SEISMIC BEHAVIOUR OF SOFT STOREY EFFECT IN RC STRUCTURE BY SHAKE TABLE TEST

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Abstract : In this thesis an investigation has been made to study the seismic behaviour of soft storey building with different arrangement in soft storey building when subjected to static and dynamic earthquake loading. The models are tested for displacement, fundamental time period, natural frequency, acceleration. It is observed that, Providing of shear wall improves resistant behaviour of the structure when compared to soft storey provided. All storey wall structure behaves very well in dynamic analysis as compare to the soft storey at various floor model. To better understand seismic activity and how they affect structures, earthquake shake tables were invented to model seismic waves and simulate an earthquake. Earthquake shake tables have been on the leading edge of seismic design and technology. The earliest use of a shake table dates back over a century. The results of the large number of analytical studies have not been practically validated by experimental testing programs using either scale models or full scale testing. Shake tables are used to test structural models and components, usually to the point of failure. These tables give the operator a wide range of seismic waves and scenarios to test against the structure's integrity. The more advanced earthquake shake tables can even recreate recorded earthquakes.

IndexTerms – **Soft storey, shake table, displacement, fundamental time period, natural frequency, acceleration, Force Vibration.**

1. INTRODUCTION

The lateral stiffness of the soft storey is less than 70 percent of that in the storey above or 80 percent of of the average lateral stiffness of the three storey above (IS1893:2002) . "Soft story" and "weak story" are irregular building configurations that are a significant source of serious earthquake damage. These configurations that are essentially originated due to architectural decisions have long been recognized by earthquake engineering as seismically vulnerable. Large open areas with less infill and exterior walls and higher floor levels at the ground level result in soft stories and hence damage. soft storey is due to the parking spaces at bottom, openings for commercial spaces, large unobstructed area and gneration of floating column.

1.1 OBJECTIVES

1. To study the soft storey effect.
2. To give guideline for elimination of soft storey effect.
3. To study the seismic response of soft storey structure.

1.2 Methodology

1. Selection of model configuration in Shake table.
2. Analysis of structure with Shake table for different time history.
3. Comparative study on results under
   i. Relative Deflection
   ii. Acceleration
   iii. Time period

2. Significance of Shake Table

Shake table is a device for shaking structural models or building components with a wide range of simulated ground motions, including reproductions of recorded earthquakes time-histories. The use of shaking tables for the assessment of the dynamic and seismic behavior of civil engineering structures is effective since the sixties.

2.1 Details of shake table
Name of Manufacture: MILENIUM TECHNOLOGIES (I) PVT. LTD., BANGALORE
Name of Instrument: SERVO SHAKE TABLE
Capacity of Instrument: 30 Kg
Testing frequency Range 0 – 12 Hz
Supporting Software -Servo Shake Table Test, Kampana.
List count -Records recording with accuracy of 0.01 mm in all three dimensions at interval of 1 mSec

Instrumentation with shake table-5 accelerometers, MILDAK Data collection system, Processing software like LAB SHAKE TABLE TEST and KAMPANA

Table -1: 1-Equipment Setup
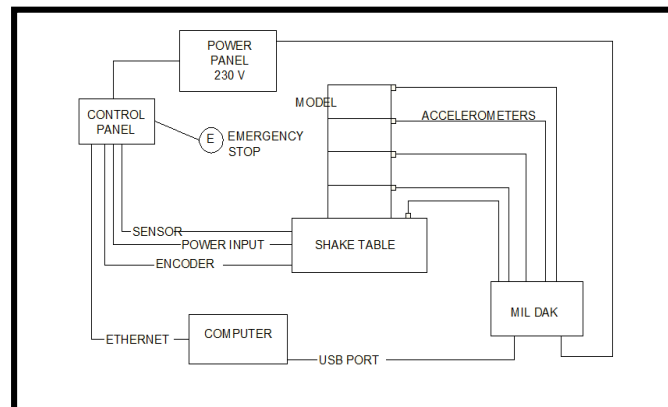
2.2 Scaling for shake table model

Various parameters are considered for selection of material for model making. Among which 'Stiffness' of member plays a vital role for governing the strength of member. 'Stiffness' of member is composed of 'Moment of Inertia' and 'Modulus of Elasticity' is given in Table

Table -2.: Engineering Properties of Various Material

MATERIAL	Type	Cost ($/kg)	Density (ρ,Mg/m³)	Young's Modulus (E, GPa)	Shear Modulus (G, GPa)	Poisson's Ratio (v)	Yield Stress (σ_Y, MPa)	UTS (σ_f,MPa)	Breaking strain (ε_f,%)	Fracture Toughness (K_c,MN m³/²)	Thermal Expansion (α,10⁻⁶/°C)
Alumina (Al₂O₃)	ceramic	1.90	3.9	390	125	0.26	4800	35	0.0	4.4	8.1
Aluminium alloy (7075-T6)	metal	1.80	2.7	70	28	0.34	500	570	12	28	33
Beryllium alloy	metal	315.00	2.9	245	110	0.12	360	500	6.0	5.0	14
Bone (compact)	natural	1.90	2.0	14	3.5	0.43	100	100	9.0	5.0	20
Brass (70Cu30Zn, annealed)	metal	2.20	8.4	130	39	0.33	75	325	70.0	80	20
Cermets (Co/WC)	composite	78.60	11.5	470	200	0.30	650	1200	2.5	13	5.8
CFRP Laminate (graphite)	composite	110.00	1.5	1.5	53	0.28	200	550	2.0	38	12
Concrete	ceramic	0.05	2.5	48	20	0.20	25	3.0	0.0	0.75	11
Copper alloys	metal	2.25	8.3	135	50	0.35	510	720	0.3	94	18
Cork	natural	9.95	0.18	0.032	0.005	0.25	1.4	1.5	80	0.074	180
Epoxy thermoset	polymer	5.50	1.2	3.5	1.4	0.25	45	45	4.0	0.50	60
GFRP Laminate (glass)	composite	3.90	1.8	26	10	0.28	125	530	2.0	40	19
Glass (soda)	ceramic	1.35	2.5	65	26	0.23	3500	35	0.0	0.71	8.8
Granite	ceramic	3.15	2.6	66	26	0.25	2500	60	0.1	1.5	6.5
Ice (H₂O)	ceramic	0.23	0.92	9.1	3.6	0.28	85	6.5	0.0	0.11	55
Lead alloys	metal	1.20	11.1	16	5.5	0.45	33	42	60	40	29
Nickel alloys	metal	6.10	8.5	180	70	0.31	900	1200	30	93	13
Polyamide (nylon)	polymer	4.30	1.1	3.0	0.76	0.42	40	55	5.0	3.0	103
Polybutadiene elastomer	polymer	1.20	0.91	0.0016	0.0005	0.50	2.1	2.1	500	0.087	140
Polycarbonate	polymer	4.90	1.2	2.7	0.97	0.42	70	77	60	2.6	70

From studying all the parameters we choose 'ALUMINIUM' is simulated for 'CONCRETE'.   The comparison of various engineering properties for material is as follows Table

Table -3: Comparison of Engineering Properties of   Aluminium and Concrete

Engineering Properties	ALUMINIUM	CONCRETE
Modulus of Elasticity (GPa)	70	25
Coefficient Of Thermal Expansion (10-6/oc)	33	12
Specific Gravity	2.7	2.5
Shear Modulus (GPa)	28	20
Yield Stress (MPa)	500	25
Breaking Strain (%)	12	0

2.2 Calculated scaling factor for samp
le model

from calculation of acceleration, mass ,time, frequency and force model for shake table is prepared by using aluminum material with different sizes.

Table -4 : Calculated Scaling Factor for Model

Parameters	Symbols	Factor
Length	S1	1/35
Elastic Modulus	SE	1/4
Acceleration	Sa	1.4
Mass	Sm	1/6860
Time	St	1/7
Frequency	Sf	7
Force	SF	1/4900

2.3 Shake Table Model

Figure1.1 : Model for Shake Table Test

Table No. 5 : Sizes of Flat Used for Shake Table Model

| Particular	Size (in mm)
Beam	10 X 5
Column	12 X 6
Connections	3mm button headed screw
Base plate	0.5 mm thickness

3. RESULT

Koyana time history

    a) Bare frame model(3m all stories)

Table no 6- Observation of Displacement and Acceleration

| Floor No	Displacement (mm)	Acceleration (g)
Base	8.215	0.339
1	7.365	0.317
2	6.622	0.356
3	9.316	0.378
4	9.747	0.388
5	8.691	0.375
6	8.431	0.359
7	7.928	0.451
8	8.481	0.575

Graph 1– Peak Displacement Graph
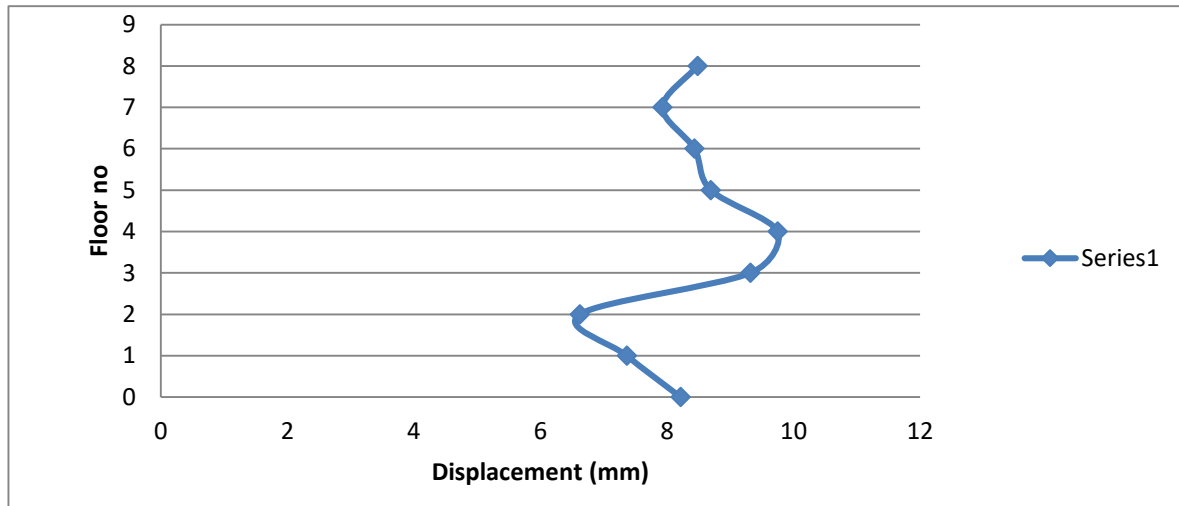
Time history result shows that the displacement at 4th storey is maximum i.e 9.7mm . Graph shows non uniform behaviour of displacement.

b) Ground storey increased Height(4m)

Table no 7- Observation of Displacement and Acceleration

| Floor No	Displacement (mm)	Acceleration (g)
Base	1.223	0.195
1	1.375	0.25
2	1.655	0.209
3	1.491	0.184
4	1.536	0.204
5	10.896	0.543
6	11.576	0.421
7	11.795	0.447
8	11.739	0.656

Graph 2– Peak Displacement Graph
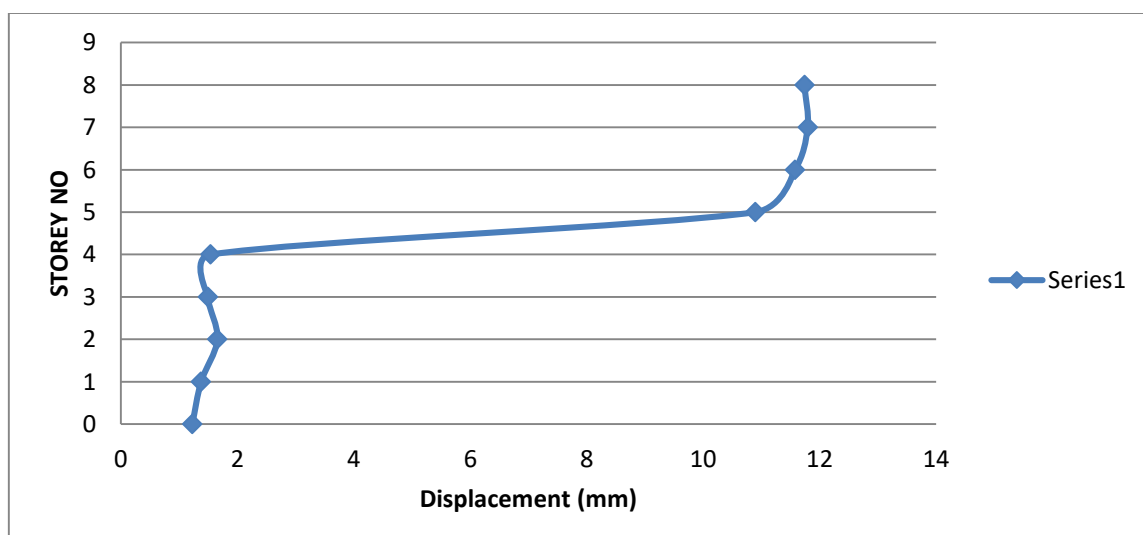
Displacement at 5th storey increases tremendously i.e. 10.89 mm and remains uniform for 6th 7th 8th storey . initially displacement is very less at ground storey.

c) G+2 increased height(4m)

Table no 8- Observation of Displacement and Acceleration

Floor No	Displacement (mm)	Acceleration (g)
Base	5.943	0.235
1	9.11	0.361
2	6.219	0.351
3	8.801	0.622
4	7.62	0.545
5	6.605	0.525
6	5.447	0.352
7	14.803	0.379
8	10.639	0.48

Graph 3– Peak Displacement Graph
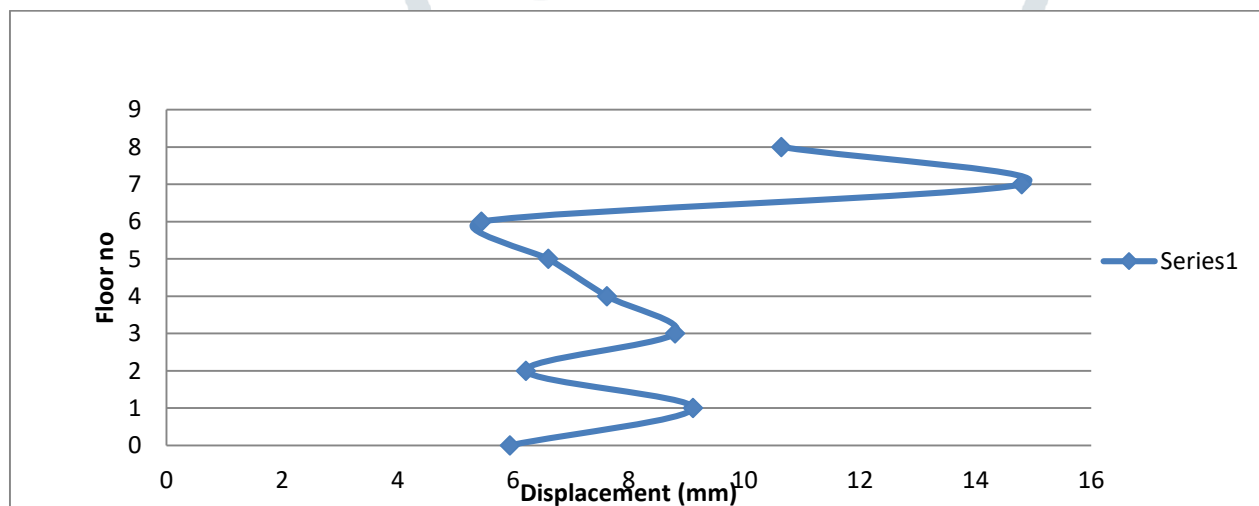
Observation shows that the displacement is maximum at 7th floor i.e 14.8 mm . initially displacement starts from 5.943mm and reaches upto 14.8 mm . the 8th floor displacement is 10.639 mm.

d) G+4 increased height(4m)

Table no 9- Observation of Displacement and Acceleration

Floor No	Displacement (mm)	Acceleration (g)
Base	4.321	0.332
1	5.012	0.443
2	5.358	0.452
3	7.998	0.648
4	9.305	0.588
5	10.067	0.636
6	12.997	0.568
7	14.327	0.675
8	15.878	0.6998

Graph 4– Peak Displacement Graph
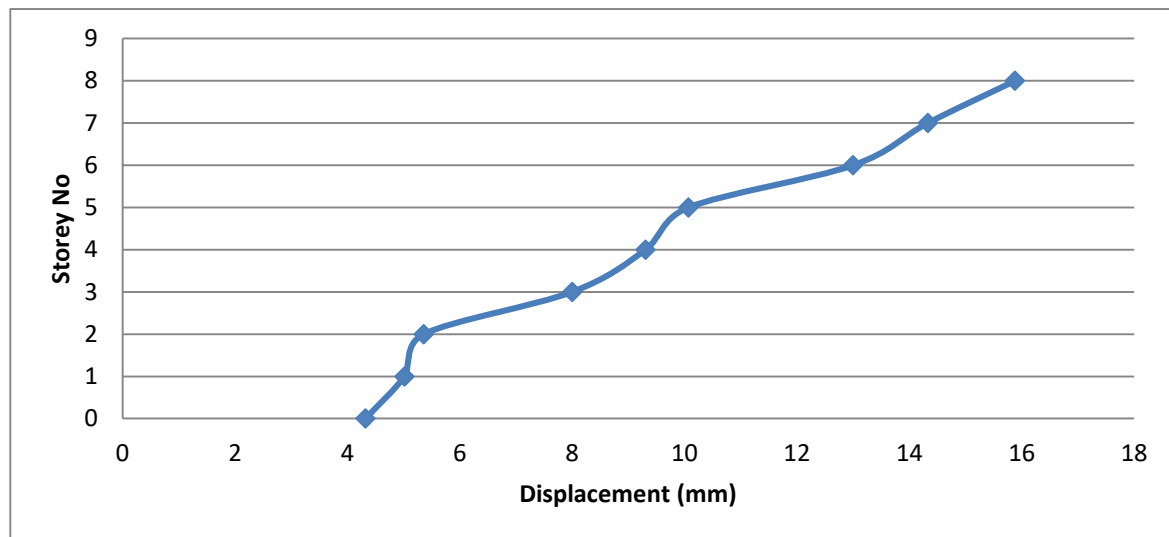
4.   CONCLUSION.

Koyana time history analysis result implies that for Ground storey increased height structure and for no wall at bottom storey structure, the initial 1st storey displacement is very high. Similarly G+2 and G+4 increased height structures have rapid increase in displacement at the respective storey, which is dangerous from seismic qualification point of view. Therefore soft storey structure should be avoided as far as possible.

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