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EXPERIMENTAL ANALYSIS OF AN EXPLOSIVE TEST CHAMBER SUBJECTED TO INTERNAL BLAST LOADING

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Abstract Explosive test chambers are huge closed chambers used in research, testing of explosive materials and armor, research, and testing of nature of explosives used in military and defense weapons. The chamber is a huge, cylindrically closed, and is reusable. The material of the chamber is structural steel. After initial observations; an experiment is conducted on a volumetrically scaled model. The prototype, which is cylindrical GI container, is closed on both ends. A simple festival cracker is used as an explosive that is placed exactly at the centre of the container. The experimental setup is totally fixed. A camera with 15 frames per second is used to capture the experiment. The deformations are measured using dial vernier, dial gauge etc. The prototype is then modeled in ANSYS with same boundary conditions as for experiment and internal pressure is applied. The time step given is taken from the experiment. The pressure values are validated. Finally, the values are tabulated comparing experimental and FEA results for prototype.

1. INTRODUCTION

Blast loading may result from the detonation of high explosives, chemical ammunitions. The type of extraordinary dynamic load it has to be described by two parameters; peak overpressure and duration.

Explosions create high-pressure, high-temperature that can create permanent deformation of vehicles or structures around it and rupture or tearing of metal takes place and generate flying fragments which can effect the surrounding Environment.

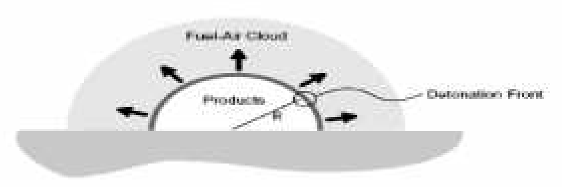

Fig.1. Generation of blast wave from rapid combustion

Expansion of combustion products due to conversion of chemical to thermal energy in combustion and creation of gaseous products in high explosives Expansion ratio for gaseous Explosions depends on thermodynamics and expansion rate depends on chemical kinetics and fluid mechanics with Flame speeds & Detonation velocity.

2. SCOPE OF WORK

Blast loading occurs due to accidents from detonation of chemical plants, gas cylinder explosions, attacks by anti-social elements and other reasons. Therefore, concerted efforts have been underway during the past three to four decades to design structures and to resist large impact loads such as those due to blast.

The difficulty of carrying out experimental tests on blast loaded structures like beams, plates, cylindrical shells, armoured vehicles etc is that the blast takes place in about a few microseconds (1E-7 to 1E-6 seconds). The resultant peak effects have to be recorded in such short durations. Strain gauge techniques, optical sensors, high speed photography are a few techniques available for measuring displacements and stresses in order to assess the structural integrity.

The displacements and stresses in the chamber during the loading event are presented in detail. The displacements are compared as obtained from the FE analysis and the tests. The advantages and limitations of the techniques are highlighted.

3. EXPERIMENTATION

A special test rig has been designed and fabricated for carrying out experimental work in this project

Experimental details are:

Experimental Test rig is experimental equipment designed to measure practically the blast effects on loads on cylindrical hollow closed container made of GI (Galvanized Iron) sheet. Test rig is fixed from outer side. A festival cracker is placed at the centre of the shell. A vernier Dial gauge is used to measure the deflections of sheet, during the blast pressure.

The Experimental Test Rig is designed with proper a dimension which is scaled by volume by 1:1.26 lakhs of the Main explosive test chamber. Experimental Test Rig is a Equipment to find the deflections Under Blast Loading .

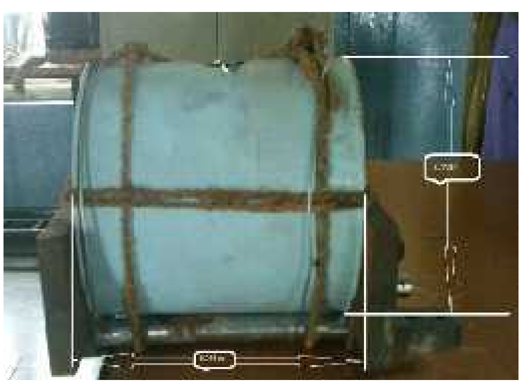

Fig 2.Experimental Test Rig Fabricated

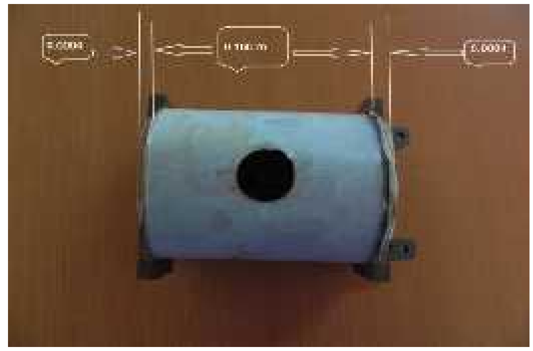

Fig 3.Deformed prototype after blast loading.

Computer Aided Design Model of a " Prototype of an Explosive test chamber" is given in below figure. Surface modeling will take less time and gives precision results and it is easy to understand the behavior of chamber under blast load. The time given for analysis is taken from the videography used in the experiment.

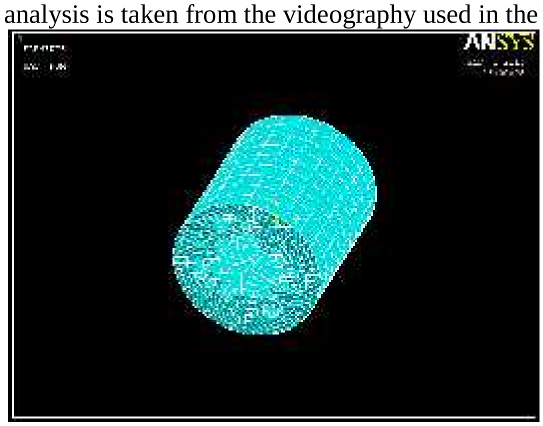

Fig 4 Meshed model of prototype

2.1 Analysis of prototype:

The prototype has been analyzed by applying internal pressure which is to be validated with experiment.

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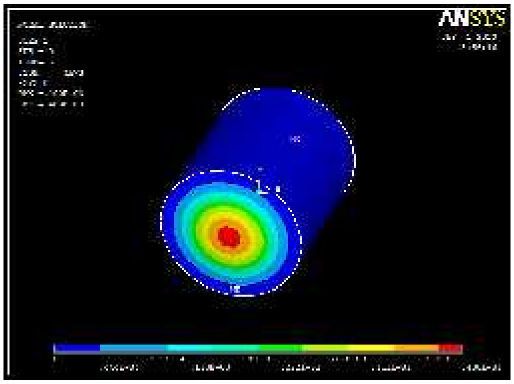

Fig 5 Deformation by explosive blast

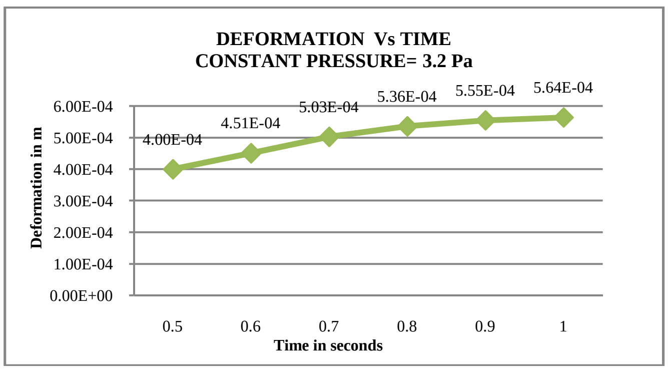

Fig 6 Deformation Vs time

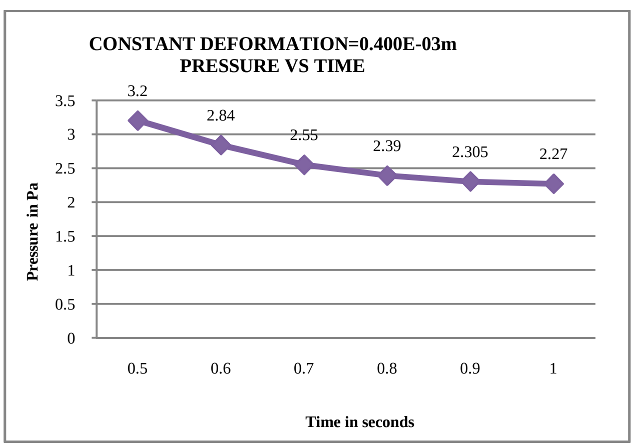

Fig 7 Pressure Vs time

3. Analysis of Main explosive test chamber :

The specifications of the main chamber are as follows:

Material used : SA 516
Inner diameter: 4 m
Length along z-direction : 5.552 m
Thickness: 0.05m .

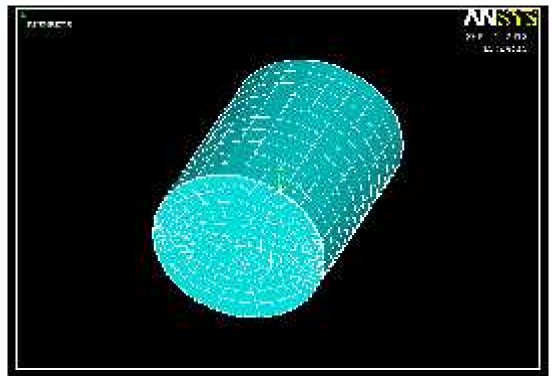

Fig.8 Meshed model of main explosive test chamber.

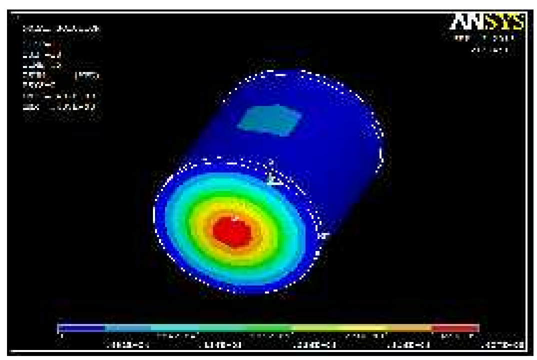

Fig 9 Deformation of main explosive test chamber

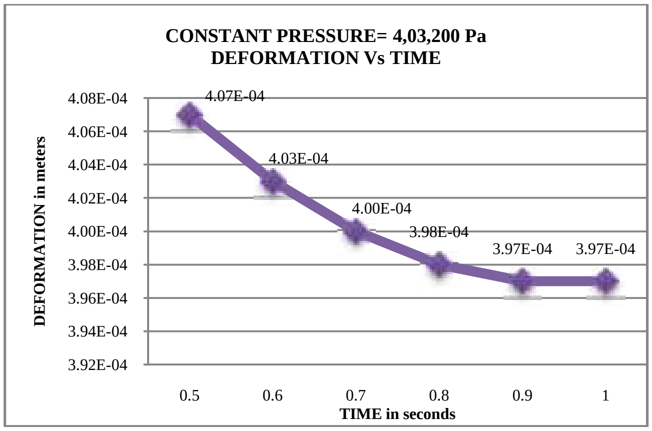

Fig 10 Deformation Vs Time

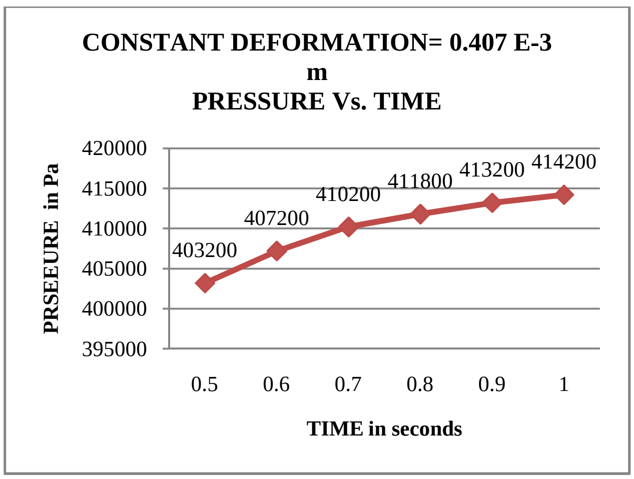

Fig 11 Pressure Vs time

4. RESULTS & DISCUSSIONS

The following table-1 compares the results obtained from the FEA (Finite Element Analysis) and prototype experimentation.

	Internal Pressure applied in Pa	Deformation In meters	Result Ratio
Prototype	3.2	0.4 E-03	
Main explosive test chamber	4,03,200 (1,26,000 X 3.2)	0.407E-03	98.28%

Table-1 Comparison of Experimental & FEA Results of explosive test chamber.

5. CONCLUSION

A detailed analysis has been carried out on explosive test chamber using finite element method and a novel experimental technique. The major conclusions are as follows.
FEA For Actual Explosive Test Chamber
The Max Deformation=0.4 E-03m in 0.5 seconds by 4,03,200 Pa Blast pressure.

FEA For Prototype
The Max Deformation =0.4 E-03m in 0.5 seconds by 3.2 Pa Blast Pressure.

The values in the model as obtained by FEM and Experiment are well allied. The methodology described in the paper, with some refinements can improve the blast resisting strength in explosion containment vessels and also increase the safety of soldiers. In future, more scaled models can be tested for different loads of blast which vary due to distance and strength of explosive. Better material modelling as available in programs like LS Dyna can also be used.

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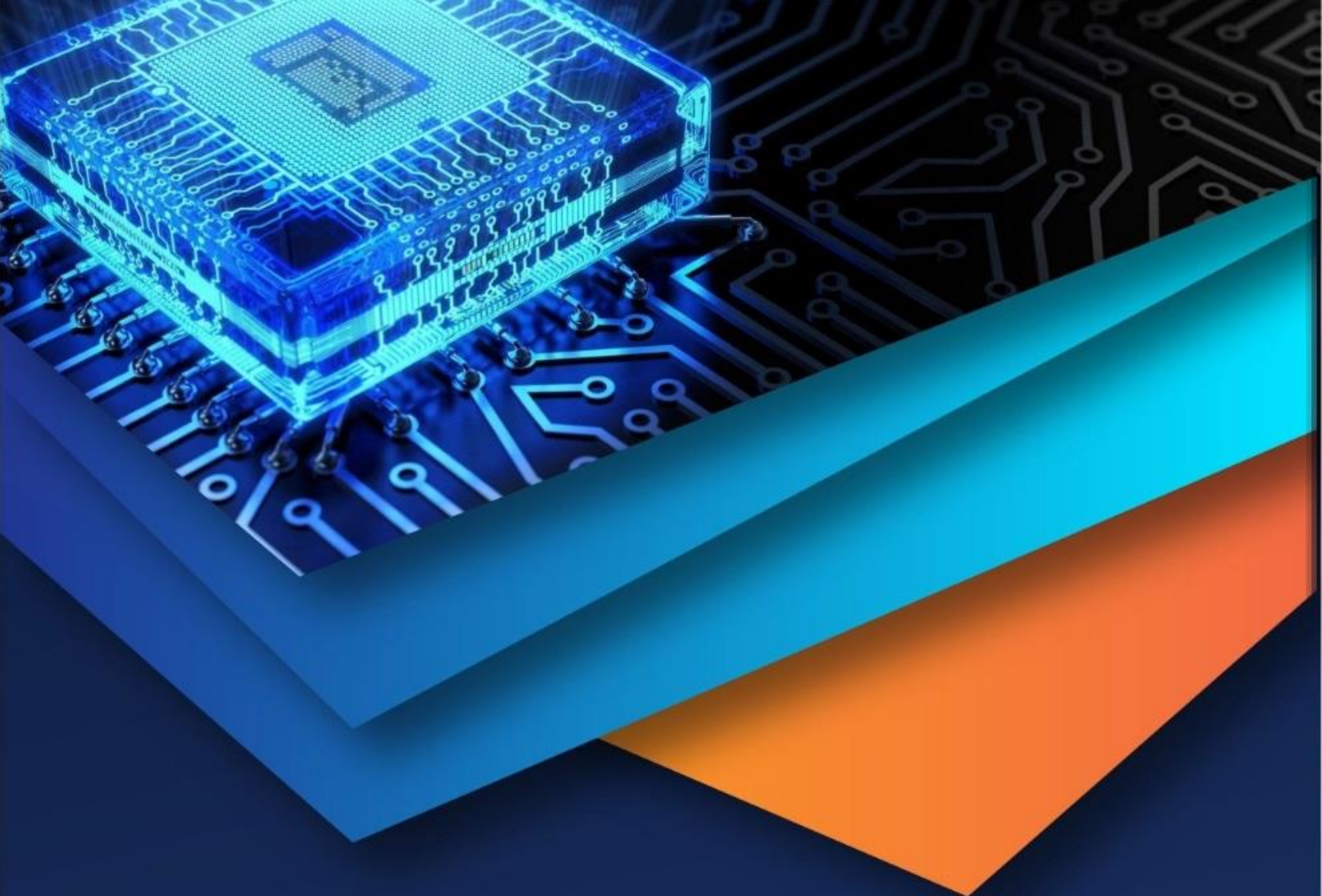

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