DESIGN AND MANUFACTURING AUTOMATIC(SEMI) PRECAST CONCRETE LID MANUFACTURING MACHINE

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Abstract - Along with the increasing economic needs in the development of construction, precast technology has become a primary solution that leads to the industrialization. This project deals with designing & manufacturing a machine for precast concrete lid to improve production rate at minimum manpower. Precasting a product with better quality with good strength at affordable price boosts precast industry to match customer requirements and meet client target. This paper focuses on the designing and construction of an integrated machine for a precast concrete lid as “Single Unit” where all precast production process can be completed in single unit. As working principle for Machine is ‘Hydraulic press’(though hydraulic cylinders) and these principle is used for important operation like Demolding & Pressing which leads to easy and fast production. It produces precast lid based on type of concrete supply to the machine. Thus production through machine enhances the productivity with good strength of lid at affordable price.

Keywords – Concrete lid, Precast concrete lid making machine, selection of type concrete, dry cast concrete

1. INTRODUCTION
In subsequent years, there will eventually increase the national cement consumption, either directly from the project activities or the impact of speedy economy growth. The use of precast concrete system offers several advantages, such as rapid erection, higher product quality, lower project cost, better sustainability, and improves occupational health and safety. There is greater control over material quality and workmanship in a precast plant compared to construction site. There are many different types of precast concrete forming systems for architectural application, different in size, function and cost. Stormwater drainage, water sewage pipes, U-drain lid make use of precast concrete units. The area of interest for this project is how to design and manufacture a machine making concrete lid to be more productive so the cost of concrete lid will be reduced. The relatively rapid development in compressive strength at early age and high sustainable compressive strength in the long term has made it become the main option for structural needs. The mold can be made of timber, steel, plastic, rubber or fiberglass, each material giving a unique finish. The color and size of aggregate can also affect the appearance and texture of concrete surfaces. The shape and surface of precast concrete molds have an effect and look.

2. PROJECT OBJECTIVES
The main objective of project is to solve the problem occurring in manual precast and Working on improving the design of a machine that works as single unit where all precast manufacturing process can be done in machine leading to increased productivity at better quality.
✓ Achieve better compressive strength.
✓ Easy and fast demolding process.
✓ Reduce manpower rate.
✓ Minimum mold setting and assembly time.
✓ Maintaining standardization of product by precasting concrete in single mold.
✓ Reducing overall fabrication cost.

3. **Problem identification**
   - As in manual precast number of mold frame increases as increase in production rate. Due to these increase in fabrication and raw material cost which leads to overall increase in cost of lid.
   - In manual precast Mold fitting and assembly of mold frame with base plate done by nut & bolt and using C-Clamp requires 2-3 person with as fitting accessories. Due to these accuracy of mold depend on person skill. As due human error improper fitting of mold dimensional error may occur leads to product rejection due improper dimension in lid (Diagonal error). Overall manpower cost increases.
   - In manual precast process concrete feeding is done with loading trolley and by using shovel from trolley concrete feeding is done in mold manually. As these is hard working process and time consumption is more. Due this manpower consumption is more.
   - In manual precast during feeding (concrete poring) process after some reptation cycle some amount of concrete deposit around mold accessories like nut & bolt or C-Clamp and after setting time concrete gets hard which damage the mold accessories. Due to this maintenance cost increase.
   - For demolding specific Siccor lifting hook is used which operated through crane which grabs the lid for lifting and transporting lid at storage area. required a skill operator in manual precast. For demolding operation skill operator is required. Sometimes due to human error during demolding lid corner of lid damages.
   - Strength of concrete plays important role in precast product so selection process of concreting is very crucial. In manual precast process Wet Cast process is used for production of lid.
   - Hence to improvise production method and avoid the problem occurring in manual precast process, Machine is Design & manufacturing is done considering these problem, where precast can be done easily with minimum manpower with better quality product at affordable price.

4. **DESIGN OF MACHINE**

A) **Design consideration /Assumption**
   In designing and fabricating a particular machine, there would be certain assumptions that are to be taken into account. The internal pressure or stress of the mould is evenly distributed. The type of lid, the composition of raw materials, compression pressure, weight, and standard dimensions as per the Indian standards were tabulated in Table-1
<table>
<thead>
<tr>
<th>Grade of concrete</th>
<th>Type of Lid</th>
<th>Area (mm²)</th>
<th>Compressive load (Kn)</th>
<th>Weight in Kg</th>
<th>Standard dimension in mm (L * b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M50</td>
<td>Wet cast concrete</td>
<td>22500</td>
<td>1160.5</td>
<td>8.5</td>
<td>150*150</td>
</tr>
<tr>
<td>M50</td>
<td>Dry cast concrete</td>
<td>22500</td>
<td>1260.6</td>
<td>8.77</td>
<td>150*150</td>
</tr>
</tbody>
</table>

Table-1

B) Design calculation

I. Hydraulic cylinder

Hydraulic cylinder and the power pump were designed after the following calculation:
- Active stroke length, the speed of piston, and an internal diameter of the cylinder.
- Pump discharge, speed, power, pressure, and torque of the pump.

II. Motor Selection

The selection of motor is based on following reason:
- Power required for the hydraulic pump.
- The torque needed for the pump.
- Shaft rotational speed.
- Environmental conditions of the site of application.

III. Mould

Depending upon the maximum stress exerted on the walls, the distribution of load intensity, cross-sectional modulus of mould walls were calculated along with the determination of factor of safety.

- Purpose of Design:
  Designing of mould shall be carried out to have secured and durable support for concrete casting.

- Basis of Design:
  The structure is considered to have pinned support on all four sides.

  Design of steel structure is carried out as per Indian code of standards referring to Woking stress method of design-IS 800.

- General:
  Structure simulation has been carried out using the structure simulation software STAAD. Pro V8i (Select Series 6).

- References:
  IS: 800-2007 : Steel Design Calculation
DATA:

a. Length of the Mould, \( L = 450 \) mm
b. Width of the Mould, \( B = 560 \) mm
c. Height of the Mould, \( H = 95 \) mm
d. Thickness of the Module, \( T = 20 \) mm

Dead Load

- Self Weight.
- Weight of concrete in mould \(-0.095 \times 25 = 2.375 \) kN/m²

Tensile stress

Max Tensile Stress in STAAD \(-0.533 \) MPa Allowable

Tensile Stress for Steel \(-250 \) Mpa.

Hence Safe.
<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HYDRAULIC CYLINDER A)CENTRE CYLINDER B) SIDE CYLINDER</td>
<td>A)single cylinder (center) has 500mm stroke length, capacity of 3 ton used in pressing application in a machine. B)Two cylinder (side) has 500mm stroke length, capacity of 3 ton used for movement of mold casing</td>
</tr>
<tr>
<td>2</td>
<td>PRESS RING</td>
<td>It is used for pressing operation after pouring process to avoid voids or honeycomb in lid</td>
</tr>
<tr>
<td>3</td>
<td>Mold casing</td>
<td>It is structural casing which gives required size of lid</td>
</tr>
<tr>
<td>4</td>
<td>Supporting structure</td>
<td>It supporting frame of whole machine</td>
</tr>
<tr>
<td>5</td>
<td>Foundation table</td>
<td>It is work as supporting member for mold casing and inside the table center- flange vibrator is attach.</td>
</tr>
<tr>
<td>6</td>
<td>RUBBER PAD</td>
<td>It is used for transferring vibration.</td>
</tr>
</tbody>
</table>

### Other accessories

<table>
<thead>
<tr>
<th>No.</th>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Motor</td>
<td>Single-phase 2HP motor with a nominal speed of 1440 rpm, rated current of 10.5 A, rated voltage of 230 V and a nominal frequency of 50 Hz.</td>
</tr>
<tr>
<td>8</td>
<td>Centrifugal pump</td>
<td>Multistage pump that creates the pressure required for the motion of oil from the oil tank. Coupled to the motor with the help of jaw coupling.</td>
</tr>
<tr>
<td>9</td>
<td>Hydraulic oil tank</td>
<td>It has a capacity of 30 litres and is made of mild steel. The tank contains an oil level indicator at the bottom part of it.</td>
</tr>
<tr>
<td>10</td>
<td>Hydraulic oil</td>
<td>Servo-68 is used as the hydraulic oil, which has a viscosity of 90 and flash point of 210°C.</td>
</tr>
<tr>
<td>11</td>
<td>Pressure control valve</td>
<td>It helps in regulating the pressure required for a particular LID</td>
</tr>
<tr>
<td>12</td>
<td>Pressure gauge</td>
<td>It measures the pressure of oil that flows in the pipe. It has a range of 0-20 MPa.</td>
</tr>
<tr>
<td>13</td>
<td>Hosepipe</td>
<td>It is a flexible hollow tube designed to carry fluids.</td>
</tr>
</tbody>
</table>

This above table shows important component along with description used in LID MACHINE

5. **Important parts of machine**

1) **MOLD CASING**

![Mold Casing Image]

- As above fig.A shows Mold Casing which is design in single form for precast concrete Lid having standard size 450-500-85thkm.
- As on mold casing guide block are attach which helps to easy and fast movement of press ring in it without any problem.
- As these mold casing is design in such way that if another size of lid is to precasted than for that bolting is removes from square plate, so whole new mold casing of required size can be attach.
- As this mold casing is fabricated as single unit, parts are design (IS-800) from 20mmthk plate so it resist maximum forces or stress acting on it during precasting.
- These structure is attach with two cylinder left and right which performs demolding operation.
- Rigid design of mold casing number of repetition increases leads enhance productivity with better accuracy.

2) **PRESS RING**

![Press Ring Image]
3) FOUNDATION TABLE OR SUPPORTING STRUCTURE

As above figure shows the foundation table which is design to withstand cylinder load or stresses acting during precast operation.
- The siting table is attach on foundation table with rubber pad through bolting (M16-75mm) to get better vibration transfer to mold casing during concreting.
- As vibration important part in precasting as less vibration cause pinhole or honeycomb in lid and if vibration is more segregation occur.
- So, considering all these criteria center flange vibrator is attach inside a foundation table at 400mm height from top of table plate.
- Vibrator motor specification (2 hp, 50hz, 1400-rpm)

Steps For Manufacturing Product
- Applying releasing oil on inner part of structural mold casing & cleaning.
- Adjusting base plate on table through locating pin matching with hole on the table.
- Pulling down structural mold casing down on table through two hydraulic attach on top of frame.
- Feeding concrete mix from the hopper inside mold casing operated through lead screw.
- Applying needle vibrator to remove air bubbles & honeycomb.
- Pressing the concrete mix through top plate attach with center hydraulic cylinder.
- Pulling up structural mold casing & final concrete lid (CAKE) ready.
- Precast concrete lid of 450*500*80mm is obtained as final product which is a standard size.

LIST OF FIGURES SHOWING MANUFACTURING PROCESS

- FIG.E
- FIG.F
- FIG.G

ACTUAL MACHINE SETUP

- FIG.H
- FIG.I
- FIG.J

- As above figure shows steps of precasting concrete lid, where after cleaning and oiling the mold casing is pushed downwards on table (FIG.E).
- After that concrete is fed inside the mold casing and vibrator is started (FIG.H).
- Then the vibrator is turned off and press ring is pushed downward inside the mold casing (FIG.I & F).
- After pressing the top ring and mold casing is pushed upward through hydraulic cylinder (FIG G & J).
5) **Conclusion**

Concrete lid making machine is designed as a single unit where most of the manufacturing operation is performed in a single unit. Accuracy in lid obtaining better as concreting is done in a single mold casing so standardization is maintain. Demolding is performed by hydraulic cylinder due to which demolding operation is easy and fast with minimum damage to lid edges. As in machine precast DRY-CAST concrete is used which leads to better strength then wet casting and improve load carrying capacity of lid.

**ACKNOWLEDGMENT**

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**REFERENCES**