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To Design of Platen and Frame of Compression Testing Machine: A Review

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***Abstract*—Compression testing of any material is very critical quality measures in many manufacturing industries and building construction works. Global competition and enhanced customer awareness has increased the need of better durability of materials in compression. Nowadays, compression testing machine (CTM) is one of the most popular machines for testing the different materials in compression. There are different types of materials on which the compression test has been done. There are limitations for selecting the dimensions of the test specimen because of the fixed body structure of the CTM. The CTM have fixture for holding the test specimen called platens in which both the ends of the test specimen hold. Present industrial designs only supports test specimens for pressure upto 350 bar, which needs to be increased upto 600 bar. The present CTM available in industries are expensive and are of heavy in weight. Also, frame cannot sustain the pressure upto 600 bar. For enhancing the working range of CTM, the frame and platens needs to be redesign.**

Keywords—Compression Testing Machines (CTM), platens, frame structure.

I. INTRODUCTION

Compression test is a method for determining the behaviour of the materials under a compressive load. Compression testing machine (CTM) is used to measure the compressive strength of the material. The compressive strength is measured by breaking the concrete test specimen in a CTM. Compression tests are conducted by loading the test specimen between two platens and applying a force to the test specimen by moving crosshead together.

The compression testing machine uses a hydraulic cylinder to generate a compressive force. Frame and platens are the main components of the CTM.

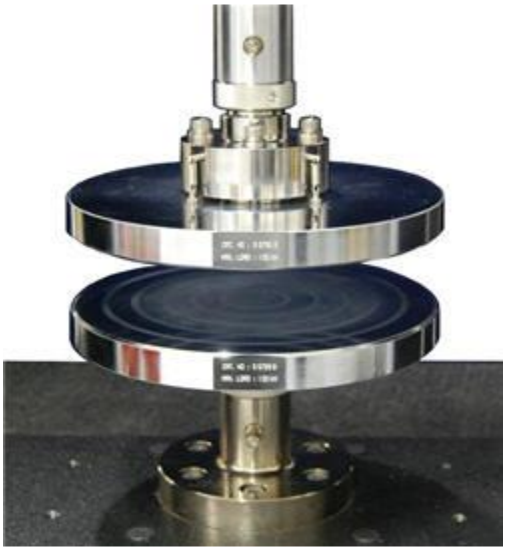

Fig. 1. Platens of compression testing machine.

Frame is used for housing the components. The various components are held together in a rigid frame. The frame allows for mounting of various test specimens to be tested. Frame maintains proper relative positions of the units and parts mounted on it over the period of service under all specified working conditions. The frame are also provides general rigidity to the machine.

Platens are used in compression testing machine for holding the test specimen of different size, shapes and heights. The test specimen is properly held between the upper and lower platen so that the uniform pressure can be applied on it. Hence, adjusting the position of the specimen, the platens should be designed properly.

II. LITERATUREREVIEW

MalachySumaila et al. [1] studied on the design of hydraulic press for maximum load of 300 kN. The different components like hydraulic cylinder, cylinder cover plate, piston, platens and frames are designed for the required strength. Here, the frame is considered as a direct tensionimposedon the column structure. The platens are designed considering they are subjected to pure bendingstresses. After determining the main dimensions of the critical sections from design, the machine is tested to ensure conformability to design objectives and serviceability.

H.N.Chauhan et al. [2] studied on the C-type power press design. In the present paper, manufactured power press found defect after punching process. Due to the impact loading at the end of the bolster plate, they is a crack at the corner and stress generated is more due to continuous loading and stress concentration. Considering a symmetrical cross-section area of frame, one side of the frame is analysed. Maximum deflection of the frame is takes place at the maximum load at point of application of load. The maximum stresses are found by bending moment theory which is less than the maximum permissible stress. The power press design is analysed using CAD model for reducing the thickness of plate required.

Abdulkadir Baba Hassan et al. [3] studied on the compression testing machine design which is compatible to Nigerian Standards using staticalmethods. The frame supportsare designed by considering that it is loaded in tension. The upper and middle platen is designed by considering uniformly distributed loading on the surface of the plate. The bottom platen in this machine is considered as concentrated type loaded at the centre of the platen and the dimension of the thickness of the platens are carried out.

B.Parthiban et al. [4] studied on the design procedure of press frame and cylinder. The frame and cylinder are modeled by using modelling software CATIA and analysed C frame hydraulic structure and cylinder using ANSYS.

The frame is designed by having direct tensile stress and bending stress consideration and the deformation of press structure during the loading condition is analysed to change the dimensions of plates. The cylinder is designed for cylinder capacity of 250 bar. The amount of pressure developed inside the cylinder during the loading condition is analysed and the wall thickness, flange thickness and number of bolts and size of bolts are selected.

N.V.Chavan et al. [5] studied on the design and manufacturing of fatigue testing machine for tension and compression spring. This paper is to provide the information about the design of fatigue testing machine for helical compression & tension spring. The objective of this paper is to design and manufactured a light weight, optimum cost, time saving and energy saving fatigue testing machine as per the requirement. The proposed design helps to save the electricity and spring testing time by arranging the springs on both side of the moving plate of fatigue testing machine.

This machine is designed for a maximum load of 13200 N. The frame design is made by considering top and bottom plates fixed with column as a beam having both ends fixed and considering maximumload at the centre of the plate, thickness of the plate is derived. After designing the machine, the spring is checked for fatigue life for number of cycles between to specified lengths.

III. PROBLEM FORMATION

The principle parameters of the design of CTM includes themaximum load of 3000 kN, piston stroke, the system pressure of 600 bar, the cylinder area and the volume flow rate of the working fluid. The critical components that require design includes the frame and the platens. The frame of CTM has to compensate the forces acting on the working frame and platens and has to fulfil certain critical constraints.

The frame design considers the compliances and deflection of the overall system during testing. The designing procedure for the structure is to design the size of the structural members and platens i.e. platen thickness, cross- sectional area of the frame etc.

IV. DESIGN METHODOLOGY

A. Platen Design

Platens are subjected to simple bending stresses. The upper and lower platens provides point of direct contact with the test specimen being compressed. Hence, they are subjected to pure bending stress due to an equal and opposite couple acting in the same longitudinal plane. Hence the design considerations of the platens are essentially for bending consideration.

Section modulus for the platens can be found out from the value of shear force (F), and bending moment (M), which gives the minimum thickness (d) of the platens. The minimum thickness of the platens can be found out using (1) [1].

$$d = \sqrt{\frac{6M}{\delta b}} \qquad (1)$$

Where, δ= allowable design stress

b= platen width

B. *Frame Design*

The structural design of frame depends on the compression force, which determines the required rigidity and work area accessibility that determines on the shape of the machine frame, the degree of guidance precision.

Factors to be considered in design of frame

- Force exerted by the component of the machine
- Manner of support of frame itself
- Precision of the system: allowable deflection of the components
- Material properties of strength and stiffness

Theoretical design of frame: Assumptions

- The material of the beam is perfectly homogeneous and isotropic.
- The material of beam obeys Hooke's law.
- The Young's modulus E is same in tension and compression.

The frame is subjected to tensile stress and bending stresses.Deflection formula for beams in bendingcan be given by (2) [6].

$$\delta = \frac{PL^3}{KEI} \qquad (2)$$

Where, P = load

L = length between supports

E = modulus of elasticity of the material in the beam

I = moment of inertia of the cross section of the beam

K = a factor depending on the manner of loading and support

The torsional deflection of a member is computed from (3) [6].

$$\theta = \frac{TL}{GR} \qquad (3)$$

Where, T = applied torque or twisting moment

L = length over which torque acts

G = shear modulus of elasticity of thematerial

R = torsional rigidity constant

V. CONCLUSION

From the literature review and design methodology, we can conclude that in the platen design, selection of good shape of the platens provides strength to the platens as the platens are only undergoes through bending.Actual structure of the frame can be designed according to bending theory and torsional theory. The values of modulus of elasticity and moment of inertia for cross section of beam should be kept large in the frame design for reducing deflection due to bending.Also, open sections are avoided in the frames.

The frame design further can be analysed using simulation software to reduce thickness of the frame within the limit. Also, frame should kept light in weight for reducing the cost of manufacturing.

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