Design and FEM Analysis of Hydraulic Tire Curing Press

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ABSTRACT
This project includes structural construction of hydraulic tire curing press, mold assembly, and also hydraulic power pack to operate machine in automotive way. In this project work all these three main sub-assemblies are clubbed together and with the proper hydraulic load's application on the machine along with self-loads and gravitational forces. Then we start the structural analysis over the frame of hydraulic tire curing press during opening and closing of top platen to the bottom platen, in order to close the mold with different closing times and speeds with the help of hydraulic power pack.Main aim of this project is to observe the stress distribution and deflections on structure at various loads,with the help of static and model analysis on the main frame. Then by verifying the results we can estimate the stability of machine main frame to with stand for working, so that we can rectify the sudden breakdowns of machines and that affects the production loses.Modeling is done by using solid works 2016.and for analysis we used ansys16.0 software.

1. INTRODUCTION

Tire curing presses plays an vital role in tire manufacturing industries .In general tire manufacturing contains different stages of process includes .In that tire curing is the 7th stage of process. But it is main stage in tire manufacturing as it includes vulcanization of tire which gives physical strength to the Green tire to become tire.Curing is the chemical cross-linking of rubber and vulcanizing agents, resulting in an elastomer. The outcome of this reaction depends primarily on the amount and purity of the raw materials. Temperatures of up to 200 °C, pressures exceeding 30 bar and long cycles ranging from a few minutes to several hours help to createthe unique properties of the final product rubber.Tire fabricators need a fully interlinked endeavor to function efficiently and compete globally. A fully connected endeavor includes the transfer of critical performance and functionalities information with OEMs to enhancethe processes, increment in the production and mitigate the risks.Enhancing throughput and increasing the machine uptime are higher key performance indicators that can degradethe cost of production for fabricating the tire. Tire manufacturers also need to manage the manufacturing process and ensure better asset utilization to maximize throughput.When productiveness and gains are crucial, manufacturers need to work with a mechanization supplier who understands their unique operation requirements.

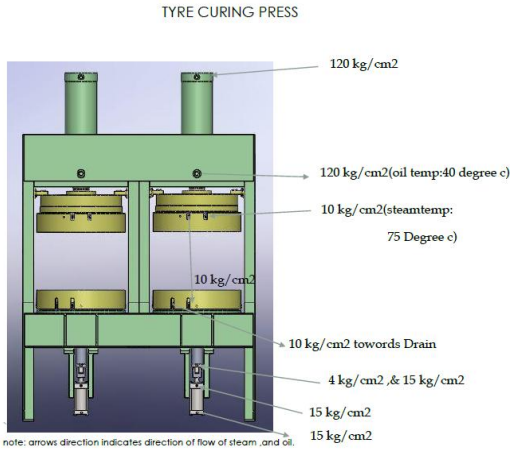


Fig. 1 Hydraulic Tire curing press

They also depend on reliable service and support around the world to keep operations running continuously.Efficient, global coordination of OEMs and system integrators is a key to improving uptime for manufacturers. Getting tire machines to market faster and profitably is a key to OEM success.

II. MAIN COMPONENTS

- Hydraulic cylinders
- Main frame Assembly
- Hub Assembly
- Top and Bottom platens with respective Tire molds
- Center Mechanism Cylinder Assembly
- Water Hydraulic Cylinder Assembly.

A. Hydraulic cylinders

Hydraulic cylinders of 2Ton capacity with aHydraulic force of 120 kg/cm2 at the temperature range of 40° C. And stroke length is 800 mm. weight of cylinder is 450 kg.

B. Main Frame Assembly

It is important sub assembly of the press, which holds and transfers the other components and their loads respectively to the Base Area, Where the proper grouting had been done to absorb the loads and their vibrations by proper holding of machine.

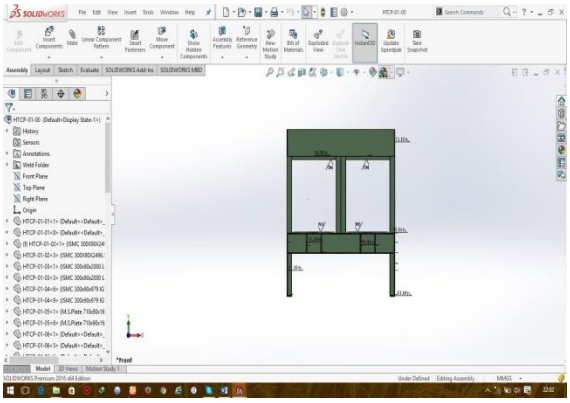


Fig. 2 Model of Main frame of tire press

C. Hub assembly

This assembly contains Circular plates with proper fabrication of gussets to distribute the load from Hydraulic cylinder ram to all over the platen area on the main frame i.e., from narrow to face load distribution.

D. Top and Bottom Platens

Top and Bottom platens are circular plates made of mild steel and having provision for steam passages inside the body and closing these provisions with help of sockets. By providing Hex nipples over the Threaded sockets we can feed the platen with the steam with 10kg/cm2 pressure and 75°C temperature. Maintaining the steam with this pressure and temperature rating gives vulcanization process optimized success. With variations on these pressure and temperature ratings gives improper curing to the tire which gives quality error on the product. Fig 4.0 shows the model of platen.

E. Center Mechanism Cylinder and Water Hydraulic Cylinders

C.M.C Cylinders are used for only lifting of Bladder which contains Greentire. Water hydraulic cylinders are used for lifting of these C.M.C Cylinders. Water hydraulic cylinders and C.M.C Cinders are maintained at 15 kg/cm2 pressure.

1) Green tire

Green tire is a readymade rubber ring which is also called uncured tire. After placing in Tire press with the help of vulcanization process, tire attains proper physical properties to with stand the radial and pressure loads of vehicles.

2) Bladder

Bladder is made of rubber with high elastic levels. This component is fixed to C.M.C Cylinder with the help of steam it pushes the green tire at semisolid condition towards the walls of mold to attain the grooves on the surface of tire, which practically calls as air passages of tire.

3) Solutions & Benefits

Faster throughput is just one part of the manufacturing equation. Batch to batch, curing presses require quick changeovers to meet the specifications which contains a list of parameters setting for different types of tires.

F. Advantages

- Curing with nitrogen offers significant advantages:
- Improved pressure stability and independent pressure level
- Maximum availability and reliability
- Cycle time reduction of up to 18%
- Up to 100 % longer bladder life time
- Reduction of production and maintenance costs
- Improved quality leads to minor tyre scrap
- Higher availability of the presses
- Reduced pipeline corrosion
- High purity guaranteed

III. MAIN FEATURES

- Fully automatic operation
- Platens or domes for heating moulds
- Single acting or double acting centre mechanisms, which ensure accurate centering, shaping and curing of bias/radial tyres
- Unloader systems
- Centralized automatic lubrication systems
- Provision for mounting segmented mould operators
- Improved design of tyre curing presses with reduced stress levels, longer life and higher accuracy

IV. BASICS OF FINITE ELEMENT METHOD

A. Basis of Finite Element Analysis

1) Introduction to F.E.A

The name finite element is of recent origin, through the concept has been used for centuries. The basic philosophy is to replace the actual problem into a simpler model, which will closely approximate the solution of the problem at hand.

A continuum is divided into a much; two adjacent regions placed side by side will have a common edge. It is assumed that the elements are connected at nodal points and it is only there that the continuity requirements are to be satisfied. Once the discrimination is made, the analysis follows a rather set procedure. The stiffness matrix of the individual element is formulated. The forces are distributed in the real structure are transformed to actually distribute in the real structure are transformed to act at the nodal lines. Assembly of individual elements is carried out to obtain stiffness matrix of the whole structure. In the finite element analysis, therefore the continuum is divided into a finite numbers of elements, having finite dimensions and reducing the continuum from infinite degree of freedom to finite degrees of unknowns. The problem to be solved by the finite element method is done in two stages:

1. The element formulation
2. The system formulation

The first stage involves the derivation of the element stiffness matrix. The next stage is the formulation of stiffness and load of the entire structure.

2) Structural Analysis

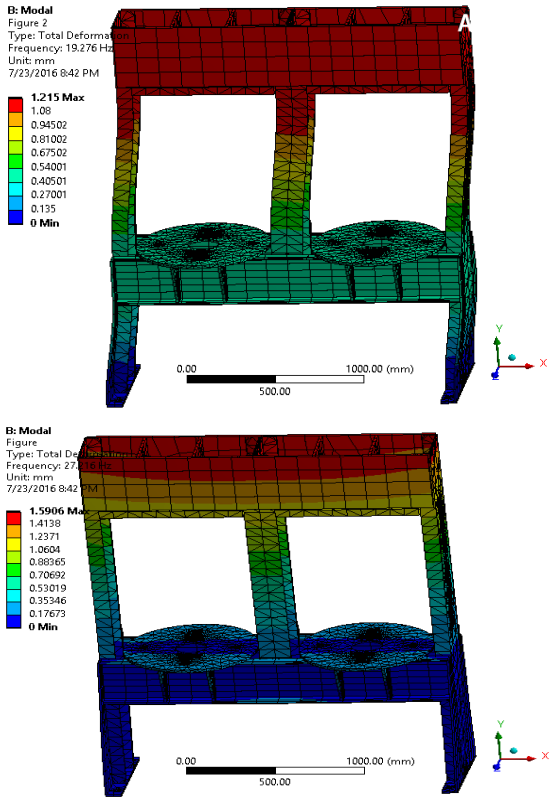
In the broad sense design of structure consists of two parts. The first part deals with determination of forces at any point (or) member of the given structure and second part deals with the selection and design of suitable sections to resist these forces so that the stresses and deformations developed in the structure due to these forces are within permissible limits. The first part is termed as structural analysis and second as proportioning structures such as bridges and buildings, but also naval, aeronautical mechanical structures such as ship hulls, aircraft bodies etc.,

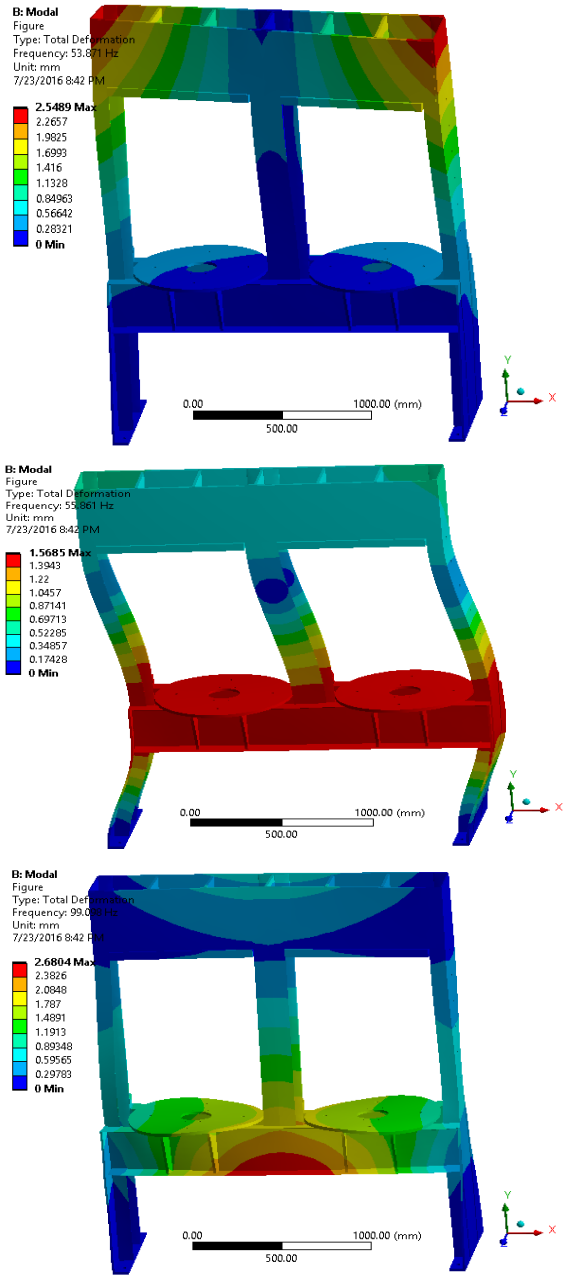
3) Modal analysis

In many engineering applications, the natural frequencies of vibration are of interest. This is probably the most common type of dynamic analysis and is referred to as 'eigen value analysis'. In addition to the frequencies, the mode shapes of vibration which arise at the natural frequencies are also of interest. These are the undamped free vibration response of the structure caused by an initial disturbance from the static equilibrium position. This solution derives from the general equation by zeroing the damping and applied force terms. Thereafter, it is assumed that each node is subjected to sinusoidal functions of the peak amplitude for that node.

V. ANSYS PROJECT

Main frame consists of steel plate and U type steel welding with high temperature treatment. After maching, release stress to improve machine life cycle. Return oil with filter and cooler to maintain stable hydraulic system.Excellent solid frame mechanism design with FEA approval to enhance body strength

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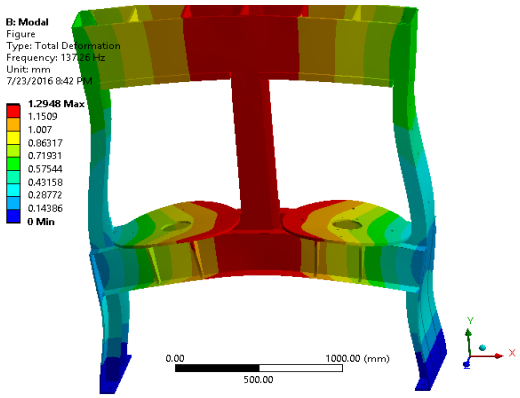
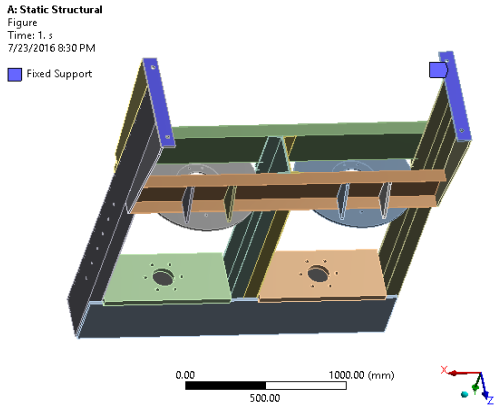
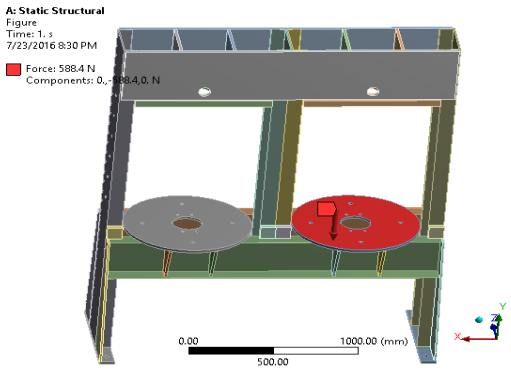
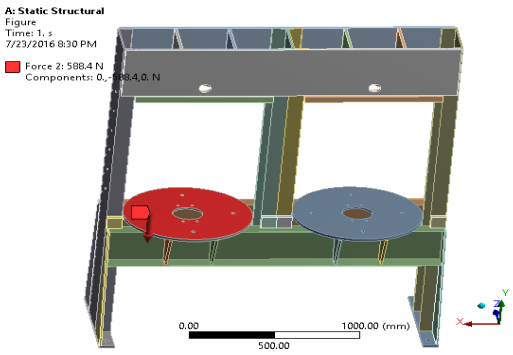
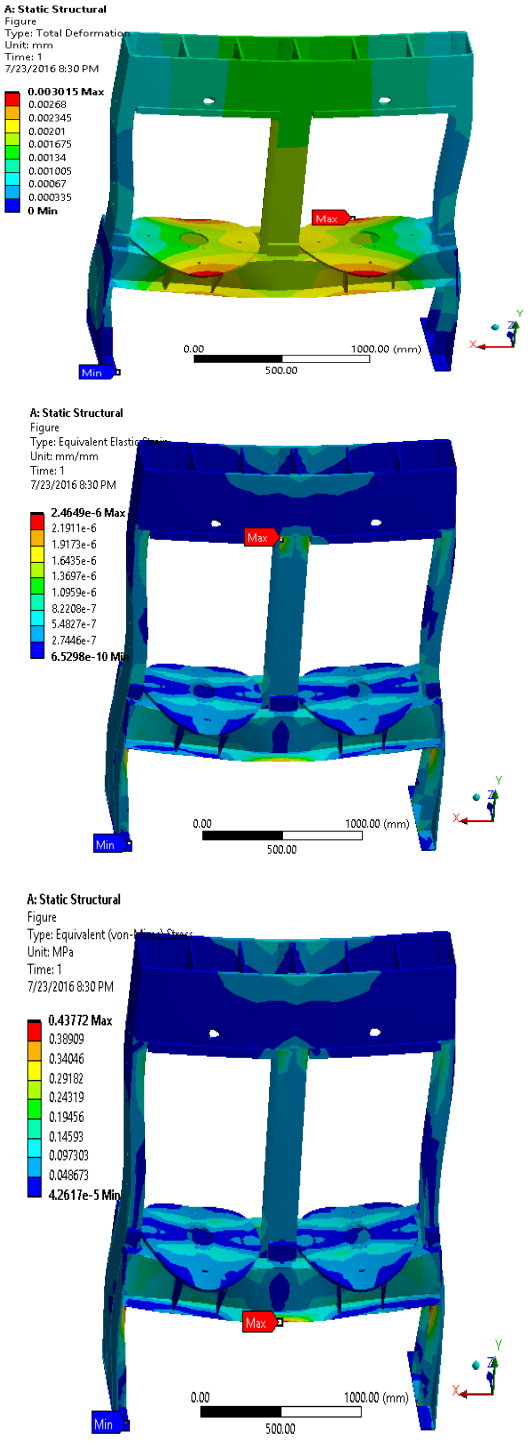


Structural Steel









VI. CONCLUSION

With reference to the analysis reports on main frame of tire curing press,total deformation max is 0.003015 mm and equivalent elastic strain with reference to stress is of maximum 2.4649 e-6 mm.From the above analysis reports we can conclude that main frame can with stand up to maximum ultimate stress of 0.43772 Mpa.

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