Examination on Geometrically Uneven R.C.C Frame Construction Soil-Structure Interaction Effects on Seismic Behaviour of Reinforced Concrete Edges

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Abstract- *It is frequently the situation that soil underneath the construction is ignored in numerical study. In most cases there are two reasons for ignored the soil in study: Problem in modelling of the soil and, as mainly believed, advantageous effects of the soil on constructions. The paper discusses three different methods on numerical modelling of fixity of constructions with the soil underneath: conventionally fixed construction, construction on Winkler springs and construction on half-space. Linear elastic study was carried out on three-, seven-and ten-story three-bay reinforced concrete frames using time history analysis. All of the constructions were founded on soft soil as defined according to Euro codes. Ground motions used were selected from the European Strong-Motion Database. Also, the paper gives outline of references on including soil-construction interaction in structural models according to European and American seismic principles and highlights harmful effects of soil construction interaction on low-rise buildings.*

I. INTRODUCTION

The Ground seismic activities are named Free Field Motion in the absence of any structural sensations effects resulting from final importance of seismic source effects and path of wave's passage. Based on the fact that earthquake waves typically pass through tens of kilometers of bed rock and less than 100 meters of soil, soil layers play a significant role in assigning the characteristics of ground surface movement in case of construction of any structure on the ground surface the seismic behavior of the underlying ground will be partial by a process called Soil-Structure Interaction.

The communication between Soil and Structure results from elasticity of the under- foundation soil and relative vibration between foundation and free surface. With implementation of these effects it is possible to assess the inertial forces and real displacements of a soil-foundation-structure system under the influence of vibrating activities of a free field motion. The communications of Soil and Structure, especially for Stiff and heavy structures located on the elastic soil have a special importance. For soft or small structures located on a Stiff soil the effects of connections are usually small and negligible. The difference between the structure on elastic soil with the one on inflexible base lies in the possibility that in the first structure, the main part of the input energy will be absorbed and dissolute by

(i) Wave Radiation, and (ii) Hysteresis process of the supportive flexible soil; whereas the importance of the second factor increases with an increase in the strength of the seismic activity

II. LITERATURE REVIEW

Hytham Elwardany, Ayman Seleemah, Robert Jankowski & SaherEl-khoriby (2019)

"Influence of soil–structure interaction on seismic pounding between steel frame buildings considering the effect of infill panels", Bulletin of Earthquake Engineering volume 17, pages 6165–6202 (2019). The present study aims to examine the influence of the soil–structure interaction or existence or abasement of masonry infill panels in steel frame structures on the seismic force induced pounding-involved response of a buildings. The analysis was further extended to compared the pounding-involved behavior vs the independent behavior of structures without collisions, focusing much on sudden behavior of single frames. The effect of soil structures interaction was examined by assuming linear springs and dashpots on the foundation level. The infill panels were modeled using equal diagonal compression struts. The steel frames were assumed to have elastic–plastic behavior with 1% linear strain hardening. The dynamic contact approach was used to simulate pounding between the side buildings. Nonlinear finite element analysis was performed for two adjacent multistory structures with four different configurations representing cases that can exist in reality. The seismic response of the examined cases generally highlight that ignore the soil flexibility or the contribution of the infill panels may compelling alter the response of side structures.

This may give result in a wrong expectation of the seismic behavior of tall buildings exposed to structural pounding under seismic excitation.

Ahmed Abdelraheem Farghaly (2017)

"Seismic investigation of adjacent buildings subject to double pounding considering soil– structure interaction" This paper focus on the examine of double pounding that takes place between the two adjacent buildings in some upper points at superstructure in the contact zone and also at foundation level. The forces of double pounding between the two adjacent buildings, which increases by softening of the soil, give a valuable assessment of straining actions of the two adjacent buildings and change the behavior of soil under the foundations and around basement floor.

Anuradha, Dr. H. M. Somasekharaiah (2015)

(SSI) Effect on the effective Behavior of Irregular R.C. Frame with the Isolated Footings", International Journal for Scientifically research| Vol. e 04, (2015). In the present study focuses on soil structure interaction analysis of 3D 2x4 bay 4 story RC frame planed vertical irregular building is on isolated footing supporting on soil medium with different type of zones and soil types subjected to normal and seismic loads. There are three linear-elastic and isotropic models of the soil beneath the structure such as fixed base, spring model and soil continuum. The analysis is carryout on RC frame irregular structure using time history analysis by the fem software sap 2000. Based on the results, comparing with three models it concludes that the soil structure interaction investigate effects are lateral displacement, natural frequency, story drift and base shear increases and there is natural period is decreases.

Prakash M. Yesane, Y. M. Ghugal, R. L. Wankhade (2019)

The theory of soil–structure interaction was invented, and the research method were discussed. Based on several data, a systematic summary of the history and status of the soil–structure interaction theory that considers adjacent structures was proposed as a reference for researchers. This study is in the growing stage, given its complexity and simplification of the model for soil and structures, and should be carried forward for its significance.

An experiment was made to summarize the all terms in this area of study. Furthermore, parametric study on soil structure interaction behavior by various researchers is tabulated. The existing problems and the future research in this field were also inspected

Arjit Verma* P. Pal** and Y.K. Gupta*Research Scholar,

MNNIT Allahabad (2019)

The following concluding remarks may be drawn from this paper based on the study for direct approach. The effect of soil-structure interaction on the effective response of building can decrease the resonant frequency. b. The interaction effect is important for shear wave velocity less than 305m/sec and foundation medium is having hear wave velocity more than 305m/sec. c. participation of rocking is more for high rise structures founded on soft soils and in significant for buildings on stiff soils. d. The stiffness and damping characteristics of these foundation medium frequency dependent and may be assumed to be constant for practical purposes.

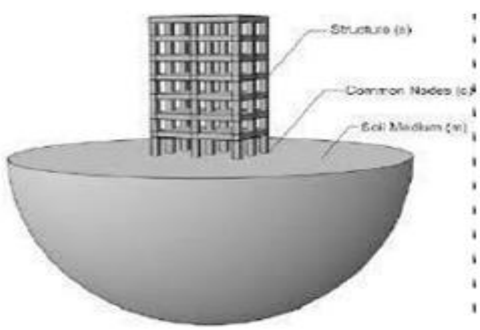
Sittipong Jarernprasert an, Enriazan-Zurita a, JacoboBielak a Paul C. Rizzo (2020) The importance of SSI effects on the dynamic behavior of the building foundation system, by comparing the seismic response coefficient or, perhaps better yet, the resulting drifts or peak structural displacement, with the corresponding fixed-base quantities. The results presented in this paper correspond to a structural aspect ratio, H/B¼2; we have also analyzed SSI systems with H/B¼4, obtaining very similar qualitative results. The impact of H/ B is properly considered in the examination of period elongation ratio l. The proposed access has been developed for a class of SSI systems, while it is reasonable to expect that they will apply to other foundation conditions, e.g., piles, and soil stratigraphy, the method should be additionally verified before applying it to systems whose structural behavior differs widely from the bilinear hysteretic considered here. It is also well to highlighted that only inertial interaction has been considered in this study. Kinematic interaction should be Involved if the dominant length of the incident wave is of the same order as the base (or depth) dimensions.

H. Matinmanesha1 and M. Saleh Asheghabadib (2011)

All soil types increase bedrock mobility in the soil-structure interface but with different degrees. The amount of addition is affected by many factors including the soil and properties, seismic frequency content and the properties of the overlying building. Those combinations of soil condition, structural models and seismic excitations that lead to lower effective damping, will amplify the bedrock motion most significantly soil-structure models including dense sand has shorter period in compare with loose sand and tall buildings have longer period in comparison with low-rise buildings. The combination of these two can assess the amount of amplification of each earthquake. Shorter period soil-structure systems (5 floor building over dense sand) demonstrated the highest amplification for have earthquake and lowest maximum acceleration (on the soil-structure interface on earthquake. Longer period soil-structure system (20 floor tall building on loose sand) presented the highest amplification in Low earthquake and lowest in have earthquake. Maximum principle stress on the soil-foundation interface in all models occurred beneath the columns while the lowest stress was in the middle of foundation.

III. METHODOLOGY

1) a. Direct approach
   b. Indirect approach
2) Analytical methods
   a. a Winkler approach
   b. P-y method
3)Irregularity-
   a. plane irregularity
   b. Stiffness irregularity
4)pounding-two adjacent building Department



Direct Method

In this soil, foundation and structures is both molded using finite element method(FEM). The ground mobility is specifying as free field motion and is apply all boundaries.

Sub structures method

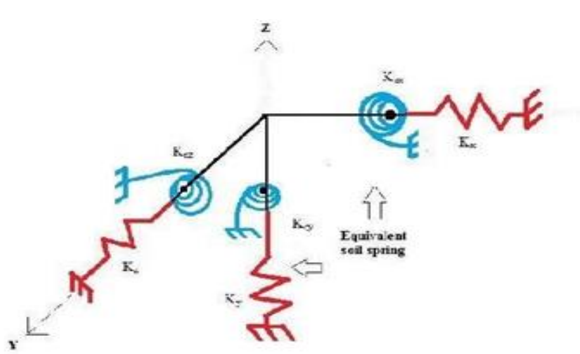
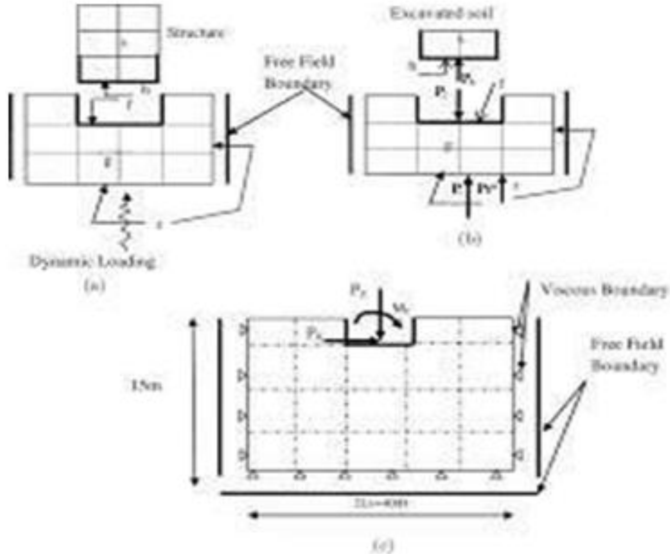


Fig.3.2 Equivalent Spring Stiffness



It is computationally more efficient than the direct method as most of the disadvantages of the direct method can be removed.

- In this method the effective input

Mobility are express in term of free field motions of the soil layer initially.

Finite Element Method

Kx, Ky, Kz =Stiffness of equivalent

soil springs along the translation degree of freedom along X, Y and Z-axes.

Krx, Kry, Krz = Stiffness of Equivalent rotational soil springs along the rotational degree of freedom along X, Y and Z-axes. Effect of Soil Structure Interaction is considered by equivalent springs with six degrees of freedom (DOF) as shown in fig

Spring Constant

		Moment of inertia	AREA
LENGTH(x)	9	0.75	108
WIDTH(y)	12	1	
HEIGHT(z)	1	1296	

NO.	Strata	Modulus of Elasticity	Poisson Ratio(M)	Shear Modulus(G)	Unit Weight(KN/m3)
1	Soft Soil	15000	0.45	10875	16
2	Medium Soil	50000	0.4	35000	16
3	Hard Soil	120000	0.4	84000	18
4	Rocky Basalt	15000000	0.3	9750000	
5	Fixed	-	-	-	-

	Soft Soil	Medium Soil	Hard Soil	Rocky Basalt
Translation X	469949.8337	407383.0497	977719.3193	97273095.55
Translation Y	327884.5127	1022283.61	2453480.664	268027299.4
Translation Z	338759.5127	1052283.61	2525480.664	274527299.4
Rotation About X	45477.27273	134166.6667	322000	32035714.29
Rotation About Y	18937.63604	55869.65422	134087.1701	13340305.19
Rotation About Z	9224154.228	29686933.15	71248639.56	8269931377

Building Plan

Seismic Analysis

For the examination of seismic responses there is necessary to carry out earthquake analysis of structure. The study can be performing on the basis of external action,

The various behavior of structure or structural component, and the type of structural model selected. Based on the type of external action and behavior of structure, the analysis can be further classified as:

1. Linear Static Analysis,
2. Nonlinear Static Analysis,
3. Linear Dynamic Analysis; and
4. Nonlinear Dynamic Analysis.

Linear static examination or equivalent static method can be used for regular structure with limited height. Linear dynamic examination a can be performed by response spectrum method. The significant difference between linear static and linear dynamic examination is the level of the forces and their distribution along the height of structure. Nonlinear static analysis is an improvement over linear static or dynamic examination in the sense that it allows inelastic behavior of structure. A nonlinear dynamic examination is the only method to describe the actual behavior of a structure during an earthquake. The method is based on the direct numerical integration of the differential equations of motion.

Nonlinear time history analysis

It is the most realistic and accurate analysis method available. It is also referred as "time history analysis". The old data of seismic activity is collected and using this data, seismic loading is applied on structure model incorporating elements with inelastic force-deformation relationship and p-delta effect.The propagation of the ground mobility throughout the structure generates all complete response histories for any quantity of interest (e.g. displacements, stress resultants) leading to a wealth of data. While different levels of complexity are possible by the modeling choices, different ground mobility records will produce demands that vary considerably. This record-to-record variation dominates the application of dynamic methods.

In SAP2000 there is inbuilt time functions, so ELECENTRO time function is used it has magnitude of earthquake up to 0.2763g and there is high variation of magnitude also you can see its graph in fig

Fig 2: G+2 and G+3 Fig 1: Deformed shape at frame with hard soil time = 0.144sec, base ishard soil. as base (moment 3-3)

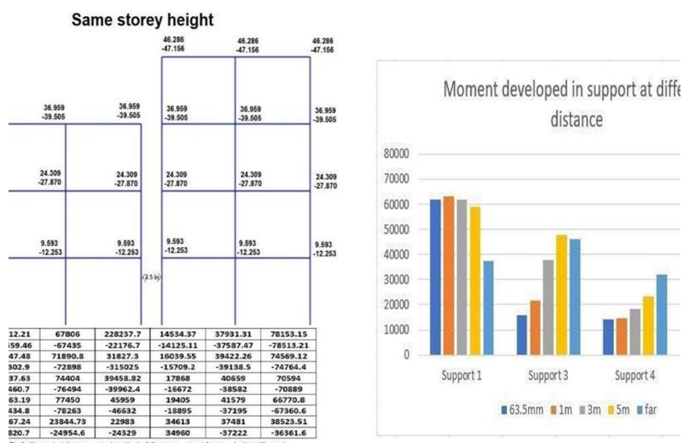
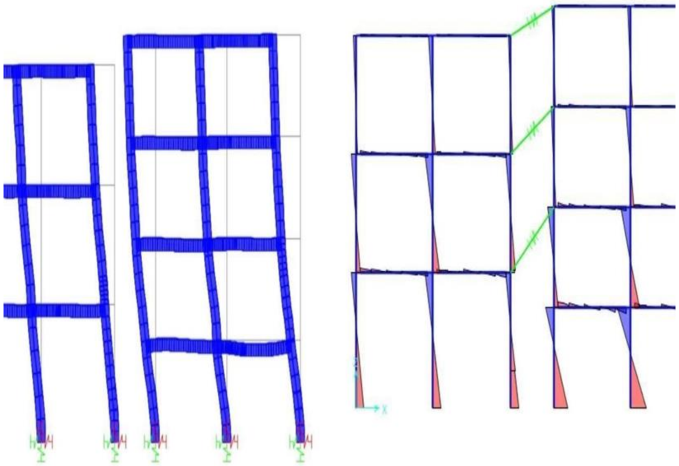
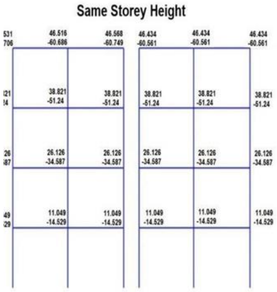


Fig 9: Moment at the support when the buildings are _ apart from eachother (Kn-mm) and displacement at joint when building is 2.5in apart

Fig 11 : Moment at support of buildings when both structure are _ apart and displacement of joint when building are 2.5in apart

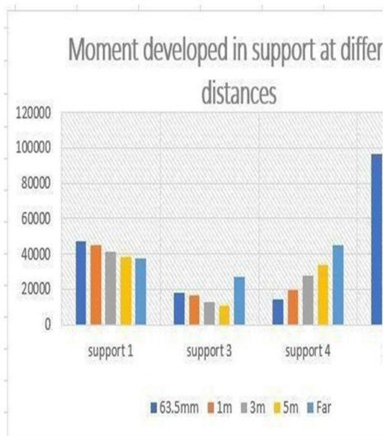


Same Storey Height

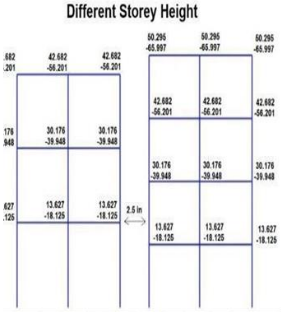


1	2	3	4	5	6
7031.96	33472	18125	14342	55288	96145
41784.5	-30472	-15610	-12482	-50785	-93782
45180	33602	16152	19605	57754	95378
-41655	-32379	-14122	-17027	-53992	-93565
41397	33384	12938	27737	60798	92663
-40378	-34914	-11719	-23931	-58452	-91713
38107	35138	10805	33320	62253	89547
-38472	-35848	-10176	-30677	-60677	-88934
37570	43984	26946	44958	62039.94	76702.25
-36724	-44258	-28129	-43983	-61350.78	-76016.02

Fig 10: Moment at the support of the buildings when both the structure are _ apart and displacement at the joint when building are 2.5in apart

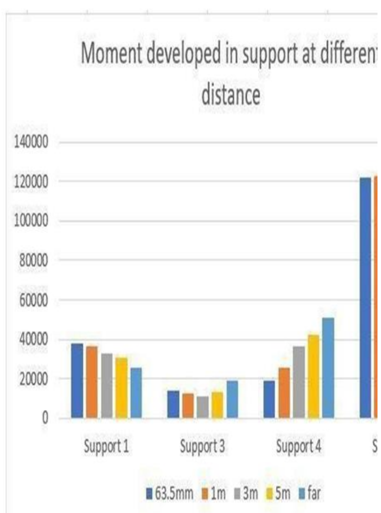


Different Storey Height



1	2	3	4	5	6
37646	29847	13851	19051	70680	122085
-32838	-26312	-16533.7	-24107	-61162	-118350
36488	30346	125211	25533	74527	123076
32469.82	-27204	-16294.62	-26993	-64603	-117025
32678	29101	11379	36557	77929	118288
-31951	-29817	-16220	-30717	-70055	-113549
30621	30621	13307	42449	78640	113399
-30781	-30780	-15928	-33619	-72820	-109679
25762.7	30665	19159	51167	74624	95519
-26125	-31630	-19972	-48260	-72377	-93306

Fig 12: Moment at the support of building when the structure is _ apart and displacement at the joint when the structure is 2.5in apart



IV. CONCLUSION

The study includes the design and analysis of the model and Non-linear dynamic analysis have been carried out on the above models. The construction passed all the check before evaluating the structure. Based on the observations from the observe results, the following conclusions can be drawn. It was establishing that minimum seismic gap can be deliver 0.015m per floor. The floor replies due to earthquake excitation in the 5 floor building and Four floor grouping and three floor and four floor grouping with different floor height were higher than other groupings.

The movement increases as the spacing between the building increased. Decrease in moment is detected to be 41.63% for building edges spaced faraway that of closely spaced edges. Soil structure interaction also studied and is noticeable that as the soil was getting stiffer the SSI effect became less important as a result the structure maximum drift decreased. Department of Civil Engineering

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