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Effect of Setbacks on Lateral Displacement in G+6 Multistorey Structure Using STAAD Pro

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Abstract: The multistorey structures/ buildings solve the population's living problems increasing daily. Many clients require more area for commercial purposes such as parties or other celebrations. Therefore, structures are designed with floating columns and setbacks. These elements generate the geometrical irregularity in the structures. Therefore, the present research work has determined the impact of setbacks on the lateral displacement of the structure. The A/L ratios of setbacks are 0.1, 0.125, 0.133, 0.167, 0.2 and 0.233 considered in the design and analysis of structure. The lateral displacement results of irregular structures (with setbacks) have been compared with regular structures (without setbacks) and provisions given in the code.

I. INTRODUCTION

A. General

A three-dimensional structure with multiple stories and vertical move mentutilizing stairsand lifts are known as a multistorey building. The multistorey building is generally designed to serve as a commercial mall, residential apartment, commercial apartment, hospital,etc. The construction speed of multistorey buildings is faster than other conventional buildings due to the high level of pre-fabrication material, accuracy in design, riskless construction, and best quality checks with the help of consulting agencies. Figure 1.1 shown below is a typical 3D multistoried building designed on software.

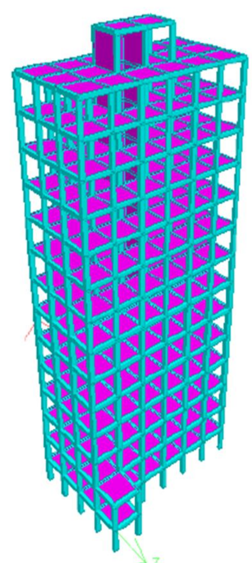

Fig. 1.1: 3D Model of Multistoried Building

B. Setbacks in Multistory Structures

When there is a need to change the terrace space at any level of the building, the structural geometry of the structure may be reduced within its original construction area. The setbacks are a geometrical part of the multistoried building used as the pathway on any floor to the super structure. The typical building having offset is provided when there is a requirement for a terrace garden, entertainment space, space for making temporary sheds, etc. Figure 1.2, shown below, illustrates a multistoried building having uniform setbacks at floor level 2.

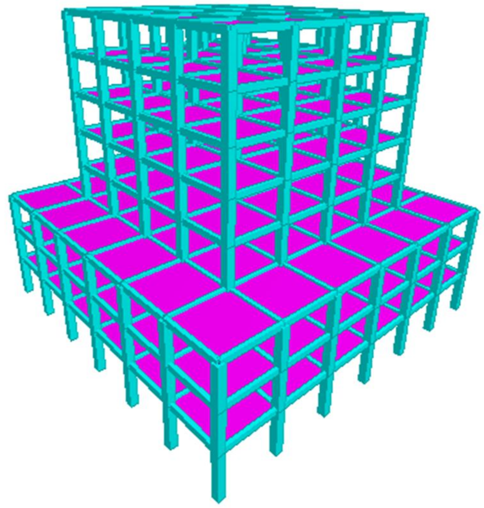

Fig. 1.2: Multistoried building having setbacks at floor level

C. Type of Setbacks/ Offsets

As per Indian standards, there is a criterion of providing setbacks in regular building configuration in clause 7.1. In this clause, the regular buildings suffer minor damage as compared to setbacks buildings since the following types define the main concept of effective setbacks:

1) Plan Setbacks
2) Vertical Setbacks

II. MODELLING AND ANALYSIS OF STRUCTURES

In the present research work, for determining the effect of setbacks, two types of G+6 storey structures having the length of 30m and 40m have been designed and analyzed using STAAD Pro. The structures are designed for aspect ratio (A/L) of 0.1, 0.125, 0.133, 0.167, 0.200, and 0.233. Six structures with setbacks at 1st, 2nd, 3rd, 4th, 5th, and 6th storey have been designed and analyzed for each A/L ratio, and displacement results have been obtained.

In addition, two bare frame G+6 storey structures have been developed and analyzed to map the comparison with structures having setbacks. However, the displacement of G+6 bare frame structures has been calculated using IS code 1893:2016 formula of 0.004*height of storey*number of the storey (i.e., 0.004*3500*7 = 98mm). Furthermore, the displacement obtained from IScodal formula, bare frame structure, and structures having setbacks has been compared. The comparison is mapped as –

1) Comparison of results of lateral displacement for Constant A/L ratio.
2) Comparison of results of lateral displacement for varying A/L ratio.

A. Structural Parameters

The following structural parameters have been used to design the G+6 storey structures with and without setbacks, as given in Table 2.1.

TABLE 2.1: STRUCTURAL PARAMETERS USED FOR DESIGN

Building configuration	G + 6
Building type	Residential building
Total plinth area	900 m^2
Height of each floor	3.5 m
Beam dimensions	500 mm x 300 mm

Column dimensions	600 mm x 600 mm
Slab thickness	130 mm
Support	Fixed
Concrete Grade	M40
Steel Grade	Fe 500

1) *Properties of Buildings*

TABLE 2.2: SITE PROPERTIES

Parameters	Values
External wall thickness	225mm
Internal wall thickness	125mm
Floor height	3.5m

2) *Size of Members*

TABLE 2.3: SIZE OF MEMBERS

Structural members	Values
Beams for all models	500 mm x 300 mm
Columns for all models	600 mm x 600 mm
Slab thickness	130 mm

3) *Loading on Structure*

TABLE 2.4: LOADING ON STRUCTURES

Loading Type	Values
Seismic loads	+X direction -X-direction +Z direction -Z direction
Dead loads Self-weight Floor finish load Waterproofing load External wall load Internal wall load Parapet wall load	 Program calculated as per model information 2.5 KN/m^2 0.408 KN/m^2 14.98 KN/m 8.33 KN/m 2.38 KN/m
Live loads For floors For roof	 3.25 KN/m^2 1.2 KN/m^2
Response spectrum load Combination method Subsoil class Damping	 CQC Medium soil 0.05

4) *Structures Developed in the Present Study*

The following structures are developed in the present study to study the effect of setbacks.

a) G+6 storey structure having the length of 30m and 40m without setbacks (model A1 and A2).

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b) G+6 storey structure having length of 30m with setbacks of different A/L ratio such as 0.1, 0.125, 0.133, 0.167, 0.200, and 0.233. The setbacks are provided at each storey for each ratio.
c) G+6 storey structure having length of 40m with setbackss of different A/L ratio such as 0.1, 0.125, 0.133, 0.167, 0.200, and 0.233.
d) For an A/L ratio of 0.1, the setbacks are provided at the first storey. Similarly, for an A/L ratio of 0.125, 0.133, 0.167, 0.200, and 0.233, the setbacks are provided at the 2nd, 3rd, 4th, 5th, and 6th storey. The model designations are given in Table 3.5 for 30m and 40m G+6 storey structures.

TABLE 2.5: MODEL DESIGNATION

L=30m			L=40m			A/L Ratio	Configuration
Case	A	L	Case	A	L		
A1	0m	30	A2	0m	40	0	Bare Frame
B11	3m	30	B21	4m	40	0.10	1 + 6
B12	3m	30	B22	4m	40	0.10	2 + 5
B13	3m	30	B23	4m	40	0.10	3 + 4
B14	3m	30	B24	4m	40	0.10	4 + 3
B15	3m	30	B25	4m	40	0.10	5 + 2
B16	3m	30	B26	4m	40	0.10	6 + 1
C11	3.75m	30	C21	5m	40	0.125	1 + 6
C12	3.75m	30	C22	5m	40	0.125	2 + 5
C13	3.75m	30	C23	5m	40	0.125	3 + 4
C14	3.75m	30	C24	5m	40	0.125	4 + 3
C15	3.75m	30	C25	5m	40	0.125	5 + 2
C16	3.75m	30	C26	5m	40	0.125	6 + 1
D11	4m	30	D21	5.32m	40	0.133	1 + 6
D12	4m	30	D22	5.32m	40	0.133	2 + 5
D13	4m	30	D23	5.32m	40	0.133	3 + 4
D14	4m	30	D24	5.32m	40	0.133	4 + 3
D15	4m	30	D25	5.32m	40	0.133	5 + 2
D16	4m	30	D26	5.32m	40	0.133	6 + 1
E11	5m	30	E21	6.64m	40	0.166	1 + 6
E12	5m	30	E22	6.64m	40	0.166	2 + 5
E13	5m	30	E23	6.64m	40	0.166	3 + 4
E14	5m	30	E24	6.64m	40	0.166	4 + 3
E15	5m	30	E25	6.64m	40	0.166	5 + 2
E16	5m	30	E26	6.64m	40	0.166	6 + 1
F11	6m	30	F21	8m	40	0.200	1 + 6
F12	6m	30	F22	8m	40	0.200	2 + 5
F13	6m	30	F23	8m	40	0.200	3 + 4
F14	6m	30	F24	8m	40	0.200	4 + 3
F15	6m	30	F25	8m	40	0.200	5 + 2
F16	6m	30	F26	8m	40	0.200	6 + 1
G11	7m	30	G21	9.32m	40	0.233	1 + 6
G12	7m	30	G22	9.32m	40	0.233	2 + 5
G13	7m	30	G23	9.32m	40	0.233	3 + 4
G14	7m	30	G24	9.32m	40	0.233	4 + 3
G15	7m	30	G25	9.32m	40	0.233	5 + 2
G16	7m	30	G26	9.32m	40	0.233	6 + 1

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B. Design And Analysis Of Models

1) Modeling of Structure with L=30 m Configurations

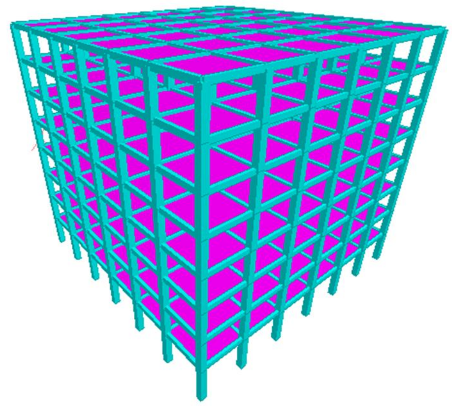

Fig.2.1: 3D view of possibility case A1 (A/L ratio = 0)

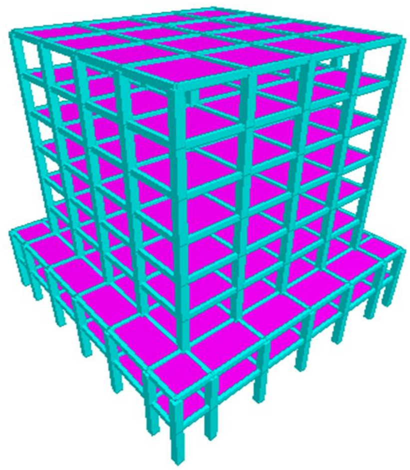

Fig. 2.2: 3D view of possibility case B11 (A/L ratio = 0.1)

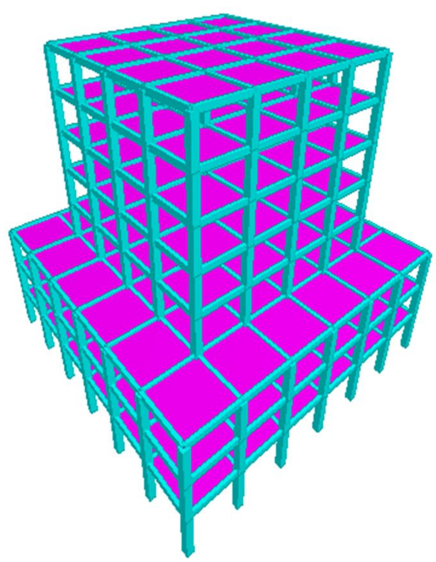

Fig. 2.3: 3D view of possibility case B12 (A/L ratio = 0.1)

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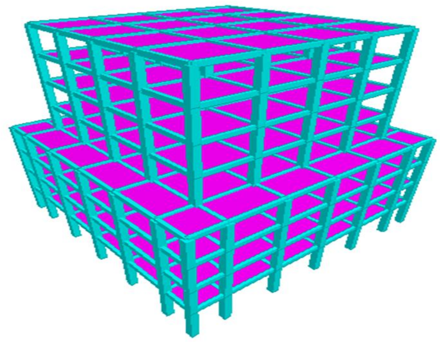

Fig. 2.4: 3D view of possibility case B13 (A/L ratio = 0.1)

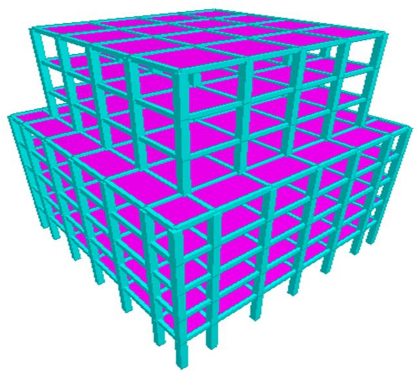

Fig. 2.5: 3D view of possibility case B14 (A/L ratio = 0.1)

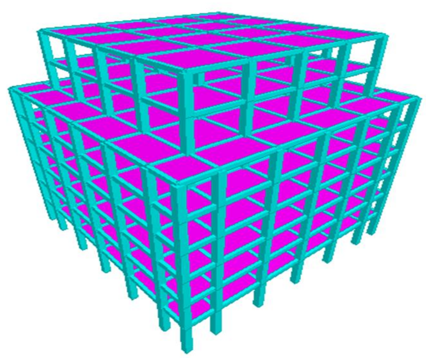

Fig. 2.6 3D view of possibility case B15 (A/L ratio = 0.1)

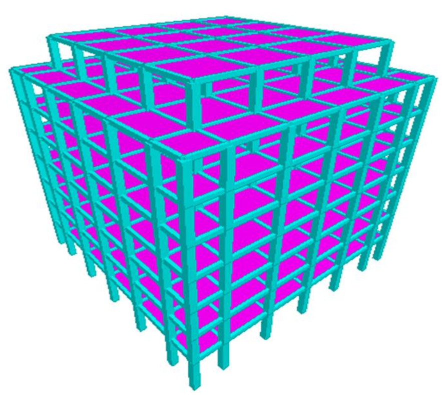

Fig 2.7: 3D view of possibility case B16 (A/L ratio = 0.1)

The same modelling is done for G+6 storey structure having A/L ratio of 0.125 (C11-C16), 0.133 (D11-D16), 0.167 (E11-E16), 0.2 (F11-F16), and 0.233 (G11-G16).

2) Modeling of Structure with L=40m Configurations

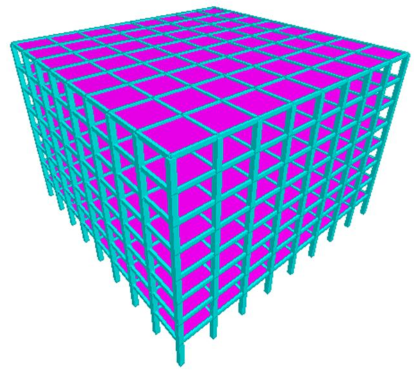

Fig. 2.8: 3D view of possibility case A2 (A/L ratio = 0)

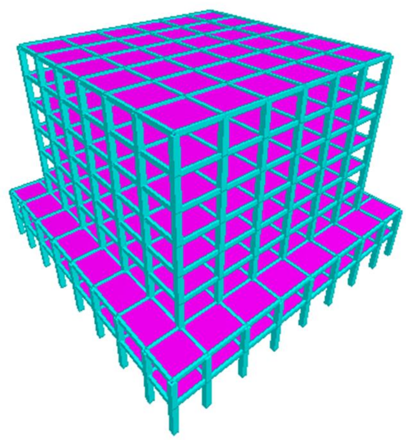

Fig 2.9: 3D view of possibility case B21 (A/L ratio = 0.1)

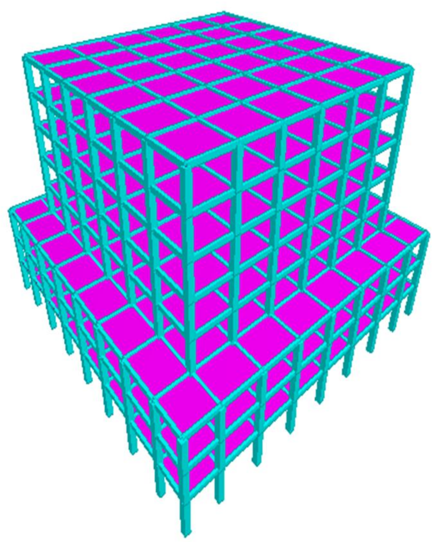

Fig. 2.10: 3D view of possibility case B22 (A/L ratio = 0.1)

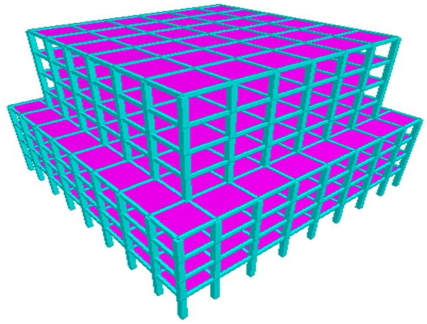

Fig. 2.11: 3D Front elevation view of possibility case B24 (A/L ratio = 0.1)

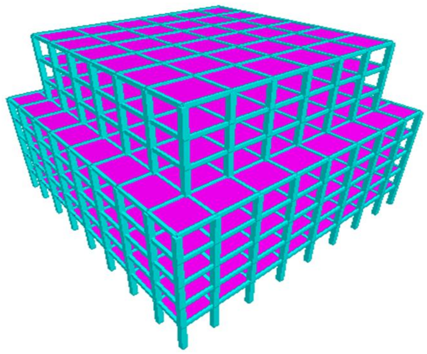

Fig. 2.12: 3D view of possibility case B24 (A/L ratio = 0.1)

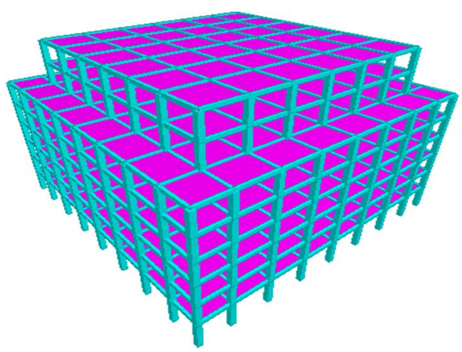

Fig. 2.13: 3D view of possibility case B25 (A/L ratio = 0.1)

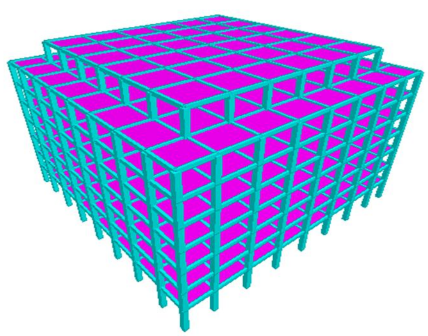

Fig. 2.14: 3D view of possibility case B26 (A/L ratio = 0.1)

The same modelling is done for G+6 storey structure having A/L ratio of 0.125 (C21-C26), 0.133 (D21-D26), 0.167 (E21-E26), 0.2 (F21-F26), and 0.233 (G21-G26).

III. RESULTS AND DISCUSSION

A. General

In the present research work, the effect of setbacks has been determined for G+6 storey structures having the length of 30m and 40m. This chapter is divided into two parts

Case A – Regular G+6 storey structure with no offset.

Cases B to G – Irregular G+6 storey structure having A/L ratio of 0.1 (Case B), 0.125 (Case C), 0.133 (Case D), 0.167 (Case E), 0.2 (Case F), and 0.233 (Case G) for each L=30m and L=40m.

TABLE 3.1 – CONFIGURATION AND POSSIBLE CASES FOR EACH A/L RATIO

Case	A/L	For L=30m	For L=40m	Configurations
B	0.1	B11	B21	1+6
		B12	B22	2+5
		B13	B23	3+4
		B14	B24	4+3
		B15	B25	5+2
		B16	B26	6+1

Table 3.1 illustrates that the setbacks have been generated from bottom to top storey. In B11 and B21, the setbacks have been generated at the first storey. In addition, B12/B22, B13/B23, B14/B24, B15/B25, and B16/B26 show that setbacks have been generated at the second, third, fourth, fifth, and sixth storey in the G+6 storey structure. The same cases have been developed for A/L ratios of 0.125, 0.133, 0.167, 0.2, and 0.233 for each L=30m and L=40m. The effect of setbacks has been determined in lateral displacement for each case and discussed below.

B. Results of Lateral Displacement

The results of lateral displacement of G+6 storey structure having L=30m and L=40m and their cases have been discussed (Refer to Annexure – I).

1) Results of Lateral Displacement for G+6 Storey Structure of L=30m

Six conditions have been developed in this research work by creating setbacks for each A/L ratio. Thus, thirty-six models have been developed and analyzed for the G+6 storey structure of L=30m. The results of lateral displacement of analyzed models have been discussed below.

a) Results of Lateral Displacement for Case B (L=30m)

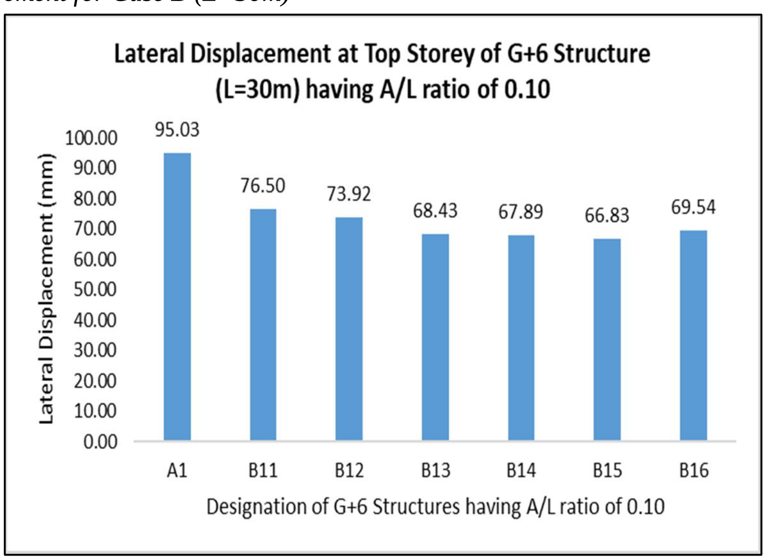

Fig. 3.1. Lateral displacement at the top storey of G+6 storey structure (L=30m) case B

Fig. 3.1 shows the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.10.

b) Results of Lateral Displacement for Case C (L=30m)

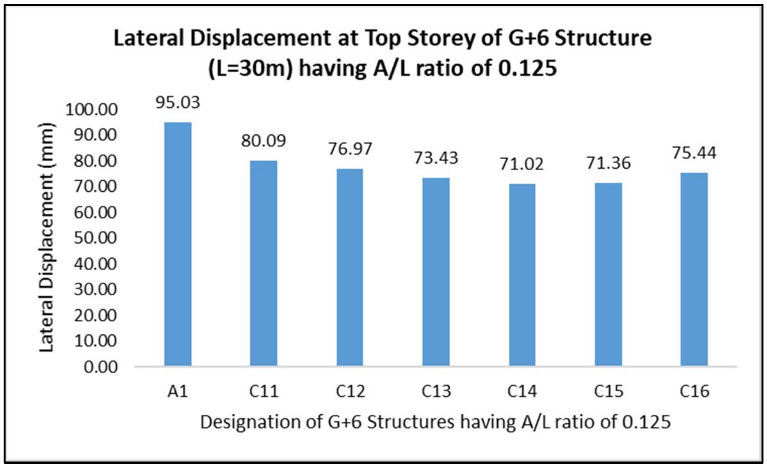

Fig. 3.2. Lateral displacement at the top storey of G+6 storey structure (L=30m) case C

Fig. 3.2 illustrates the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.125.

c) Results of Lateral Displacement for Case D (L=30m)

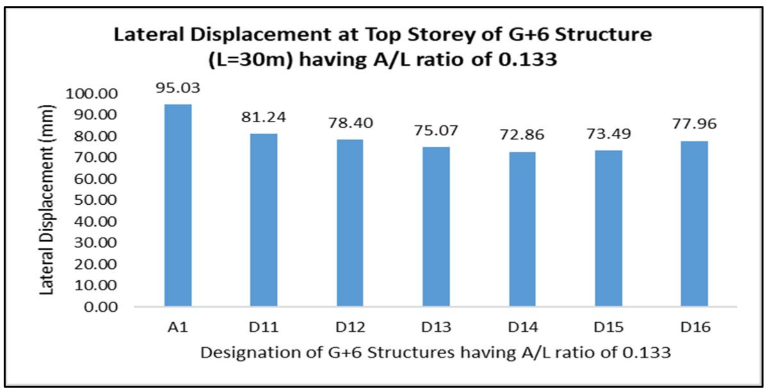

Fig. 3.3. Lateral displacement at the top storey of G+6 storey structure (L=30m) case D

Fig. 3.3 depicts the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.133

d) Results of Lateral Displacement for Case E (L=30m)

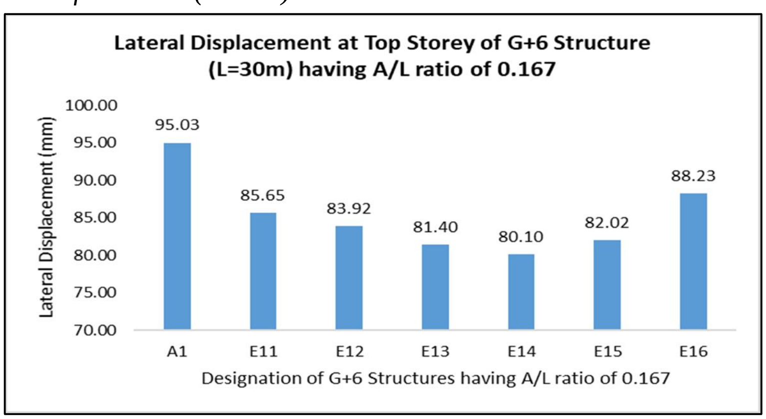

Fig. 3.4. Lateral displacement at the top storey of G+6 storey structure (L=30m) case E

Fig. 3.4 illustrates the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.167.

e) Results of Lateral Displacement for Case F (L=30m)

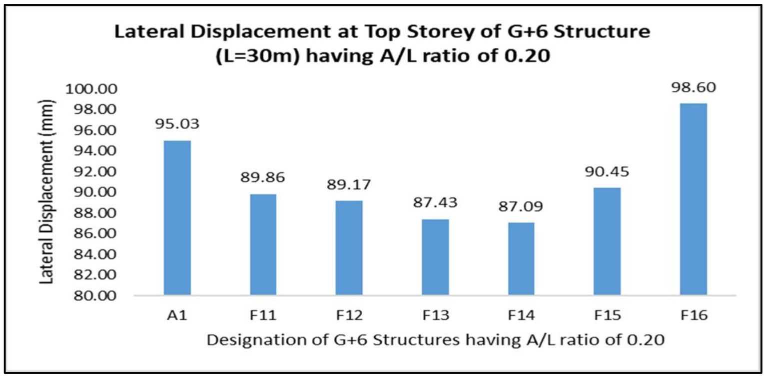

Fig. 3.5. Lateral displacement at the top storey of G+6 storey structure (L=30m) case F

Fig. 3.5 depicts the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.20

f) Results of Lateral Displacement for Case G (L=30m)

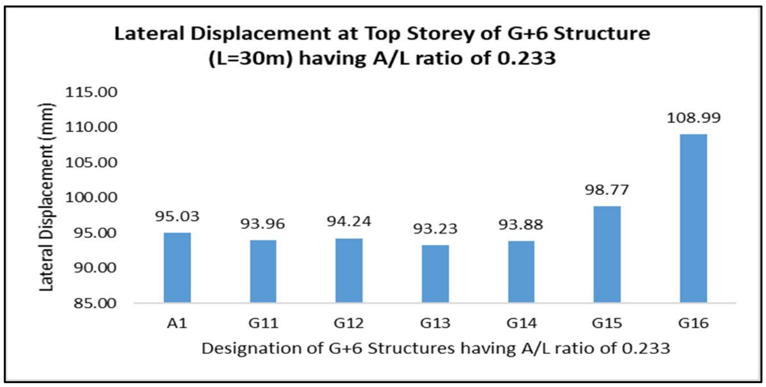

Fig. 3.6. Lateral displacement at the top storey of G+6 storey structure (L=30m) case G

Fig. 3.6 depicts the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.233.

2) Results of Lateral Displacement for G+6 Storey Structure of L=40m

Six conditions have been developed in this research work by generating setbacks for each A/L ratio. Thus, thirty-six models have been developed and analyzed for the G+6 storey structure of L=40m. The results of lateral displacement of analyzed models have been discussed below.

a) Results of Lateral Displacement for Case B (L=40m)

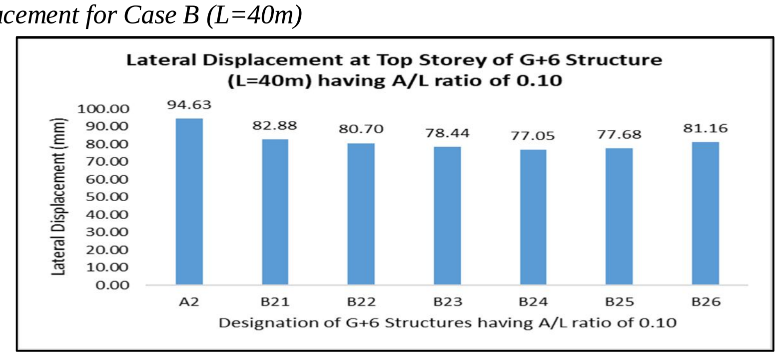

Fig. 3.7. Lateral displacement at the top storey of G+6 storey structure (L=40m) case B

Fig. 3.7 illustrates the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.10.

b) Results of Lateral Displacement for Case C (L=40m)

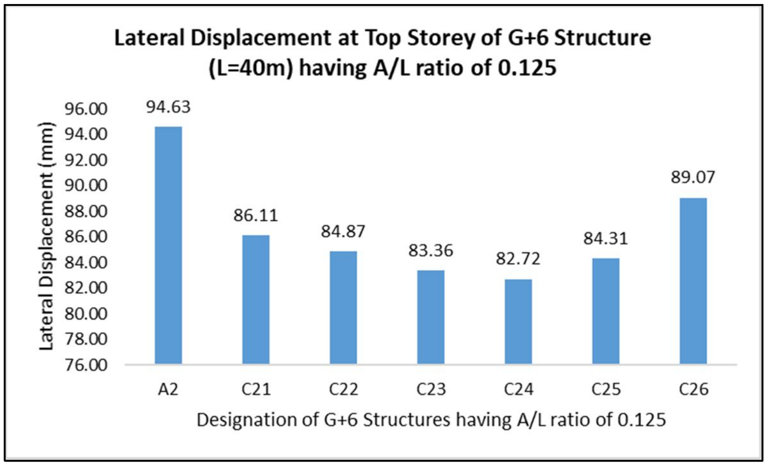

Fig. 3.8. Lateral displacement at the top storey of G+6 storey structure (L=40m) case C

Fig. 3.8 depicts the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.125.

c) Results of Lateral Displacement for Case D (L=40m)

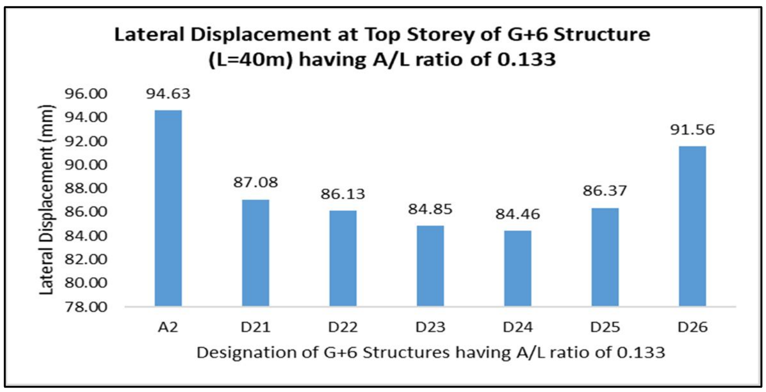

Fig. 3.9. Lateral displacement at the top storey of G+6 storey structure (L=40m) case D

Fig. 3.9 demonstrates the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.133.

d) Results of Lateral Displacement for Case E (L=40m)

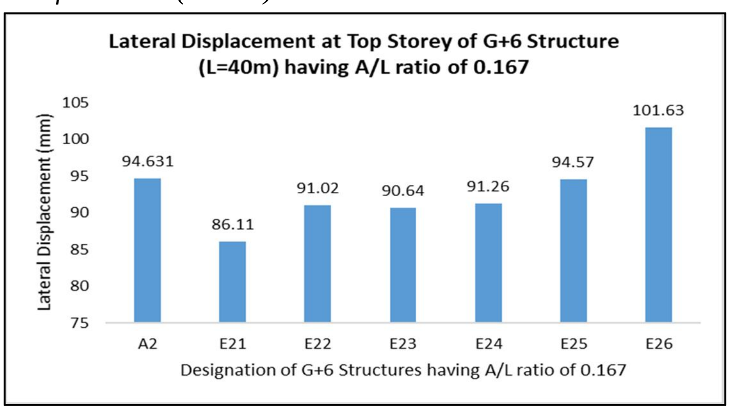

Fig. 3.10. Lateral displacement at the top storey of G+6 storey structure (L=40m) case E

Fig. 3.10 depicts the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.167.

e) Results of Lateral Displacement for Case F (L=40m)

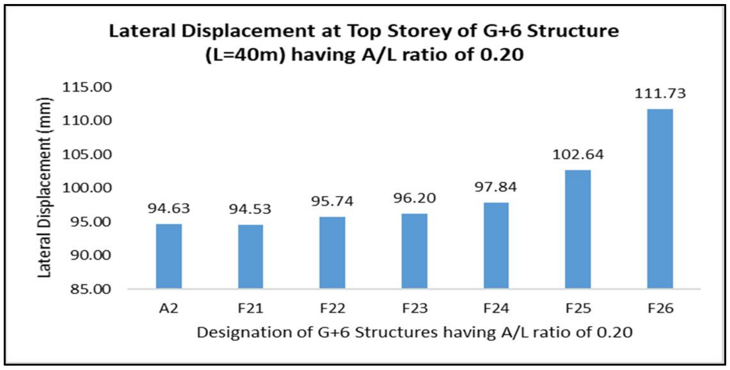

Fig. 3.11. Lateral displacement at the top storey of G+6 storey structure (L=40m) case F

Fig. 3.11 shows the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.20.

f) Results of Lateral Displacement for Case G (L=40m)

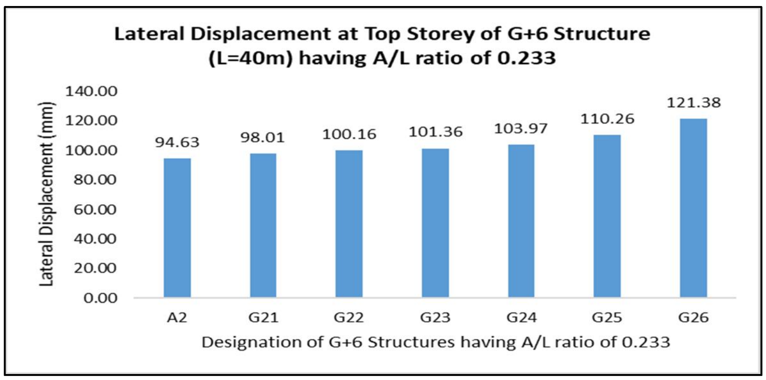

Fig. 3.12. Lateral displacement at the top storey of G+6 storey structure (L=40m) case G

Fig. 3.12 depicts the lateral displacement at the top storey of a G+6 structure with an A/L ratio of 0.233.

C. Comparison of Results of Lateral Displacement

The comparison of results of lateral displacement has been mapped for the G+6 storey structure of L=30m and L=40m.

1) Comparison of Results of Lateral Displacement for constant A/L ratio (L=30m)

Based on the constant A/L ratio, the lateral displacement of the G+6 storey structure of L=30m has been discussed separately.

a) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.1 (L=30m)

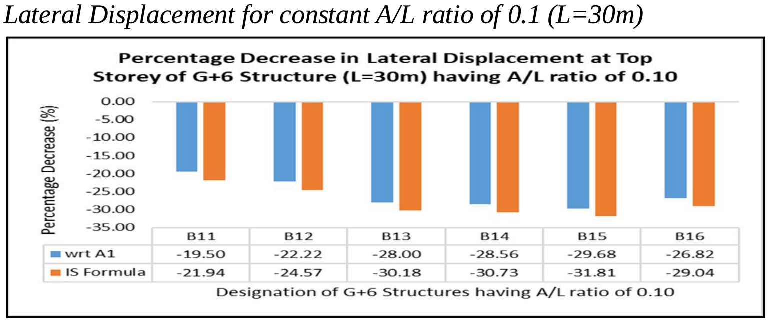

Fig. 3.13 Comparison of results of lateral displacement for A/L ratio of 0.1

Fig. 3.13 depicts the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.1.

b) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.125 (L=30m)

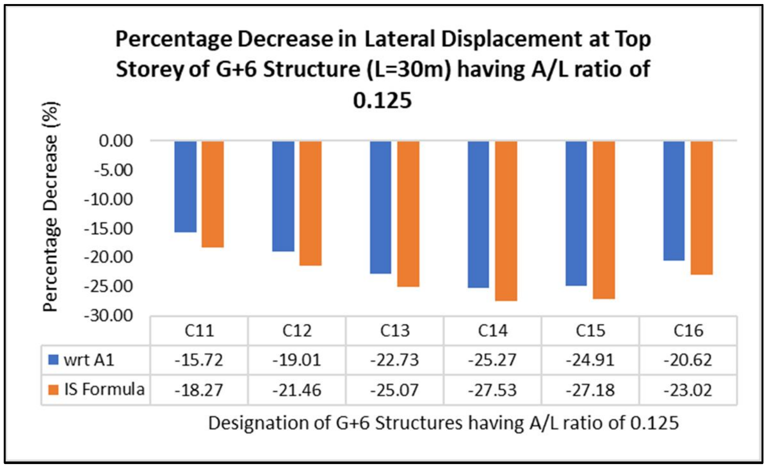

Fig. 3.14 Comparison of results of lateral displacement for A/L ratio of 0.125

Fig. 3.14 shows the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.125.

c) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.133 (L=30m)

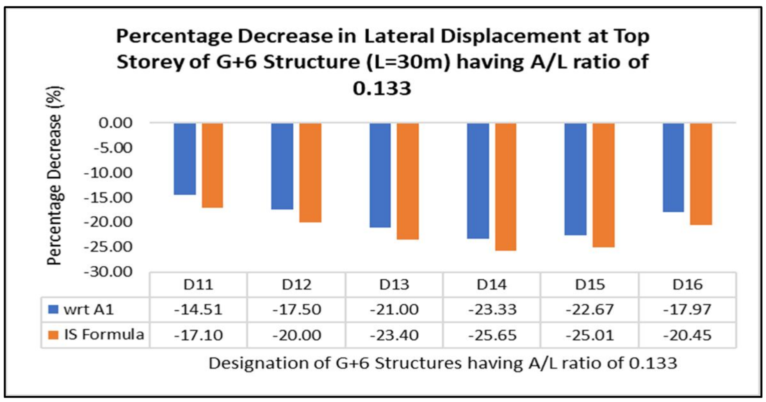

Fig. 3.15 Comparison of results of lateral displacement for A/L ratio of 0.133

Fig. 3.15 depicts the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.133.

d) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.167 (L=30m)

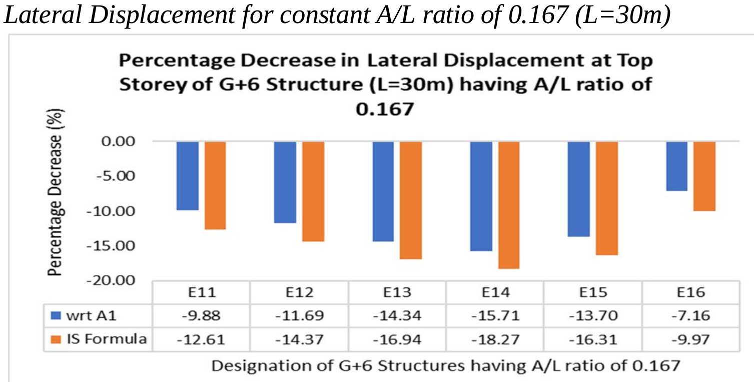

Fig. 3.16 Comparison of results of lateral displacement for A/L ratio of 0.167

Fig. 3.16 illustrates the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.167.

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Volume 11 Issue X Oct 2023- Available at www.ijraset.com

e) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.200 (L=30m)

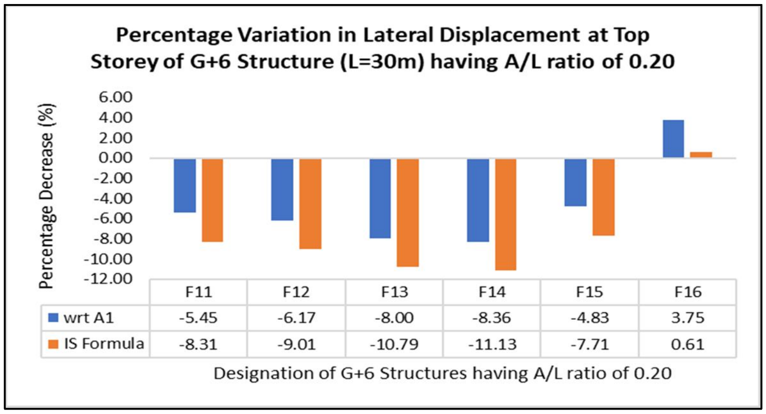

Fig. 3.17 Comparison of results of lateral displacement for A/L ratio of 0.200

Fig. 3.17 demonstrates the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.200.

f) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.233 (L=30m)

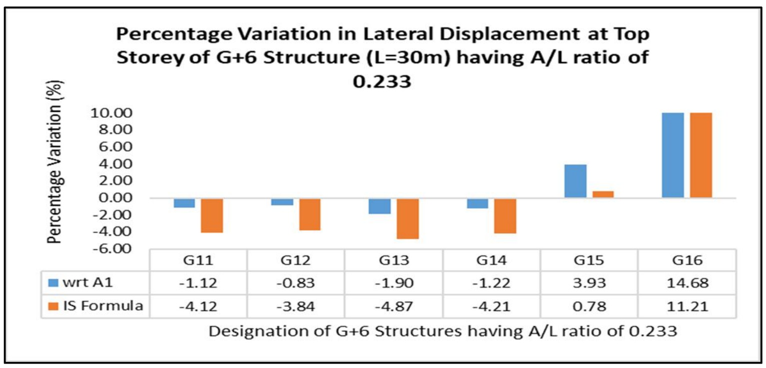

Fig. 3.18 Comparison of results of lateral displacement for A/L ratio of 0.233

Fig. 3.18 shows the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.233.

2) Comparison of Results of Lateral Displacement for constant A/L ratio (L=40m)

Based on the constant A/L ratio, the lateral displacement of the G+6 storey structure of L=40m has been discussed separately.

a) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.1 (L=40m)

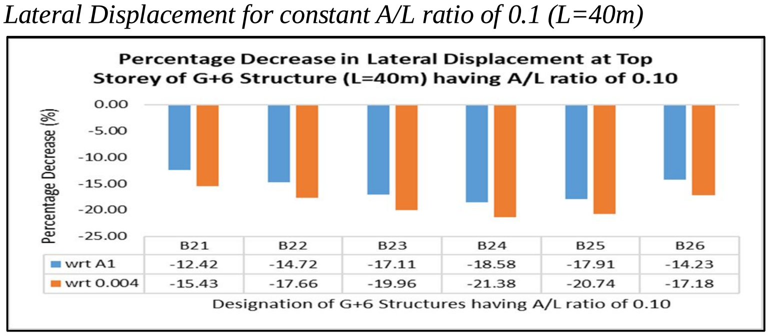

Fig. 3.19 Comparison of results of lateral displacement for A/L ratio of 0.1

Fig. 3.19 demonstrates the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.1.

b) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.125 (L=40m)

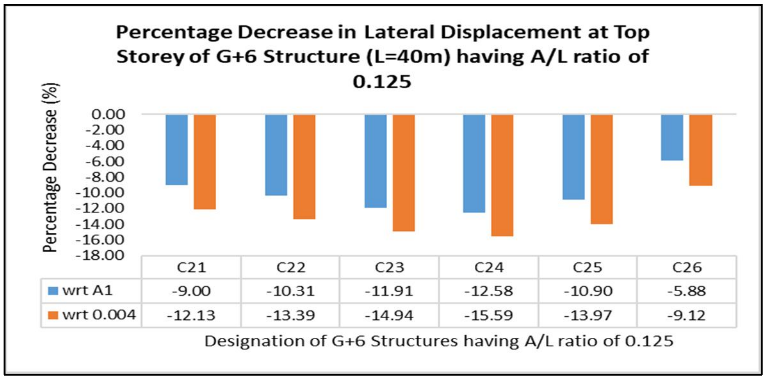

Fig. 3.20 Comparison of results of lateral displacement for A/L ratio of 0.125

Fig. 3.20 illustrates the percentage decrease in lateral displacement at the top storey structure (L=40m), having an A/L ratio of 0.125.

c) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.133 (L=40m)

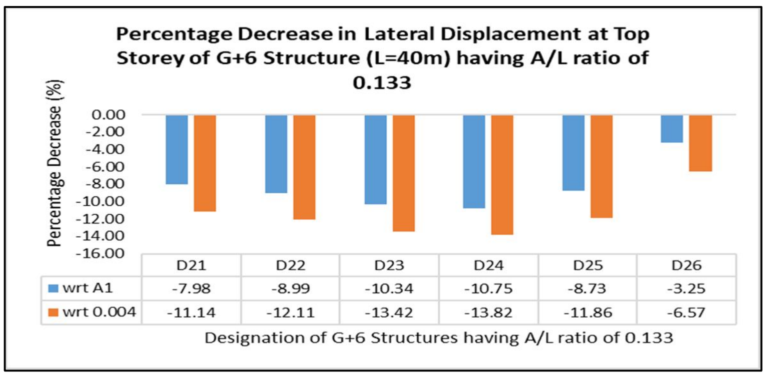

Fig. 3.21 Comparison of results of lateral displacement for A/L ratio of 0.133

Fig. 3.21 represents the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.133.

d) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.167 (L=40m)

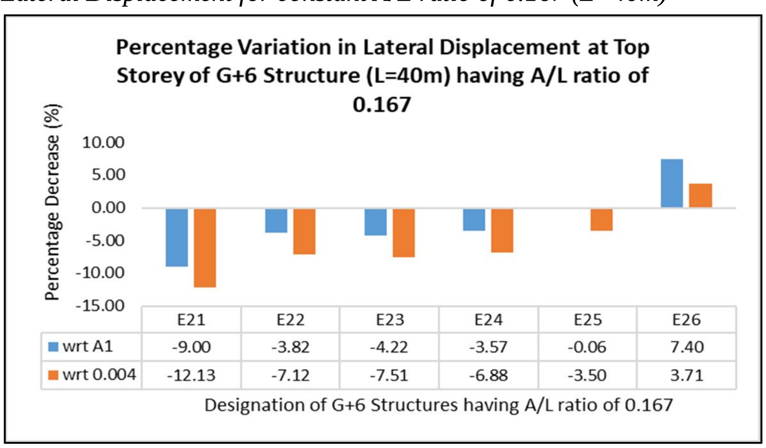

Fig. 3.22 Comparison of results of lateral displacement for A/L ratio of 0.167

Fig. 3.22 presents the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.167.

e) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.200 (L=40m)

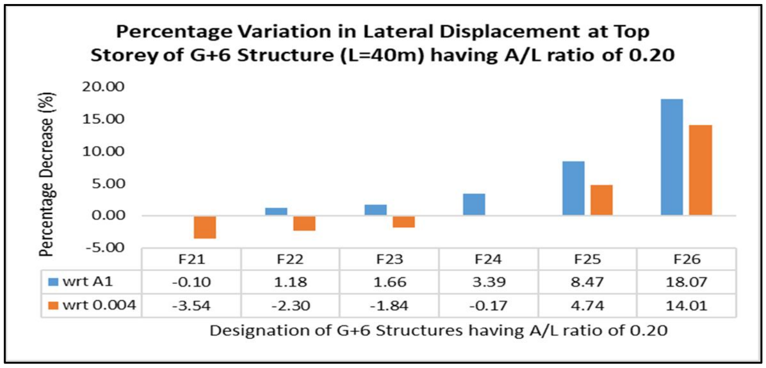

Fig. 3.23 Comparison of results of lateral displacement for A/L ratio of 0.200

Fig. 3.23 depicts the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.200.

f) Comparison of Results of Lateral Displacement for constant A/L ratio of 0.233 (L=40m)

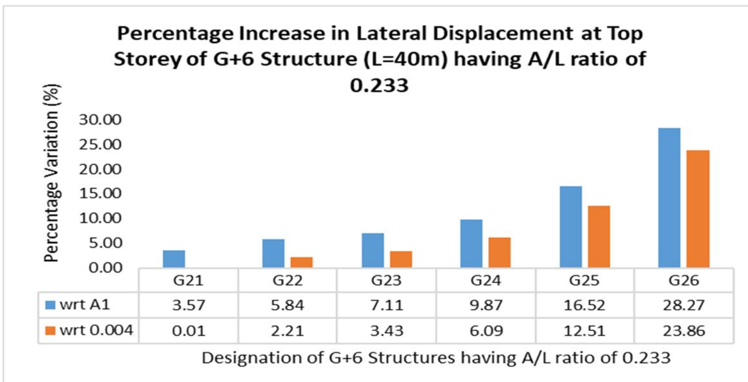

Fig. 3.24 Comparison of results of lateral displacement for A/L ratio of 0.233

Fig. 3.24 illustrates the percentage decrease in lateral displacement at the top storey structure (L=30m), having an A/L ratio of 0.233.

1) Comparison of Results of Lateral Displacement for Varying A/L ratio (L=30m)

Based on the varying A/L ratio, the lateral displacement of the G+6 storey structure of L=30m has been discussed separately.

a) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.1 (L=30m)

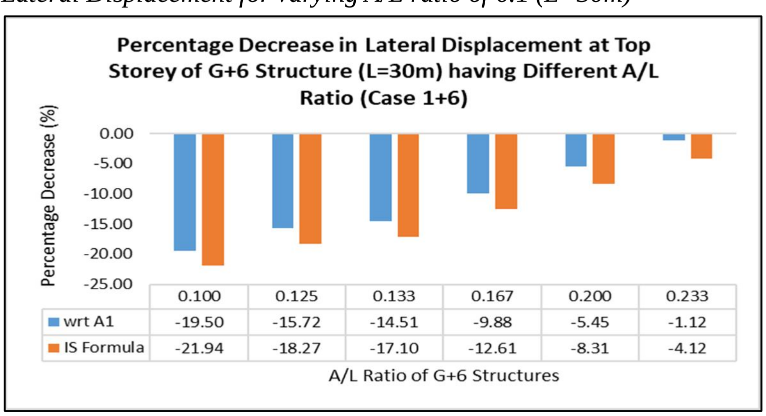

Fig. 3.25 Comparison of results of lateral displacement for varying A/L ratio (case 1+6, L=30m)

Fig. 3.25 shows the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=30m), having varying A/L ratios (case 1+6).

b) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.125 (L=30m)

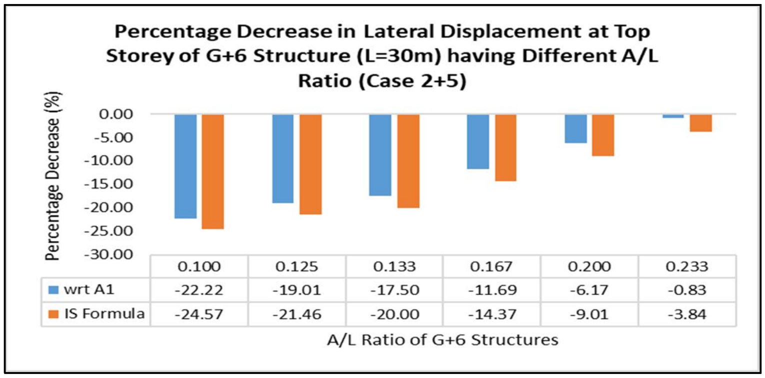

Fig. 3.26 Comparison of results of lateral displacement for varying A/L ratio (case 2+5, L=30m)

Fig. 3.26 illustrates the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=30m), having varying A/L ratios.

c) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.133 (L=30m)

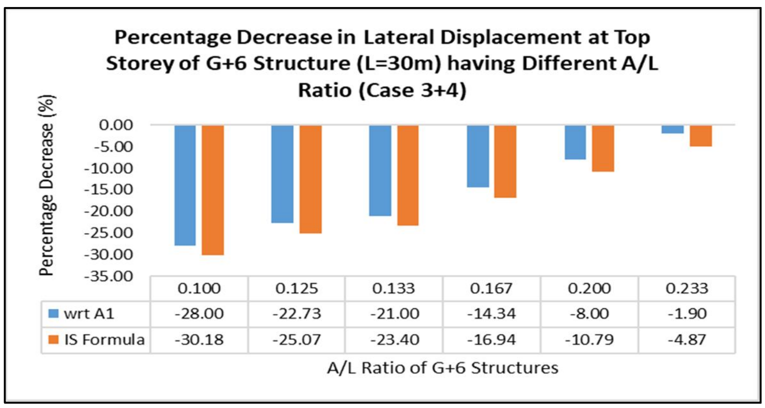

Fig. 3.27 Comparison of results of lateral displacement for varying A/L ratio (case 3+4, L=30m)

Fig. 3.27 shows the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=30m), having varying A/L ratios.

d) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.167 (L=30m)

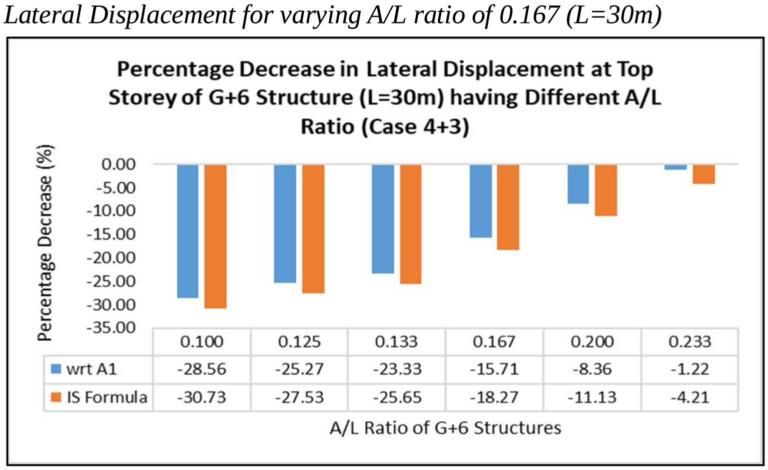

Fig. 3.28 Comparison of results of lateral displacement for varying A/L ratio (case 4+3, L=30m)

Fig. 3.28 presents the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=30m), having varying A/L ratios.

e) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.200 (L=30m)

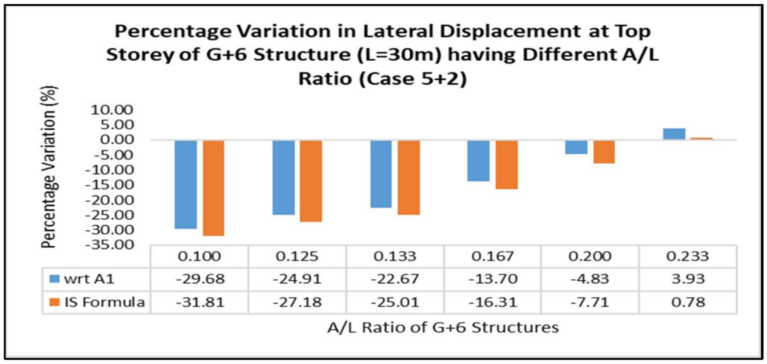

Fig. 3.29 Comparison of results of lateral displacement for varying A/L ratio (case 5+2, L=30m)

Fig. 3.29 presents the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=30m), having varying A/L ratios.

f) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.233 (L=30m)

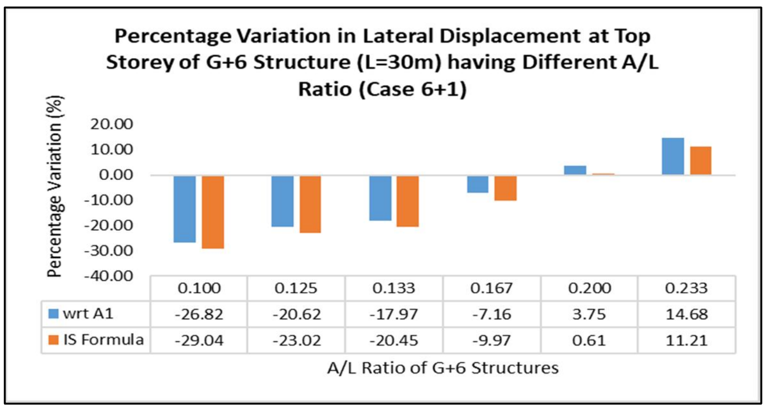

Fig. 3.30 Comparison of results of lateral displacement for varying A/L ratio (case 6+1, L=30m)

Fig. 3.30 shows the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=30m), having varying A/L ratios.

2) Comparison of Results of Lateral Displacement for Varying A/L ratio (L=40m)

Based on the varying A/L ratio, the lateral displacement of the G+6 storey structure of L=40m has been discussed separately.

a) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.1 (L=40m)

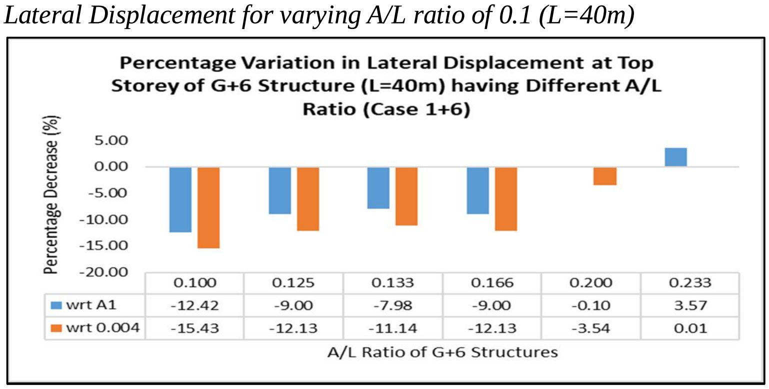

Fig. 3.31 Comparison of results of lateral displacement for varying A/L ratio (case 1+6, L=40m)

Fig. 3.31 shows the percentage variation in lateral displacement at the top storey of the G+6 structure (L=40m), having varying A/L ratios (case 1+6).

b) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.125 (L=40m)

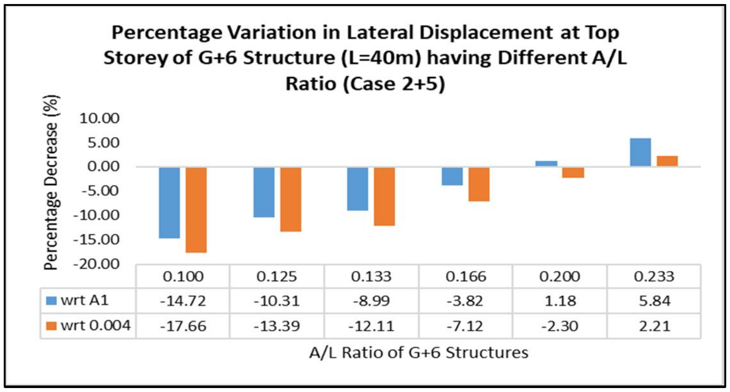

Fig. 3.32 Comparison of results of lateral displacement for varying A/L ratio (case 2+5, L=40m)

Fig. 3.32 illustrates the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=40m), having varying A/L ratios.

c) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.133 (L=40m)

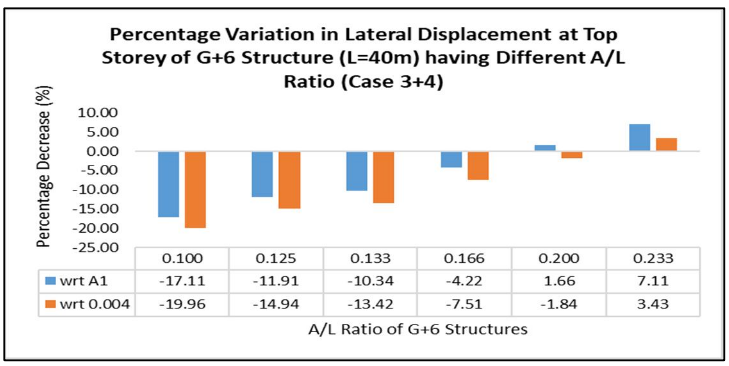

Fig. 3.33 Comparison of results of lateral displacement for varying A/L ratio(case 3+4, L=40m)

Fig. 3.33 depicts the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=40m), having varying A/L ratios.

d) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.167 (L=40m)

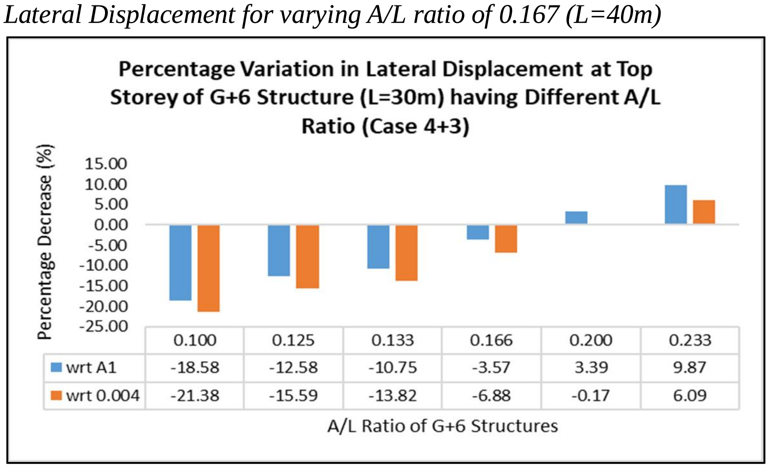

Fig. 3.34 Comparison of results of lateral displacement for varying A/L ratio (case 4+3, L=40m)

Fig. 3.34 presents the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=40m), having varying A/L ratios

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e) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.200 (L=40m)

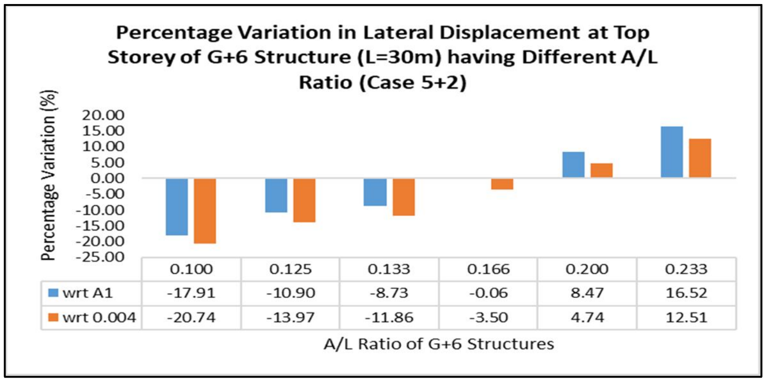

Fig. 3.35 Comparison of results of lateral displacement for varying A/L ratio (case 5+2, L=40m)

Fig. 3.35 depicts the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=40m), having varying A/L ratios.

f) Comparison of Results of Lateral Displacement for varying A/L ratio of 0.233 (L=40m)

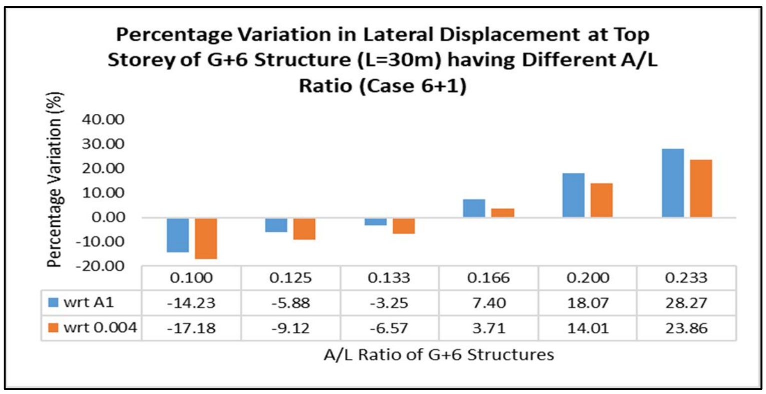

Fig. 3.36 Comparison of results of lateral displacement for varying A/L ratio (case 6+1, L=40m)

Fig. 3.36 shows the percentage decrease in lateral displacement at the top storey of the G+6 structure (L=40m), having varying A/L ratios.

IV. CONCLUSIONS

The following conclusions are mapped from the comparative study of lateral displacement results.

1) The lateral displacement results of the G+6 storey structure having an A/L ratio of 0.1 to 0.167 (L=30m) show that the lateral displacement increases if the setbacks are provided up to the fifth and sixth storey. These kinds of structures are having lateral displacements within permissible limits as per IS code and hence, safe. Furthermore, the G+6 storey structure having an A/L ratio of 0.2 and 0.233 (L=30m) achieves more lateral displacement than the regular structure and the Indian standards, which makes the structure unsafe. G+6 storey structures having an A/L ratio of 0.2 and 0.233 are unsafe if the setbacks are provided at the sixth and fifth storey, respectively.
2) On the other hand, lateral displacement results of the G+6 storey structure having an A/L ratio of 0.1 to 0.133 (L=40m) show that the lateral displacement increases if the setbacks are provided up to the fifth and sixth storey. These kinds of structures are having lateral displacement within permissible limits as per IS code and hence, safe. Furthermore, the G+6 storey structure with an A/L ratio of 0.2 and 0.233 (L=40m) achieves more lateral displacement than the regular structure and the Indian standards, representing the structure as unsafe. The G+6 storey structure having an A/L ratio of 0.233 is identified as a critical structure because the lateral displacement is found more than regular structure and codal provisions, i.e., 98.01mm (case 1+6), 100.16mm (case 2+5), 101.36mm (case 3+4), 103.97mm (case 4+3), 110.26mm (case 5+2), 121.38mm (case 6+1).

3) The comparison of G+6 storey structure having L=30m and L=40m shows that if the length of the structure increases, the A/L ratio decreases for safe design and structure. In other words, the G+6 storey structure (L=30m) is safe for A/L ratios of 0.1, 0.125, 0.133, and 0.167, but the G+6 storey structure (L=40m) is only safe for A/L ratios of 0.1, 0.125, and 0.133.
4) The comparison of results of lateral displacement for G+6 storey structure with varying A/L ratios shows that lateral displacement increases with A/L ratio in both L=30 and L=40m structures.
5) Finally, the present study has concluded that the A/L ratio of setbacks affects the lateral displacement of the structure. The G+6 storey structure having an A/L ratio of less than 0.167 (for L=30m) and 0.133 (for L=40m) are safe as per the Indian provisions and may be constructed.

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ANNEXURE

Results of Lateral Displacement for G+6 Storey Structure (L=30m)

L=30m			A/L Ratio	Configuration	Lateral Displacement (mm)
Case	A	L			
A1	0m	30	0	Bare Frame	95.03
B11	3m	30	0.10	1 + 6	76.50
B12	3m	30	0.10	2 + 5	73.92
B13	3m	30	0.10	3 + 4	68.43
B14	3m	30	0.10	4 + 3	67.89
B15	3m	30	0.10	5 + 2	66.83
B16	3m	30	0.10	6 + 1	69.54
C11	3.75m	30	0.125	1 + 6	80.09

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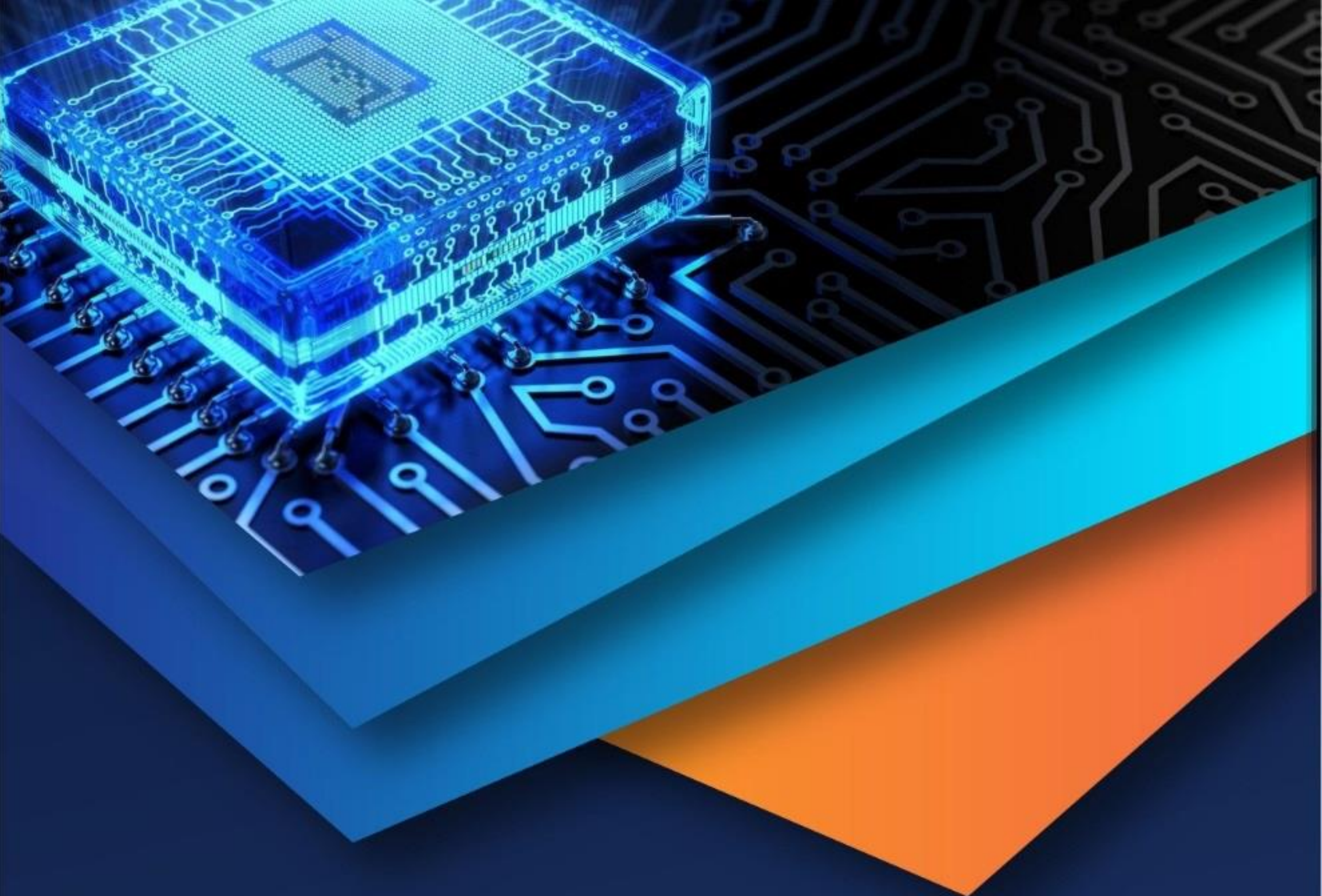
C12	3.75m	30	0.125	2 + 5	76.97
C13	3.75m	30	0.125	3 + 4	73.43
C14	3.75m	30	0.125	4 + 3	71.02
C15	3.75m	30	0.125	5 + 2	71.36
C16	3.75m	30	0.125	6 + 1	75.44
D11	4m	30	0.133	1 + 6	81.24
D12	4m	30	0.133	2 + 5	78.40
D13	4m	30	0.133	3 + 4	75.07
D14	4m	30	0.133	4 + 3	72.86
D15	4m	30	0.133	5 + 2	73.49
D16	4m	30	0.133	6 + 1	77.96
E11	5m	30	0.166	1 + 6	85.65
E12	5m	30	0.166	2 + 5	83.92
E13	5m	30	0.166	3 + 4	81.40
E14	5m	30	0.166	4 + 3	80.10
E15	5m	30	0.166	5 + 2	82.02
E16	5m	30	0.166	6 + 1	88.23
F11	6m	30	0.200	1 + 6	89.86
F12	6m	30	0.200	2 + 5	89.17
F13	6m	30	0.200	3 + 4	87.43
F14	6m	30	0.200	4 + 3	87.09
F15	6m	30	0.200	5 + 2	90.45
F16	6m	30	0.200	6 + 1	98.60
G11	7m	30	0.233	1 + 6	93.96
G12	7m	30	0.233	2 + 5	94.24
G13	7m	30	0.233	3 + 4	93.23
G14	7m	30	0.233	4 + 3	93.88
G15	7m	30	0.233	5 + 2	98.77
G16	7m	30	0.233	6 + 1	108.99

Results of Lateral Displacement for G+6 Storey Structure (L=40m)

L=40m			A/L Ratio	Configuration	Lateral Displacement (mm)
Case	A	L			
A2	0m	40	0	Bare Frame	94.63
B21	4m	40	0.10	1 + 6	82.88
B22	4m	40	0.10	2 + 5	80.70
B23	4m	40	0.10	3 + 4	78.44
B24	4m	40	0.10	4 + 3	77.05
B25	4m	40	0.10	5 + 2	77.68
B26	4m	40	0.10	6 + 1	81.16
C21	5m	40	0.125	1 + 6	86.11
C22	5m	40	0.125	2 + 5	84.87
C23	5m	40	0.125	3 + 4	83.36
C24	5m	40	0.125	4 + 3	82.72
C25	5m	40	0.125	5 + 2	84.31
C26	5m	40	0.125	6 + 1	89.07
D21	5.32m	40	0.133	1 + 6	87.08
D22	5.32m	40	0.133	2 + 5	86.13

D23	5.32m	40	0.133	3 + 4	84.85
D24	5.32m	40	0.133	4 + 3	84.46
D25	5.32m	40	0.133	5 + 2	86.37
D26	5.32m	40	0.133	6 + 1	91.56
E21	6.64m	40	0.166	1 + 6	86.11
E22	6.64m	40	0.166	2 + 5	91.02
E23	6.64m	40	0.166	3 + 4	90.64
E24	6.64m	40	0.166	4 + 3	91.26
E25	6.64m	40	0.166	5 + 2	94.57
E26	6.64m	40	0.166	6 + 1	101.63
F21	8m	40	0.200	1 + 6	94.53
F22	8m	40	0.200	2 + 5	95.74
F23	8m	40	0.200	3 + 4	96.20
F24	8m	40	0.200	4 + 3	97.84
F25	8m	40	0.200	5 + 2	102.64
F26	8m	40	0.200	6 + 1	111.73
G21	9.32m	40	0.233	1 + 6	98.01
G22	9.32m	40	0.233	2 + 5	100.16
G23	9.32m	40	0.233	3 + 4	101.36
G24	9.32m	40	0.233	4 + 3	103.97
G25	9.32m	40	0.233	5 + 2	110.26
G26	9.32m	40	0.233	6 + 1	121.38



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