aim of every industry is to reduce their manufacturing lead time, increase the rate of production, reducing cost of labour-in short they are adopting the policy of cost cutting in every possible ways to maximize their profit.

1.1 Dimensions Available From Industry

- Specifications for max 6 inch Diameter Pipe,
- Internal Diameter of mould = 252 mm;
- Outer diameter of covering plate = 250 mm;
- Thickness of Covering plate = 12 mm;
- Bore diameter = 60 mm;
- Max speed = 1500 rpm;
- Average speed = 1200 rpm;
- Contact surface thickness = 11.5 mm;
- Temp. Of the molten metal = 1500ºC;
- Temp. Of the covering plate = 1400ºC.(max)

Figure 1.1 Molten metal Sprinking out from cavity.

The cavity must be closed down so that molten metal shoud not come out and the hazard to worker is reduced. Conventionally this locking and unlocking is done manually; which also increases chances of accidents to workers as it is at very high temperature.

Figure1.2 Attachement of Lock Plate (Manual)

2.0 COMPONENTS OF LOCK PLATE

2.1 Base plate

- 250 mm dia thickness 20 mm
- Mild Steel material
- We can use any shape any material as per requirement.

Figure 2.1 Base plate

2.2 Lever and Bearing

- 6204 Steel Bearing

Figure 2.2 Lever and Bearing

2.2 Guide Plate

- Mild Steel material
- Holes are provided on the circumference of the plate for insertion of locking wire.
- Wire used are accelerator cables of two vehicles
- Guide plates are mounted on bearing as shown follows

Figure 2.3 Guide Plate with Lever and bearing

2.3 Total Assembly of Lock plate

Figure 2.4 Front View of Lock Plate with magnet for attachment and deattachment of plate into machine

Figure 2.5 Side View of Lock Plate with all arrangements

3.0 CALCULATIONS

- **Centrifugal Force**

Thickness of pipe =10 mm,

Diameter of pipe =152 mm,

Therefore, r = 76 mm,

Mass of Molten metal =15 kg,

Velocity of the molten metal =1200rpm

Centrifugal Force = $m.v^2 / r$

= (15 X 202) / 76

= 45 N

Keeping tolerance of 50%, for our design safety,

Centrifugal force = 70 N

4.0 FEM ANALYSIS USING ANSYS

4.1 A General Procedure For Finite Element Analysis

Certain steps in formulating a finite element analysis of a physical problem are common to all such analyses, whether structural, heat transfer, fluid flow, or some other problem. These steps are embodied in commercial finite element software packages (some are mentioned in the following paragraphs) and are implicitly incorporated in this text, although we do not necessarily refer to the steps explicitly. The steps are described as follows.

4.1.1 Preprocessing

The preprocessing step is, quite generally, described as defining the model and includes

- Define the geometric domain of the problem.
- Define the element type(s) to be used.
  - Define the material properties of the elements.
  - Define the geometric properties of the elements (length, area, and the like).
  - Define the element connectivities (mesh the model).
  - Define the physical constraints (boundary conditions).

- Define the loadings.

The preprocessing (model definition) step is critical. In no case is there a better example of the computer-related axiom "garbage in, garbage out." A perfectly computed finite element solution is of absolutely no value if it corresponds to the wrong problem.

4.1.2 Solution

During the solution phase, finite element software assembles the governing algebraic equations in matrix form and computes the unknown values of the primary field variable(s). The computed values are then used by back substitution to compute additional, derived variables, such as reaction forces, element stresses, and heat flow. As it is not uncommon for a finite element model to be represented by tens of thousands of equations, special solution techniques are used to reduce data storage requirements and computation time. For static, linear problems, a wave front solver, based on Gauss elimination, is commonly used. While a complete discussion of the various algorithms is beyond the scope of this text, the interested reader will find a thorough discussion in the Bathe book.

4.1.3 Postprocessing

Analysis and evaluation of the solution results is referred to as postprocessing. Postprocessor software contains sophisticated routines used for sorting, printing, and plotting selected results from a finite element solution. Examples of operations that can be accomplished include:

- Sort element stresses in order of magnitude.
- Check equilibrium.
- Calculate factors of safety.
- Plot deformed structural shape.
- Animate dynamic model behavior.
- Produce color-coded temperature plots.

4.2 Finite Element Generation

The IGES file is imported and meshing is done. Mesh Element type was Tetrahedran. Number of elements generated were 145831

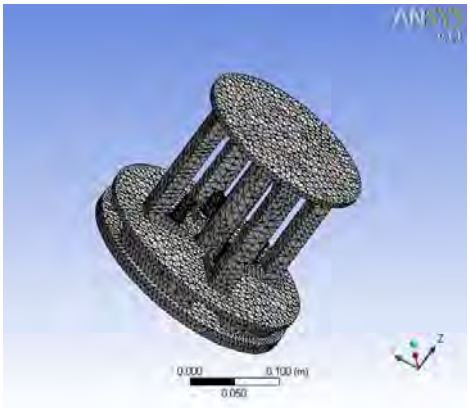

Figure 4.1 Meshed Geometry

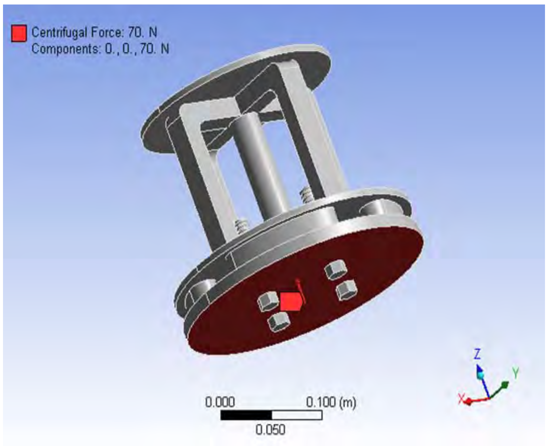

Figure 4.2 Applied force of 70 N

5.0 Results Observed

Following results were available after analysis is carried out

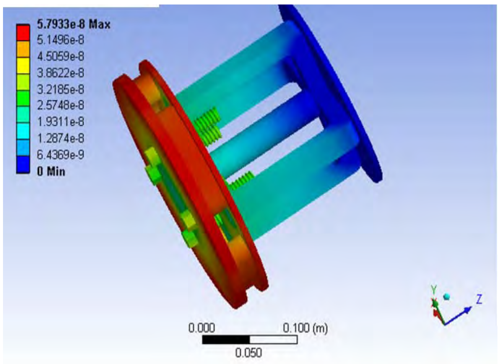

Figure 5.1 Deformation is Very less (i.e 5.7 X 10 $^{-5}$ mm) and hence the assembly would not fail

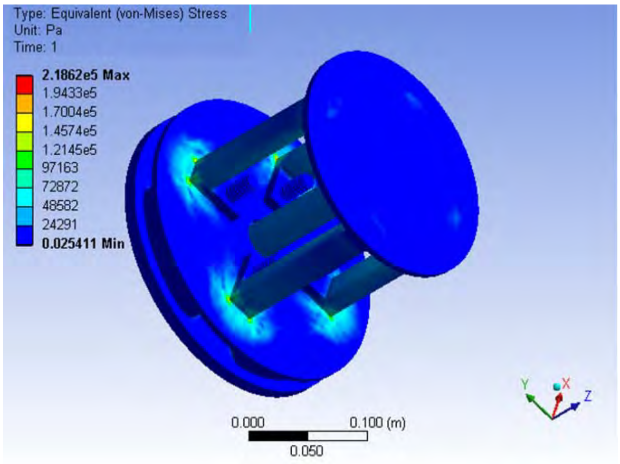

Figure 5.2 Von mises Stress Occurred in assembly.

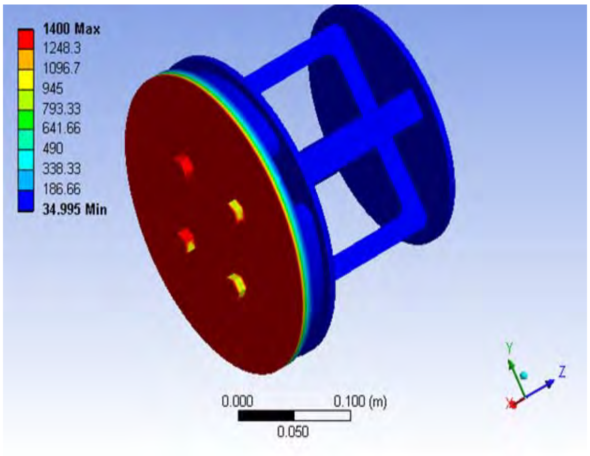

Figure 5.3 Temperature Distribution

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