Response of C.S.B With Isolated Footing Considering SSI

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Abstract- *In this study behavior of conventional truss structure is included. To study structural nature of any structure, the effects of soil structure interaction (SSI) should be considered preferably. The present theories and practices are referred by some of the resources like IEEE explorer, fundamental technical papers from journals and conferences, latest technical papers, patent information, research thesis, international and national workshop proceedings, research institute publications, authorized websites and reference books etc. In following case, attempt have been made to study the influence of soil structure interaction on Conventional truss Building (C.S.B). By considering the fixed support conditions at the base of structure the structural behaviour is analyzed. The structural response of building is seems to be affected because In conventional method the foundation flexibility of soil mass has been ignored. Winkler's spring model approach is used for the analysis of soil flexibility by integrating. The effect of SSI on various parameters like base shear, lateral displacement, etc are studied and discussed. The subgrade must be modeled adequately well To get real behavior of superstructure. The analysis is administered in STAAD Pro.V8i software using response spectra of IS 1893-2002.*

Keywords- Soil Structure Interaction (SSI), Conventional truss building (C.S.B), Equivalent static method, etc.

I. INTRODUCTION

An earthquake is a shaking of the ground caused by sudden rupture and movement of large tectonic plates. The Indian sub-continent has a history of devastating earthquakes. After Killari (1993), Jabalpur (1997), and Bhuj (2001) earthquake it is clear that no part of the country is free from the seismic hazard. The main reason for the high intensity of earthquake in India is because of the movement of Indian plate towards the Eurasian plate at the rate of 49mm per year approximately. Geographical statistics shows that the India has almost 54 percent of land susceptible to seismic hazards. There are many cases in civil engineering for which interaction between structure and ground has to be considered. Hence during the earthquake excitation forces and other lateral forces on the structure, behavior of soil strata under the structure plays an important role. The advance countries like USA, Japan are already constructing the structures which can resists the earthquake of magnitude 7 and above. India is not more aware about the importance of constructing earthquake resisting structures.

II. SOIL STRUCTURE INTERACTION

Soil structure interaction is the general phenomena involved in the behavior of structure which interacting with soil medium in response to the lateral loading imposed on the structure. The phenomena could also be defined as "The process during which the response of soil influences the motion of reference to structure influence the response of the soil is termed as SSI". This phenomenon deals with interaction between structure & sub soil. Winkler's model is mechanical type of model for soil idealization. This model in common use in the analysis of foundation problem. The Winkler's model is studied in 1867. Winkler's theory represents the soil medium as a system of identical but mutually independent, discrete, closely spaced, linearly elastic springs. According to this theory, deformation of foundation because of applied load is confined to loaded regions only. A numerous studies in the area of soil structure interaction have been carried out on the basis of Winkler hypothesis for its simplicity. The basic problem with the use of this model is to determine the stiffness of elastic springs used to replace the soil below foundation. The effect of soil flexibility is suggested to be considered through deliberation of springs of specified stiffness. To analyze the complete structural system containing of soil foundation and structure under loading, the impedance functions associated with a rigid mass less foundation are used. To make analysis most general, translations of foundation in two mutually perpendicular principal horizontal directions and vertical direction as well as rotations of the same about these three directions are considered. For building with raft footing, below the foundation three translational springs along with two horizontal and one vertical axes respectively together with three rotational springs about those mutually perpendicular axes respectively have been attached to simulate the effect of soli flexibility.

III. OBJECTIVE OF STUDY

The underlined objective of this work is to study the Conventional truss building response by equivalent lateral force method. STAAD Pro.V8i software has been used for this analysis. The another objective is to investigate the influence of soil structure interaction. In which equal bay spacing is considered, also to understand the influence of soil structure interaction on the performance of C.S.B considering three different soil strata's.

IV. STRUCTURAL MODELING

For the analysis of work a Conventional truss building with 30 m span is considered. The earthquake excitation forces considered to study the soil structure interaction behaviour of this building. The building is 11m high and length is 60m, height of crane girder is 8m. Building is symmetrical along both the X and Z-axis having 10 bays along Z-axis and 5 bays along X-axis, each bay of 6m. Isolated footings are considered to be resting on three sorts of soil strata's namely, hard soil, medium soil, and soft soil.

Table -1: Geometric and material properties of building

Structure	C.S.B
Spans	30m.
Column Height(m)	10m
Roof slope	1:10 and 1:5
Crane height(m)	8m
Bay spacing	6m
Purlin spacing	1.507m and 1.53m
Steel grade	345 Mpa and 250 Mpa
L/W	2

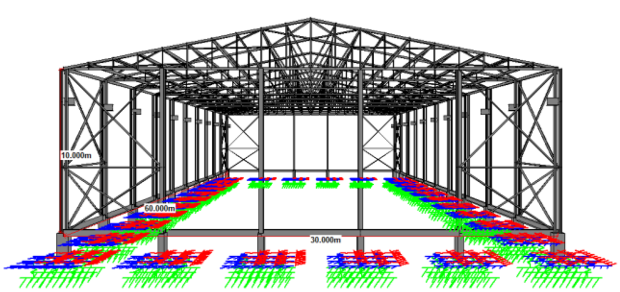

Fig.1: Front View of the structure

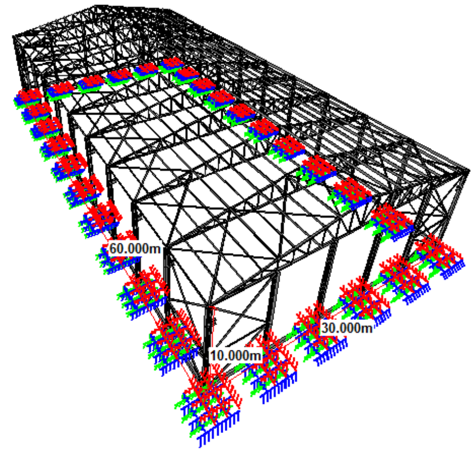

Fig.2: Front View of the structure

Table-2: Soil Elastic Constants

Soil type	Modulus of Elasticity (kN/m^2)	Unit Wt. (γ)	Poisson ratio (μ)
Hard	65000	16	0.3
Medium	35000	16	0.4
Soft	15000	16	0.3

Winkler's spring model:

Winkler's model is used for analysis of soil structure interaction. Equivalent springs are considered in this model which has six degree of freedom for representing the soil medium. Specific stiffness of the spring is depends upon the properties of respective soil conditions. The stiffness is calculated by George Gazetas formulas and shown in table.

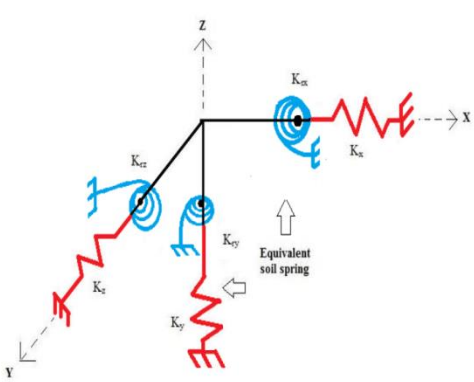

Fig.3: Equivalent spring stiffness.

Where, Kx, Ky, Kz = Stiffness of equivalent soil springs along the translational DOF along X, Y and Z axis.

Krx, Kry, Krz= Stiffness of equivalent soil springs along the rotational DOF along X, Y and Z axis.

Table-3: George Gazetas formulas for stiffness calculation

Degrees of Freedom	Stiffness of equivalent soil spring
Horizontal(lateral)	$[2GL/(2-v)](2+2.50\chi^{0.85})$ with $\chi = A_b/4L^2$
Horizontal (longitudinal)	$[2GL/(2-v)](2+2.50\chi^{0.85})-[0.2/(0.75-v)]GL[1-(B/L)]$ with $\chi = A_b/4L^2$
Vertical	$[2GL/(1-v)](0.73+1.54\chi^{0.75})$ with $\chi = A_b/4L^2$
Rocking(about longitudinal)	$[G/(1-v)]I_{bx}^{0.75}(L/B)^{0.25}[2.4+0.5(B/L)]$
Rocking (about lateral)	$[G/(1-v)]I_{by}^{0.75}(L/B)^{0.15}$
Torsion	$3.5G\, I_{bz}^{0.75}(B/L)^{0.4}(I_{bz}/B^4)^{0.2}$

Table-4: Calculated Spring Stiffness of Soil Springs 30m span C.S.B

Degrees of freedom	Calculated Stiffness of soil springs (kN/m)		
Soil Type	Hard	Medium	Soft
Horizontal (lateral direction)	152205.8	77343.7	43529.5
Horizontal (longitudinal)	152205.8	77343.7	43529.5
Vertical	186464.28	104041.6	53327.16
Rocking (about longitudinal)	24442.63	10695.5	10733.3
Rocking (about lateral)	2442.63	10695.5	10733.3
Torsion	315581.5	138091.25	138580

Parametric study:

Different base condition gives the different effects on performance of C.S.B. While studying soil structure interaction is considered. Effect of SSI on C.S.B is shown in following parametric study.

Base shear:

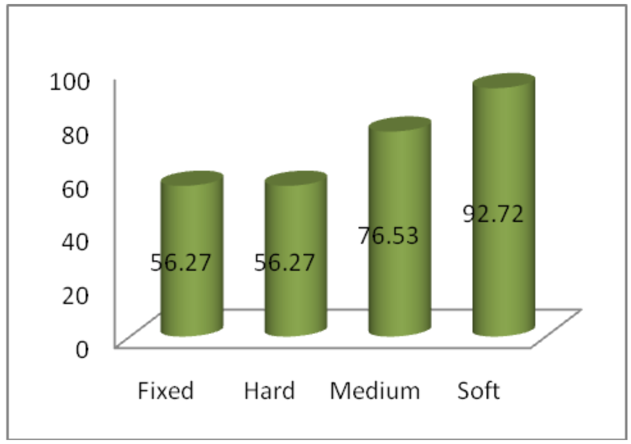

Fig 4: Base shear for different Soils.

Lateral deflection:

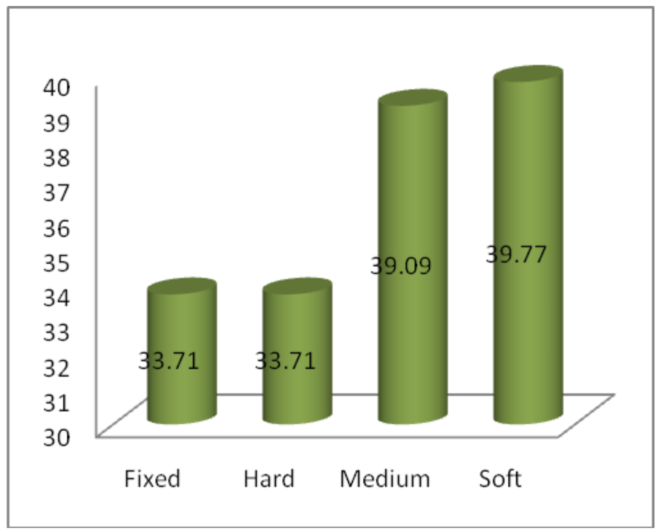

Fig 5: Displacement for various soils.

Column moment:

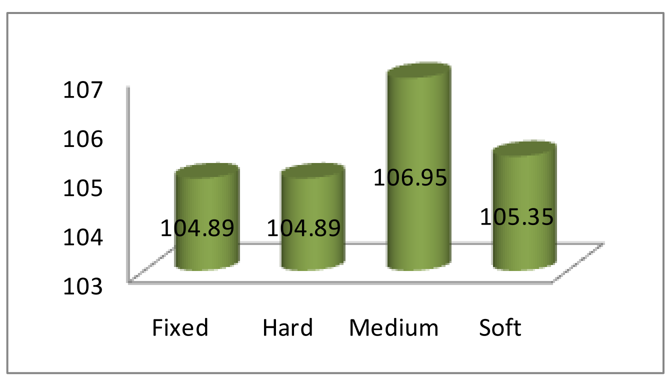

Fig 6: Column moment for different soil.

V. CONCLUSIONS

1. Base shear and lateral deflection for soft soil is 64.77% and 18% more as compared to fixed support condition.

2. It is observed that column moment 30m span increases by 0.52% for soft soil condition compared to fixed base condition
3. Due to soil structure interaction column moment of structure increase, which is depends on the flexibility of soil. As flexibility of soil increases column moment increases. Column moment is important element while designing C.S.B structure. If evaluation of this parameter is ignored SSI effect may cause severe error in designing.
4. As on actual site condition supports are not perfectly rigid, has some flexibility due to different soil conditions. Hence considering SSI effect is important for steel structure building.

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