CAD Model Analysis of Vibration Table & Human Body

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Abstract— In this paper, A 3D CAD model has been modeled according to the Indian human male subject anthropometric data. 3D CAD model of vibro-table was developed considering automobile norms of public transportation analyzed with ANSYS workbench 14.5. three vibro motors were considered on table to produce vibration in all three-liner direction. Modal analysis and random vibration analysis were done to evaluate comfortable range of operation as per ISO 2631-1:1997. The model has been developed using 95th percentile anthropometric data of 76 kg mass Indian human male subject. Harmonic analysis of vibration table recorded at 5 Hz. Modal analysis of human CAD model reported in low frequency vibration zone. Both CAD model will be useful for futuristic computational analysis of vibration on human body.

Key words: CAD, Vibration Table, Human Vibration, Modal Analysis

I. INTRODUCTION

The vibration platform is mainly composed of support, table vibration mechanism, and shock absorption mechanism. Driven by the vibration mechanism, it makes three dimensional vibrations, such as transverse, longitudinal, up, and down, so it is named. The vibration mechanism of the vibration platform is mainly composed of several vibration motors and transmission plates. The number of vibration motors is usually even, such as 2, 3, 4, 6, etc. the type of vibration motor determines the main technical parameters of the three-dimensional vibration platform. The shock absorption mechanism of the vibration platform is mainly composed of a damping spring, which is divided into a rubber spring, composite spring, and gas spring.

In the process of using the vibration platform, the vibration force of the vibration motor can be adjusted to make any type of thing on the platform realize the ideal method. The oscillating motor is an exciting source with low noise, low power consumption, and simple protection. The vibration platform is divided into three oscillation methods: up and-down oscillation, spiral oscillation, and three-dimensional oscillation. A vibrating table is a motor-driven unit in which the motor rotates at variable speeds with the help of a potentiometer and it produces vibrations. Throughout this assembly the motor is mounted in three different directions and it produces vibration in its direction. In this structure, three motors fitted in such a way that, they can rotate and vibrate at different angles. We have also given a way to easily change the angle of the motor in this structure.

Vibration platform is widely used in metallurgy, mold/food, the chemical industry, building materials, and other professions. The vibration platform is used to change the particle and powder material from bulk to block and shape in the production process.

II. LITERATURE REVIEW

Structure of large vibrating screen with hyperstatic net-beam The hyperstatic net-beam structure was applied in the design of new types of vibrating screens based on the characteristics of the hyperstatic structure. A hyperstatic net-beam device was set between two side plates of the vibrating screen which was composed of six beams, two exciter beams, and three static plates. The beams are distributed on the support plates according to the requirement of exciting force.

The vibration exciters were set on both sides of static plates and the exciting transmission shaft was connected to a synchronous vibration generator. Thus, big vibration generators were replaced by series-connected small vibration generators. The girder steel or rectangular steel was not needed in the hyperstatic net-beam structure. The vibrating screen improved the production effect of a single machine and is suitable for medium draining of raw coal, and other materials.[1] J. Manikandan et al., 2017 studied on design and fabrication of a vibrating table for separating nuts using different sizes of mesh [2].

Osamu Furuya, et al., 2008 studied on research and development of a vibrating attenuation technique for a lightweight structure. Waluyo Adi Siswanto, et al., 2011 studied the shaker table design for an electronic device vibration test system. A general-purpose vibration test system has been developed to provide a testing platform for electronic devices. Igor Ovchinnikova, et al., 2017 studied, an attempt has been made to test the vibrations caused by the vibrating table. The requirements for test results on vibration authenticity and reproducibility are discussed.

Ercan yoga, et al., 2011 studied concrete as composite material commonly used in construction and defined it as composed of aggregate (coarse and fine), water, cement, and sometimes chemical and/or additives. Aditya Pawar, et al., 2016 studied a vibration exciter as a machine that produces mechanical vibratory motion to provide forced vibration to a specimen on which modal analysis and testing are to be performed. Afework Achalu, et al., 2017 studied Concrete material as the most common building material relatively low maintenance requirements add to its popularity. Sudarshan N.M., et al., 2017 studied the strength and durability of conventional concrete depending on the number, shape, and size of air voids in concrete.

Y Ito, T. Uomoto., 1997 studied the sound induced by hammering the surface of the concrete has often been used for detecting defects such as voids and delamination in actual structure [3]. In one study, the design and manufacture of a mechanical vibration table working at constant amplitude and different frequencies was performed. The table was driven by a variator and a sinusoidal motion was produced. The fresh concrete should be compressed to the highest possible density in practice so that there are no air pockets in it.

In this study, vibrations were applied to samples prepared for fresh concrete by a table vibrator for different durations. Vibrated samples had higher compressive strength 3 and unit weight compared to non-vibrated samples. All parameters affecting durability are also effective in the carbonation of concrete. Carbonation tests can be done in normal environments and laboratories by acceleration. In this study, concrete was compressed with the vibration technique, and accelerated carbonation studies were carried out at different humidity rates on the samples which were presumed to have the least amount and the ideal amount of voids. In the optimum design study of cement-based composite materials, cement, silica flour, crushed sand, and crushed stone were mixed first, and then water, hyper-plasticizer, and steel wire were added to produce concrete. The obtained mixture was compressed with the mold it was poured into and taken to the vibration table. The density and compressive strength of two different polyester resins widely used in the market were studied. Different samples were produced with varying ratios of filler material and without filler material and then tested. The vibration was applied for 7 minutes at 3000 rpm before gelling started in casting. Although sample dimensions changed in the compressive strength measurement of concrete, the mixes prepared were taken from the same batch, placed on the same vibration table, and compressed. For engineering targets, a 1.5x1 meter large mechanical shaking table was designed and manufactured to be able to model the dynamic effect caused by earthquake effect in laboratory conditions. One-way movement of the shaking table was provided by the electric motor and speed, acceleration, frequency, and period values were determined. With 30 mm horizontal movement, 0-190 rpm, the study conditions can range up to 600 cm/s2 acceleration and 30 cm/s speed.

Travertine residues and limestone aggregates from the Denizli basin and concrete sample mixtures by the pre-determined granulometry distribution curves were taken into molds and compressed in the vibration table. The wooden plate produced in dimensions of 50 x 50 x 50 cm can provide one-way and harmonic motion ranging from 0-6 Hz. From the cast on the plate, the displacements at the upper, middle, and lower points were recorded with a camera and analyzed in the computer program.[4] By adding various wastes into the concrete mixture to reduce the cost of the concrete, both environmental protection and cost reduction were achieved. These samples were prepared using a vibration table and by the standards. One of the important issues in the production of prestressed concrete and reinforced concrete components is to ensure that the fresh concrete is placed without gaps and has the desired strength characteristics. The mobility of fresh concrete is low.

Therefore, in this study, the vibration technique was applied to the compression of fresh concrete. Sudarshan N.M., et al., 2017 studied the strength and durability of conventional concrete depending on the number, shape, and size of air voids in concrete [5]. Y Ito, T. Uomoto., 1997 studied the sound induced by hammering the surface of the concrete has often been used for detecting defects such as voids and delamination in actual structure[6]

III. COMPUTATIONAL MODELING & BOUNDARY CONDITIONS:

All the parts that have been used in the design of this structure have been taken from ISI standard parts so that if any maintenance comes in the future, its maintenance can be done easily and its maintenance costs are also reduced. As per our calculation, we choose an ISI standard weldment channel section C (100 x 50) with 5mm thickness. vibratory motor 0.5hp /0.37Kw 1440 rpm was selected for each linear axis.

Distributed load on table surface was calculate with shear moment & bending moment diagram with single span beam which lead to evaluate load of 0.77 KN & 0.61 KN corresponding to span length of 1.53 Meter & 1.23 Meter for CAD model of vibro table as shown in Fig.1(a). while fig.1(b) shows cad model of human model considering 1) Modulus of Elasticity = 13 MN/m^2 and 2) Human density = 1.062 x 10^3 kg/m^3.

Fig. 1 (a): CAD Model Vibro Table

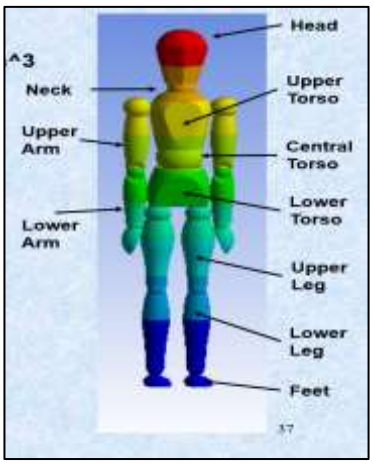
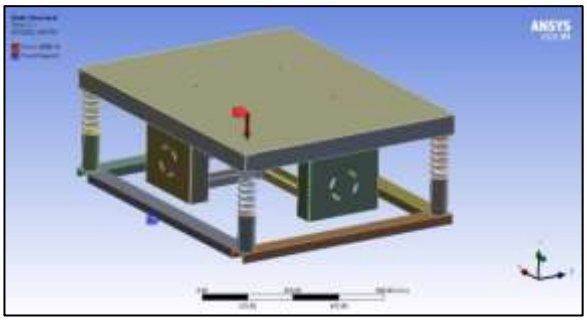


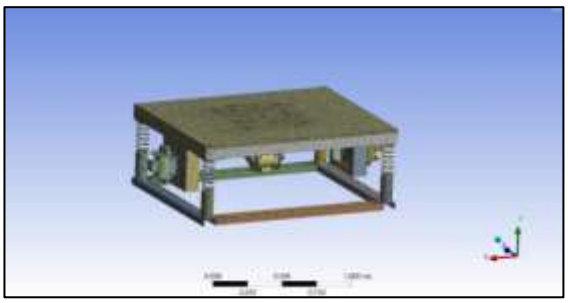
Fig. 1 (b): CAD Model human

IV. HARMONIC ANALYSIS OF VIBRO TABLE

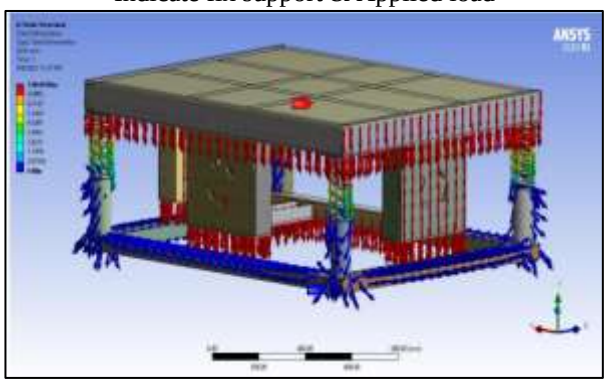
Strctural strength analysis for load range from 1000 N to 4000 N were carried out and entier analysis process was sequentially presented in Fig.2. Total Deformation at 1000 N was 1.966 mm and Maximum stress was 48.32 MPa. At 4000 N, total deformation was 7.864 mm and maximum stress was 193.29 MPa. Which lead to coclude the strength of table.



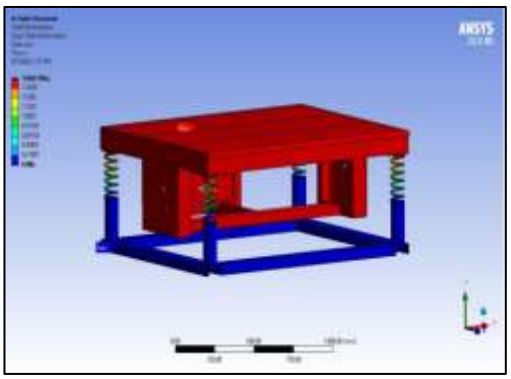
Indicate fix support & Applied load



Mesh Generation



Load Transfer direction



Total Deformation of structure

Fig. 2: Structural Analysis of Vibro Table

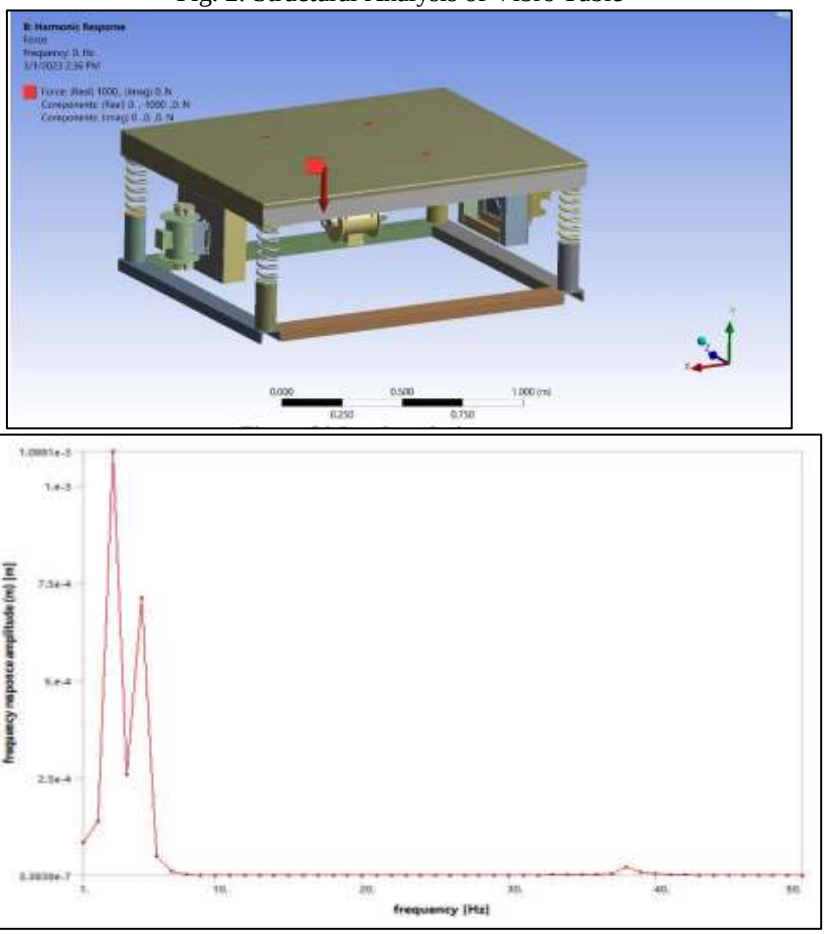
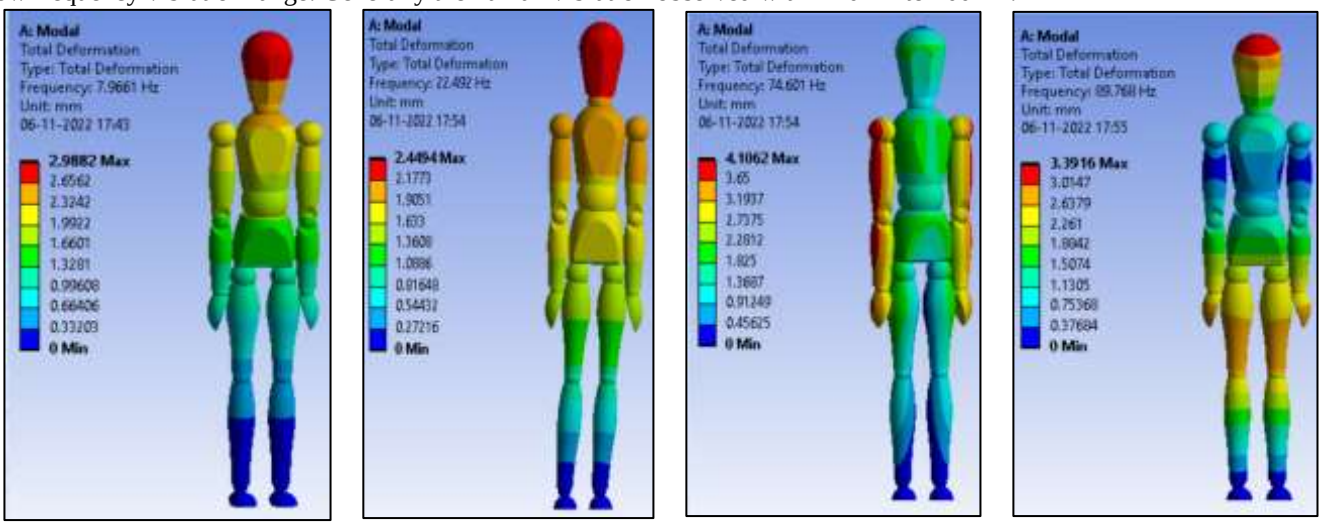


Fig. 3: Harmonic Response Analysis

further harmonic analysis was carried out to evaluate strength of vibro table against variable load and corresponding process were mention in Fig. 3 and achieved modal frequencies were 3.146 Hz at Mode 1 and 25.73 Hzs at Mode 4 which lead to conclude that overall vibro table developed here is within vibration range of human comfort. Thus the further human model may model and evaluate on this table.

V. MODAL ANALYSIS OF HUMAN BODY

Modal analysis of human cad model was carried out up to 4 mode and it's behaviours were presented in fig. 4 and corresponding mode deformation & modal frequencies were tabulated in Table 1, Which lead to conclude that our CAD model is operating low frequency vibration range. Generally the human vibration observed within 10 Hz to 100 Hz.



Mode 1 Mode 2 Mode 3 Mode 4

Fig. 4: Modal Analysis of Human CAD Model

Mode Number	Deformation (mm)	Frequency (Hz)
1	2.92	7.96
2	2.44	22.49
3	4.10	74.60
4	3.39	89.76

Table 1: Modal Analysis Responses of Human CAD Model

VI. CONCLUSION:

- Proposed computational study of Human model is well range of 10 Hz to 100 Hz which means that over human CAD model is useful for further studies related to human vibration and it's overall effect of human body in different traveling conditions.
- Proposed CAD model Vibro table is also indicating harmonic responses within vibration frequency of 5 HZ which lead to conclude that modulation of other vibration were filtered out in proposed CAD model of vibro table.

Overall CAD model of Vibration Table and Human body is accepted and ready for futuristic analysis with computational only.

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