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DESIGN AND FABRICATION OF BULLET IMPACT TEST FACILITY FOR COMPOSITE MATERIALS

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ABSTRACT

The purpose of this facility is to determine the impact strength and natural frequency of composite materials. A bullet with a spherical shape is used so that a maximum impact that the material can withstand is found instead of the bullet easily piercing through the material causing low impact and high damage which eventually fails the purpose of the test. The bullet is fired at different velocities by adjusting the pressure feed from the pressure tank which is used to trigger the bullet. The maximum impact load that the material can withstand and the corresponding vibration of the material is determined using a double bending beam load cell and accelerometer. Using infrared sensor the velocity of the bullet for the corresponding trigger pressure is determined. With these sensor data the impact load and natural frequency of the composite material is calculated and determined.

KEYWORDS: Bullet Velocity, Impact Load, Natural Frequency

INTRODUCTION

Figure 1

The bullet impact test facility is designed to determine the strength and natural frequency of composite materials that has been newly designed and fabricated. The strength of the existing materials is generally known as their corresponding young's modulus, chemical and physical properties are known, unlike the compositethat is newly designed. Using this facility we can determine the physical properties of the newly fabricated composite materials experimentally. For the measurement and data acquisition we are using double bending beam load cell, accelerometer and infrared transmitter and receiver integrated along with the arduino board in which the programme is coded according to the requirements and design.

DOUBLE BENDING BEAM LOAD CELL

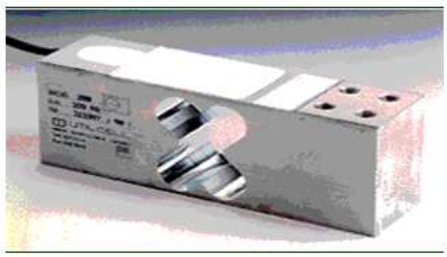

Figure 2

Through a mechanical construction the force being sensed deforms a strain gauge. The strain gauge measures the deformation (strain) as a change in electrical resistance, which is a measure of the strain and hence the applied forces.

HX711 is a load cell amplifier is used to get a measurable data out from a load cell and strain gauge.

The load cell is fitted at the back side of the composite slightly away from the center to prevent damage caused by the bullet. The load cell is connected to the HX711 which amplifies the output and gives an output that can be detected by the arduino board which is programmed to find the impact load.

ACCELEROMETER

Figure 3

An accelerometer is a device that measures the proper acceleration (g-force). Proper acceleration is not the same as the co-ordinate acceleration (rate if change of velocity).for example, an acceleration at rest on the surface of the earth will measure the acceleration g= 9.81 m/s^2straight upward by contact accelerators in free fall(falling towards the center of the earth at rate of 9.81 m/s^2) will measure .

This accelerometer is fitted on the back side of the composite material to be tested and is attached to the arduino board and programmed to find the vibration in x, y, z axes.

INFRARED SENSOR

Figure 4

Active infrared sensors consist of two elements, Infrared source and the detector. Infrared sources include photo diodes or photo transistors. The energy emitted by infrared source is reflected by an object and falls on the infrared detector.

Two infrared transmitters are fitted along the trajectory of the bullet in such a way that the transmitter and receiver are opposite to each other and the bullet cuts the transmission. Similarly another transmitter and receiver are placed along the trajectory of the bullet at some known distance such that the distance between the two transmitters and receivers are known. The distance between the two transmitters and receivers is updated in the program. The program is prepared for the measurement of velocity and executed in the arduino board.

BARREL AND BULLET

Figure 5

The barrel is made up of two layers. The outer layer is made up of mild steel and the inner layer is made of plastic. The barrel is 1 meter long and 3cm dia. It is coated with plastic for smooth movement of the bullet inside the barrel. The bullet used here is a metal ball (sphere). The barrel used must not have any grooves inside it. The ball surface must be smooth to move freely. The grooves inside the barrel will create a spiral spin and pointed tip of bullet will make it easy to penetrate through the material.

But the purpose is not to penetrate the material, instead it must create an impact on the material and to find at what impact load the material fails. Hence the strength of the material can be found.

TARGET HOLDER

Figure 6

The target holder is designed to hold material of 200mm square and 300mm square and the material thickness of 1mm-15mm and also designed to install double bending beam load all element accelerometer and digital displays from both the sensors. The back, top and bottom side of the target holder is covered with mild steel sheets to withstand bullet impact and protect the things and people around the setup. Hence it is safe to use in any place.

AIR COMPRESSOR AND PRESSURE TANK

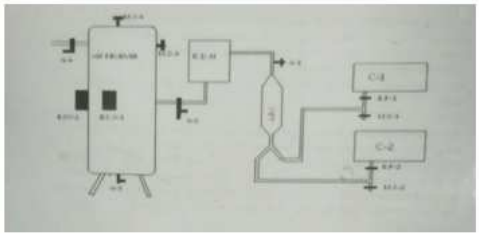

Figure 7

MODEL: FTC500 [CEC TECHNO]

MOTOR HP: 15

DISP'T: 120 ltr/min

WORK PRESSURE: 22kg/cm^2

UNIT RPM: 950

TANK CAPACITY: 5k liters

C1 and C2 are air compressors 1 and 2 of 15 H.P each

EP1 and EP2 – HIGH PRESSURE SOLINOID VALVE

MS1 and MS2, Ms-3&MS-4 MECHANICAL SAFETY VALVE

G-1, G-2,G-3&G-4 USER GATE VALVE

A.F.C –After cooler

A.R –Air reservoir tank

R.D.H – Refrigerated type DEFLUMIDIFIER

E.S.V1 and ESV@- Electrical safety out off valves

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CONCLUSIONS

By using this set up, the velocity at which the Bullet strikes the composite and the impact created by it on the composite is noted. And the maximum impact that the composite material can withstand is determined experimentally. From the data established by the accelerometer, a time domain and frequency domain graph are plotted and the natural frequencies of the corresponding composites are determined. Further the data can be used for the future study of the physical properties of the composite material

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