Design And Fabrication Of Zig-Zag Rod Folding Machine For Pre-Casted Beam Used For Roofing Construction

Dr. K. Deepandurai, T. Enith, D. Bharanidharan, K. Arun Kumar

Abstract: The pre-casted beams are used in building constructions. This pre-casted beam needs an inverted T-beam, which acts as a base material. The bending of inverted T-beams is done by hydraulic pressing. The straight T- beam is bent, and a zig-zag frame is obtained. This zig-zag frame is pressed perpendicularly by hydraulic pressing. The primary process in hydraulic bending is the selection of a hydraulic cylinder with required pressure. After the selection of a hydraulic cylinder, the frame design is made concerning the stroke length of the cylinder. After designing the materials required for manufacturing like pipes and valves are purchased. The frame is designed for the required dimensions. The frame is strong enough to withstand high pressure. The hydraulic cylinder is positioned at the top. The holder used for holding the beam is placed below the cylinder, and an adjustable bar is welded with the holder. The required welding is done. The length of the bed can be varied according to the number of bending per time. A tray is fixed at the bottom to collect the oil leaked during the press. The cylinder valves are connected to the hydraulic system. When pressure is applied the piston moves towards the beam positioned below the cylinder and bend the zig-zag beam. Now the zig-zag bend is made which is more easy and accurate than the manual method. Now the pre-casted beam is obtained by using this zig-zag beam.

Index Terms: Bending of TMT bars,Construction works,contol valves, Hydraulic cylinder, Hydraulic power pack,Inverted T-beam, Pre-casted beam,

1 INTRODUCTION

Construction of buildings becomes a major aspect in the modern world for industrial, household and other purposes. Nowadays such construction works take place in large numbers when compared to the last decade. Construction works involve many portions like laying of the foundation, raising the columns and walls. The major portion in constructing a building is roofing of the building with the use of concrete mixture as well as this is the most time-consuming process because the setting of the concrete takes more time normally a month and requires more manpower and machinery.

1.2 Pre-casted beams

To reduce the time for the setting of concrete and reducing the manpower cost pre-casting of concrete beams and slabs can be used as an alternative process. It reduces the overall time of the construction process. It involves two types. Pre-casting using square beam and pre-casting using inverted T-Beam. Inverted T-Beam is a more efficient method because it transmits load equally in all directions and withstands higher load than a normal square frame design as shown in fig.1.1. Pre-casted concrete material which is created by casting concrete in a reusable mold or shape, which is then healed in a controlled environment, transported to the consruction site and lifted.

Standard concrete, on the other hand, is poured into site-specific forms and cured on site. Precast stone is characterize d by using a fine aggregate in the mixture from precast concret eThe end product resembles the appearance of natural rock or stone. Recently expanded polystyrene is used as the center for wall panel prefabrication. This is lightweight and has better insulation of the sun. For architectural applications, there are many different types of precast concrete forming systems, which vary in size, function and cost. Precast architectural panels are also used to coat all or part of building façades and stand-alone walls used for landscaping, soundproofing, or safety walls, some of which may be pre-stressed concrete structural components. Storm water drainage, water pipes and tunnels make use of concrete prefabricated structures. In the same way the pre-casted concretes are also used in roofing purposes. This helps in the elimination of large manpower requirements as well as the period of the construction process. A T-beam shaped pre-casted concrete beam is preferred for this kind of process

Fig.1.1 *Pre-casted beam*

1.3 Inverted T-beam

A T-Beam used in building is a reinforced concrete, wood or metal load-bearing structure with a t-shaped cross-section as shown in fig.1.2. The top of the t-shaped cross-section serves as a flange or compression member in resisting compressive stresses. The web (vertical section) of the beam below the compression flange serves to resist shear stress and to provide

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greater separation for the coupled forces of bending. In the case of inverted T-beam which are pre-stressed concrete elements that have a constant cross-section. They are manufactured using pre-stressed wires of high tensile strength or single wire embedded in the component. Such components were produced using our slip casting machi nes, which cast continuously on a long production bed without the need for any shaping. Pre-stressed beams have many uses in floor construction. A floor is usually made of pre-stressed T beams with in-fills of concrete or clay hollow blockThe blocks that are filled in can be laid in two layers. The in-fills hold the floor weight to a minimum and then filled with concrete in-situ to shape the ribs and the ground slab.The same technique is used when it comes to the process of roofing. Where the required sized inverted T-beams are placed over the opposite sidewall of the construction with an appropriate spacing between each other in which the floor slabs are placed, followed by putting a layer of concrete over it.

Fig.1.2 *Inverted T-beam*

2 COMPONENTS

2.1 Hydraulic cylinder

A hydraulic cylinder also called as a linear hydraulic motor is a unidirectional stroke mechanical actuator used to provide unidirectional control as shown in the fig.2.1. It has much application, especially in construction equipment (engineering vehicles), machinery manufacturing and civil engineering.

Fig.2.1 *Hydraulic cylinder*

2.2 Hydraulic power pack

In comparison to an integrated power supply for hydraulic machinery, hydraulic power packs are stand-alone products. Many power packs are massive, others are more compact and stationary devices. There is a stream in a hydraulic tank, regulators that allow users to control the amount of pressure delivers to a valve, pressure supply lines and relief lines, a pump and a motor to power the pump The main function is to provide a variety of valve connections to allow users to connect them to a control valve or valves for a variety of machines to operate. The power pack provides hydraulic power to operate via a control valve for another component as shown in fig 2.2.

Fig.2.2 *Hydraulic power pack*

3 METHODOLOGY

Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part.

- The problem in the manual bending and other bending methods are identified by physical observation and experimentation.
- The literature related to the bending of rods is collected from different sources and observed the methodologies used.
- Analyzed the gap and drawbacks found in the collected literature, nature of the project and cost involved.
- Conceptualization of the project to solve the problems found in the currently available methodologies by applying the engineering principles.
- The feasibility of the project checked by analyzing the process parameter in the hydraulic rod bending machine with the proposed mechanism and materials are selected.
- Design calculations are carried out to meet up the process required for each component such as the force and pressure required to bend the rod using a hydraulic cylinder.
- Materials are purchased for each component according to the requirement and design. Fabrication of each component are done according to design and assembled to achieve the proposed mechanism.
- The project is operated to perform the process of bending the rod of pre-casted beams and results are noted and analyzed the obtained results with the other equipment.

The performance of the machine is analyzed continuously to improve the quality of the work.

4 DESIGN AND CALCULATIONS

4.1 Design

The design of the rod bending machine is inserted below in fig.4.1.

Fig.4.1 *Isometric view*

4.2 Design Calculation

- Cylinder specification

B - Bore diameter
T - Wall thickness
L - Length
t - Piston thickness
L_s - Stroke length

B = 76 mm
T = 2.84 mm
L = 186mm
t = 27 mm
Ls = 150 mm

- Pump specification

Pmax - Maximum Pressure
$P_{max.}$ = $175x10^5 N/m^2$

- Force calculation

A = Area
A = πr^2 (1)
= $4.53x10\text{-}3\ m^2$
F = Force or load
F = P × A (2)
= $175x10^5 x 4.53x10^{-3}$
Max force = 79.275 kN

Normal torque required to bend the rod using electric motor

P - Power
T - Torque
N - Speed in rpm
T = P*60/2*π*N (3)

Where, P = 700 W
N = 90 rpm
T = $74.27 X 10^3$ N-mm

Force required for bending the bar

Bending equation,

M - Bending moment
I - Moment of inertia
σb - Bending stress
y - Distance from neutralaxis

M/I = σ_B/y (4)

For solid circular shaft,

I = $(\Pi/64)*d^2$ (5)
= $63.617\ kg/m^2$

y = d/2 (6)
= 6/2
= 3mm.

σb = $415\ N/mm^2$

Using bending equation

M = 8.8kN-mm
T = $(\pi/16)*d^2*\tau$
τ = $10.50kN/mm^2$

5 PROPOSED SYSTEM

The TMT bar which is bendend in the zig-zag manner is kept in between the vice and hold rigidly. When the hydraulic cylinder is powered using the hydraulic power pack the piston in the cylinder is moved down and tends to bend the triangualr projection of the zig-zag rod perpendicularly which is holded in the vice such a manner. The fabricated model is shown in the fig.5.1

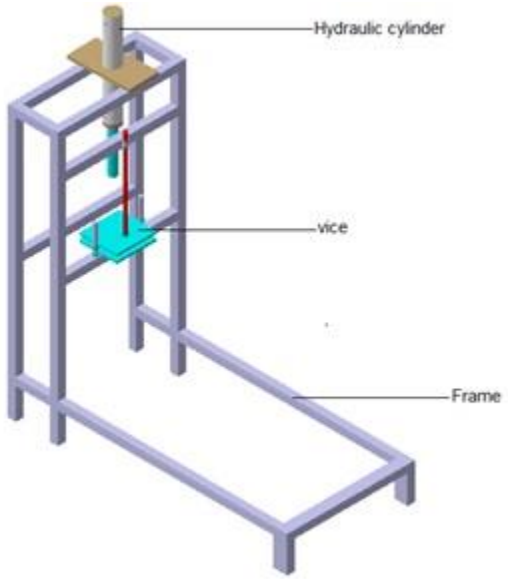

Fig.5.1 *Pictorial view*

6 RESULTS AND DISCUSSION

Thus the proposed design is successfully implemented in the form of a project. The bending action in the developed machine has been comparatively good as shown in table 6.1

Table 6.1 *Test result*

MAN		MACHINE	
Time taken for bending the rod (seconds)	Angle of bending (degree)	Time taken for bending the rod (seconds)	Angle of bending (degree)
10	75	7	80
12	80	9	85

This project can be used effectively in small level industries where they cannot afford costly machines for their small scale business. This machine can also be easy in transporting from

one place to another as it is compact in size and shape. This project can be effective for mass production as it reduces the normal time taken by a man to bend a rod.

7 CONCLUSION

Thus the developed machine can be employed in bending of rods used for the manufacturing of pre-casted beams used in construction. The time required for bending the rod the time taken is reduced on an average of 2 seconds when compared with manual techniques. The accuracy in the angle of bending is increased on an average of 5 degrees when compared with manual techniques. The angle to which the rod is to be bent is more accurate when done using the machine fabricated when compared with the manual bending methods. The devolved machine can be used in the small scale industries as the total machine cost is too low when compared with the available bending machine and increase productivity

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