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Design, Modelling and FEM Analysis of Fly Ash Brick Making Machine

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Abstract- Production of Fly ash brick is another utilization of ash. The most important part of the ash Bricks plant is Pan Mixer, conveyor belt, and main fly ash brick molding machine. There are a unit number of strategies for molding of bricks, however here we have used bottom side hydraulic pressing methodology that is reduced repeated investment on fly ash brick machine. In fly ash, the brick machine has three sets of brick molds apart from 120o each other. In this process, one set of molds receive the fly ash mixture such as fly ash, sand or stone dust, cement, and water, then it's compressed by downside Hydraulic press and at last nine bricks area unit created in one revolution of this machine This research also serves to determine the most vulnerable locations on the machine structure as a concern when the load capacity will be increased. The analysis was carried out using the finite element method by using the finite element software. The simulation results obtained are, this fly ash brick molding machine is safely operated for pressure loads of 100 bar (10MPa).

Keywords: - Fly ash, Molds, Bottom Side hydraulic mechanical press, Bricks, etc.

I. INTRODUCTION

In this twenty-first century, there has been a drastic increase within the demand for brand spanking new modern artifacts and eco-friendly material which results in minimum or almost negligible harmful effects to the environment. In these orders to match the provision, we've to modify over to innovative and automation methods from the normal and standard methods of producing bricks and other building materials of the last century.

With the fast- moving life cycle of cities, the automated and pollution-free brick making machine is required and indeed to meet needs like green and eco-friendly material, low cost of producing for the low and socio-economic class, reduction in time for manufacturing, fast production, less and cheaper rate, excellent quality such factors have pushed the demand of contemporary days need of automatic and pollution less ash Brick making machine. Thus, thanks to advancements in technology and automation, there has been an outsized scope of such fully automatic ash brick-making machines. Nowadays in India is observing a replacement introduce development with the fast process and high rate of urbanization.

In India, the rough calculation of total ash generation from thermal power plants is at regarding sixty million tons p.a., which might increase with regard to 100 and ten million tons p.a. by 2015, the employment of ash for the assembly of bricks is another step to extend the use of ash itself are mainly used for the brick-making since it contains appropriate ceramic characteristics and properties.

Alternative ingredients that so far unit commercially protected square measure low-cost, unremarkable obtainable and, although essential, unit solely minor quantities. So, the use of ash for the assembly of bricks as other steps to extend the use of ash. Primarily, the only solid ingredient of the bricks is that the ash, stone or sand dust, cement, and so the liquid ingredient is water.

Many studies are conducted on cement and concrete applications that were licensed and federally funded projects and also approved. Fly ash brick unit fabricated from ash, cement, and sand or stone dust.

These are mostly stepping to utilize all told building constructions activities rather like same as burnt clay bricks. The ash bricks unit relatively stronger than common clay brick likewise as lighter in weight Fly ash is obtainable in numerous varieties, like C and F.

The F kind includes an occasional metal content, and its content of SiO2 + Fe2O3 + Al2O3 is larger than seventy (ASTM C 618). It's a finely divided residue of ash arising from the combustion of fine- grained coal and take-up by electronic precipitations in thermal power plants.

1. Composition of brick:

The results of this investigation suggest that it's possible to provide lightweight bricks from ash. Particularly, with proper proportioning, these bricks can produce compressive strengths adore those of common clay bricks. Although their strength is somewhat below the standard values of clay bricks, the absorption characteristics could also be such as those of clay bricks. There appears to be an optimum composition for the ash bricks studied.

Table 1. Composition Fly Ash Brick.

Fly Ash Brick or Cement Brick	FAL G Brick
Fly Ash: 60-80%	Fly Ash: 60-80%
Sand and Stone Dust: 20 –25%	Sand and Stone Dust:10-20%
Cement (Ordinary Portland Cement): 7-10%	Lime: 10-20% and Gypsum: 5-10%
Water	Water

2. Problem Statement

Currently, available ash Brick making machines which are currently available within the market are the price 15 to twenty lakhs for various cavities per stroke. Such costly machines can't be afforded by medium porters. In fly ash, the brick machine has three sets of brick molds other than 1200 one another.

During this process, one set of molds receive the ash mixture like ash, sand or stone dust, cement, and water, then it's compressed by downside press and ultimately nine bricks unit created in one revolution of this machine. Here we've used a bottom side hydraulic pressing methodology that's reduced repeated investment in ash brick machine. This can increase the productivity and quality of bricks.

3. Objectives:

- Developing the new process for fly ash brick
- Experimental analysis of new processes
- To improve the Quality and productivity of bricks.

II. METHODOLOGY

The work is especially focused on the ash brick molding mechanism. There are two methods of brick- making mechanism. One is press and also the other is vibro press, but we are using only the hydraulic compression method which may be a more efficient and reliable method.

The pressing table is circular having three sets of brick molds each 120° apart. One set of mold receives the mixture, then it's compressed by press hydraulic and after molding of brick dispatch hydraulic ejects the molded brick from the mold. These processes of filling mold, pressing of fabric, and dispatching of molded bricks for one revolution are done at identical times. In this way, two bricks are made in one revolution of this circular table. The components of the ash brick machine as given within the following;

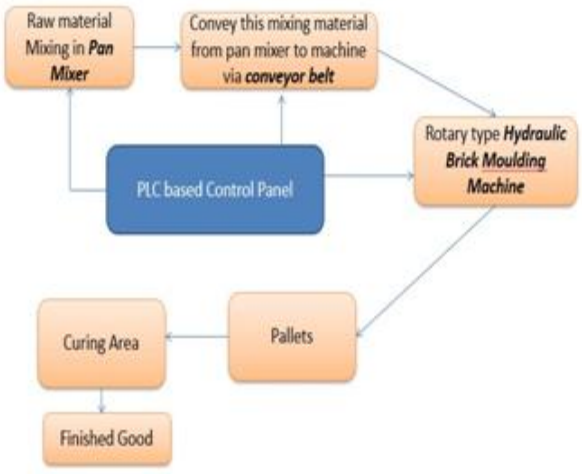

Fig 1. Flowchart of Fly Ash Brick Machine.

1. Main Frame:

The main machine body is known as Main Frame. In these frames, the principal operation of making brick

is carried out A conveyor belt passes the material mixture composition to the mainframe and then the operation relating to mold, Main cylinder, Ejection Cylinder, hydraulic cylinder, and Hydro motor is fitted in the frame.

We selected IS 2062 A material of mild steel and it is classed under engineering steels and is normally used because it is high strength and it is easy to weld. Apart from the important parts in the machine frame, there are several components that play a vital role in the operation.

These are listed as below:

- Ring Gear and Pinion
- Mould and Mould Frame
- Ram and Adjusting frame of Ram

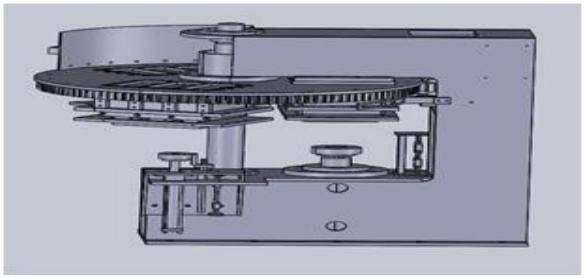

Fig 2. Main Body of Fly ash Brick Machine.

2. Pan Mixer

Pan Mixer is a drum-type system that combines various ingredients or materials to form the final brick material. Some of these inputs include Fly ash, Sand, Cement along the water. Pan Mixer stores raw materials very efficiently and puts these raw materials into the mixer in correct proportions to grant a very consistent and high quality of output.

It should be very precise, accurate and ensure that these inputs are in exact proportions. Using the Specific gravity and density of material we calculate the total volume required in the pan mixer and a total weight of each material and also the weight of pan mixer.

- Mass of fly ash in mixer = 300 kg
- Mass of cement in mixer = 35 kg
- Mass of Sand in pan mixer = 100 kg

Total weight of raw material in pan mixer = 500 kg

3. Conveyor Belt:

Conveyor belt is used to convey material from one place to another place. So, in our system, transfer mixing material from Pan Mixer to Fly Ash Brick Machine.

III. DESIGN CALCULATION AND CAE ANALYSIS OF COMPONENTS OF FLY ASH BRICK MACHINE

Thus, the researching and experimental analysis of the pressure on single brick is taken as 3 Mpa. Using the size of brick 228×101×75 mm (9"x 4"x3") force and total pressure is calculated.Considering standard dimension of hydraulic cylinder as;

Bore diameter = 170 mm

Total number of bricks in one cavity = 03 bricks

(No. of bricks x pressure on single brick (Mpa) x Area of Brick = (Hydraulic pressure required on Ram x Bore diameter of cylinder)

$$3 \times 3 \times 228 \times 101 = P \times \pi/4 \times 170^2$$

$$P = 9.13 \text{ Mpa}$$

So, main hydraulic Cylinder downside Hydraulic Pressure on three bricks of three cavity by ram is 10 Mpa (approx. 100 bar).The loading analysis of the molding machine is simulated using Finite Element software application. The magnitude of stress that occurs in the molding machine varies between 9.4762x10-12 Mpa to 118.54 Mpa.

The main components of fly Ash Brick Machine to be analyzed in Ansys Software, same would be given in following;

1. Mold:

Mold cavity simulated by using EN31 material and 10 Mpa of Pressure. In the mold component, the stress that occurs is in the range from 9.4762 x 10-12 Mpa to 19.79 Mpa as shown in below Figure. It means that the minimum stress that occurred is 9.4762 x 10-12 Mpa and maximum stress on mold is 19.79 Mpa.

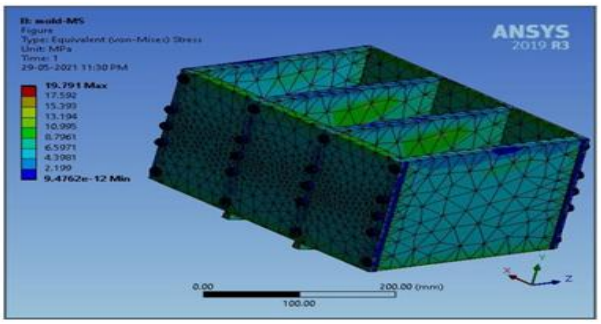

Fig 3. Stress Analysis of Mold

2. Ram:

Ram is simulated by using IS 2062 A material and 10 Mpa of Pressure exerted by main cylinder on Ram.

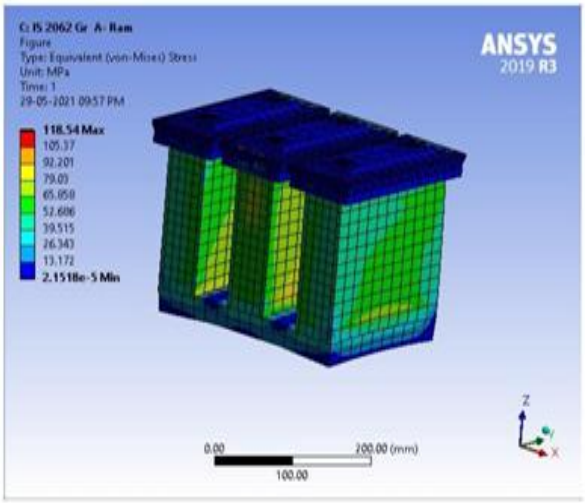

Fig 4. Stress Analysis of Ram.

In the ram component, the stress that occurs is in the range from 2.15 x 10-5 Mpa to 118.54 Mpa as shown in above figure. It means the minimum stress that occurred is 2.15 x 10-5 Mpa and maximum stress on mold is 118.54 Mpa.

3. Upper Fixed Plate:

This plate is simulated by using IS 2062 A material and 10 Mpa of Pressure exerted by main cylinder on Ram.

In the ram component, the stress that occurs is in the range from 0.0093325 Mpa to 8.32 Mpa as shown in below Figure. It means the minimum stress that occurred is 2.15 x 10-5 Mpa and maximum stress on mold is 118.54 Mpa.

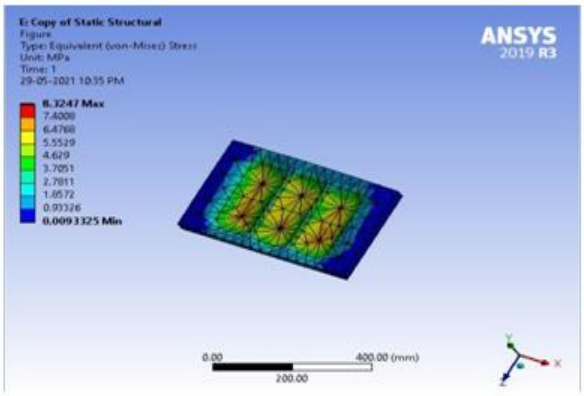

Fig 5. Stress Analysis of Upper Fixed Plate

Table 2. Differentiate stresses of three components.

Sr No	Component	Material	Min Stress (Mpa)	Max Stress (Mpa)
1	Mold	EN 31	9.4762×10^{-12}	19.79
2	Ram	MS	2.15×10^{-5}	118.54
3	Upper Fixed Plate	MS	0.0093325	8.32

The highest stress that occurs on the molding cavity is 19.79 Mpa on the mold plate. The yield strength of EN 31 material is 450 MPa. If the occurring stress is compared to the yield strength of the material, the highest stress is still below the yield strength. This means that the molding component of fly ash brick machine can be safely used for 100 bars of Hydraulic pressure.

Similarly, for the highest stress that occurs on the ram and Upper Fixed Plate is 118.54 Mpa on the ram plates. The yield strength of MS material is 250 MPa. If the occurring stress is compared to the yield strength of the material, the highest stress is still below the yield strength. This means that the molding component of fly ash brick machine can be safely used for 100 bars of Hydraulic pressure.

IV. TESTING RESULTS AND DISCUSSIONS

Testing process of fly ash brick on Universal Testing Machine:

- Load capacity of UTM is 1000 KN and Ram Diameter is 165 mm.
- Take minimum five specimen of bricks
- Put bricks in cold water for 24 hours
- After 24 hours soaking leave bricks for draining surface water
- Make 1:3 cement sand mortar ratio
- Wipe out excess water from bricks
- Flush mortar pastes in to frog
- After setting of mortar covered bricks by jute or cotton cloth for 24 Hours.
- After 24 Hours put brick in water for three days curing
- After three days take out bricks and leave for draining surface water

- Keep bricks surface dry Put brick into Compressive testing
- Machine load plate between on both faces.
- Switch on loading and note down applied load.

Following table gives you to detail compressive testing of five standard specimens of fly ash brick (228x101x75);

Table 3. Compressive Strength of Bricks.

Sr. No	Brick Dimensions	AppliedLoad (KN)	Compressivee Stress (Mpa)	Avg. Compressive Stress (Mpa)
1	228x101	250	10.8563	10.726
2	228x101	255	11.0735	
3	228x101	240	10.4221	
4	228x101	248	10.7695	
5	228x101	242	10.5089	

From above table the compressive stress of fly ash brick is varies from 10.42 Mpa to 11.07 Mpa. Therefore, the averages compressive stress of fly ash brick is 10.726 Mpa, which is completely match with prescribed compressive stress of fly ash brick is 10-11 Mpa. Standard size of fly ash brick :228x101x75
No of Bricks per Mould: 02 or 03 No of Moulds per Machine: 03 Set

It will get nine bricks in one revolution of three set of mould cavity attached table. Average compressive strength of Bricks: 10 - 12 Mpa Production Capacity of fly ash brick: 1600 – 1800 Bricks per Hour. From above discussion per day average production rate of fly ash brick in eight hours shift is 13600 bricks.

V. CONCLUSION

Therefore, the projected model of brick creating machine is totally machine-controlled with bottom side hydraulic pressing and is a controlled by Programming Logic controller (PLC). The Rotary fly ash brick pressing machine has three numbers of sets of brick mould that are apart from 120 degree each another. One set of mould receive the mixture such as Fly ash, Cement, sand or stone dust, then it's compressed by bottom side hydraulic pressing and eventually nine bricks are created in one revolution of this table of rotary fly ash brick machine.

Thus, by implementation of this rotary fly ash brick machine to increase the production rate of bricks. And also reduced the repeated investment on wooden pallet which is mostly used in top side hydraulic pressing machine. Complete system is an automatic.

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