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Motor operated automatic ramming machine

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ABSTRACT

Molding is one of the important metals forming process in manufacturing components for various applications in industry. It is important to make cast product precisely. Automation and sophisticated electronic in ramming process help to improve the foundry environment and accuracy of the cast parts. Reliability of cast product depends on various parameters like permeability, compactness, adhesiveness etc. Hence process of ramming in molding play a vital role in the process of casting. The defects occur in cast component leads to great problem in foundry and all associated industries. Hence this ramming machine found large application in manufacturing industry. The machine is operating on electric drive motor. Even though skilled labor is employed for ramming operation, the packing of molding sand will not be even throughout the molding box. So, we have selected the idea of fabricating "Motor Operated Automatic Ramming Machine". This machine is operating mechanically. By using this machine molding sand will be packed evenly throughout the box. Machine is operated by five electric motors which are electronically operated. The ramming tool rod work as a connecting rod hence rotary motion of motor converted into reciprocating motion of ramming tool. There are four lead screw which convert rotary motion of motor into linear movement of ramming tool and impart movement to it so that ramming tool move within entire working space so that ramming will be uniform on sand. Two lead screw used for imparting transverse motion to tool in the plane perpendicular to tool while remaining two are used for elevating the tool position in the plane of tool for further compaction of sand.

Keywords— *Ramming, Casting, Electronic controller, and Compaction*

1. INTRODUCTION

Casting is a process of making product by using mould cavity. Mould cavity is negative part of pattern, Pattern is a replica of final casting with some necessary allowances. Allowances are provided on the pattern to eliminate the defect that cause by various parameter like shrinkage of casting because of solidification of poured molten metal, damage to the mould wall during withdrawal of pattern. This defect involved in casting process are eliminated by providing allowances like shrinkage allowances, draft allowances, machining allowances. Many defects are still involved in casting which cannot be eliminated by providing any allowance. Many of this defect can e encountered by proper compaction of moulding sand. Defects like blow hole, porosity, rough casting surface, mould collapse (due to low compaction forces). hence compaction have direct and maximum influence on this defect. Therefore, by only proper compaction many defects can eliminate. Forces required for Compaction are vary with type of sand, water-sand mixture, surface finish of casting, additives in sand, etc. The ramming process is done by using a tool called rammer it is made up of wood or metal. Manual ramming done by human cannot produce constant force to compact sand for total ramming process. This varying forces during ramming introduce error in mould cavity which further affect final casting. In manual ramming rammer is operated by human operator while in automatic ramming machine it is operated by electric motor through linkages. The present invention proposes a new design in the field of manufacturing industries which uses casting as a manufacturing process. This setup allows the manufacturers to increase the rate of production by decreasing time for making mould. As the consumption of product is increasing the demand of producing the product at mass scale is also increasing hence our invention reduce the time for making mould. This setup allows the compaction of the sand by means of proper ramming. The ramming of sand is done by the ramming tool which reciprocate by crank and connecting rod mechanism. The ramming tool can move over entire workspace of mould box. This setup has electric motor, ramming tool, square threaded lead screw. Lead screws are placed on two different horizontal plane perpendicular to each other hence ramming tool can move in entire work space of mould.

1.1 Prior Acts

There are conventional ramming machines which are used to ram the sand. which just compact the sand by manual hammering. Other ramming machines are Pneumatic ramming Machine, hydraulic Machine and manual Machines. In the conventional ramming machine, the forces that act for compaction of sand are by the hammering action of operator. In this operator apply forces on the

sand by ramming tool. In pneumatic ramming machine hammering action of ramming tool is done by compressed air. When the machine is started the compressed air from compressor supply to pneumatic actuator which then actuate and apply force on sand.

Now the ramming of the sand happens in the following way:

(a) The ramming of sand is done by force exerted by ramming tool on sand
(b) The ramming tool may be the size of entire mould box instead of small square shape rammer.
(c) As the sand get compacted the length of stroke of cylinder is also increase.

But conventional ramming machines take too much time for ramming and the compaction of sand is not so uniform. In today's world mass production require less time for manufacturing a component but due to this limitation they can't. There are other ramming machines which can ramm the sand at much faster but the advance machines are far more expensive. So, in this invention all the above problems are rectified.

1.2 Objective of invention

Automatic Ramming Machine has been proposed in this invention. The new idea of Automatic Ramming Machine has been proposed in this invention. It means that the machine operation of ramming is conduct automatically by motors and controls. Hence our projects concentrate on providing an inexpensive ramming machine which in way superior that conventional ramming machine. The objectives of this invention are:

(a) Objective of the present invention is to provide high rate of mould making as compared to conventional ramming Machine
(b) Another objective of the present invention is to make facility easily portable
(c) Another objective of the present invention is to achieve uniform compaction of sand
(d) Yet another objective of the invention is to have accurate control over the working of the ramming tool with the help of a stepper motor and controller
(e) Yet another objective of the invention is to provide a better ramming machine than conventional ramming machine economically.

2. WORKING PRINCIPLE

The electric supply is given to the electronic controller. The controller is connected with motors, after switch on the controller it operates all motor with proper synchronization. One motor is used for reciprocating motion of rammer while other motors are used for linear travel of ramming tool. The motor start to rotate and hence rammer start to reciprocate. The movement of ramming tool operated by rotation of lead screw. The machine parameters are then set on the controller and the machine is started. So, as per the requirements of a mould the machine will ramm the sand.

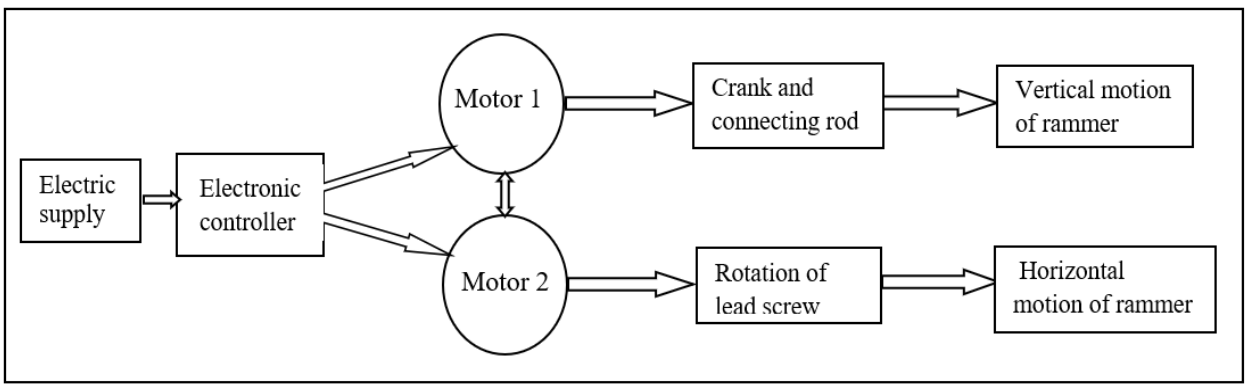

Fig. 1: Flow chart

2.1 Construction

A frame of 4 L-shape column and 4 horizontal beam work as a structure for entire machine and provide good rigidity. The vertical L-shape column are made of mild steel and 4 beams are made of wood. The columns and beams are firmly joining together with the help of bolts and nuts. This setup is look like a coordinate measuring machine or rapid prototyping machine. The ramming tool is operated by electric motor. The rotary motion of motor converted into reciprocating motion of ramming tool by means of crank and connecting rod mechanism. The length of crank and connecting rod is depends on length of stroke required for compaction of sand per stroke. The motor which operates ramming tool is mounted on one moving aluminum square block. This aluminum block (fig-2) move in the work space i.e. over moulding box (cope or drag) by means of two square threaded lead screw. This two-lead screw are operated by two stepper motor and both are placed in two different horizontal plane perpendicular to each other. Depending on the rotation of motor, the rotary motion of lead screw converted into linear motion of moving block i.e. ramming tool. There are two other square threaded lead screw which elevate the beams on column in vertical direction. Because with each stroke of ramming tool sand get compacted. So, in order to compact the sand fully we have to take down the beams at lower position. Lead screws are connected with spindle of motor by attachments or couplings. The stepper motors are mounted on the frame of beams. A controller is also connected to the stepper motor. The motor is connected with components like motor controller, Push buttons. The controller and motor works on single phase 230 V AC supply.

The foregoing objects of the invention are accomplished and the problems and shortcomings associated with prior techniques and approaches are overcome by the present invention as described below, in the preferred embodiment. The present invention has new techniques like the reciprocation of ramming tool by crank and connecting rod mechanism with the use of motor and lead screw for transverse movement of tool which has never been done before. First of all, aluminum block is taken and then it is machined or

mill and other manufacturing is done on the block and it is made like (Fig 2). The foundation of machine is made by 4 vertical columns. This vertical column is made of Mild Steel. This foundation is made such that it provides space for moulding box and rigidity to machine in order to damp the vibrations. The base is made as per the dimensions (Fig. 3). The horizontal beam provide space for motor mounting and lead screw. Lead screw is inserted into the beam length wise. Only two beams contain lead screw while other two contain guide ways like roller. There are two square threaded lead screw made by carbon steel. This lead screw is placed in horizontal plane perpendicular to each other. So that one lead screw moves the ramming tool in x- direction while other is in y-direction. The lead screws are mounted on the shaft of motor by means of coupling. The length of travel of tool in work space is governed by rotation of lead screw. The rotation of lead screw is controlled by electronic controller which measure the rotation of lead screw in the form of angle turned by screw. Hence the movement of tool is properly controlled. The upward and downward movement of rammer is done by converting rotary motion of motor into reciprocating motion by means of crank and connecting rod through motor mounting on the moving block. The controller is also fitted on its place. The controller works on single phase AC supply. The machine parameters which are covered in the controller are speed of motor in rpm, rotation of shaft.

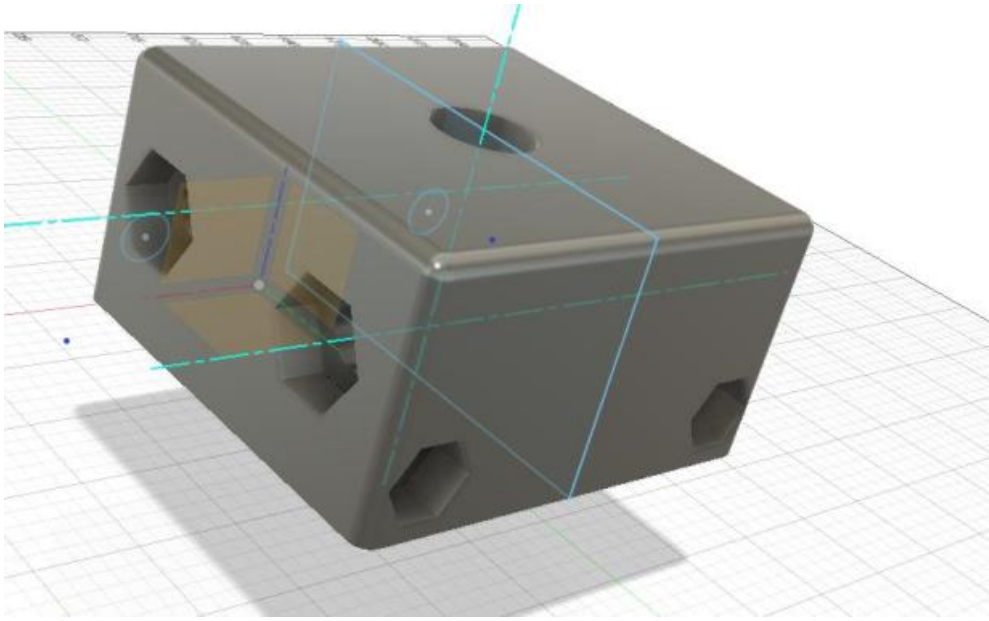

Fig. 2: Moving Aluminum Block

3. COMPONENTS

Table 1: List of components

Sr. No	Name of component	Quantity
1	Columns	4
2	Beams	4
3	Motors	5
4	Aluminium block	1
5	Lead screw	4
6	Guiding rods	4
7	Crank and connecting rod	1
8	Rammer	1
9	Couplings	4
10	Push buttons	4
11	Electronic controller	1

3.1 Base Structure

A frame of 4 L-shape column and 4 horizontal beam work as a structure for entire machine and provide good rigidity. The vertical L-shape column are made of mild steel (fig-3) and 4 beam are made of wood (fig-4). The columns and beams are firmly join together with the help of screws and nuts as shown in fig-5. It look like table without roof. Wooden beams of machines are made by using C-type cross section area block and two pairs of C cross section block forms one beam as shown in (fig-6). Among any four beams any two beams perpendicular to each other carry square threaded lead screw. Motors are mounted at the ends of that beam only. Beams are connected with columns by nuts and bolts. Beams are use in structure structure bear loads but in case of automatic ramming machine there is no direct load on beams hence choice of wood will provide all require strength to structure. fig -5 show complete structure.

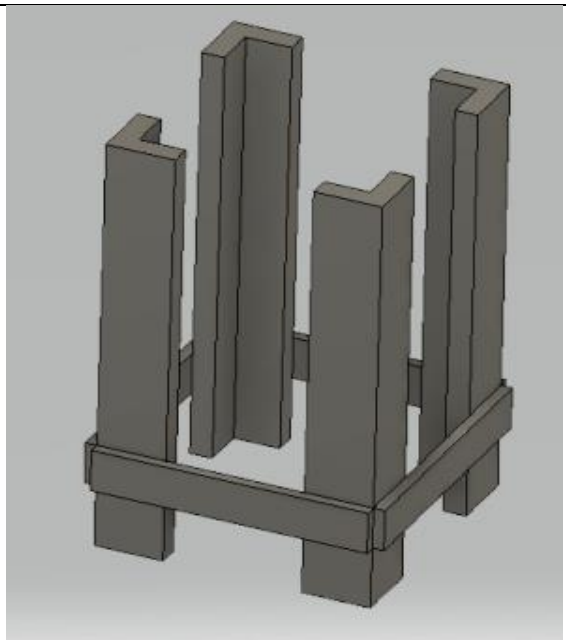

Fig. 3: Columns

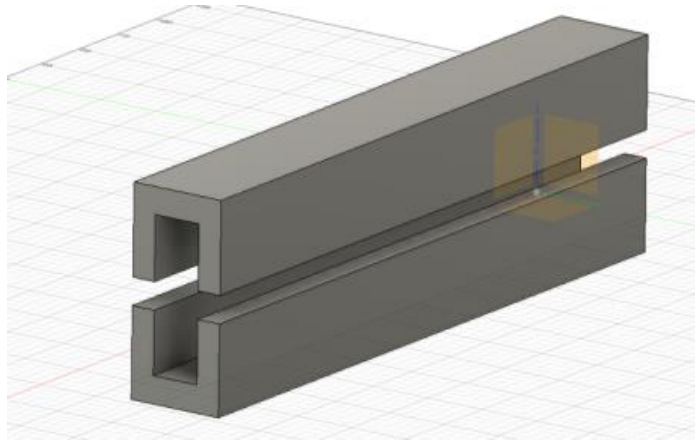

Fig. 4: Beam

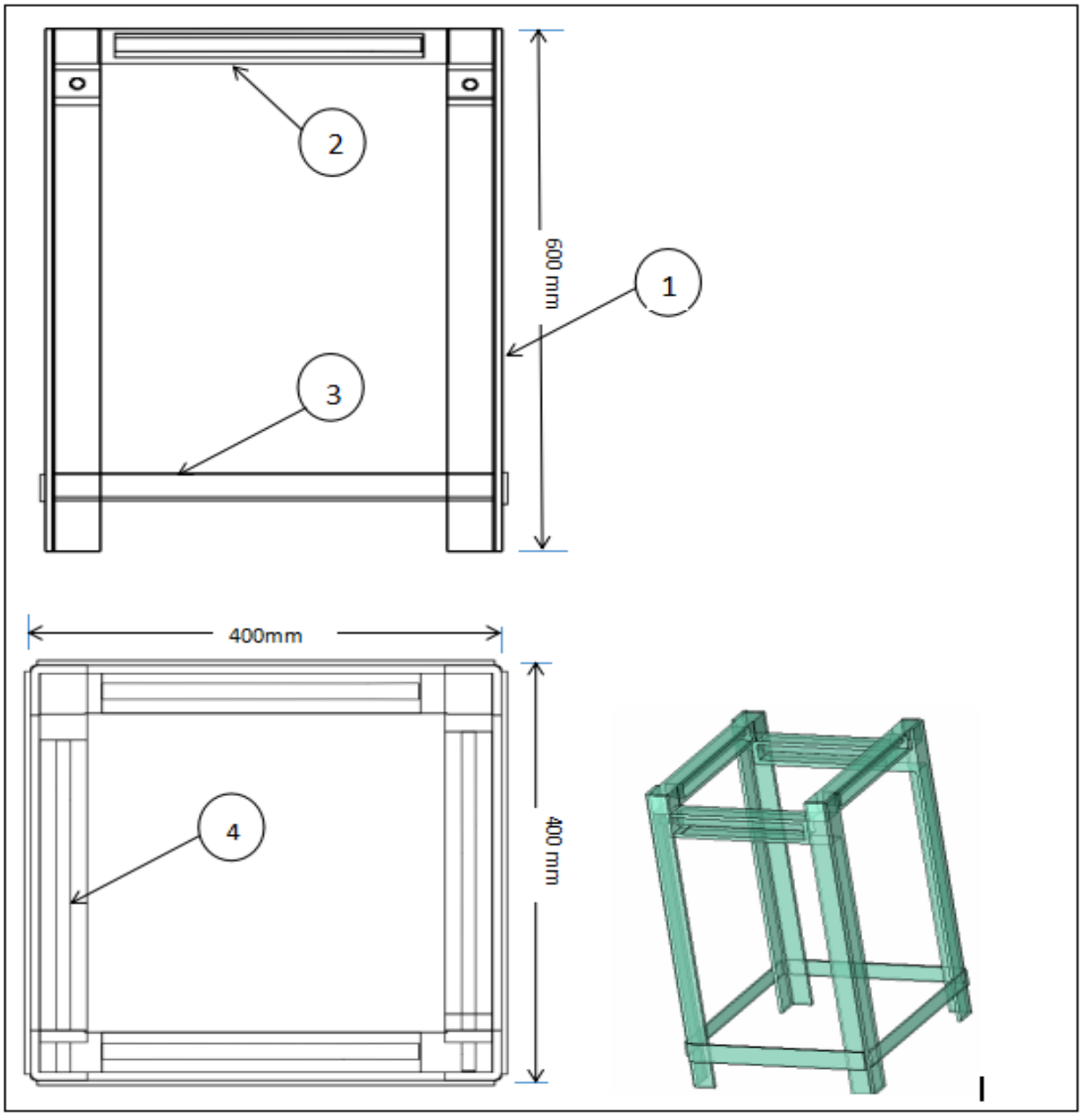

Fig. 5: Structure

Table 2: Structure components

Sr No	Part label	Part name
1	1	column
2	2	beam
3	3	support
4	4	Square thread

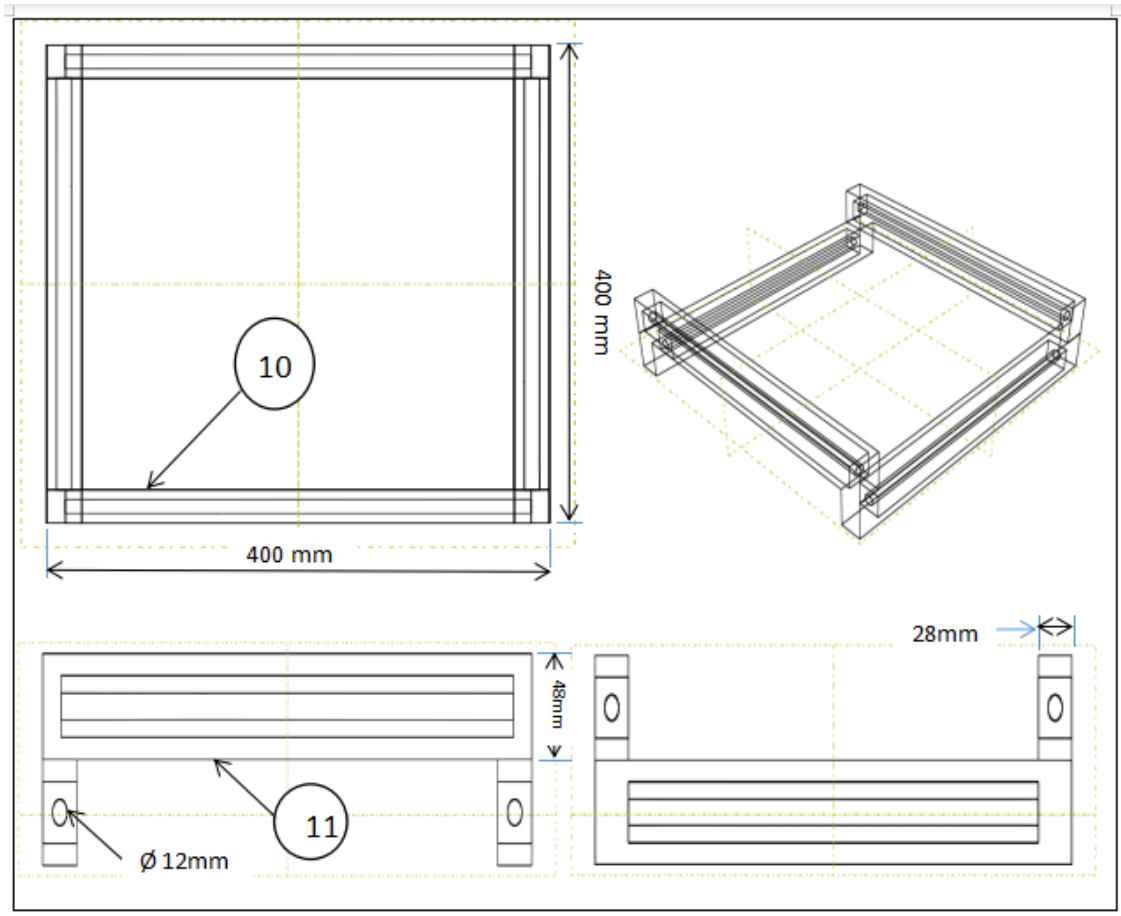

Fig. 6: Arrangement of beams

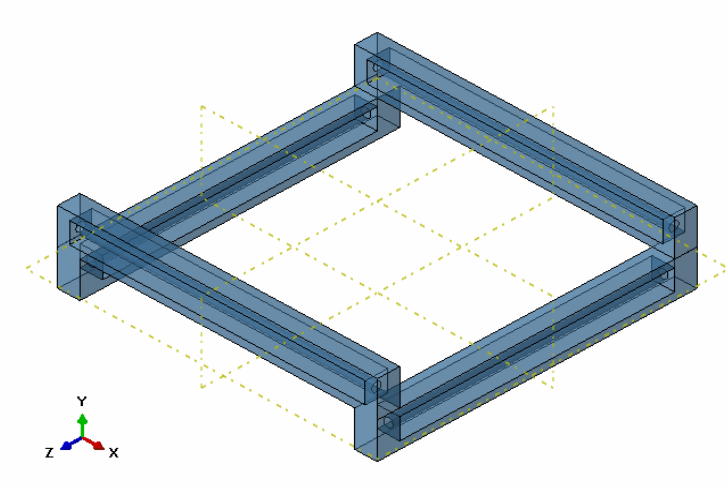

Fig. 7: Beams

Table 3: Beam parts

Sr No	Number	Part name
1	10	Lead screw
2	11	Beam

3.2 Aluminium Block

The aluminium block (fig 8) is move in horizontal plane in both x and y direction. A 15 mm diameter vertical through hole is drilled on it through which rammer reciprocate. Motor which reciprocate rammer through linkages is also placed on the top of block. Other

holes are provided horizontally on vertical surfaces of block. Two hole are drilled in one horizontal plane while two are drilled in other plane perpendicular to each other. The mild steel circular rods are passed through this holes to guide the block in working space.

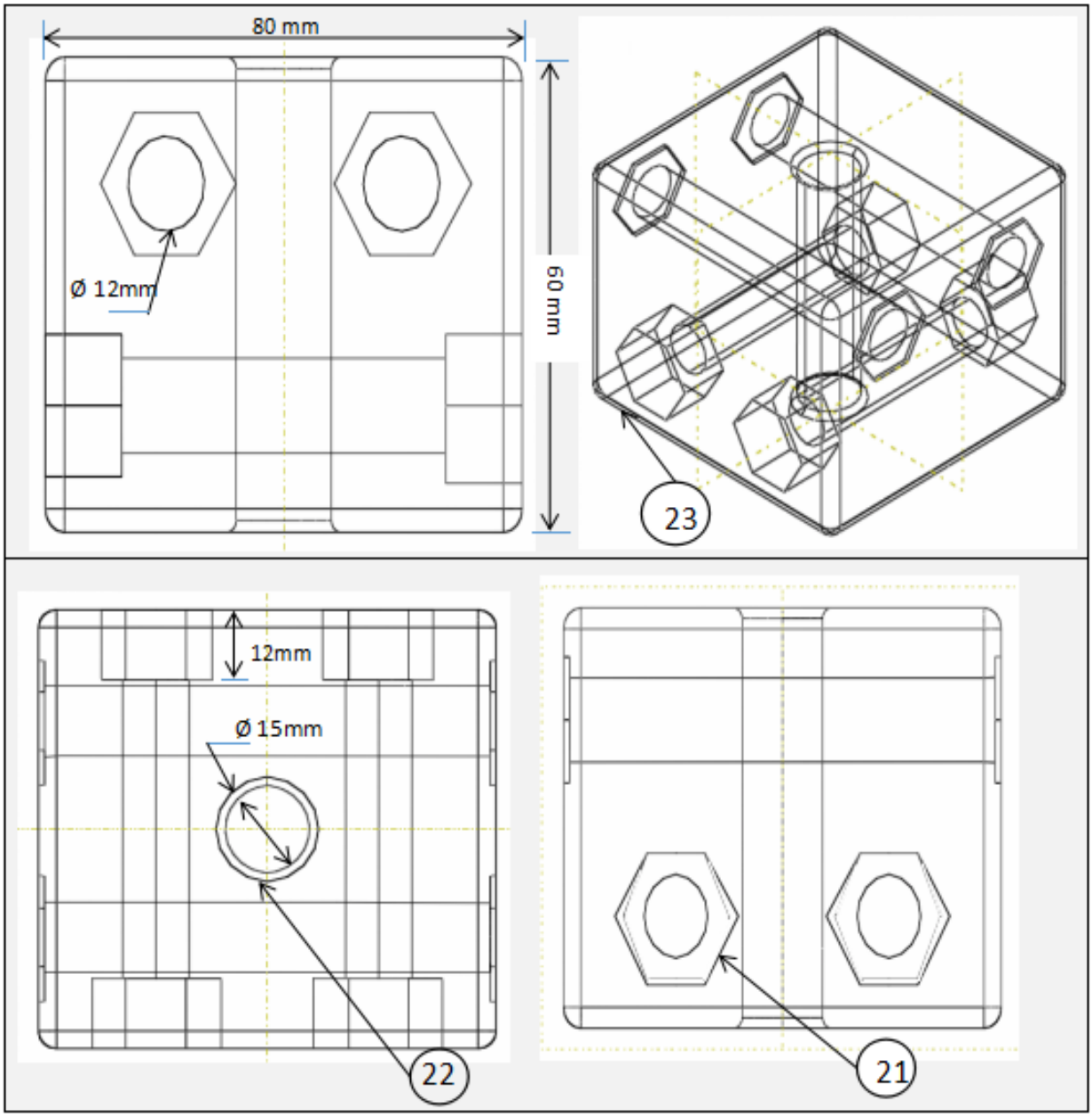

Fig. 8: Aluminium block

Table 4: Structure components

Sr No	Number	Part name
1	21	Drilled hole for rod
2	22	Drilled hole for rammer
3	23	Aluminium block

3.3 Lead Screw

Lead screw (fig 10) for movement of rammer in horizontal plane are placed in beam between two c block. Lead screw are placed perpendicular to each other. A square thread profile of screw is used to get maximum transmission efficiency. One end of the lead screw is connected with the motor while other is placed in bearings. All lead screw are single threaded to get normal speed.

3.3.1 Calculation

Total load on the screw = W = 1 kN
Nominal diameter of square thread = d = 22 mm
Pitch = p = 5 mm
Nut diameter = 22.5 mm
Coefficient of friction = μ = 0.15

Torque requirement

d_m = Mean diameter
= d - 0.5p
= 22 - 0.5 x 5
= 19.5 mm

$$\tan \alpha = \frac{p}{\pi d_m} = \frac{5}{\pi \times 19.5} = 0.0816 \qquad \alpha = 4.66^0$$

$$\tan \emptyset = \mu = 0.15 \qquad \emptyset = 8.53^0$$

$$M_t = \frac{W d_m}{2} \tan(\alpha + \phi) = \frac{1000 \times 19.5}{2} \tan(4.66 + 8.53) = 2285.04 \text{ N-mm}$$

Hence 2285.04 N-mm torque required for machine.

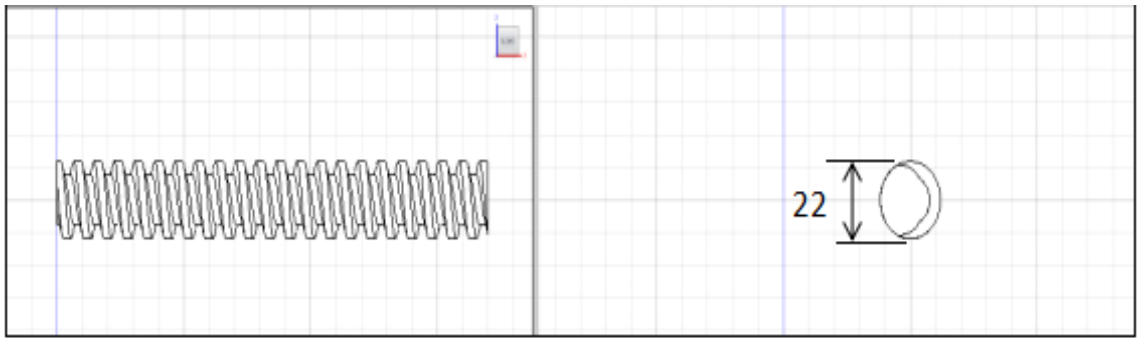

Fig. 9: Square threaded lead screw

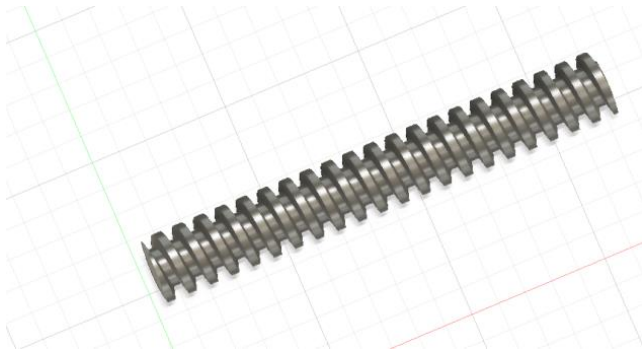

Fig. 10: Lead screw

3.4 Guiding Rods

Guiding rods are used to guide or move the aluminium lock in working space. This are made of mild steel. Every rod is arranged between two beams and passing through aluminium block, horizontal beams act as a simply support point for each rod. Rods are arranged in a pairs of two perpendicular to each other in to different horizontal plane as shown in fig-12.

3.4.1 Calculation

Total load on rod = W = 1000 N
Number of rods = 4
Length of rod = 400mm

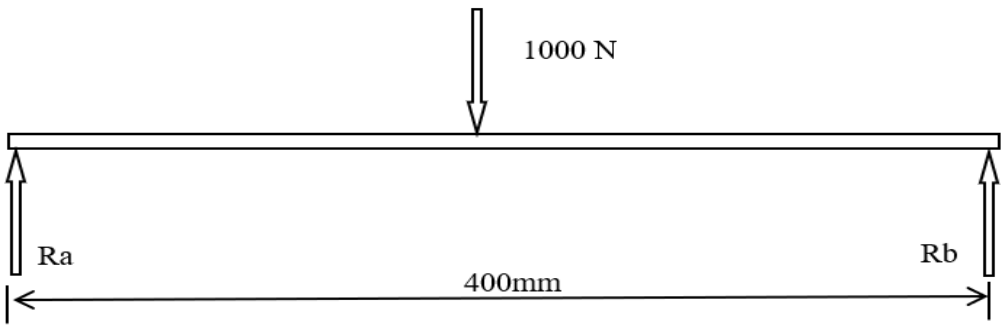

Fig. 11: Rod as a beam

$\sum Y = 0$

Ra +Rb = 1000 N

Ra =Rb = 500 N

Now, moment cause by 1000 N about A

Ma = 1000 x 200 = 200000 N.mm

I = moment of inertia = $\frac{\pi}{64} d^4$

By using ending moment equation,

$\frac{M}{I} = \frac{\sigma_b}{y} = \frac{200000}{\frac{\pi}{64} d^4} = \frac{48}{\frac{d}{2}}$ d = 11.2 = 12 mm

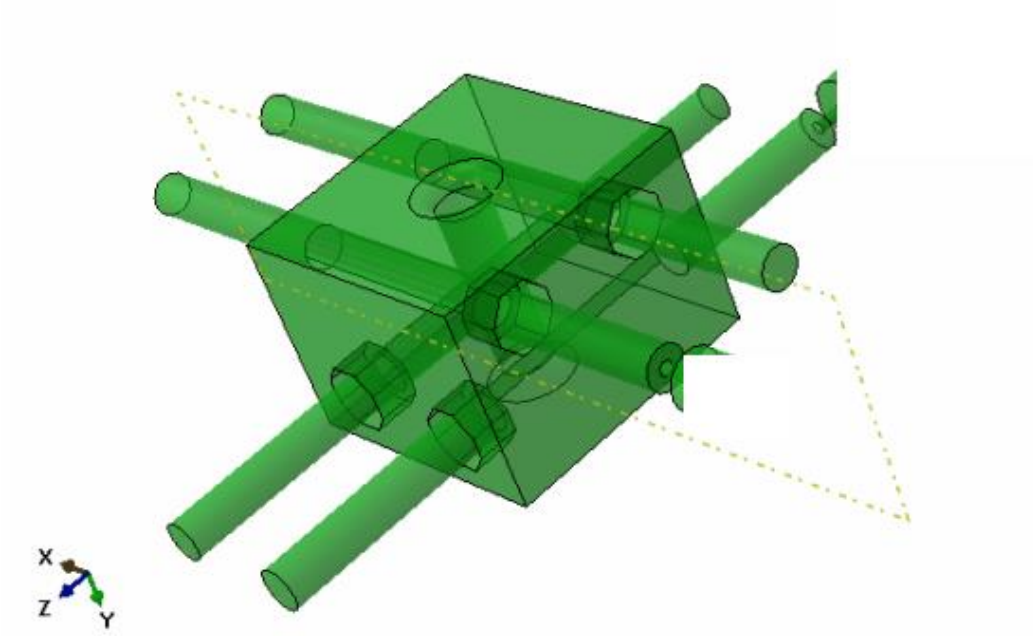

Fig. 12: Arrangement of rod

3.5 Rammer (Ramming Tool)

Rammer is used to compact the sand in moulding box. It consist of two parts, one stem and other is flat base. Flat base of rammer can be rectangular or circular shape. In many case flat base of rammer (fig- 13) is of the size of hole moulding box.

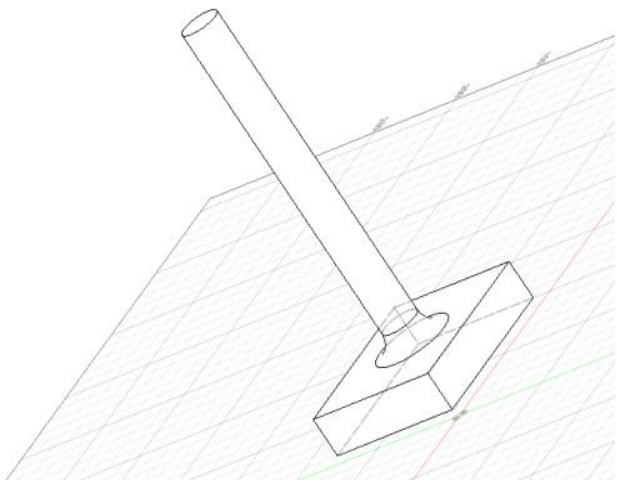

Fig. 13: Rammer

3.6 Motor

Two kinds of motor are involved in automatic ramming machine. A simple DC motor is used for operating ramming tool. Stepper motors are used for operating lead screw. Torque required for motor is equal or greater than 20 kg-cm. Horizontal movement of tool is depends on pitch and speed of motor. Higher the pitch and speed faster the travel speed. For adequate ramming the speed of motor must be slow hence high torque and slow speed motor is preferred.

3.6.1 Motor Specification

Table 5: Motor specification

Sr. No	Parameter	Specification
1	Voltage (V)	3.2
2	Current (I)	2.8
3	Torque (kg.cm)	20
4	Weight (kg)	1
5	phase	2
6	Step angle (degree)	1.8

3.7 Crank and Connecting Rod

Stem of a ramming tool act as a connecting rod. One end of connecting rod is connected to the crank while other to the flat base. Crank is a circular disc which connect connecting rod to motor. The size of crank is depending on the length of stroke required for ramming.

Length of stroke = 2 x crank radius
= 2 x 1.2 (cm)
= 2.4 (cm)

4. RESULT

The rate of mould making by electric motor operated automatic ramming machine as compared to manual ramming is high. Constant magnitude force applied throughout the operation helps to get uniform compaction. Location of ramming tool is precisely controlled by stepper motor. Foundation of columns and beams provide good rigidity to the system. Mass manufacturing of mould reduces per unit cost of mould making and hence cast components.

Fig. 14: Old version of our motor operated automatic ramming machine

[This is the old version of our proposed motor operated ramming machine. The only difference between this machine (figure 11) and proposed machine is the arrangement of lead screw and rods]

5. CONCLUSION

The proposed invention gives higher rate of mould making as compared to conventional ramming machine. Also give the uniform compaction of sand. It does ramming on a faster rate than conventional ramming machine The proposed ramming machine can be controlled accurately with the help of stepper motor and controller. The parameters which can be accurately controlled are Speed of rotation in rpm and stroke of tool. It is is economical as compared to other ramming machine and easily portable The automatic

ramming machine provide the facility of changing tool of different size and shapes. The proposed invention results in reduce the unit cost of casting product. and eliminate the necessity of high skilled labour.

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