iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** Issue II **Month of publication:** June 2015

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Seismic Response of RC Bare Frame and Shear Wall Frames With and Without Considering Soil Structure Interaction in Buildings

Mahadev Prasad N[1], Manogna H N[2], Dharmesh N[3] and Madhu Sudhana Y B[4]
Post Graduate Student[1], Assistant Professor[2], Department of Civil Engineering, Shridevi Institute of Engineering and Technology, Tumkur, India
Assistant Professor[3, 4], Department of Civil Engineering, East Point College of Engineering and Technology, Bangalore, India
Abstract: The significance of incorporating soil-structure interaction effect in the analysis and design of RC frame buildings is increasingly recognized but still not penetrated to the grass root level owing to various complexities involved. It is well established fact that the soil-structure interaction effect considerably influence the design of multi-storey buildings subjected to lateral seismic loads. The shear walls are often provided in such buildings to increase the lateral stability to resist seismic lateral loads. In the present work, the linear soil-structure analysis of a G+5 storey RC shear wall building frame resting on raft footing and supported by deformable soil is presented. The finite element modelling and analysis is carried out using SAP2000 software under gravity loads as well as under seismic loads. The interaction analysis is carried out with and without shear wall to investigate the effect of inclusion of shear wall on the forces in the footing due to settlement of soil mass. The frame and soil mass both are considered to behave in linear elastic manner. It is observed that the soil-structure interaction effect significantly alters the time period, frequency and base shear of the building due to the soil settlement. The non-interaction analysis of space-frame-shear wall suggests that the presence of shear wall significantly reduces time period and displacement of the building but the interaction effect causes restoration of the time period and displacement to a great extent.
Keyword: soil-structure interaction, SAP2000, bare frame, shear wall, time history analysis, time period, natural frequency, displacement, base shear.

I. INTRODUCTION

The conventional structural analysis of a RC bare frame is carried out assuming foundation resting on unyielding supports. The analysis is carried out by considering bottom end of the columns fixed and neglecting the effect of soil deformations. In reality, any building frame rests on deformable soil resulting in redistribution of forces and moments due to soil-structure interaction. Thus, conventional analysis is unrealistic and may be unsafe. The interaction effect is more pronounced in case of multi-storeyed buildings due to heavy loads and may become further aggravated when such buildings are subjected to seismic loads. The shear walls are usually provided in such situation to resist seismic lateral loads. The behaviour of shear walls in the space frame during soil structure interaction is a matter of high concern. In the present work, 3-D soil- structure interaction analysis has been carried out for a G+5storey RC framed building with raft footing under gravity as well as seismic loads using finite element software SAP2000. The analysis has been carried out considering space frame with and without shear walls located at the corners of the building. Here time history analysis is carried out using Bhuj earthquake data. The model is easily extendable to any configuration of space frame and shear wall as full 3-D space frame is considered for analysis. The results of conventional i.e. non interaction analysis as well as linear interaction analysis are compared for the space frame with and without shear wall to investigate the effect of displacement, time period, base shear and stresses in the footing.

II. REVIEW OF LITERATURE

H K Chinmayi and B R Jayalekshmi (2014). In this paper seismic response of RC framed building considering variation in natural period, base shear and spectral acceleration coefficient, obtained by adopting the seismic provisions of International building code (IBC) and Indian seismic code (IS1893:2002 part-1) with soil structure interaction in multi-storey RC framed buildings with different aspect ratio having cylindrical, rectangular and channel shapes of shear walls over raft foundation. Analysis of 3-dimensional models with these three different shapes of shear wall founded on four different types of soil categorized based on

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

shear wave velocity are been carried out using LS DYNA finite element software. In this paper they concluded that base shear in cylindrical shaped shear wall building is lower for buildings with aspect ratio less than 3 when compared with other shape of shear walls.

Er. Puneet Sharma, et al (2014). It has carried out study on asymmetrical RC building with shear wall considering soil structure interaction. Here it is firstly the asymmetrical building frame with shear walls at different location is analysed using conventional approach i.e. the base is fixed by providing a fixed support without considering the SSI effect. In the second case, the building is analysed with the flexible approach i.e. effect of SSI is considered the footing is assumed that it is resting on elastic medium. In the third case, the building is analysed without SSI and without shear wall. Thirdly the difference in results between these cases is compared with each other on the bases of bending moments, shear force, axial forces, time period and storey drift. The STAAD PRO software is used for structural analysis which is based on stiffness matrix method. Here different types of loads and load combinations are taken for analyzing multi-bay reinforced building i.e. Gravity Load which include dead load and live load (GL); Seismic or Earthquake load (EL).

Jain D K and Hora M S (2014) In this paper the linear soil-structure analysis is carried out for RC shear wall G+5 storey building frame resting on isolated column footings and supported by deformable soil is considered. The ANSYS software is used for finite element modeling and analyzing under gravity loads as well as under seismic loads. Various load combinations are taken as per IS-1893 (Part-1):2002. The soil interaction analysis is carried out with and without shear wall to investigate the effects of inclusion of shear wall on the forces in the footings due to differential settlement of soil mass. The soil mass and frame both are considered to behave in linear elastic manner. Here they observed that the SSI effect significantly alters the moments and axial forces in the footings due to the differential settlement. The non-interaction analysis of RC space-frame-shear wall suggests that in the presence of shear wall it significantly reduces bending moments in the column footings but in interaction effect causes restoration of the bending moments to a great extent.

III. PROBLEM FOR INVESTIGATION

A six storey RCC framed building with raft footing resting on homogeneous soil mass has been considered in this study. The building consists of 3 bays in X-direction and 2 bays in Y-direction. For resisting lateral forces a dual system consisting of special moment resisting frames (SMRF) and reinforced concrete shear walls are considered. The shear walls are provided in the corners of the building. The plinth beams are also provided. Such types of buildings are very common in urban areas. The space frame, shear walls and soil mass are considered as a single compatible structural unit for the interaction analysis. The interaction analyses are carried out with and without shear walls. The complete details of the problem under investigation are shown in Figure 1(a)-1(c). The building is considered to be situated in seismic zone V of India. For the present analysis, super-structure, foundation, as well as soil are considered to behave in linear elastic manner.

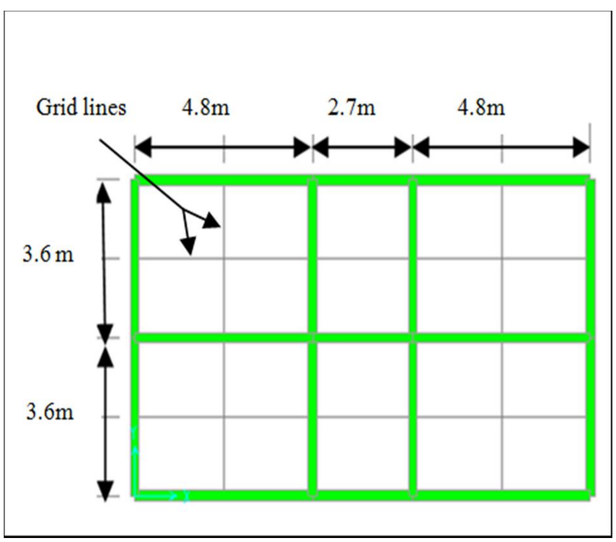


Figure-1(a). Plan of the space frame without shear wall.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

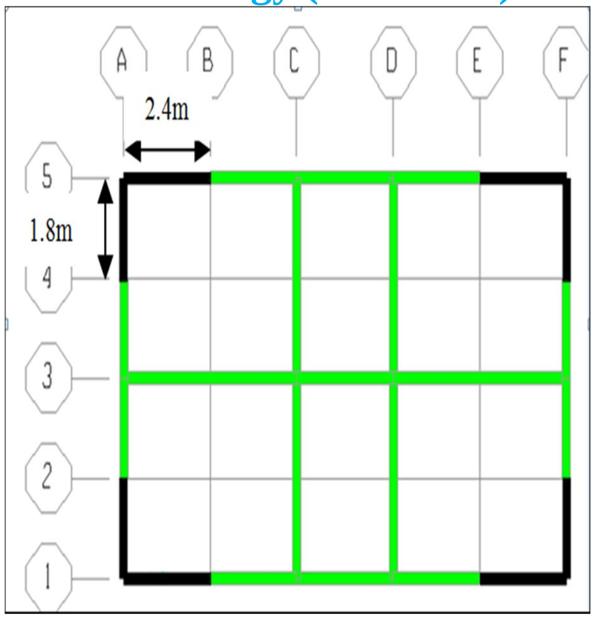


Figure-1(b) Plan of the bare frame with shear wall.

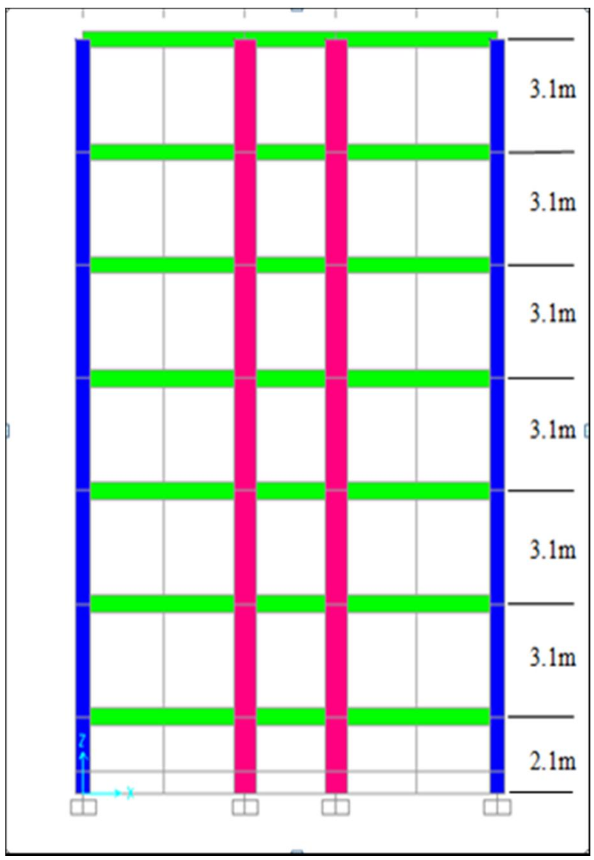


Figure-1(c) Sectional elevation

The geometrical properties of space frame-shear wall-soil system are provided in Table-1.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table-1 Geometric parameters of space frame-shear wall- soil system.

Parameter	Value
Number of storeys	6
Number of bays in X direction	3
Number of bays in Y-direction	2
Bay width in X-direction	4.8m, 2.7m, 4.8m
Bay width in Y-direction	3.6m each
Storey height	3.1m
Slab thickness	150mm
Beam size	230mm x 450mm
Column sizes: 1. Exterior 2. Interior	 230mm x 450mm 230mm x 650mm
Shear wall thickness	230mm
Depth of foundation below G.L.	2.1m
Raft foundation thickness	0.6m
Semi-infinite extent of soil mass	15m from all the sides of the building and depth is 30m below footing (5m intervals)

The work is done for three different types of soil as shown in below table based on shear wave velocity. The soil properties and concrete properties are provided in Table-2 and Table-3 respectively.

Table-2 Properties of soil.

Soil type	Shear wave velocity (m/sec)	Poisson's ratio (μ)	Density (kN/m^3)	Elastic modulus (kN/m^2)
Hard rock	1420	0.2	24	1.18×10^7
Dense soil	650	0.3	22	2.5×10^6
Soft soil	100.50	0.3	15	4.02×10^4

Table-3 Material properties of concrete.

Property	Value
Grade of concrete for all structural elements	M30
Modulus of elasticity of concrete (N/mm^2)	$E_c = 5000\sqrt{fck}$
Poisson's ratio of concrete	0.2
Density of concrete	25000 N/m^3

The building is considered to be an residential building. The live loads are considered as per IS 875 (Part 2):1987. The brick masonry wall on the beams of the building and parapet wall on roof periphery are also considered. The details of various loads considered are given in Table-4. These are in addition to the self-weight of the structure.

Table-4 Dead load and Live load on structure.

Description	Value
Dead load of floor finish	1.5kN/m^2
Dead load of finishing and water proofing on roof	1.5kN/m^2
Live load on floors	2 kN/m^2
Live load on roof	1 kN/m^2
Brick walls (on all beams)	14.26 kN/m
Parapet wall on roof periphery	4.6kN/m

For seismic load calculations, equivalent static lateral force method is used as per IS 1893 (Part 1): 2002. The parameters used for seismic load calculations are given in Table-5.

Table-5 Parameters for Lateral Seismic Load calculations on the structure.

Parameter	Value
Earthquake zone	V
Zone factor 'Z' (Table 2 of IS 1893 (Part 1): 2002)	0.36
Importance factor 'I' (Table 6 of IS 1893 (Part 1): 2002)	1.0
Response reduction factor 'R' (Table-7 of IS 1893 (Part 1): 2002) (Ordinary shear wall with SMRF)	5
Approximate fundamental natural period of vibration (Ta) $Ta = 0.075h^{0.75} = 0.075(20.7)^{0.75} = 0.7278452$ (as per clause 7.6.1 of IS 1893 (Part 1): 2002	0.7279 sec
Soil type	I (Hard soil)

In this study Bhuj earthquake data is considered for the time history analysis.

IV. SEISMIC LOAD CALCULATIONS

The equivalent static lateral force method [IS 1893 (Part 1): 2002] is adopted for evaluation of seismic forces:
(i) Calculation of lumped masses to various floor levels The earthquake loads are calculated for full dead load plus the percentage of imposed load as given Table-8 of IS 1893 (Part 1): 2002. Accordingly 25% of live load on floor and roof is considered. The lumped mass of each floor is worked out by adding mass of slab, mass of reduced live load on slabs, mass of beams in longitudinal as well as transverse directions at that floor, mass of column for half column height above and below floor, mass of wall for half height

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

above and below beams (wall is considered only on outer periphery), mass of parapet wall on outer periphery beams on roof. Seismic weight of floor = lumped masses of floors x g. where, g = gravitational acceleration and W = Seismic weight of building (sum of seismic weights of all floors)

(ii) Determination of fundamental natural period of the shear wall-space frame The approximate fundamental natural period of vibration (Ta) of the space frame-shear wall structure is estimated as per the empirical expression given in the clause 7.6.1 of IS 1893 (Part 1): 2002:

$Ta = 0.075\ h^{0.75}$

Where h = height of building, in m.

For moment resisting frame building,

$Ta=0.09h/\sqrt{D}$

Where h = height of building, in m,

D=Base dimension of the building at the plinth level in m, along the considered direction of the lateral force.

(iii) Determination of design base shear

The design base shear is calculated as per clause 7.5.3 of IS 1893 (Part 1): 2002:

The design seismic base shear, $V_b = A_h\ W$

A_h = Design horizontal acceleration spectrum coefficient, as per clause 6.4.2 of IS 1893 (Part 1): 2002.

W = Seismic weight of the building

$A_h = (Z/2)x(I/R)x(Sa/g)$

Z = Zone factor [Table 2 of IS 1893 (Part 1): 2002]. I = Importance factor [Table 6 of IS 1893 (Part 1): 2002].

R = Response reduction factor, depending on the perceived seismic damage performance of the building [Table 7 of IS 1893 (Part 1): 2002].

Sa/g = Average response acceleration coefficient for soil for 5% damping [Figureure-2 of IS 1893 (Part 1): 2002] for the natural period as worked out above.

A. Finite Element Modeling

The finite element modelling and analysis of the problem is achieved using SAP2000 software which has wide variety of elements and material models suited for the problem under consideration.

SAP2000 requires creation of model geometry, selection of appropriate element types, defining real constant sets in terms of cross sectional details for various elements, defining material properties, assigning these element types, real constants and material properties to various components of the interaction system and finite element mesh discretization in its pre-processing module. Boundary conditions, analysis type and loads are defined in its solution module.

B. Extent of soil mass

The soil mass is considered to be made up of homogeneous linear elastic isotropic material. Above mentioned three types of soils are encountered in most of the sites at varying depth from ground level. It is assumed that bed rock is encountered 30m below top of soil in the present case. Horizontal extent of soil mass is considered as 15m from the sides of the building in this study and depth is 30m which is sufficient to capture the dominant effect of soil-structure- interaction of the problem under consideration.

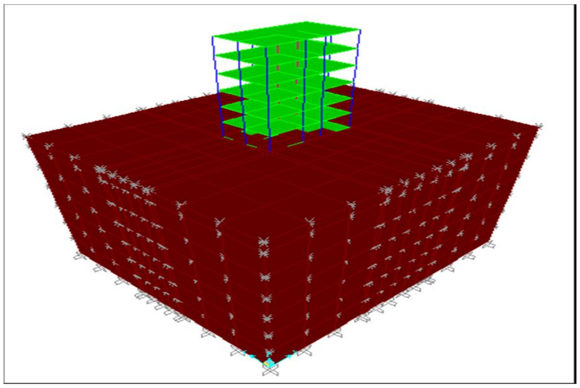


Figure-2. Space frame- shear wall-soil system (Soil Structure Interaction)

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

V. RESULTS AND DISCUSSIONS

The results of the interaction and non- interaction analyses are compared to investigate the following;
The analysis is further carried out to the foundation by checking out the stresses produced for various soil types. Table 6, 7, 8, 9, 10 and 11 will show the details of variation of time period, base shear, circular frequency and displacements.

A. Time Period

Table-6 Percentage variation in natural period of building

<table>
<tr><th colspan="7">Percentage variation in natural period of building</th></tr>
<tr><th rowspan="2">Building type</th><th rowspan="2">Soil type</th><th colspan="2">Time period (Sec)</th><th colspan="3">% variation in natural period</th></tr>
<tr><th>Without SSI</th><th>With SSI</th><th>Due to soil</th><th>Due to shear wall</th><th>Due to soil and shear wall</th></tr>
<tr><td rowspan="3">Bare frame</td><td>Hard rock</td><td rowspan="3">1.675868</td><td>1.569717</td><td>-6.33</td><td rowspan="3">--</td><td rowspan="3">--</td></tr>
<tr><td>Dense soil</td><td>1.573237</td><td>-6.12</td></tr>
<tr><td>Soft soil</td><td>1.699989</td><td>1.43</td></tr>
<tr><td rowspan="3">Shear wall</td><td>Hard rock</td><td rowspan="3">0.858127</td><td>0.552015</td><td>-35.67</td><td>-67.06</td><td>-64.83</td></tr>
<tr><td>Dense soil</td><td>0.568183</td><td>-33.78</td><td>`-66.09</td><td>-63.88</td></tr>
<tr><td>Soft soil</td><td>0.888187</td><td>3.50</td><td>-47.00</td><td>-47.75</td></tr>
</table>

The variation of fundamental natural period due to the effect of soil–structure interaction was studied on a G+5 storey building over raft foundation resting on various soil types like soft soil, dense soil and hard rock. The percentage variation in natural period with and without SW incorporating soil stiffness as compared to fixed base condition is as tabulated in Table-6

From Table-6 it is observed that, the inclusion of soil flexibility in buildings increases in the value of natural period in the soft soil. It is observed to be maximum in soft soil and minimum in hard rock. The natural period values which are obtained in shear wall building is lower when compared to bare frame building due to increase in stiffness of the building by the presence of shear wall. The maximum reduction of 67.06% is observed due to the inclusion of shear wall in hard rock and minimum variation of 47% in soft soil. However, the values which are obtained of natural period by considering the both the effect of soil and shear wall it indicates that the effect of soil flexibility in increasing the natural period is higher in shear wall buildings (67.06%).

B. Base Shear

Table-7 Percentage variation in base shear of building

<table>
<tr><th colspan="7">Percentage variation in base shear of building</th></tr>
<tr><th rowspan="2">Building type</th><th rowspan="2">Soil type</th><th colspan="2">Base shear (kN)</th><th colspan="3">% variation in base shear</th></tr>
<tr><th>Without SSI</th><th>With SSI</th><th>Due to soil</th><th>Due to shear wall</th><th>Due to soil and shear wall</th></tr>
<tr><td rowspan="3">Bare frame</td><td>Hard rock</td><td rowspan="3">555.081</td><td>60514.0</td><td>108×10^2</td><td rowspan="3">--</td><td rowspan="3">--</td></tr>
<tr><td>Dense soil</td><td>55524.1</td><td>99×10^2</td></tr>
<tr><td>Soft soil</td><td>38059.7</td><td>67×10^2</td></tr>
<tr><td rowspan="3">Shear wall</td><td>Hard rock</td><td rowspan="3">947.933</td><td>103649.5</td><td>108.3×10^2</td><td>185.7×10^2</td><td>71.28</td></tr>
<tr><td>Dense soil</td><td>95102.6</td><td>99.32×10^2</td><td>170.3×10^2</td><td>71.28</td></tr>
<tr><td>Soft soil</td><td>65188.4</td><td>67.77×10^2</td><td>116.4×10^2</td><td>71.27</td></tr>
</table>

The seismic lateral vulnerability of building structures is reflected by the seismic base shear of the buildings and is considered to be important parameter in seismic design. Base shear of the buildings with the cases in fixed base and buildings resting on different soil types are as tabulated in table 7. For the ground motion considered the values of base shear obtained for building models with shear walls are more when compared with bare frame. This increase in base shear is due to the increase in structural mass of building by the presence of shear wall.

C. Circular Frequency

Table-8 Circular frequency of building models for bare frame with SSI

MODELS	Circular frequency (rad/sec)			
MODE NO.	BF WITH-OUT SSI	BF+SSI (HARD ROCK)	BF+SSI (DENSE SOIL)	BF+SSI (SOFT SOIL)
1	3.7492	4.0027	3.9938	3.696
2	4.0113	4.291	4.2881	4.2036
3	5.5356	6.0055	5.9824	5.3028
4	10.934	11.58	11.575	9.0212
5	12.150	12.99	12.983	10.208
6	13.600	13.755	13.753	10.477
7	17.000	18.375	18.351	11.367
8	17.621	18.534	18.528	12.641
9	18.581	19.271	19.268	12.737
10	20.517	21.882	21.872	13.701
11	23.666	24.701	24.697	14.345
12	26.123	27.377	27.371	14.791

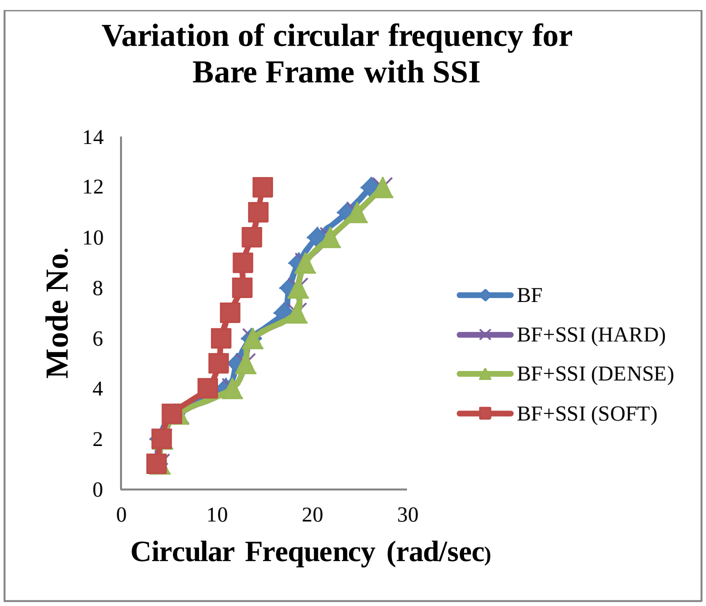


Figure-3 Variation of circular frequency for bare frame with SSI

From the Figure-3 it is clear that circular frequency is more in bare frame with SSI in hard and dense soil because stiffness in hard and dense soil is more. Hence hard and dense soil is having higher circular frequency than soft soil and with bare frame

Table-9 Circular frequency of building models for bare frame with shear wall and SSI.

MODELS / MODE NO.	Circular frequency (rad/sec)				
	BF WITH-OUT SW	BF+SW	BF+SW +SSI (HARD ROCK)	BF+SW +SSI (DENSE SOIL)	BF+SW +SSI (SOFT SOIL)
1	3.7492	7.322	11.382	11.058	7.0742
2	4.0113	10.056	15.139	14.516	8.2348
3	5.5356	11.065	18.486	17.798	9.0242
4	10.934	18.967	21.205	21.164	10.851
5	12.15	21.942	24.632	24.469	10.883
6	13.60	29.88	31.97	31.952	12.603
7	17.00	34.673	38.83	38.792	13.233
8	17.621	37.617	38.852	38.827	14.406
9	18.581	38.645	41.297	41.28	15.038
10	20.517	40.507	42.864	42.832	15.674
11	23.666	41.247	46.017	45.731	15.723
12	26.123	43.15	49.11	49.095	16.674

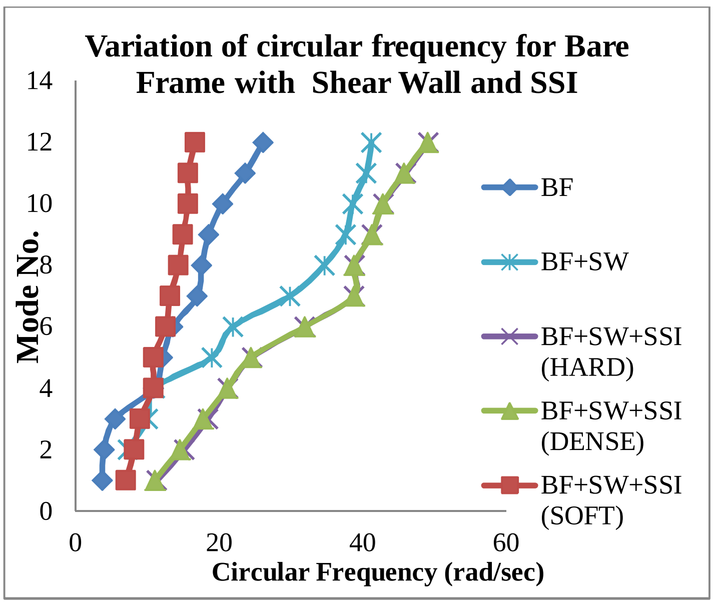


Figure-4 Variation of circular frequency for bare frame with SW and SSI

From the Figure-4 it is clear that circular frequency is more in bare frame with shear wall and SSI in hard and dense soil due to stiffness when compared with bare frame with shear wall in soft soil. And when bare frame with shear wall is considered, circular frequency is more in bare frame with shear wall due to presence of shear wall when compared with bare frame due to stiffness.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

D. Displacement

Table-10 Displacement in X-X-direction of building models for BF with SSI

` MODELS / NO. OF STOREY	Displacement in X-X-Direction (mm)			
	BF WITH-OUT SSI	BF+SSI (HARD ROCK)	BF+SSI (DENSE SOIL)	BF+SSI (SOFT SOIL)
7	84.57	61.85	63.28	111.917
6	79.24	58.15	59.44	97.49
5	69.10	50.86	51.93	75.41
4	54.96	40.13	40.95	57.09
3	38.34	26.70	27.27	45.02
2	20.83	11.98	12.32	28.41
1	4.84	0.007	0.07	12.98
BASE	0	0.005	0.023	11.48

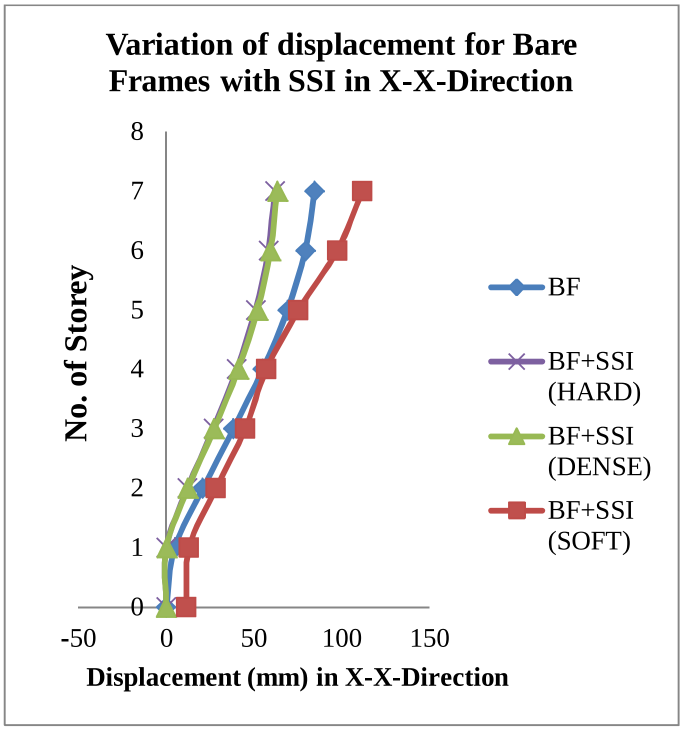


Figure-5 Variation of displacement for bare frames with SSI in X-X-direction

From the Figure-5 it is observed that displacement is more in top storey in bare frame with SSI in soft soil when compared with bare frame with SSI in dense and hard soil. And when SSI is considered soft soil have more displacement in base of the building when compared with hard and dense soil. And the displacement is more in bare frame without SSI when compared with bare frame with SSI in hard and dense soil.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table-11 Displacement in X-X-direction of building models for bare frames with shear wall and SSI

MODELS / NO. OF STOREY	DISPLACEMENT IN X-X-DIRECTION (mm)				
	BF	BF+SW	BF+SW +SSI (HARD ROCK)	BF+SW +SSI (DENSE SOIL)	BF+SW +SSI (SOFT SOIL)
7	84.57	27.52	11.23	11.99	61.54
6	79.24	23.028	9.07	9.78	51.86
5	69.1	18.40	6.83	7.48	42.17
4	54.96	13.67	4.50	5.12	32.73
3	38.34	9.04	2.46	2.90	24.23
2	20.83	4.80	0.81	1.10	17.38
1	4.84	1.40	0.02	0.10	13.50
BASE	0	0	0.0029	0.012	12.78

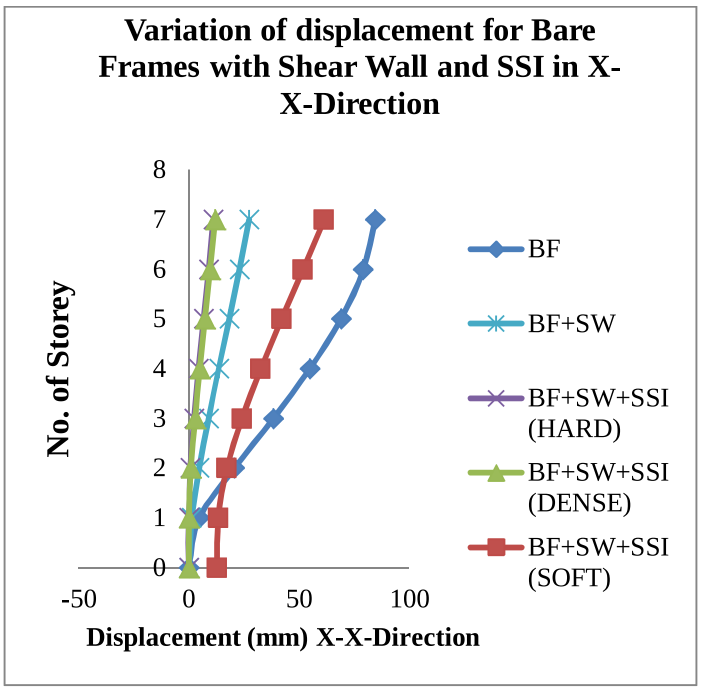


Figure-6 Variation of displacement for bare frames with shear wall and SSI in X-X-direction

From Figure-6 it is observed that in top storey the displacement is reduced in bare frame with shear wall when compared with bare frame due to stiffness presence from the shear wall. And displacement is more in bare frame with shear wall and SSI in soft soil when compared with dense and hard soil. In base of the building displacement is more in soft soil when compared with dense and hard.

From Figure-5 and Figure-6, the displacement in bare frame with shear wall and SSI in soft soil is less than bare frame with SSI and without shear wall

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table-12 Displacement in Y-Y-direction of building models for bare frames with SSI

MODELS	DISPLACEMENT IN Y-Y-DIRECTION (mm)			
NO. OF STOREY	BF WITH - OUT SSI	BF+SSI (HARD ROCK)	BF+SSI (DENSE SOIL)	BF+SSI (SOFT SOIL)
7	78.46	67.84	68.41	98.55
6	73.73	63.23	63.7	85.61
5	65.23	54.06	54.42	66.11
4	53.93	42.21	42.49	52.72
3	39.8	29.37	29.59	41.17
2	23.15	14.70	14.83	23.21
1	5.50	0.02	0.03	2.59
BASE	0	0.0022	0.01	1.3

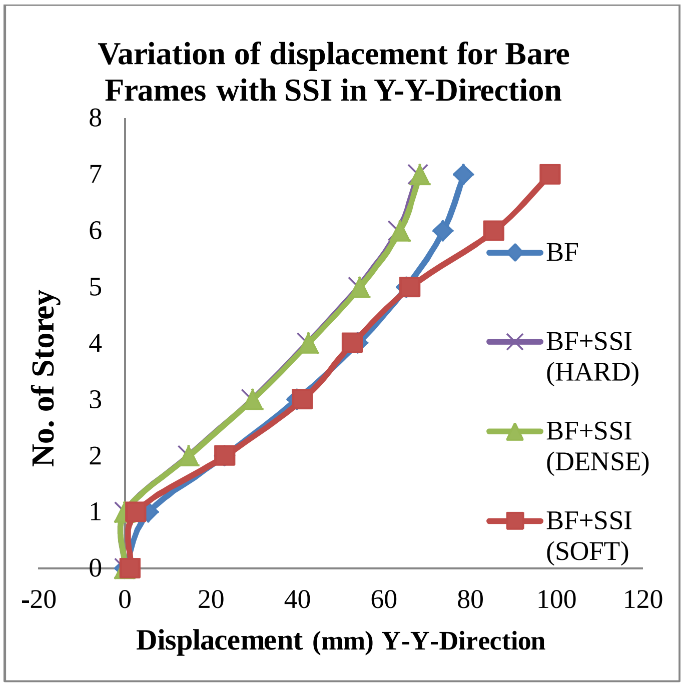


Figure-7 Variation of displacement for bare frames with SSI in Y-Y-Direction

From the Figure-7 it is observed that displacement is more in top storey in bare frame with SSI in soft soil when compared with bare frame with SSI in dense and hard soil. And when SSI is considered soft soil have more displacement when compared with bare frame.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653

Table-13 Displacement in Y-Y-direction of building models for bare frames with shear wall and SSI

MODELS / NO. OF STOREY	DISPLACEMENT IN Y-Y-DIRECTION (mm)				
	BF WITH-OUT SW	BF+SW	BF+SW +SSI (HARD ROCK)	BF+SW +SSI (DENSE SOIL)	BF+SW +SSI (SOFT SOIL)
7	78.46	67.95	24.73	25.15	65.26
6	73.73	56.74	20.48	20.94	54.93
5	65.23	45.20	15.81	16.31	44.15
4	53.93	33.45	10.81	11.34	33.00
3	39.8	21.95	5.94	6.47	22.87
2	23.15	11.47	1.95	2.38	16.15
1	5.50	3.13	0.03	0.14	12.06
BASE	0	0	0.0041	0.018	11.79

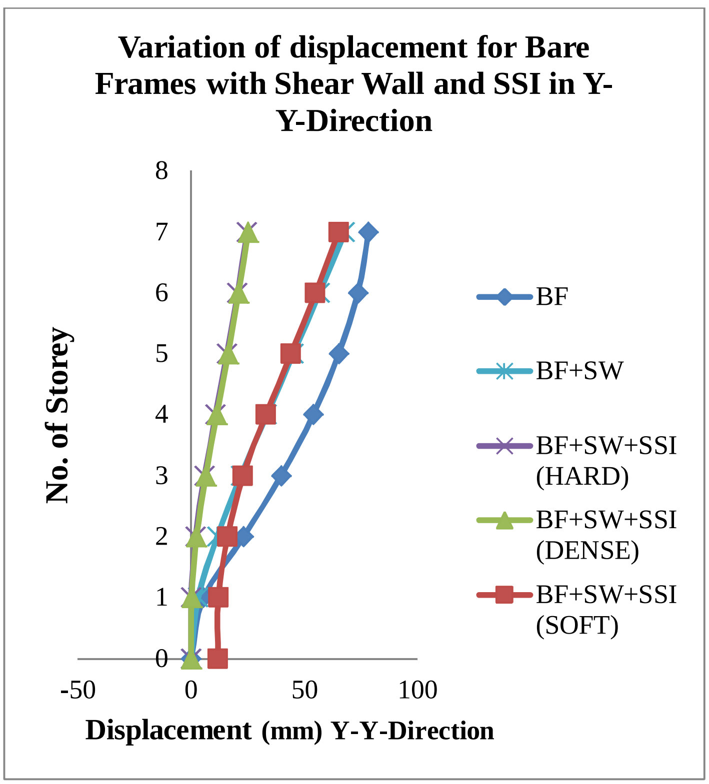


Figure-8 Variation of displacement for bare frames with shear wall and SSI in Y-Y-Direction

From Figure-8 it is observed that in top storey the displacement is reduced in bare frame with shear wall when compared with bare frame due to stiffness of shear wall. And displacement is more in bare frame with shear wall and SSI in soft soil when compared with dense and hard soil.

E. Stresses in Footings

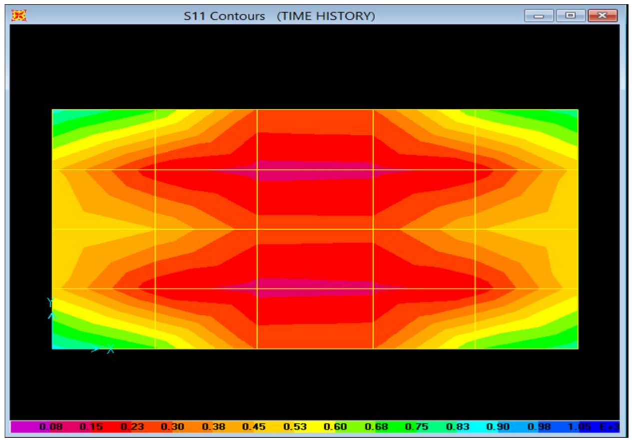


Figure-9 Element stress contours of raft footing in bare frame

From Figure-9 stresses in raft footing is less in center of footing and gradually increases towards corner. Stress is around 900kN/m^2 in the corners of the footing and decreases towards the centre of the footing

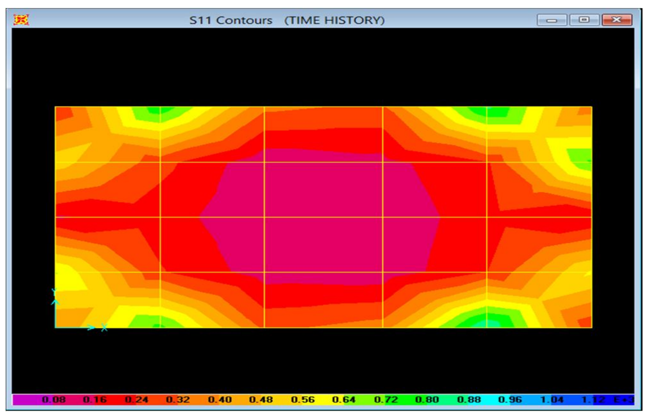


Figure-10 Element stress contours of raft footing in bare frame with SW

From Figure-10 stresses in raft footing is less in center of footing and gradually increases towards corner and stress is more than bare frame due to presence of shear wall. And from the above figure in the corner of shear wall stress is around 880kN/m^2 and decreases towards centre of the footing.

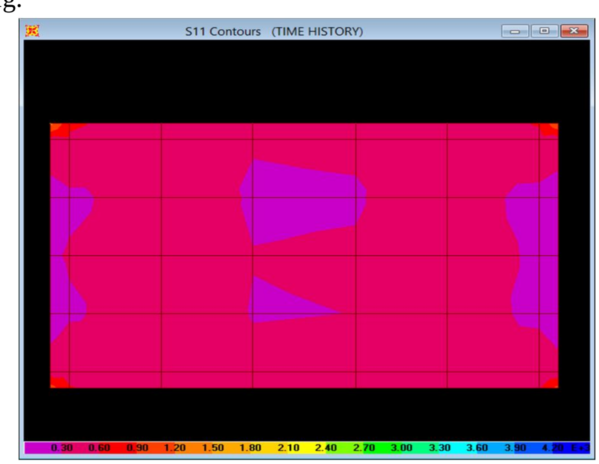


Figure-11 Element stress contours of raft footing in bare frame with SSI soft soil

From Figure-11 it is clear that in this model due to presence of soil the stress are maximum same in the footing and slightly increase in corners. In corners of the footing stress is around 1200 kN/m^2 when the soft soil is considered.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

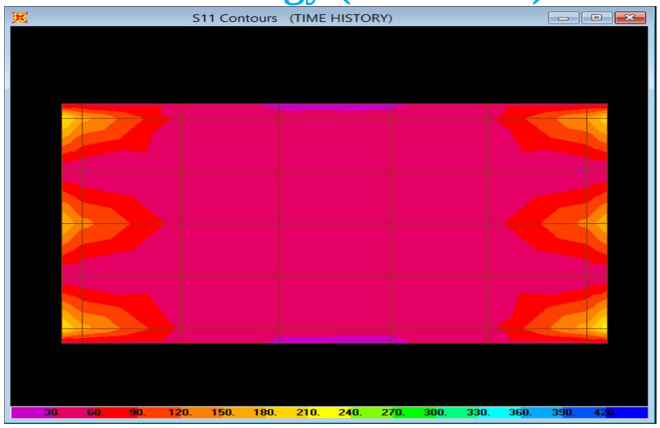


Figure-12 Element stress contours of raft footing in bare frame with SSI dense soil

From Figure-12 it is clear that in this model due to presence of soil the stress are maximum same in the footing and slightly increase in corners. In the corners of the footing stress is around 240kN/m^2 it is less than soft soil due to the stiffness of dense soil stresses is reduced than soft soil.

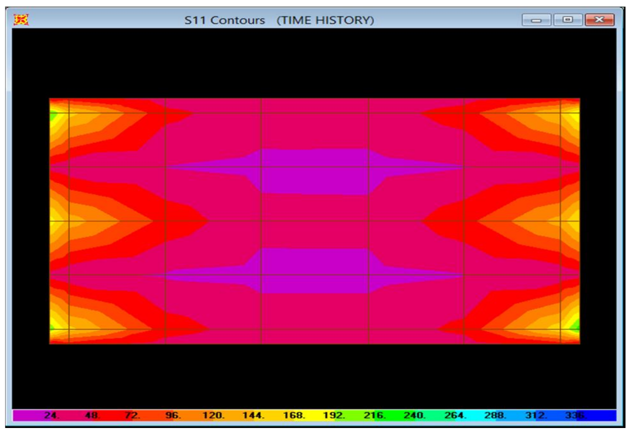


Figure-13 Element stress contours of raft footing in bare frame with SSI hard soil

From Figure-13 it is clear that in this model due to presence of soil the stress increases from centre to corner of the footing and slightly increase in corners. In the corners of the footing stress is around 216kN/m^2 it is less than dense and soft soil due to stiffness in hard soil.

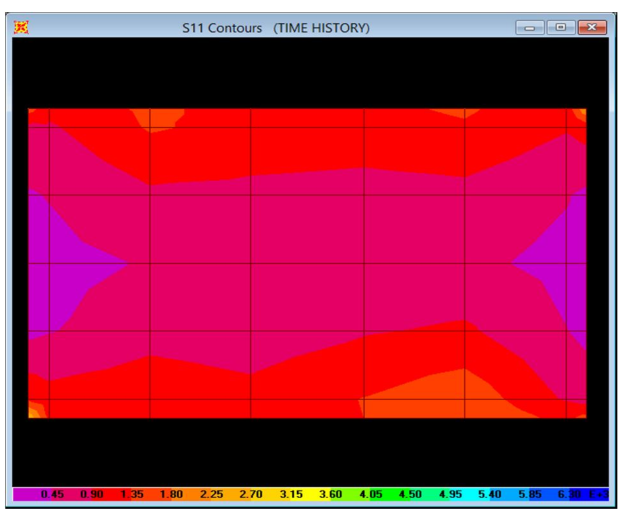


Figure-14 Element stress contours of raft footing in bare frame with SW and SSI soft soil

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653

From Figure-14 it is clear that in this model due to presence of soil and shear wall the stress are same in the centre of the footing and increase in sides of footing. In the corner of the footing stress is more about 2700 kN/m^2 and it is more than bare frame with SSI in soft soil due to presence of shear wall.

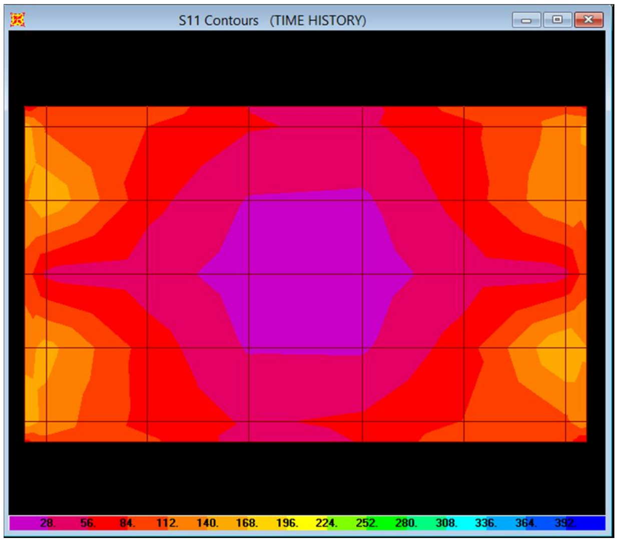


Figure-15 Element stress contours of raft footing in bare frame with SW and SSI dense soil

From Figure-15 it is clear that in this model due to presence of soil the stress are increased from centre to corner of the footing and slightly increase in corners. Due to stiffness of the dense soil stresses is reduced than soft soil.

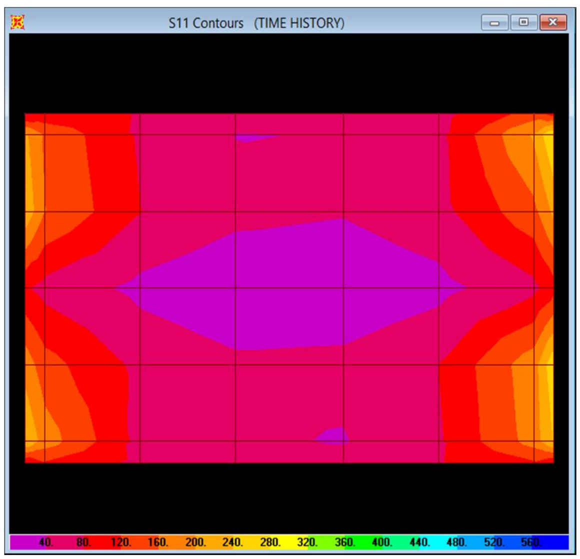


Figure-16 Element stress contours of raft footing in bare frame with SW and SSI hard soil

From Figure-16 it is clear that in this model due to presence of soil the stress increases from centre to corner of the footing and slightly increase in corners. Stress in the corner of the footing spreads less than dense soil due to stiffness of the hard soil.

VI. CONCLUSIONS

The important research findings emerged from the study, are summarized as follows:

A. The seismic forces cause compression/tensions in the footing and reversal in the nature of forces is found when direction of seismic forces is reversed. Interaction effect reduces this effect and provides more stability to the structure. Shear walls further add to the stability of the structure.

B. The interaction effect causes significant increase in time period in the soft soil.

C. The interaction effect significantly increases the value of displacement when soft soil is considered and reduces when shear wall is provided to the structure.

D. Base shear is more in dense soil because the mass of the soil and base shear is more in with shear wall structures when compared with bare frames.

E. Stresses in footings is more in when SSI is considered in soft soil due to less stiffness than hard and dense soil.

F. The interaction effect causes highly significant increase in values of displacements in the space frame-soil system as well as for space frame-shear wall-soil system. The highly increased values may require revision of design.

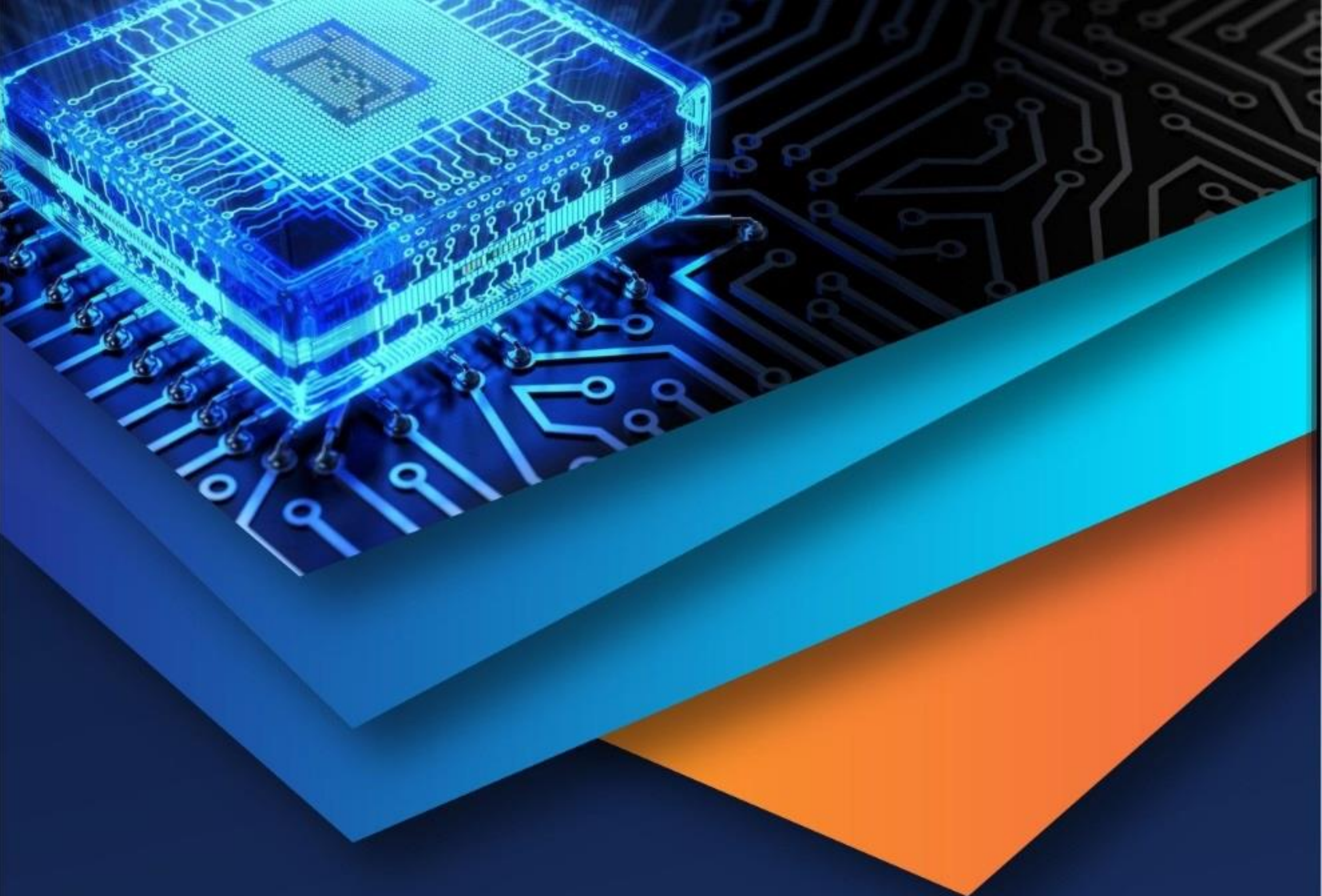
G. The proposed methodology can be effectively used to evaluate the displacements and forces in the superstructure and foundation for multi-story space frame-shear wall-soil system for better and efficient building design.

REFERENCES

[1] Varsha R. Harne (2014) "Comparative Study of Strength of RC Shear Wall at Different Location on Multi-storied Residential Building"
[2] Er. Puneet Sharma, Er. Ankit and Er. Ismit Pal Singh (2014) "Soil Structure Interaction Effect on an Asymmetrical R.C. Building with Shear Walls"
[3] B. R. Jayalekshmi and H. K. Chinmayi (2014) "Soil–Structure Interaction Effect on Seismic Force Evaluation of RC Framed Buildings with Various Shapes of Shear Wall: As Per IS 1893 and IBC"
[4] Chinmayi H. K. And Jayalekshmi B. R. (2014) "Soil-Structure Interaction Analysis of Reinforced Concrete Buildings with Various Shapes of Shear Wall – A Comparative Study of Various International Seismic Code Provisions"

STANDARD CODES

[1] 2006 International Building Code
[2] IS: 456-2000 - Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi.
[3] IS: 875 – 1987 - Code of Practice for Design Loads (other than Earthquake) for Buildings and Structures, Part 1: Dead Loads, Part 2: Imposed Loads, Part 5: Special Loads and Load Combinations, Bureau of Indian Standards, New Delhi.
[4] IS: 1893 (Part – 1) – 2002 - Code of Practice for Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings, Bureau of Indian Standards, New Delhi



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY