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Study and Proposed Design of Centrifugal Casting Machine for Manufacturing of Turbine Bearing

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Abstract—*Centrifugal casting has been used for obtaining cylindrical parts with axisymmetry. The quality of tubular parts obtained during centrifugal casting process is strongly effected by process parameters like pouring temperature, rotational speed of the mould, pre heat temperature of the mould, pouring rate of molten metal and selection of proper material to be cast. The paper concerns to the study and proposed designs of horizontal centrifugal casting machine to produce bearing of steam turbine. The turbine bearing has dimensions: Diameter =1200 mm, Length =700 mm, Maximum weight of bearing =3000 kg and mold speeds before and after rotation are 10 RPM and 350 RPM respectively. Reliable technique to manufacture such dimensioned bearing is Centrifugal casting with controlled metal pouring. Depending on length to diameter ratio, the vertical casting machine is preferred to produce bearing of turbine. However, in vertical centrifugal casting, there is a tendency of molten metal to form a parabolic shaped under combined effect of gravitational and centrifugal forces. So, designs are proposed in form of drawings for dual faceplate centrifugal casting equipment which is horizontally aligned.*
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1. INTRODUCTION

The Casting produced by a process in which molten metal is poured and allowed to solidify while the mold is kept revolving, is known as centrifugal casting. In centrifugal casting, a permanent mold is rotated continuously about its axis at high speeds (300 to 3000 rpm) as the molten metal is poured. The molten metal is centrifugally thrown towards the inside mold wall due to the effect of centrifugal force $mr\omega^2$, where it solidifies after cooling. The cooling takes place from outside to inside the mold. Due to density effect, the particles of lighter weight will be thrown to the mold wall while heavy particles will be near to the axis of the job. Impurities and inclusions are thrown to the surface of the inside diameter, which can be machined away. Casting machines may be either horizontal or vertical-axis. Horizontal axis machines are preferred for long, thin cylinders, vertical machines for rings while Vertical machines are used for casting jobs having diameter higher than length.

2. TYPES OF CENTRIFUGAL CASTING MACHINES

2.2 Flanged Shaft Machine

This type of machine supports a mold on a flange as an overhung load. Horizontally molds are usually used to casting which are sufficiently long i.e. length to diameter ratio >1.5.

2.2. Roller type horizontal machine

This is a horizontal machine where mold is oriented horizontally axially on the rollers. Rollers are provided to support the rotor for rotation. The mold is covered by plates at one side and completely closed at another slide. The side where cover plate is placed, the hole is provided to protrude the pipe of molding spout in mold to pour the metal. The motion is provided to the rotors and transferred to the mold so as to rotate it. Using this machine, tubular structure which has length higher than diameter can be manufactured.

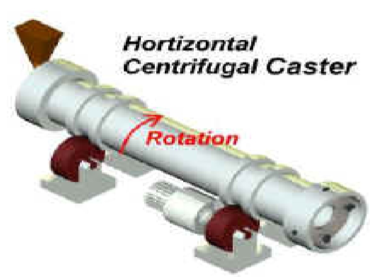

Fig. 1: Rotary type horizontal casting machine

2.3. Dual faceplate centrifugal casting machine

This is another horizontal centrifugal casting machine. In this, the roller are not provided to support the mould. Here, the mould is fixed to the rotating shaft. The faceplates are used for mounting the mould on rotating shaft with required clamping arrangement. It is developed to line bearing shells with the white metal. The structure of this machine can be treated as headstock and tailstock of lathe machine tool. The cover plates are fixed at both ends of mould. On one side, the hole is provided on cover plate to protrude the moulding spout inside mould to pour the metal. When the casting is finished, it is removed for extracting of extra material to achieve the required dimension.

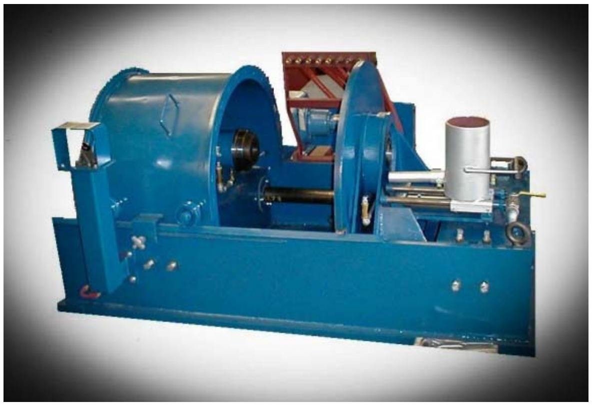

Fig. 2: Dual faceplate machine

2.4. Vertical axis centrifugal casting machine

In this machines, the moulds are oriented vertically. The mould is attached to the faceplate or flange of a vertical shaft. It requires less amount of space on shop floor. On the top side of the mould, the moulding spout is protruded inside the mould to pour the metal. Due to the effect of gravity while pouring material inside the cavity and with the effect of centrifugal force, the distribution of material takes place in such a way that parabolic shape may be generated. This machine is used where diameter of casting is more compared to length.

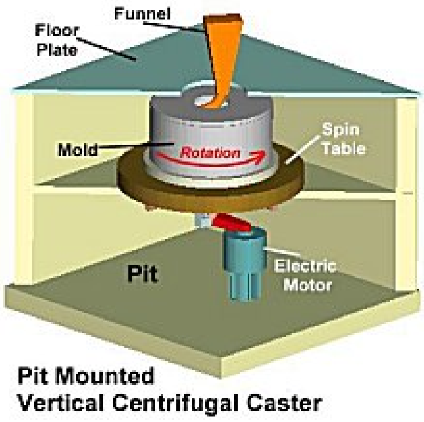

Fig. 3: Vertical axis centrifugal casting machine

3. LITERATURE REVIEW

Since a research work has been carried out throughout the world to investigate and analyze the effect of different operating parameters such as mould speed, vibration of Centrifugal Casting Machine, Centrifugal Pressure and mold wall thickness, comparison with gravity casting, on alternative proposed designs, CAD and FE analysis.

(1) Madhusudan et al have presented that the solidification takes place at faster rate as the thickness of mould increases. This is due to the chilling effect of the mould. The chilling effect on the casting depends on thermal mass of liquid metal and relative movement between the liquid metal and inner surface of the mould. Rapid solidification shows the well distributed fine grains and slow solidification rate shows coarse grain size.
(2) Madhusudan et al have presented that as the rotational speed increases the centrifugal force also increases which creates a strong convection in the liquid pool and this leads to the rapid cooling of the liquid. The rotational speed depends on the material centrifugally cast.
(3) Eurico Sabra et al have presented the design and development of a centrifugal casting equipment to produce engine pistons with gradient of properties. The conception and design of the envisaged equipment includes two main sections: the centrifugal equipment itself and the metallic mould. The alternate (proposed) designs are presented in the Figures 4, 5 and 6. Design-1 is very compact design due to less component but it has high vibration in shaft as there is no intermittent drive is used to power to output (mold). This results in poor working of equipment.

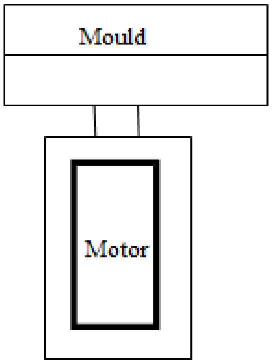

Fig. 4: Design 1

Design 2 shows the structural rigidity of the equipment. The power transmission is smoothly done due to the gear drive but due to high speed, the noise phenomenon may occur as in the case of spur gear drive.

Design-3 shows flexible drive system like pulley. There is low vibration in equipment and larger stability due to its rigid structure but special care has to be taken as in the case of belt drive due to belt slipping from the pulley. So, where high power transmission is required and space constraint is there, the use of gear drive is beneficial.

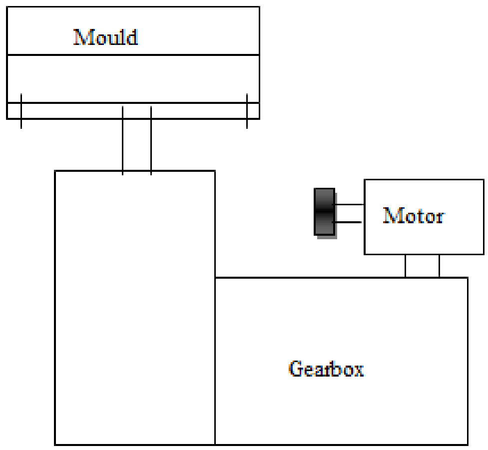

Fig. 5: Design 2

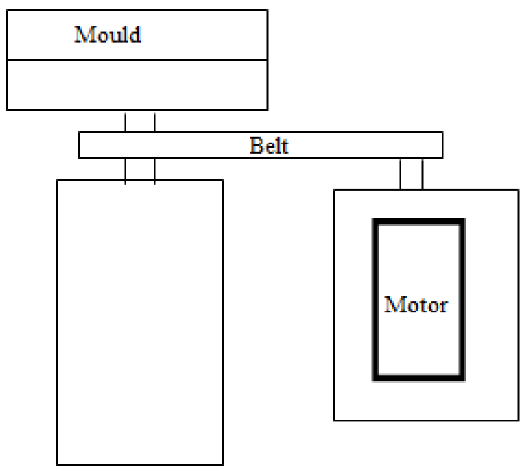

Fig. 6: Design 3

(4) Adedipe Oyewole et al have carried design and fabrication of a vertical centrifugal casting machine. They conclude that during rotation of the mould as the casting solidifies from the outside, the inner surface feeds the necessary molten metal to the reminder of the casting as required and the grain structure is created, ready for ejection. After pouring for a while the speed of the rotating mold has to be reduced to allow the molten metal to rotate freely on the wall of the mould.

(5) Nagesh Ijamulwar et al have carried out work on locking plate of centrifugal casting machine. They have found that during pouring of molten metal into mould, the end where spout is taken out ramains open. While rotating, there may be possible of sprinkling out of molten metal from the mould and it wll create hazardous effect. Due to this, the end should be closed so material will not be sprinkled out. While loading, workers need to do fastening the cover plate manually and it requires more time. This results in reduction in productivity.

4. SPECIFICATIONS OF PRODUCT FOR DESIGN OF CASTING EQUIPMENT

The dual faceplate horizontal centrifugal casting machine must be designed according to the following specification of turbine bearing:

(1) Length of bearing = 700 mm.
(2) Diameter of the bearing =1200 mm
(3) Maximum weight of the bearing = 3000 kg.
(4) Maximum rotational speed of mold =350 RPM
(5) Minimum rotational speed of mold = 10 RPM

5. Proposed Designs

5.1 Proposed Design 1

According to the requirement, the first thing is to hold the mold in the groove of faceplate such that there is an alignment of shaft as well as mold axes. Initially, the mold rotates at 10 RPM to pour the metal inside the mold. After pouring process, the speed will increase to 350 RPM. The centrifugal casting equipment must have provision for this. As shown in figure, 3-phase is motor is used as prime mover which is connected to variable frequency drive for changing the mold rotational speed. The power is transmitted through helical gear drive. The required output speed of system cannot achieve so to increase the speed, a belt pulley drive is used at output shaft.

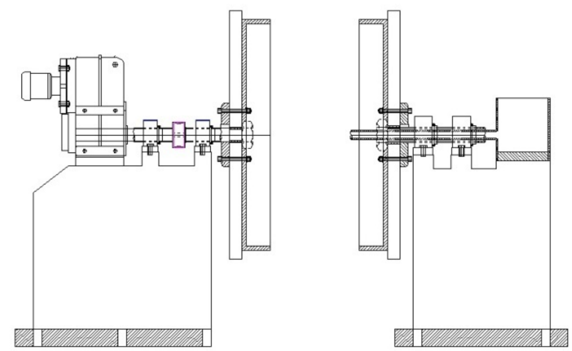

Fig. 7: Front View of proposed design 1

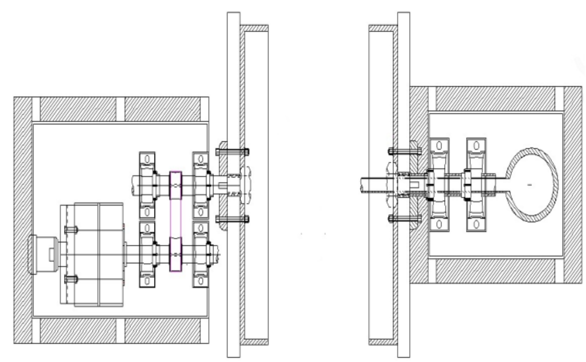

Fig. 8: Top view of proposed design 1

5.2 Proposed Design 2

As described in proposed design-1, to increase the speed, belt-pulley drive is used. In pulley drive, there are chances of slippage of belt, wearing of belt, sticking of belt and elongation of material fibers of belt. Due to these, pulley drive is less preferred to gear drive. In proposed design-2, the belt drive is replaced by spur gear drive (positive displacement drive) shown in Fig. 9 and 10.

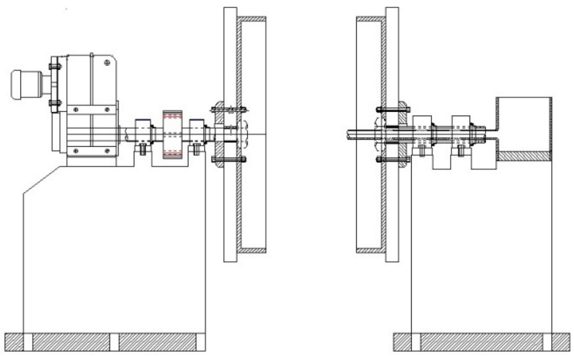

Fig. 9: Front view of proposed design 2

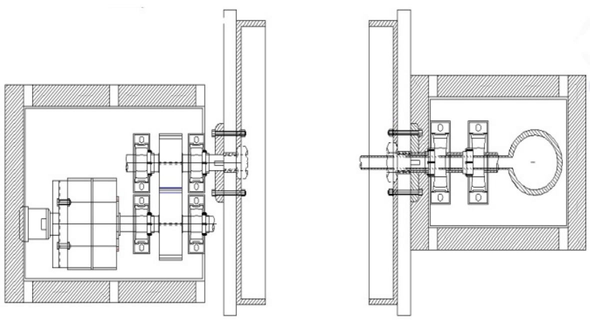

Fig. 10: Top view of proposed design 2

5.3 Proposed design 3

In the previous proposed designs, there is no provision to accommodate change in length of casting. In proposed design 3 shown in Fig. 11 and 12, the flat slideway is provided to and fro motion of the tailstock structure. The leadscrew and split nut mechanism is used to move the structure at operator's will. A single stage reduction worm gear is used to rotate the leadscrew.

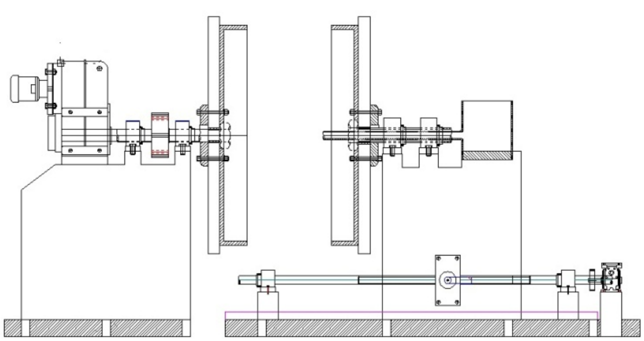

Fig. 11: Front View of Proposed Design-3

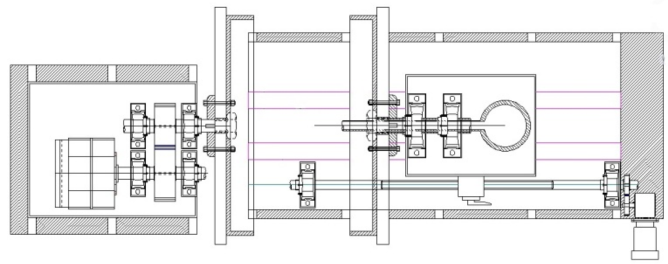

Fig. 12: Top View of Proposed Design

5. CONCLUSION AND FUTURE SCOPE

Proposed Designs are made according to the requirement. Proposed design will give an idea about the different parts that will come into consideration during design and selection. In next stage, detail design and selection of parts will be done and based on it, modelling of individual parts and assembly of the same will be prepared.

REFERENCES

[1] Madhusudhan, Narendranaath, S., Mohankumar, G.C.M., Mukunda, P.G., " Effect of Mould Wall Thickness on Rate Of solidification Of Centrifugal Casting ", *International Journal of Engineering Science and Technology*, ISSN: 0975-5762, Vol. 2(11), 2010, 6092-6096.

[2] Madhusudhan, Narendranath S., Kumar, G.C.M., Mukunda, P.G., " *Experimental Study on rate of solidification Of Centrifugal Casting ", International Journal of Mechanical and Materials Engineering (IJMME)*, Vol. 5 (2010), No. 1, 101-105.

[3] Adesina, A. S., and Adegbite, D. A., " Technology Adaption: Design of Centrifugal Casting Head ", *Journal of Engineering & Applied Science*, Volume 4, September 2012.

[4] Oyewole, A., and Sunday, A. M., " Design and Fabrication of a Centrifugal Casting Machine ", *International Journal of Engineering Science and Technology (IJEST)*, ISSN: 0975-5462, Vol. 3 No.11 November 2011.

[5] Jamulwar, N., Chimote, K., Bhambulkar, A., " Design and Implementation of Centrifugal Casting Locking Plate ", *International Journal on Computer Technology and Electronics Engineering (IJCTEE)*, Volume 2, Issue 2, April 2012, ISSN 2249-6343

[6] Wei, S., and Lampman, S., " *Centrifugal Casting* ", ASM Handbook, Volume 15: Casting, p: 667-673

[7] Erica Robertson, " The potential for centrifugal casting for the production of near net shape Uranium parts "