Effect of Soil Structure Interaction on Structure Response with Isolated Footings

Kapil Upadhyay[1] Dr. Raghvendra Singh[2]
[1]M.E. Scholar [2]Professor
[1,2]Department of Civil Engineering
[1,2]Ujjain Engineering College, Ujjain (MP), India

Abstract— Soil-structure interaction, SSI, in some cases assumes a significant part, particularly for monstrous designs developed on the somewhat delicate soil, which might modify the unique attributes of primary reactions. In the standard sort of primary investigation, soil-structure cooperation is disregarded and the primary reactions are simply represented. The proposed work looks to appreciate the influence of soil structure interaction on the fundamental conduct of a structure supported on an isolated footings exposed to seismic burden; the Time History technique is utilized in the investigation. To accomplish the previously mentioned objective, the accompanying targets have been laid out. This work focused on the investigate the soil structure collaboration impact on uncovered outlines for square as well as rectangular footings for different types of soil, such as hard soil, medium soil, and soft soil. The experimental results reveals that in comparison of time span for fixed help and point spring component it is seen that, the size of time-frame (T) for Soft Soil Condition is higher in comparison with Fixed Support, Medium and Hard Soil types. The even dislodging of design is viewed as most extreme for delicate soil (45.6 mm-Square, 41.353mm-Rectangular) at 15 m stature and for Fixed help model is 34.852 mm. The Soft Soil is uprooted by 1.308 and 1.186 (Square, Rectangular), that of Fixed Support condition. Comparably Hard Soil and medium Soil are uprooted by 35.774, 38.448 mm and are 1.02 and 1.103 seasons of Fixed Support condition.

Keywords: Soil-Structure Interaction, Isolated Footings, 5-Story, 8-Story, Time Span

I. INTRODUCTION

The soil - structure connection has drawn in the consideration of both primary and geotechnical designs everywhere. Their main issue is the investigation and the plan of an assortment of designs, to be specific multi-celebrated structures, towers, chimney stacks, modern constructions, reactors, furthermore covered structures. The plan of these designs without a doubt addresses one of the most troublesome specialized parts of structural designing practice, as it requires an amalgamation of underlying and geotechnical examination.

The normal practice typically disregards impacts of SSI on seismic conduct of base-disconnected structures, bookkeeping on the adaptability of base-confined structures, in spite of, the new examinations on the base-separated scaffolds and designs have shown the viability of SSI on seismic reactions of the frameworks. Henceforth, for the seismic plan as well as from practical viewpoints, SSI may be important to be considered in the plan of a base-disconnected building. The coupled impact of SSI and the base disengagement on structures has acquired the interest of various specialists during the New Year's. Soil-structure association has been principally considered for base-detached extensions and fluid stockpiling tanks. In the following, a short audit on the fundamental examinations in this field is introduced.

The disconnected balance is utilized to help construction and it is planned by regular technique expecting that the establishment to be unbending. The separated balance straightforwardly interfaces with the dirt and responses from the construction are brought through the supporting establishment. The super structure-soil is considered as a solitary unit for the investigation. The sap2000 is utilized to display the 3D fixed, spring and versatile soil continuum model (FEM model). The superstructure, establishment and the dirt are considered as single unit and the issue is breaking down by the product (FEM). The design and the establishment are put on various soil conditions like delicate, medium and hard. The properties like young's modulus flexibility (E), poison's proportion (μ) unit weight of soil (γ) and shear modulus of soil (G).

The Severe Damage saw in past earthquakes, like in the Mexico City tremor in year 1985 (Resendiz, 1986; Avilés and Pérez-Rocha, 1998), in the year 1995, Kobe tremor (Mylonakis, et al., 2000), and in the year 1999 Ji-Ji Taiwan tremor (Earthquake Engineering Field Investigation Team, 2011), has exhibited that the seismic conduct of a design is impacted by a few boundaries, specifically the construction's reactions, its establishment, and the ground. An intricate collaboration among soil and design, as well as trial constraints because of a costly methodology, has aroused specialists' curiosity in an insightful investigation of the effect of SSI exposed to dynamic burden. By and large, outline structures based on delicate soil will support huge harm because of their expanded adaptability to disfigure, bringing about an increment in the regular time span of the construction.

II. LITERATURE REVIEW:

1) B.R.Jayalekshmi, Katta. Venkataramana, R. Shivashankar, (2009) Studied the seismic response of space frames with disconnected balance on layered soil. In this paper, Seismic reaction of multi-story RC space outline working with detached balance laying on shallow layered soil. Different firmness layered soil from exceptionally delicate to solid reach is thought of. The examination of construction exposed to is code configuration utilizing programming ansys. Structure is introduced the impact of layer soil on regular period and base shear. The impact of ssi expands the seismic base shear.
2) Vivek Garg and M.S.Hora, (2012) dissected An audit Interaction Behavior of Structure-Foundation-Soil System. In this current review the structure and soil is displayed by limited component technique and by the

traditional non-straight investigation, the segments in the structure outlines are expected to be lay on the non-yielding help. The conduct of the construction because of static stacking and seismic stacking is examined by the limited component investigation. The current review is to assess the impact of SSI on the structure outlines. The distinctions in stacking examples, aggregate and differential settlements in non-straight examination are contemplated.

3) Mr Magade S B, Prof. Patankar J P (2009) concentrated on the influence of soil structure interaction on dynamic behavior of the buildings. In this paper for the examination reason the structure model is fixed at their base. Because of the general development of soil medium influence the structure to twist for some degree. This diminishes the general solidness of primary framework and these builds the normal time frame. The reaction of the structure is adjusted by the incomplete fixity of the establishment because of soil adaptability. The primary target of this paper is to concentrate on the impact of soil structure association on infill outline and uncovered outline with shear dividers considered for various soil conditions utilizing STAAD-PRO 2008 programming bundle. The relocation, base shear, regular recurrence is assessed in examination and these are contrasted and the different soil profiles.
4) Ayman Ismail (2014) concentrated on the effect of soil flexibility on seismic performance of three dimensional Frames. In this paper the impact of soil firmness on the seismic execution of seismic reaction unbending underlying structure outlines laying on separated balance. The adaptability of the dirt reasons the horizontal normal time of the primary framework decline in parallel firmness. The examination of the impact of adaptable establishment soil of 2D-3D edge establishment and dynamic conduct from sucker investigation and static nonlinear examination utilizing programming sap2000. The impact of soil -structure communication on parallel regular period as the equivalent even a pontoon establishment is given other than separated balance.
5) D. K. Jain & M.S. hora (2014) focused on a analysis of space frame - Shear Wall-Soil System interaction to investigate Foundation Forces under Seismic stacking. In this paper the dirt construction investigation of G+5 RC shear divider multi story outlined structures laying on disconnected segment footings. The model investigation is completed by utilizing the Ansys programming. With respect to the Is code 1893-2000 the seismic deposit blend is thought of. The impact of SSI investigation completed shear divider with and without on the footings for differential settlement of soil mass. The SSI impact altogether the powers and minutes in the footings to the differential settlement. In the in a large portion of section footings lessens bowing minutes.
6) H. Matinmanesh and M.Sales Asheghababi (2011) discuss the seismic analysis on soil-structure interaction of buildings over sandy soil. In this current paper 2D plane strain FEM component seismic SSI investigation considering 3 ground movement records in low, moderate and high seismic movements for recurrence, enhancement, speed increase reaction and stress engendering content of the quakes with various dirt, structures stature. The impact of SSI in both sandy soils enhances seismic waves on the SSI.
7) Constantinou and Kneifati (1986) proposed an energy strategy to gauge the damping of seismically confined structure, considering the energy dispersal of the bearing and the radiation damping in the dirt.
8) Novak and Henderson (1989) explored the modular properties of base-disconnected structures furthermore presumed that, when the adaptability of soil and isolators are equivalent, the commitment of SSI ought not be overlooked.
9) Kelly (1991) completed an exploratory review concerning base-secluded atomic offices established on delicate destinations, prompted the end that the isolator configuration ought to be taken into the record for huge dislodging requests.
10) Spyrakos and Vlassis (2002) surveyed the impacts of SSI on the reaction of base-confined spans by a parametric report. They inferred logical articulations to show the meaning of SSI peculiarities in impacting the reaction of the disengaged framework.
11) Tsai et al. (2004) fostered a period area method to research the productivity of isolators to lessen the energy imported in a FPS-disengaged working for seismic tremor movement. Both radiation damping and establishment adaptability were viewed as fundamental in the precision of reaction forecast and wellbeing of the disengaged structure.

III. Soil Structure Interaction and Isolated Footings

The impacts of the SSI are more centred around its unfavourable impacts. As referenced, regardless of whether studies have informed that the plan in light of soil structure connection builds the time span, expansion in time-frame isn't generally a valuable element. There is prolongation of seismic waves when it is on a site of delicate soil residue. This outcome in the increment of the regular time frame thus prompting reverberation. This occurs with a significant stretch vibration. Assuming the regular period builds, the interest for malleability additionally increments. This might bring about long-lasting disfigurement and soil disappointment that will additionally deteriorate the primary seismic reaction. A design under the activity of seismic power (seismic excitation), there is association between the dirt and establishment which acquires changes the ground movement. The dirt design association can have two kinds of peculiarities or impacts (according to FEMA P-750 and NEHRP).

Isolated footings (otherwise called Pad or Spread footings) are normally utilized for shallow establishments to convey and spread concentrated loads, caused for instance by sections or points of support. Disconnected footings can comprise both of supported or non-built up material. For the non-built up balance in any case, the tallness of the balance must be greater to give the fundamental spreading of burden. Disconnected footings should possibly be utilized when it is sure beyond a shadow of a doubt, that no changing settlements will happen under the whole structure. Spread

footings are unsatisfactory for the course of broad burdens. For this situation, either strip (consistent) footings or mat footings are utilized.

There are different sorts of secluded footings, for example, spread balance, ventured balance, inclined balance and so on They are normally square, rectangular or round in shape. Each sort of balance is chosen in view of the dirt condition and design of forced loads. Secluded footings are quite possibly the most conservative kinds of balance and are utilized when sections are divided at generally significant distances. Disengaged or single footings are underlying components used to send and circulate heaps of single segments to the dirt without surpassing its bearing limit, as well as forestalling inordinate settlement and giving sufficient wellbeing against sliding and upsetting. Besides, they are utilized on account of light section loads, when segments are not firmly divided, and on account of good homogeneous soil.

IV. RESULTS:

The variations for Base Shear are presented in figure 4.9, 4.10, 4.11 and 4.12.and are story shear variation are shown in figure 4.13, 4.14, 4.15 and 4.16 respectively.

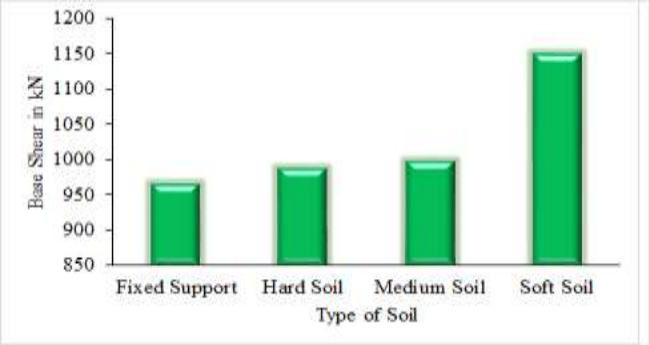

Fig. 1: Base Shear Variation for 5- Storey building (Square Footing)

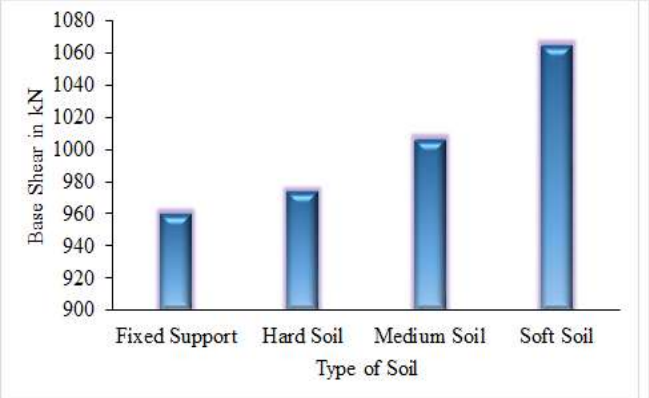

Fig. 2: Base Shear Variation for 5- Storey building (Rectangular Footing)

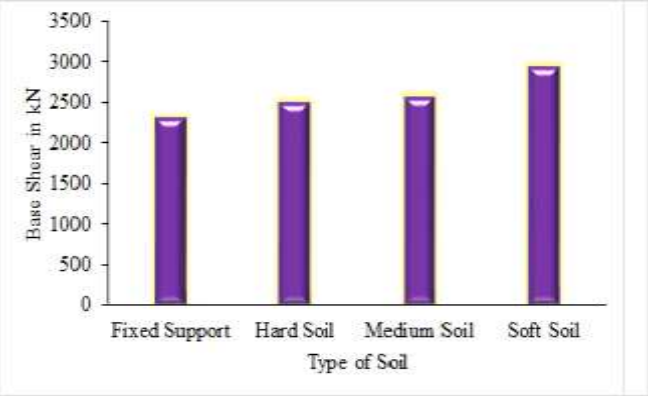

Fig. 3: Base Shear Variation for 8-Storey (square footing)

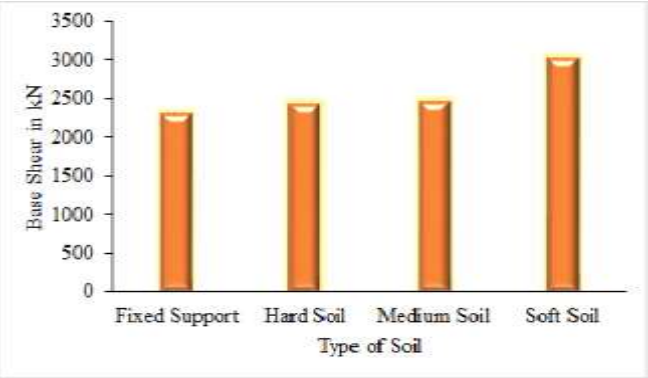

Fig. 4: Base Shear Variation for 8-Storey (Rectangular footing)

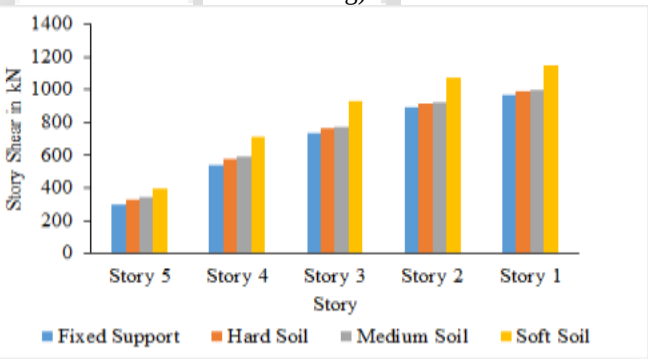

Fig. 5: Storey Shear Variation for 5- Storey (Square Footing)

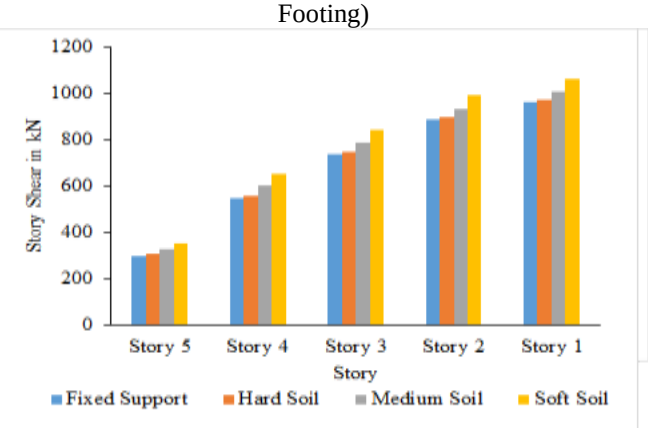

Fig. 6: Storey Shear Variation for 5-Storey building (Rectangular Footing)

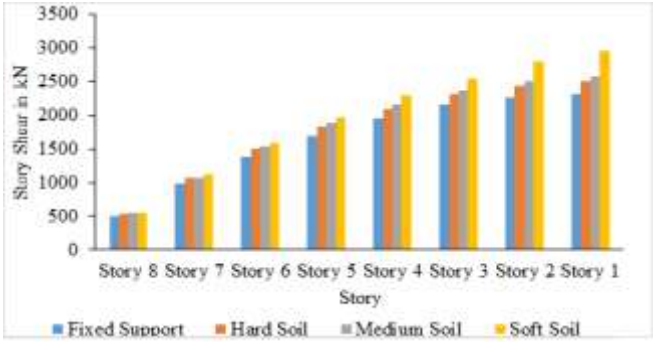

Fig. 7: Storey Shear Variation for 8- Storey (Square Footing)

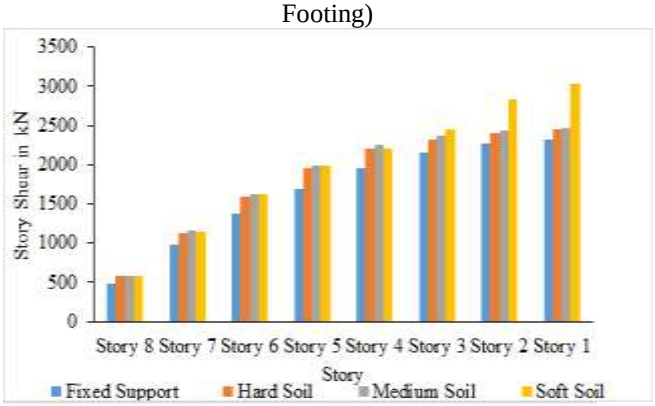

Fig. 8: Storey Shear Variation for 8-Storey (Rectangular footing)

V. CONCLUSION:

This study explains the behavior of dampers on structural system under the performance of dynamic loads from which the following conclusion can be drawn, based on the result:

A. Perceptions Based on Comparison of Base Shear and Story Shear

1) For 5 Story Building - The Base Shear an incentive for fixed help building was 960 kN. The Magnitude of Base Shear for square and rectangular balance were are practically comparative. The Scale factor for Hard, Medium, and Soft Soil is viewed as 1.021, 1.034 and 1.195 times of Fixed Support Condition.
2) For 8 Story Building - The Base Shear an incentive for fixed help building was 2315 kN. The Magnitude of Base Shear for square and rectangular balance were are practically comparable. The Scale factor for Hard, Medium, and Soft Soil is viewed as 1.08, 1.10 and 1.27 seasons of Fixed Support Condition.

B. End Based on Comparison of Story Displacement

1) For 5 Story Building - The even dislodging of design is viewed as most extreme for delicate soil (45.6 mm-Square, 41.353mm-Rectangular) at 15 m stature and for Fixed help model is 34.852 mm. The Soft Soil is uprooted by 1.308 and 1.186 (Square, Rectangular), that of Fixed Support condition. Comparably Hard Soil and medium Soil are uprooted by 35.774, 38.448 mm and are 1.02 and 1.103 seasons of Fixed Support condition.
2) For 8 Story Building - The level uprooting of construction is viewed as greatest for soft soil (54.426mm) at 24m stature, while for Fixed help model least even dislodging is noticed (41.698mm). Consequently, soft soil is dislodged by 1.31 in compare with Fixed Support condition. Correspondingly Hard Soil and medium Soil are dislodged by 45.87, 47.464 mm and are 1.1 and 1.14 seasons of Fixed Support condition

REFERENCES:

[1] Yingca, PallaviBadry and Neelima Satyam. (2008) "DSSI for pile supported asymmetrical building: A review" Civil Engineering and Urban planning:An International Journal(CiVEJ)Vol.1, No.2/3,
[2] Saranya.P and NeelimaSatyam.D,(2011) "Soil structure interaction of high rise structure supported by pile foundation" Proceedings of Indian Geotechnical Conference, Kochi (Paper No.F-005).
[3] SushmaPulikanti andPradeep Kumar Ramancharla (2014) "SSI Analysis of FramedStructure Supported on Pile Foundations - With and Without Interface Elements" Frontiers in Geotechnical Engineering (FGE) Volume 3 Issue 1.
[4] Vinayak Garag , S Karuna " Effect of Soil-Structure Interaction on Regular and Irregular, Medium RC Framed Structure"ISSN: 2278 – 7798 International Journal of Science, Engineering and Technology Research (IJSETR) Volume 5, Issue 5, May 2016
[5] Gazetas, G., Soil-Dynamic and Earthquake Engineering, Symeon Publishing, Athens, 1996.
[6] Idriss, I.M., Kennedy, R.P., Agrawal, P.K., Hadjian, A.H., Kausel, E., and Lysmer, J. (1979). Analyses for soil structure interaction effects for nuclear power plants. ASCE.
[7] Johnson, J.J. (1981). Soil Structure Interaction (SSI). The status of current analysis method and research, Lawrence Livermore National Laboratory (LLNL), UCRL-53011, NUREGICR-1780, US Nuclear Regulatory Commission.
[8] Constantinou, M.C., kneifati, M.C. (1986). Effect of soil-structure interaction on damping and frequencies of base-isolated structures. The 3rd US national conference on earthquake engineering. 1: 671-681.
[9] Novak, M., Henderson, P. (1989). Base-isolated buildings with soil-structure interaction. Earthquake Engineering Structural Dynamic. 18: 751-765.
[10] Kelly, J.M. (1991). Shake table tests of long period isolation system for nuclear facilities at soft soil sites. UBC/EERC-91/03, University of California at Berkeley.
[11] Kelly, J. M. (1996). Earthquake-Resistant Design with Rubber. 2nd edition, London, Springer. International Conference of Building Officials Uniform Building Code,(1997). UBC97 , USA.
[12] Naeim, F., Kelly. J.M. (1999). Design of Seismic Isolated Structures, From Theory to Practice. John Wiley & Sons, Inc.
[13] Lee, D.G., Hong. J.M. and Kim, J. (2001). Vertical distribution of equivalent static loads for base isolated building structures. Journal of Engineering Structures, Vol. 23, p.1293-1306
[14] Spyrakos, C.C. and Vlassis, A.G. (2002). Effect of soil-structure interaction on seismically isolated bridges. Journal of Earthquake Engineering. 6: 3, 391-429.

[15] Johnson, J.J. (2003). Soil-Structure interaction. Earthquake engineering handbook, Boca Raton, CRC Press. 10.1-10.31.
[16] Tsai, C.S., Chen, C.S. and Chen, B.J. (2004). Effects of unbounded media on seismic responses of FPS-isolated structures. Journal of Structural Control Health Monitoring. 11: 1-20.
[17] Spyrakos, C.C., Maniatakis, Ch.A., Koutromanos, I.A. (2009). Soil-structure interaction effects on base-isolated buildings founded on soil stratum. Engineering Structures. 729-737.
[18] Alavi, E., Zohrei, M., and Alidoost, M. (2010). Investigation on Accuracy of Simplified Equivalent Static Method in Design of Based-Isolated Buildings. The 14th ECEE, 30 Aug.-03.Sep., Macedonia, Proceedings, No. 609.
[19] George Gazetas, (1991) Member, ASCE, "Formulas and charts for impedances of surface and embedded foundations."
[20] Sekhar Chandra Dutta, Rana Roy, "A critical review on idealization and modelling for interaction among soil-foundation structure system", Computers and Structures 80 (2002), pp.1579_1594
[21] Koushik Bhattacharya, Shekhar Chandra Datta, "Assessing lateral period of building frames incorporating soil flexibility", Journal of sound and vibration, 269 (2004), pp.795-821
[22] B.R. Jayalekshmi, (2007) "Earthquake response of multi-storeyed R.C. frames with soil structure interaction effects."

