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Study on lateral deflection of buildings with fixed support under various soil conditions

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Abstract:- Generally the structures are not only supported by their respective foundations but also by the Soil. But in most of the cases the designers fail to consider the interaction of the soil as well as its influence over superstructure during Earthquake. This paper studies the lateral deflection on the regular and vertically irregular framed RC Buildings with fixed support, under various soil conditions like hard, medium and soft. The regular and irregular RC framed buildings were modelled for 4m and 5m spacing. These buildings were analysed using STAAD Pro V8i under various soil conditions. The lateral deflection of these buildings were tabulated and compared with respect to types of buildings. The lateral deflection was analysed for both X-direction and Z-direction. It was concluded that the lateral deflection for regular building in Z direction was higher for 5m spacing of column with respect to soft soil.

Keywords:- Fixed Base; Deflection; Various Soil Condition; Irregular Structures.

I. INTRODUCTION

Buildings are not only a man made structure with columns, walls, beams etc.., that are built for human habitations, every building has a complexity which are to be carefully designed from the beginning. The recent past, several case studies have been carried out repeatedly and that assures that designing of a building with consideration of Seismic loads and its effects, which sustain at the time of Earthquake. When the seismic waves hits a structure the physical properties and layout of structure are the main responsibilities via which a building could sustain. These are all the prominent factors that may lead to deflect the building laterally. Lateral deflection is the major phenomena that may even leads to collapse of a building .Structures which are usually tall or slender, respond dynamically to the effects of lateral deflection. This lateral deflection of a building may varies with respect to various soil conditions such as hard, medium and soft. The response of the foundation of the building and the motion of the layout of the building influences the lateral deflection of the building. Every designer might consider the maximum deflection limits that are appropriate to the structure and its respective use. The calculated deflection must not exceed these limits. According to Bureau of Indian Standard [7] the buildings must be analysed for earthquake resistance.

II. REVIEW OF LITERATURE

Devesh p. Soniet al (2006) summarized the seismic response of vertically irregular building frames. A review of study on seismic behaviour of vertical irregular structures along with their finding was presented in this study. It was observed that building codes provide criteria to classify the vertically irregular structures and suggest dynamic analysis to arrive at design lateral forces. Most of the studies agree on the increase in drift demand in the tower portion of set-back structures and on the increase in seismic demand for buildings with discontinuous distributions in mass, stiffness, and strength. The largest seismic demand was found for the combined stiffness and strength irregularity.

Sadashiva et al(2010) studied the simple models of a nine storey structure that were designed to have a constant inter storey drift ratio in all floors or to have a constant stiffness throughout the height of thebuilding when designed according to the equivalent static method of the New Zealand seismic loading standard. The structures were modelled in two ways, one with a vertical shear beam and the other model was a combination of a vertical beam and a continuous column. The buildings were analysed using inelastic dynamic time history analysis considering p-Δ effects using a suite of 20 earthquake records. Further structures were designed with different amounts of mass eccentricity and they were subjected to the same range of earthquake excitations. It was shown from the study that the New Zealand code does not always conservatively estimate the median interstorey drift ratio for both Irregular and regular structures. The lower and upper levels of the structure rather than the mid-height stories were more sensitive to mass increases. The average median interstorey drift increase was approximately equal to 0.02 to 0.04 times the increase in mass at a critical level.

Birendrakumarkaraiya et al (2014) studied the seismic vulnerability assessment of the multi-storeyed buildings. Rapid visual assessment method was used for the assessment of seismic vulnerability. Though existing rapid screening approaches consider the effect of vertical and plan irregularity in seismic vulnerability assessment; they fail to distinguish different cases of vertical and plan irregularity. Buildings having different degrees of irregularity may have varied seismic performances. Due to this aspect the rapid seismic assessment procedure, the assessment procedure was more accurate. In this view the effect of different degrees of vertical and plan irregularities on the seismic performance of RC buildings has been examined in this study. For comparison, same storey stiffness and loads have been maintained &a variation of member forces, base shears and drifts was observed.

III. METHODOLOGY

The model of the buildings with different column spacing (4m & 5m) were considered under different soil condition like hard, medium and soft soil , the multi storeyed building with fixed base was analysed subjected to seismic forces using STAAD pro software by Response spectrum method. The regular and vertically irregular buildings were analysed for both X & Z direction. The response of these building were computed and tabulated.

A. *Input Data*

Size of building - 80mX60m, Type of structure- RCC Multi storey frames, No. of storey - 10, Height of the floor - 4m, Imposed load - 4kN/m^2, Response spectra – IS 1893(part 1) 2002 , Seismic zone - V , Response reduction factor -3, Importance factor – 1, Depth of foundation - 1.5m, Type of soil -Hard, Medium and Soft. Damping ratio - 5%, Wall thickness - 230mm, Depth of slab - 200mm, Materials - M25(beam), M30(column) , Fe415, Unit weight of RCC-25kN/m^2.

IV. ANALYSIS OF RESULTS

Multi-storeyed building was analysed and designed to resist the seismic forces. Lateral deflection for both the irregular and regular frames was compared. Seismic analysis was carried out as per IS1893:2002 Part-I. The buildings were compared with respect to different soil conditions. Different response results were found for fixed base building.

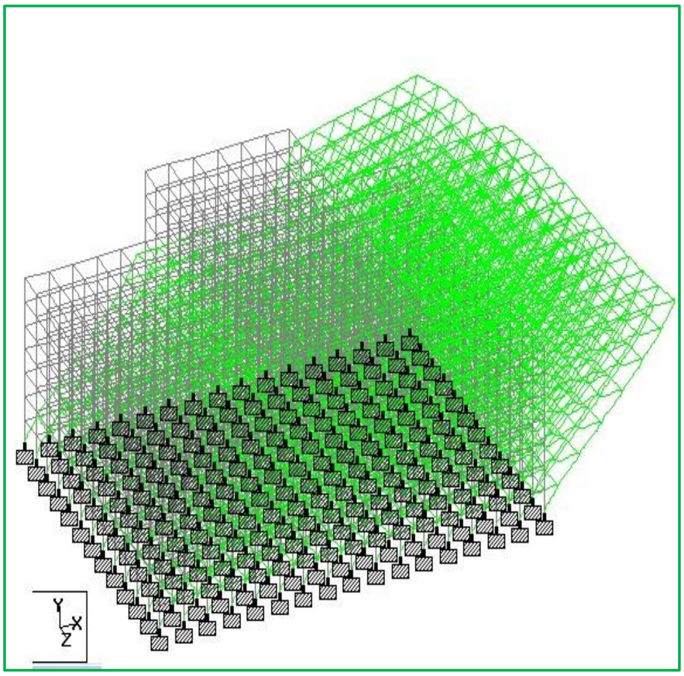


Fig. 1: Lateral deflection of vertical irregular building with Fixed Base

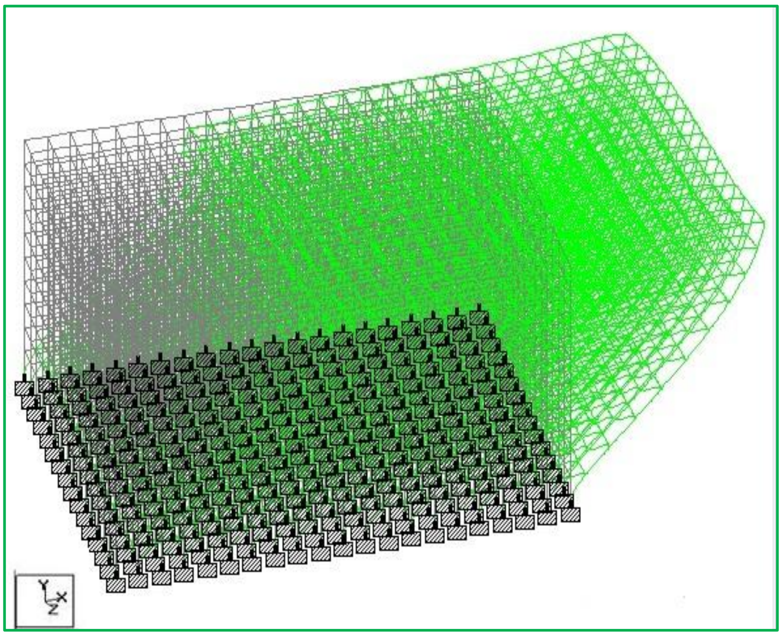


Fig. 2: Lateral deflection of the regular building with Fixed Base

Table I: Comparison of Lateral Deflection Values of building frames for various soil condition and spacing of columns.

Building Type	Direction	Type of Soil	Column Spacing	
			4m	5m
Deflection of Building with Vertical Irregularity (mm)	X	Hard	7.26	17.71
		Medium	9.87	24.09
		Soft	12.13	29.57
	Z	Hard	9.70	24.13
		Medium	13.20	32.82
		Soft	16.21	40.29
Deflection of Regular Building (mm)	X	Hard	6.37	16.06
		Medium	8.67	21.91
		Soft	10.65	27.76
	Z	Hard	9.05	22.45
		Medium	12.31	30.60
		Soft	15.12	37.58

Fig.3: Comparison of deflection in X-direction for 4m column spacing

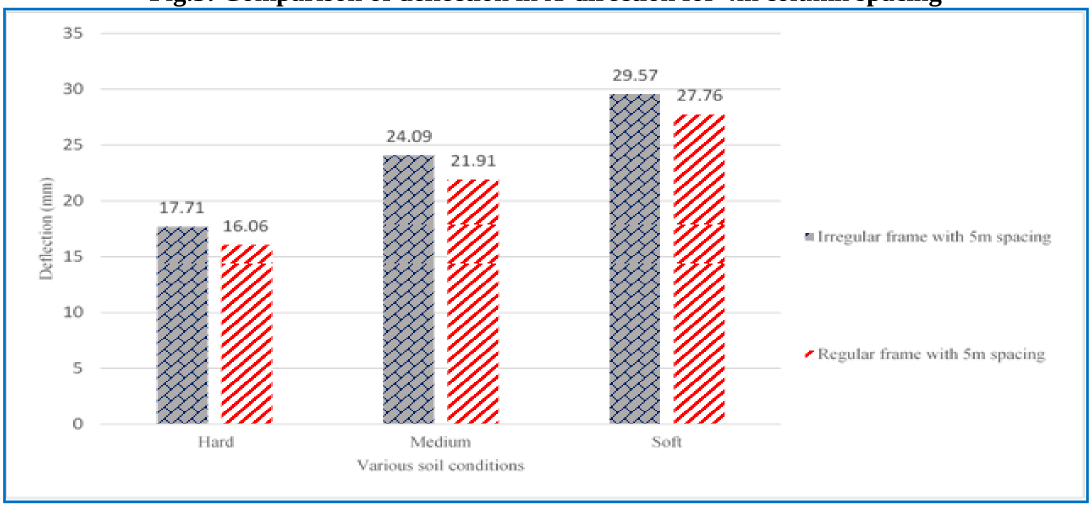


Fig. 4: Comparison of deflection in X-direction for 5m column spacing

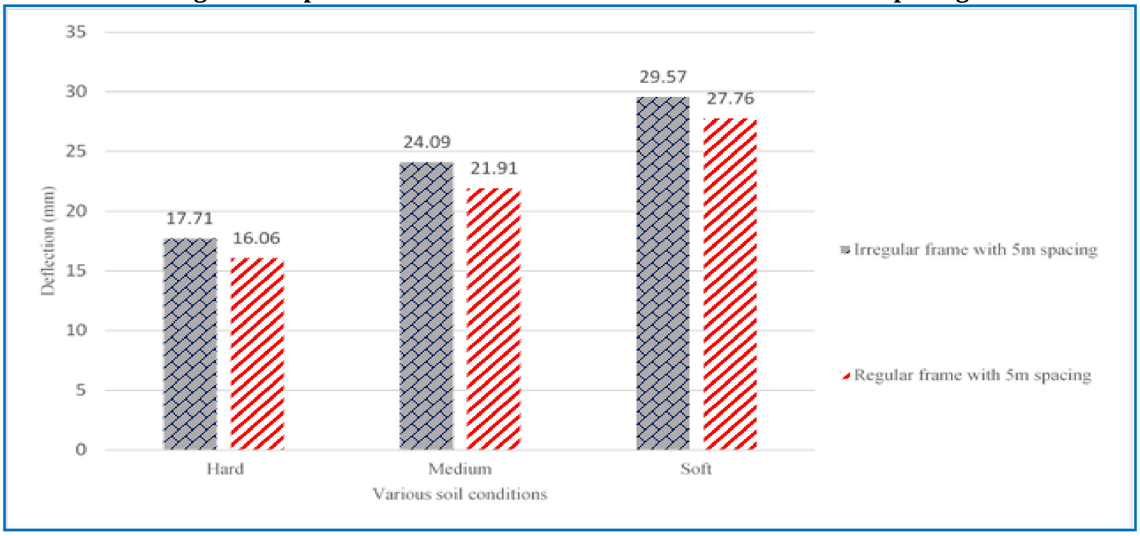


Fig. 5: Comparison of deflection in Z-direction in 4m Column Spacing

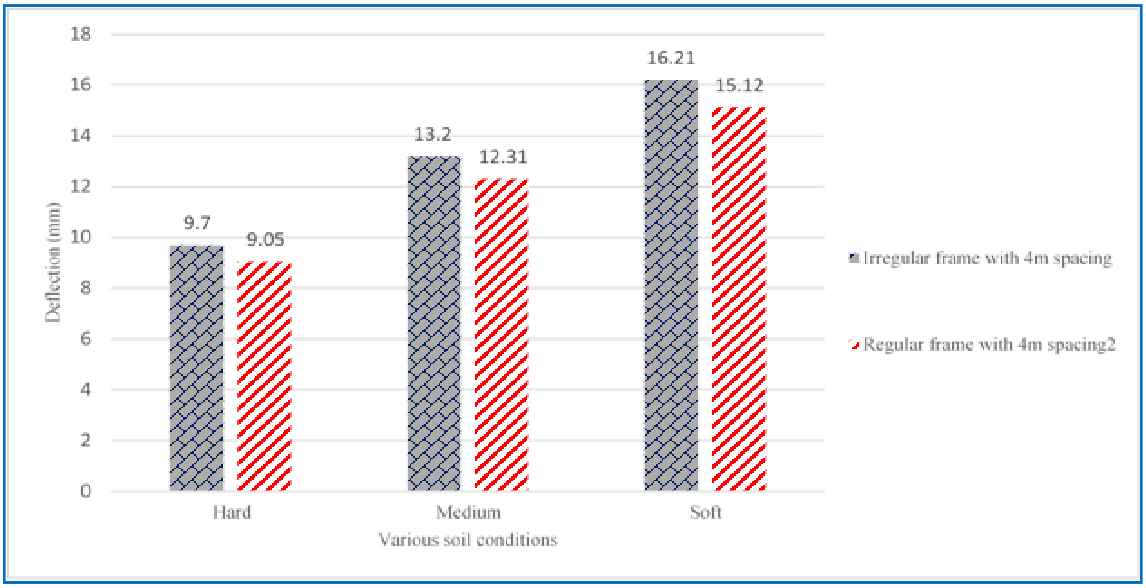
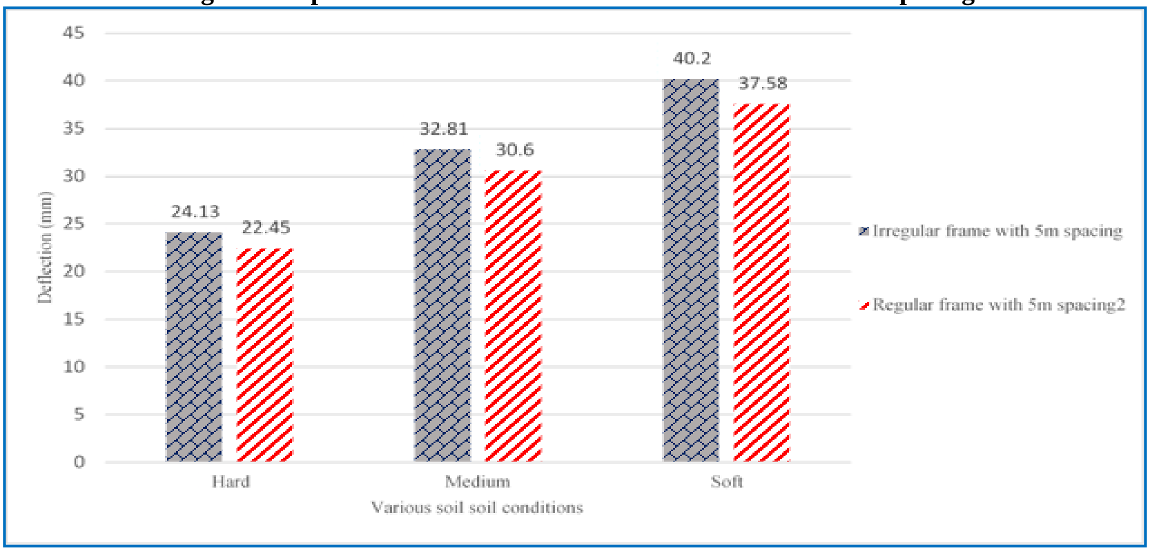


Fig. 6: Comparison of deflection in Z-direction in 5m Column Spacing



The above figures (Fig 3, Fig 4, Fig 5, Fig 6) shows the deflection values of both regular and vertical irregular building subjected to seismic force. These values were compared with respect to various soil condition and column spacing. The deflection values increased from hard soil to medium soil and from medium soil to soft soil. The deflection value of vertical irregular building was high for soft soil compared to regular building and other soil conditions. The results confirmed that the irregular building with 5m column spacing deflected with higher values for fixed support in soft soil condition.

V. CONCLUSION

Multistoried building frames with fixed support subjected to seismic force were analyzed for different soil conditions. The response of regular buildings was compared with response of vertical irregular buildings. The lateral deflections values increased when type of soil changes from hard to medium and medium to soft soil. The deflection value in X direction for vertical irregular building increased with 7% compared to regular building for 5m spacing subjected to soft soil condition under fixed support. Hence suitable soil condition has to be adopted along with the type of foundation while designing building for Earthquake resistant.

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