Response Spectrum of Multistory Building Situated on different Soil Condition

Mr. Abhijit Ukey[1], Prof. Raju A. Bondre[2]

[1]*Research Scholar, Guru Nanak Institute of Technology, Nagpur*
[2] *Assistant Professor, Guru Nanak Institute of Technology, Nagpur*

***Abstract*— The importance of soil-structure interaction (SSI) effects on the seismic response of buildings has been long recognized and has been researched for over 40 years. However, SSI analysis has only been applied in a few building projects because the fixed base condition is considered to provide a conservative estimation for the response of buildings under seismic loads. This assumption of a fixed base condition adopted by practitioners is not always conservative or cost-effective, especially for rigid buildings over soft soils. Additionally, for the case of ductile steel frames with eccentric configurations, the influence of SSI on their seismic performance has not been investigated.**

Nonlinear time history and reaction range investigations is done utilizing Etabs-2015 programming to examine the impact of soil condition underneath the disconnected base. The impacts of soil adaptability are considered in the current study to analyze the distinctions in otherworldly increasing speed, base shear, story removals, story floats and story shear acquired after the seismic arrangements of Indian standard code. Different soils are methodically analyzed and examined for a seismic exhibition of multistory structures. Parametric examination of the structures fitted with seclusion gadgets is conveyed out to pick the proper kind of soil. The investigation shows that the estimation of base shear increments with an expansion of soil adaptability and superstructure solidness. It additionally saw that the spectral acceleration (SA) and spectral displacement (SD) are higher in delicate soil condition, which gives us proof that the reaction unearthly of a structure is related with soil condition.

***Index Terms*— SSI, ETABS, Spectral Acceleration, Spectral Displacement**

I. INTRODUCTION

The dirt condition is a basic field of investigation in seismic tremor building; this dirt condition is characterized as (Dexter 1988) "The state of being of the dirt and its dynamic properties, which can be separated by standard Indian code into; hard soil (Rocky), medium soil, delicate soil (free). Taking into account auxiliary building (Mondal and Jain 2005), the building network examined SSI just when the storm cellar movement by cooperation powers when contrasted with the ground movement of free field (Alam and Bhuiyan 2013). The power and disfigurement in the supporting soil cause vibration of structure and produce base shear, second and removal (Hatami 2015; Baratta et al. 2008).

The Indian gathering of Agricultural Research (ICAR) set up an All India Soil Survey Committee in 1953 which isolated the Indian soils into eight significant gatherings. For simplicity of understanding and relative investigation, this post about the 8 soil types is set up in even structure, featuring the key contrasts.

Soil is a characteristic asset that can be sorted into various soil types, each with particular qualities that give developing advantages and restrictions. Distinguishing the kind of soil you require for a venture is fundamental to help the solid development of vegetation.

Soil can be classified into sand, mud, sediment, peat, chalk and topsoil kinds of soil dependent on the overwhelming size of the particles inside dirt.

II. PROCEDURE FOR PAPER SUBMISSION

A. Review Stage

Submit MuberraEserAydemir (2006) [2]

This paper tends to the conduct of multistorey structures considering soil structure cooperation under seismic tremor excitation. For this reason, test 3, 6, 9 story RC outlines are planned dependent on Turkish Seismic Design Code and dissected in time area with gradual powerful investigation. Quality

decrease factors are examined for created test plane casings for 64 distinctive tremor movements recorded on various site conditions, for example, rock, hardened soil, delicate soil and extremely delicate soil. As indicated by the investigation result, quality decrease elements of test structures considering soil structure communication are seen as quite often littler than plan quality decrease factors given in current seismic structure codes, which cause a risky plan and non-moderate structure powers.

Mollaioli, S. Bruno (2008) [3]

Parallel relocations control of structures exposed to quake ground movement has now been perceived as a key factor in the appraisal of framework execution, prompting configuration moves toward that utilization removal instead of powers as the beginning stage for the seismic assessment of structures. Truth be told execution based methodologies offer critical focal points in examination with customary power based methodologies, since the previous are fit for concentrating on nonlinear conduct and subsequent harm to the structure, as opposed to the last mentioned. Parallel uprooting request, especially in structures that display nonlinear conduct, can be altogether influenced by the highlights of solid ground movement, i.e., plentifulness, recurrence substance and span. Such attributes are thus significantly impacted by the anomaly and variability in tremor ground movements, which ought to in this way be considered fittingly. The extraordinary number of solid movement records accumulated all through the most recent decades in the most generally changing soil-site conditions has made representing soil-site impacts in the portrayal of versatile and inelastic removal requests practical.

V. M. Sorin, et al. (2009) [4]

A coupled range seismic examination of the ITER tokomak-building-basement-soil‟ framework has been performed. Soil structure cooperation (SSI) is demonstrated as a lot of springs and dampers. Another strategy is proposed to supplant the definite limited component model of the structure by an identical arrangement of equal oscillators having a similar characteristic frequencies, modular compelling masses and tallness as the structure and making a similar shearing power and upsetting second. The reaction of the ITER tokamak is found versus distinctive soil boundaries. For some specific soil conditions, the common recurrence of the structure is near that of the tokamak and basic reverberation impacts may occur.

Gheorghe Asachi, et al. (2011) [8]

Seismic hazard appraisal of structures is one of the key components in assessing and lessening misfortunes that may show up after quakes. Building weakness evaluates the harms a structure can deal with under a known seismic burden. For the most part, structures are viewed as fixed at the base in the plan procedure, however analysts have featured the significance of considering the real soil conditions in the examination. In this paper, a nonlinear static investigation (sucker) is acted in SAP 2000, for a fortified solid 2-D outline laying on various kinds of soils. Correlations between limit bends, weakness bends and between the disappointment systems have been performed. From these examinations, it was conceivable to remove a few perceptions concerning the dirt condition impact after structure powerlessness and seismic hazard for a RC outline.

III. METHODOLOGY

Method to evaluate Structure

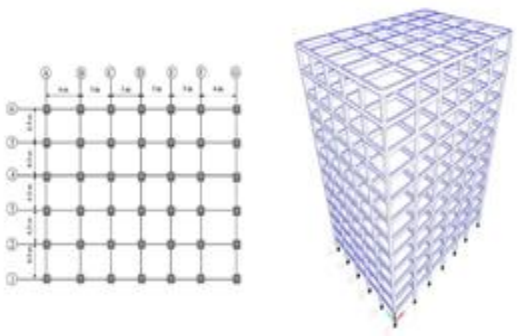
Create a New Model

We will start a new model using the following steps:

1 Set the units to kips and inches, “Kip-in”, using the dropdown box in the lower right corner of the ETABS screen.
2 Select the File menu > New Model command.
3 Click the No button in the New Model Initialization form. This indicates that we do not wish to use a previous model as the starting point for this model.
4 This now opens the Building Plan Grid System and Story Data Definition form, where much of the definition of the structure takes place.

- Grade of concrete- M 25
- Zone factor (Z) -0.36
- Grade of steel -Fe 415
- Response reduction factor (R)- 5.0
- Floor to floor height -3.5 m
- Importance factor (I) -1.0
- Ground floor height -3.5 m
- Soil type Hard soil- I
- Medium soil- II

- Soft soil- III
- Dead load- 1.5 kN/m2
- ECC. ratio (e) -0.05
- Slab thickness -150 mm
- Effective stiffness (Keff) -79148.6 kN/m
- Wall partition on beams- 2 kN/m
- Force at 0 displacement (F0)- 1000 kN/m
- Internal wall -150 mm
- Stiffness of rubber in LBR (Kr) -72932.28 kN/m
- Columns -450 × 450 mm
- Bearing horizontal stiffness(Kb) -13854.3 kN/m
- Beams -300 × 600 mm
- Total bearing vertical stiffness (kv) -25386991 kN/m
- Live load on all floors -3 kN/m2
- Damping ratio- 5%



Geometric of the building

Design criteria for seismic loading for model

In the preliminary design, the equivalent static force procedure is applied to calculate the seismic forces. According to the NBCC 2005, the base shear V is a function of design spectral acceleration value, S(Ta), the high mode factor, Mv, the importance factor, IE, the building weight, W, the ductility-related force modification factor, Rd, and the over-strength-related force modification factor, Ro. By combining all the above parameters, the base shear equation is given below:

$$V = S(Ta)\, Mv\, IE\, W/(Rd\, Ro)$$

For a seismic force resisting system (SFRS) designed with Rd ≥1.5, the NBCC2005 also requires that V shall not be less than:

$$V_{min} = S(2.0)Mv\, IE\, W/(Rd\, Ro)$$

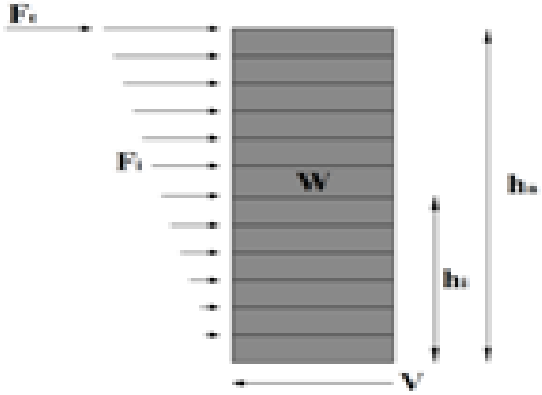
And not larger than:

$$V_{min} = \frac{2}{3}S(2.0)Mv\, IE\, W/(Rd\, Ro)$$

In addition, for a building with a fundamental period larger than 0.7s, the seismic force shall be distributed in such a way that a portion is concentrated at the roof level, Ft, and the reminding amount (V-Ft) is distributed along the building height. Thus, Ft = 0.07TaV but should not exceed 0.25V. The distribution of the base shear force is illustrated in Figure 3.2 and is based on the following equation:

$$F_i = (V - F_t)W_i h_i / (\sum_{m=1}^{n} W_m h_m$$

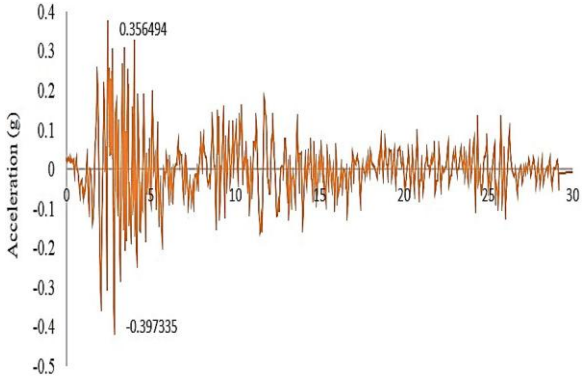
Where hn is the total height of the structure; Fi and Wi are the storey force and seismic weight of the ith floor, respectively; and hi, is the height of the ith floor measured from the ground floor level.



The distribution of seismic forces

IV. RESULT AND DISCUSSION

During the ongoing decades, broad investigates have been directed in regards with the impacts of soil-structure connection (SSI) on the seismic reactions of the structures. It was found that the cooperation among soil and structure brings about a lessening of the principal recurrence of the reaction and an alteration in the vitality scattering, which is ascribed to radiation and material damping in the dirt



Matched response spectrum–time history function (El Centro 1940)—hard soil

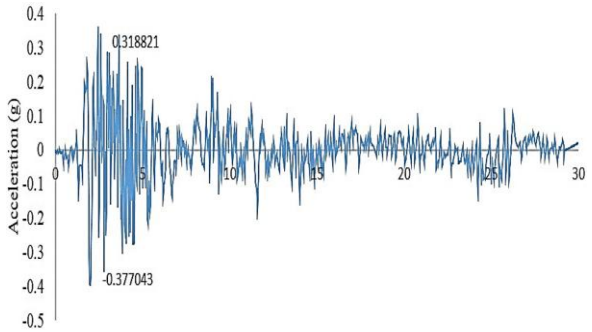


Figure 4.4 Matched response spectrum–time history function (El Centro 1940)—medium soil

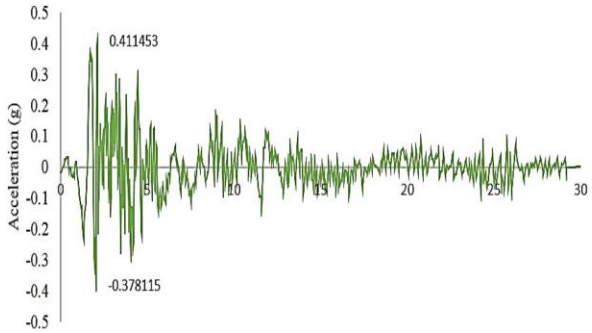


Figure 4.5 Matched response spectrum–time history function (El Centro 1940)—soft Soil

Story Displacement

Story relocation can be characterized as "It is the uprooting of a story as for the base of a structure". These the two terms are utilized in quake or seismic building design. In this video one model has been taken to show the specific contrast between these two terms.

Story displacements, response spectrum analysis, x-direction (mm)

No. of Story	Hard Soil			Medium Soil			Soft Soil		
	FB	IB	DIFF %	FB	IB	DIFF %	FB	IB	DIFF %
12	25.4	27.7	8.3	25.7	37.8	23.01	26.1	46.5	43.87
11	24.9	27.3	8.79	25.2	37.2	23.26	25.5	45.8	44.32
10	24	26.6	9.77	24.3	36.2	32.87	24.6	44.6	44.84
9	22.7	25.6	11.33	23	34.8	33.91	23.3	42.8	45.56
8	21.1	24.2	12.81	21.4	33	35.15	21.7	40.6	46.55
7	19.2	22.6	15.04	19.4	30.8	37.01	19.7	37.9	48.02
6	17	20.7	17.87	17.2	28.2	39.01	17.4	34.7	49.86
5	14.5	18.6	22.04	14.7	25.4	42.13	14.9	31.2	52.24
4	11.8	16.3	27.61	12	22.2	45.95	12.1	27.3	55.68
3	8.9	13.8	35.51	9	18.8	52.13	9.1	23.1	60.61
2	5.8	11.1	47.75	5.8	15.1	61.59	5.8	18.5	68.65
1	2.5	7.8	67.95	2.5	10.6	76.42	2.5	12	80.77
Base	0	0	0	0	0	0	0	0	0

Story displacements, time history analysis, y-direction (mm)

No. of Story	Hard Soil			Medium Soil			Soft Soil		
	FB	IB	DIFF %	FB	IB	DIFF %	FB	IB	DIFF %
1	2.1	7.8	73.08	3.4	10.5	67.62	1.9	12.8	85.16
2	5	10.8	5370	8	14.8	45.95	4.5	17.9	74.86
3	7	13	39.23	12.4	18.2	21.87	6.9	21.5	67.91
4	10.8	14.7	26.53	16.7	21.1	20.85	9.1	24.4	62.7
5	135	17	20.59	20.7	23.8	13.03	11.1	26.5	58.11
6	16.3	1.2	15.1	24.1	26.2	8.02	12	28.8	54.86
7	18.8	21.8	13.76	26.9	28.2	4.61	14.6	31.4	53.5
8	21.1	24.1	12.45	29	29.9	3.01	15.9	33.6	52.68
9	23.1	25.8	10.47	30.7	21.6	2.85	17.2	35.4	51.41
10	24.6	27.3	9.89	32.2	32.9	2.13	18.2	36.7	50.41
11	25.7	28.5	9.82	33.3	33.7	1.19	18.8	37.6	50
12	26.3	29.1	9.62	33.7	34.2	1.46	19.2	38.1	49.61

The most extreme removal of secluded base and fixed base did by Response Spectrum Analysis (RSA) for three cases, which are: hard soil, medium soil, and delicate soil conditions, the consequences of disengaged base model show that at highest level the hard soil condition produces 27.7 mm as fixed base delivered 25.4 mm with 8.3% distinction. It additionally saw that the removal story of the secluded base model at the rooftop is 37.8 mm and 43.87 mm for medium soil condition and delicate soil condition, separately.

Story drifts

Drift is an exceptionally unpredictable subject in basic designing. It includes such a large number of components to show up at an appropriate choice. It includes designing judgment; the wonder new specialists probably won't feel. In this article, I have attempted to clarify what is building drift, permissible cutoff points, and available resources to check in ETABS models and to control the over the top drift. It would be ideal if you remember, this

article isn't about the structure drift most definitely; rather this subject of drift is identified with ETABS programming.

Story drift can be characterized as "It is the dislodging of one story concerning the other story." Story uprooting can be characterized as "It is the removal of a story as for the base of a structure"

Table No. 5 Story drifts, response spectrum analysis, x-direction

No. of Story	Hard Soil			Medium Soil			Soft Soil		
	FB	IB	Diff %	FB	IB	Diff	FB	IB	Diff %
12	0.207	0.148	-39.86	0.195	0.194	-0.52	0.187	0.232	19.4
11	0.364	0.269	-35.32	0.351	0.355	1.13	0.339	0.427	20.61
10	0.484	0.375	-29.07	0.48	0.502	4.38	0.471	0.608	22.53
9	0.573	0.46	-24.57	0.579	0.623	7.06	0.574	0.76	24.47
8	0.645	0.531	-21.47	0.654	0.724	9.67	0.653	0.886	26.3
7	0.709	0.593	-19.56	0.715	0.808	11.51	0.717	0.991	27.65
6	0.768	0.649	-18.34	0.769	0.881	12.71	0.774	1.081	28.4
5	0.82	0.7	-17.14	0.821	0.948	13.4	0.828	1.162	28.74
4	0.868	0.746	-16.35	0.874	1.011	13.55	0.883	1.241	28.85
3	0.914	0.795	-14.97	0.925	1.081	14.43	0.935	1.329	29.65
2	0.942	0.946	0.42	0.951	1.289	26.22	0.957	1.585	39.62
1	0.708	2.219	68.09	0.71	3.02	76.49	0.712	3.709	80.8
Base	0	0	0	0	0	0	0	0	0

Table No. 6 Story drifts, time history analysis, x-direction (mm)

No. of Story	Hard Soil			Medium Soil			Soft Soil		
	FB	IB	Diff %	FB	IB	Diff	FB	IB	Diff%
Base	0	0	0	0	0	0	0	0	0
1	0.597	2.216	73.06	0.982	2.995	67.21	0.544	3.655	85.12
2	0.83	0.872	4.82	1.298	1.231	-5.44	0.733	1.45	49.45
3	0.844	0.788	-7.11	1.265	0.988	-28.04	0.703	1.092	35.62
4	0.846	0.806	-4.96	1.226	0.928	-32.11	0.658	1.088	39.52
5	0.832	0.864	3.7	1.143	0.866	-31.99	0.609	1.059	42.49
6	0.796	0.851	6.46	0.979	0.809	-21.01	0.57	0.973	41.42
7	0.736	0.76	3.16	0.958	0.737	-29.99	0.523	0.944	44.6
8	0.656	0.741	11.47	0.872	0.66	-32.12	0.487	0.853	42.91
9	0.558	0.663	15.84	0.724	0.576	-25.69	0.427	0.715	40.28
10	0.441	0.518	14.86	0.618	0.434	-42.4	0.34	0.623	45.43
11	0.327	0.346	5.49	0.484	0.326	-48.47	0.235	0.466	49.57
12	0.22	0.193	-13.99	0.276	0.174	-58.62	0.13	0.257	49.42

V. CONCLUSION

It is seen that the estimation of story shear increments with decline in firmness of soil, etc.; it is most noteworthy for the delicate soil type (SS) and most reduced for hard soil type (HS).

• It is seen that the ghostly quickening history at rooftop level of a separated base model increments in delicate soil condition by 48.7% and 40.5% in medium soil condition when contrasted and hard soil.

• The paper shows that the story dislodging increments with the expanded adaptability of the dirt; in different words, conditions are way off the mark to being considered as a consistent state. Then again, there is countless patterns (of the request for 100), which can energize a structure having resonances in the 0.5–30-Hz run. The registered reaction spectra for 2% and 5% damping are demonstrated as follows. Contrasted and hard soil and medium soil. It is too seen that the relocation delivered because of time history examination being more than the removal created because of reaction range examination in hard soil conditions with an expansion of 5%. In any case, it diminishes by 9.5% furthermore, 18% for medium soil condition and delicate soil condition, separately.

VI. FUTURE SCOPE

1. The soil type II is admirable to design the multistory building with the pushover analysis result.
2. Design of slab for the multistory building is also applicable in various soil type.
3. Seismic analysis of multistory building with various soil type will also be done with reference of this project.

REFERENCE

[1] Alam AKMT, Bhuiyan MAR (2013) Effect of soil–structure interaction on seismic response of a seismically isolated highway bridge pier. J CivEng 41(2):179–199
[2] Baratta A, Corbi I, Jayalekshmi BR, et al (2009) Comparative evaluation of base-isolated and fixed-base buildings using a comprehensive response index. EngOptim 135:1141–1160. https ://doi.org/10.1016/j.jsv.2007.10.008
[3] CSI (2013) CSI analysis reference manual. Computers and Structures inc, Berkeley, p 496
[4] Dexter AR (1988) Advances in characterization of soil structure. Soil Tillage Res 11(3–4):199–238.