INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) www.irjaet.com

ISSN (PRINT) : 2454-4744 | ISSN (ONLINE): 2454-4752

Vol. 1, Issue 4, pp.207 - 211, November, 2015

# DESIGN OF SHAKE TABLE TO TEST THE INTEGRITY OF BUILDINGS AND DETERMINE REINFORCEMENTS

**P.V. SANKAR[1], DR.R.MADESWARAN[2]**

[1]PG Scholar, Bharathidasan Engineering College, Natrampalli

[2]Professor, Head of the Dept, Bharathidasan Engineering College, Natrampalli

**ARTICLE INFO**

**Article History:**

Received 1st Nov, 2015

Received in revised form 3rd Nov,2015

Accepted 5th Nov, 2015

Published online 16th Nov, 2015

**Keywords:**

Table,Seismic Analysis, Teaching Tool, Seismic Modeling.

**ABSTRACT**

This is about the process of a shake table for use in seismic analysis of small-scale models in the earthquake engineering In order to test seismic response of a prototype building, a 2-story reinforced concrete building was modeled in small scale with small steel wire and concrete and tested on the shake table. The shake table recorded data from an accelerometer mounted on the model. The model was built to have the same resonant frequency as the prototype building. The model clearly shows modal forms and shows exaggerated deflection, as well as torsion caused by modeling inconsistencies. Reactions in the model correlate to the prototype. A model on a shake table is useful to the earthquake engineering as a teaching tool to visually highlight the effect strong ground motion can have on a building.

## 1. INTRODUCTION

The development in the field of earthquake engineering requires experimental study. Laboratory testing of components and structures as physical models is an effective way to study the complex phenomena. Correlation of results from laboratory experimentation and analytical modeling will increase the confidence of the researcher. A Shake table can be used to test the model of the structure which may be scaled or prototype to seismic shaking. Shake tables are used to simulate earthquake ground motions, and the motions of structures excited by earthquakes.

### 1.1 Earthquake Motion And Response Spectra

Seismic ground or structure motions can be presented as accelerograms – time histories of acceleration. These can be actually measured earthquakes, results of structural calculations, or artificially generated time histories having certain desirable properties. Shake tables are typically asked to reproduce these

motions, within certain limits. Peak responses are typically about 3 g, 40 ips (1m/s), and +/-3" (+/-8cm). Sometimes responses several times smaller or larger than these are required. The lower the damping the greater the larger the spectra, although all spectra converge at high frequencies (to the Zero Period Acceleration or ZPA). Lower damped spectra are more variable ("hashier") than higher damped spectra. Note that the acceleration reported is spectral acceleration and not the maximum acceleration required of the table. For example, the 1% spectrum in Figure 1 has a peak value of about 10 g. This is the maximum acceleration that a 1% damped oscillator with about a 2 Hz resonant frequency .

### 1.2. Seismology

Seismology is a relatively recent field of study. Seismology is the study of earthquakes, which are caused mostly by plate tectonics, the huge pieces of the earth's crust as they move relative to each other, which causes strain in the intersecting fault lines. One of the major plate boundaries occurs in California at the boundaries of the Pacific Plate and the Continental Plate; known as the *San Andreas Fault*. This is a strike slip fault, meaning it moves laterally along the fault. The study of earthquakes is important because earthquakes cause billions of dollars in damage every year around the world, and thousands of deaths and tens of thousands of injuries. In the United States, around 1,200 deaths have been recorded since 1900.

## 2. SHAKE TABLES

The shake table is a device that simulates a seismic event. It can also be used to create fictional "worst case" scenarios or resonant frequencies. In computer controlled shake tables a computer program generates a signal, and a digital signal is sent to a digital/analog converter, which sends a voltage to the amplifier. The amplifier amplifies the voltage and sends it to the shaker platform to which the model is attached. The Shake Table is a one-degree of motion shake table, meaning that it will move only in one lateral direction.

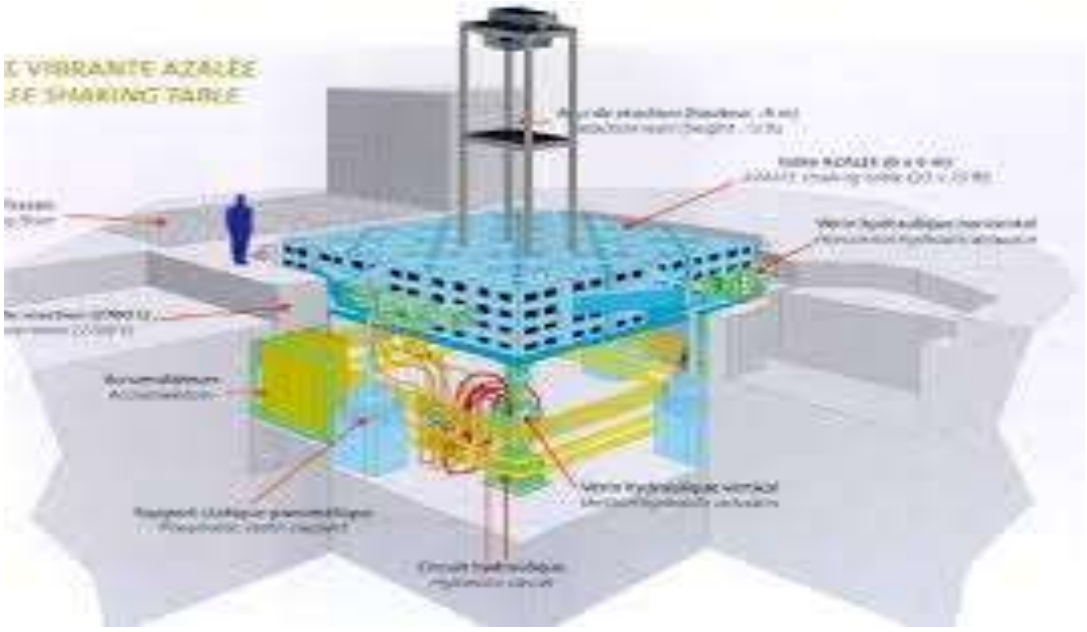

**Figure 1.1: Shake Table with testing model**

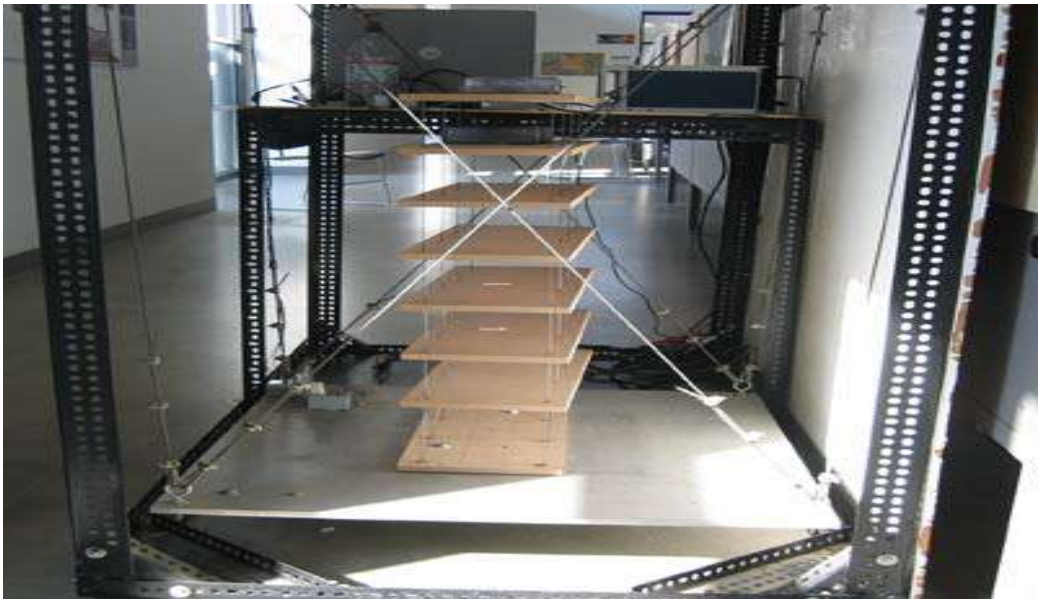

**Figure 1.2: G. Schierle Shake Table**

The shaker is bolted to the base of the frame, and connected to an aluminum platform with a long bolt. The platform is suspended from the top of the frame with cables and cross-braced to reduce the introduction of torsion into the model. The platform has holes drilled 3" on center regularly spaced in a grid, for ease of securing models for tests. The whole frame is 3' tall, and 2.5' wide.

### 2.1. Types Of Shake Tables

Seismic tables are typically uniaxial, biaxial, or triaxial, as discussed above. They can be driven by servo-hydraulic actuators, servomotor actuators, Electro-dynamic actuators, or mechanical actuators. Servo-hydraulic actuators are the most common and can handle large tables with large test object masses and high acceleration requirements. Their disadvantage is higher noise, high oil pressure, oil leakage, maintenance, and requirement for special maintenance training. Servomotor driven tables are cleaner and less noisy than servo-hydraulic tables and require no special maintenance training. However, they have limited payload mass capacity and can be more expensive than servo-hydraulics for larger tables. Electro-dynamic actuators have limited stroke (except for certain newer models) and are generally limited to uniaxial tables. Hence they are seldom used for seismic qualification, except for relatively small and rigid equipment.

## 3. MECHANISM & KINEMATIC ARRANGEMENT

The motor is connected to the table for getting the vibratory movements of the shake table and The transmission is done with the help of connecting rod and variable displacement disk. The vibratory movement mechanism system includes motor, motor shaft, driven shaft and coupling The motor shaft is connected to driven shaft with the help of coupling provided in the system.

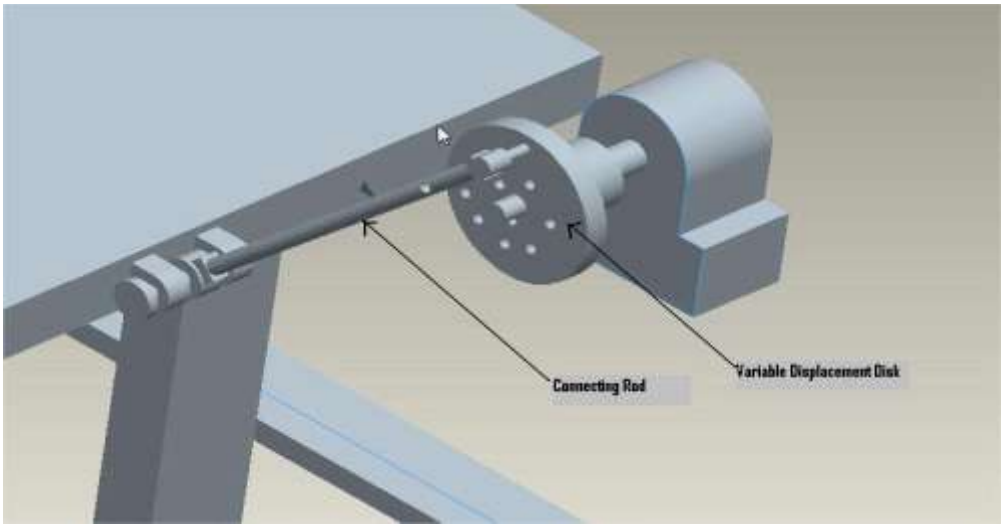


**Figure 3.1 Motor and connecting rod assembly**

*DESIGN AND DEVELOPMENT OF SHAKE TABLE*

There Are Two Types Of Tables:
A) Main Shake Table
B) Secondary Guide Table
• The Structural Model Is Kept On The Main Table And Secondary Table Guide The Main Table For Vibration
• V- Notches Are Provided On The Main Shake Table.

## 4. SEISMIC FORCES AND SHAKE TABLE ANALYSIS

An earthquake occurs when built up energy is released in a sudden slippage of a fault. Faults, or cracks in the earth's surface, occur primarily at the edges of tectonic plates, large pieces of the earth's crust. An earthquake occurs when built up energy is released in a sudden slippage of a fault. Faults, or cracks in the earth's surface, occur primarily at the edges of tectonic plates, large pieces of the earth's crust. Strike Slip faults are the faults most relevant to Southern California. A Strike Slip fault is a fault in which one side of a fault moves horizontally in relationship to the other side of the fault typically parallel to the fault. The San Andreas Fault System that forms part of the boundary between the North American Plate and the Pacific Plate is a Strike Slip fault.

## 5. MATHEMATICAL MODELLNG AND SIMULATION

**ASSUMPTIONS**
o Forced type vibrations
o Dampers
o Damped forced vibration with multiple degree of freedom system.

**CALCULATION**

**Considering**

o m1(mass of shake table) =52kg
o m2(mass of secondary guide table) =52kg
o c1 = c2 = c3 = c4 = c (dampers)
o k1 = k2 = k3 = k4 = k (springs)
[m] = mass matrix
[c] = damping matrix
[k] = stiffness matrix
[F] = force matrix

**Mathematical Modeling of Vibration System I**

For Stimulation Purpose we are using: -

- Considering undamped system.
- Single degree of freedom system.
- Simple spring mass system.

## 6. CONCLUSION

From the test data, it can be seen that the shake table is restored to working order. The shake table can run both sine waves and earthquake waveforms. When running a sine wave at 1 Hz, the accelerometer on the shake table sends a 1 Hz waveform back into the computer. The test data also shows that the shake table seems to run consistently. This is more evident in the data files taken from the lower 2nd and 3rd floors, where there is lessvariation in the waveforms, and the three tests seem to more closely match. Theshake table also can create repeatable tests.

## REFERENCES

1. Trifunac, M, Hao, T, 2001, *7-storey reinforced concrete building in Van Nuys, California: photographs of the damage from the 1994 Northridge earthquake*, *USC Report CE 01-05*, University of Southern California, Los Angeles, CA.
2. Todorovska, M, Trifunac, M, 2006, *Impulse response analysis of the Van Nuys 7- story hotel during 11 earthquakes and earthquake damage detection*, *Structural Control and Health Monitoring*, University of Southern California, Los Angeles, CA.
3. Todorovska, M, Trifunac, M, 2006, *Impulse response analysis of the Van Nuys 7- story hotel during 11 earthquakes (1971-1994): one-dimensional wave propagation and inferences on global and local reduction of stiffness due to earthquake damage*, *USC Report CE 06-01*, University of Southern California, Los Angeles, CA.