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Comparative Study of Infill Frame and Structural Wall RCC Residential Building

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***Abstract*- RCC is commonly used for construction of building. Framed Structures are normally adopted however there is growing interest in continuous concrete structure incorporating shear wall which improves the seismic response of the building by providing additional stiffness to the building. In this thesis report a linear static and linear dynamic forces comparison has been provided in order to get the overview of the advantages and the utility of the RCC Structural wall structure over the traditional infill frame as the frame shows sign of failure in the zone IV, V so RCC structural wall are used instead of frames according to recommendation of IS 1893-2016. It can be observed that the displacement and drift has been reduced but the weight of the building increases eventually increasing the need of stable foundation and hence increasing the cost.**

***Keywords*- RCC frame, Structural wall, Seismic analysis, dynamic analysis**

I. INTRODUCTION

The primary purpose of all kinds of structural systems used in the building type of structures is to support gravity loads. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake.

Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. In India, a considerable number of buildings have reinforced concrete structural systems. This is due to economic reasons. Reinforced concrete building structures can be classified as :

1. Structural Frame Systems: The structural system consist of frames. Floor slabs, beams and columns are the basic elements of the structural system. Such frames can carry gravity loads while providing adequate stiffness.

2. Structural Wall Systems- In this type of structures, all the vertical members are made of structural walls, which may or may not be reinforced or have any ductile detailing

3. Structural Wall - Frame Systems (Dual Systems): The system consists of reinforced concrete frames interacting with reinforced concrete structural walls.

4. Flat slab- Structural Wall Systems: The system consist of RC walls resisting the lateral forces. In India most of the building are not engineered buildings and the one which are does not have adequate ductility or stiffness to overcome a design earthquake. It is only after tragedy of Bhuj earthquake that the concern towards the earthquake resistant buildings had been risen. As a result we had a revised code of IS 1893 in 2016 which covers a great variety of structural system to give guideline on how to design them.

II. LITERATURE REVIEW

Ugaldea, Diego Lopez-Garciaa[1] et al.paper on a 17 storey and a 26 storey building which are analysed using linear and non linear method of approach against Chile (2010) earthquake.

Demand vs Capacity ratio were generated for various stories that consider three cases.

- Frame only.
- Frame with shear wall.
- Foundation uplift considered.

In the paper it is suggested that third case should be considered as prominent factor in design as the Demand vs Capacity ratio was nearest to unity in this case which means members were not over strength which is a general practice in Chile.

Yu Zhang, Caitlin Mueller[2[et. al. uses Genetic Algorithm was used to optimize shear wall and the parameters used to comparison were fitness score, structural weight and distance between center of stiffness and center of mass for unfixed and fixed plan of the building It gives a variety of design alternatives placing the walls near the core and at corners for a fixed dead load, live load and wind for a given moment vs axial load curve.

V.S.Damam[3] et al deals with simulation of the G+10 building against the seismic load with four kinds of arrangement of shear wall and then check for the lateral displacement and storey drift in various seismic zones according to IS 1893:2002.

The findings of the paper provide following,

- If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall.
- In zone V and IV like high earthquake intensity areas, provide shear walls on all four corners and Centroid of the building to reduce deflection.

Dr. Rajashekhar Talikoti Pravin D. Deore et al[4] deals with simulation of the G+12 building in Zone V. Calculations are according to IS 1893:2002 for various percentages of opening keeping the location of the wall constant for dynamic forces and check for the lateral displacement and storey drift.

The findings of the paper provide following,

- Reducing the opening in shear wall by 50% the displacement is reduced up to 44.7%.
- A control over displacement, drift, can be achieved by keeping the minimum possible opening provided in shear wall. With the increase in openings in shear wall lateral displacement increases to 11%.

Dr.SV Itti, Pooja Hegde[5] et al deals with a G+4 building of 3m floor height, shear wall in zone IV with seismic loading according to IS1893:2002 with a non-linear static analysis is performed in ANSYS for two parameters – a) location of the base opening and b) the percentage area of base opening for the Shear wall.

The findings of the paper provide following,

- The shear wall load capacity reduces by 10% for symmetric opening at base and 44% for eccentric opening at base compared to solid.
- For symmetric opening sizes of 35%, 50%, 60% and 75% at base, percentage reduction of load capacity observed were 8%, 22%, 25%and 66% respectively.

Haijuan Duan , Mary Beth D. Hueste[6] et al describes a typical five-storey reinforced concrete frame building is designed.

The frame structure is evaluated using both a nonlinear static (push-over) analysis and nonlinear dynamic time-history analysis.

- The push-over analysis indicated the potential for a first storey to be soft storey
- The drift and plastic rotation demands from the dynamic analysis did not indicate a risk of collapse

III. OBJECTIVES

The broad objective of the study is stated here in;

1. To evaluate the seismic response of an actual structural wall residential structure.
2. To evaluate the seismic response of corresponding infill RCC frame structure.
3. To summarize the structural response for a Structural wall and corresponding infill RCC frame.(i.e. displacement ,storey drift and storey shear).

IV. STRUCTURAL MODELLING DATA

1. Assumptions in modeling

- The frames are assumed to be symmetric in plan and hence Torsional effects are neglected.

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- The structural wall considered in the study is provided throughout the height of the building as studies [4] suggests the same.
- The interaction effect of the soil-structure is neglected.
- Base of columns has been assumed fixed, we are considering start of columns above the raft.
- Dimensions conforming to IS 13920 – 2016[7] has been adopted for the beam and column.

Table 1. Infill Frame Structure

300x450	C1	At the outer corner
300x600	C2	At the outer edges
300x750	C3	At the inner place
300x900	C4	At the core location

Table 2. Concrete

Infill Masonry		
Density	Modulus Of Elasticity	Poisson ratio
15kN/m^3	4846MPa	0.2

- Beams 300mm x 300mm and Column are
- Floor to floor height is 3.15m
  - Live load 2 kN/m^2 (according to IS 875 Part2-1987[Reaffirmed 2008])
- Seismic Loads are taken according to IS 1893 Part1-2016[8]
- The infill masonry modulus of elasticity is given by $E_m=550\ f_m$ according to clause 7.9.2 from IS 1893
- where $f_m=0.433 f_{brick}^{0.64} f_{motar}^{0.36}$ according to IS 1905.

2. Structural Rcc Wall

- Thickness of the wall is taken as 120mm
- Dead load 3.75kN/m^2 (assume 125mm slab)
- Floor to floor height is 3.15m
- Live load 2 kN/m^2 (according to IS 875 Part2-1987[Reaffirmed 2008])
- Seismic Loads are taken according to IS 1893 Part1-2016[8]

Table 3. Concrete

Concrete		
Density	Modulus Of Elasticity	Poisson ratio
24.2kN/m^3	21.72 GPa	0.3

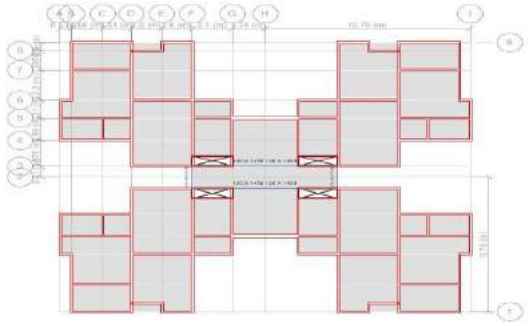


Fig 1. Plan of Structural R.C.C. wall.

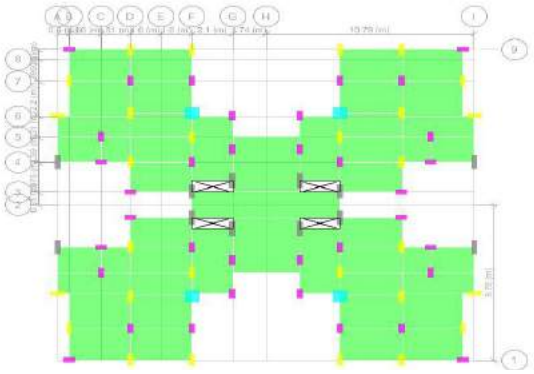


Fig 2. Plan of Framed infill wall.

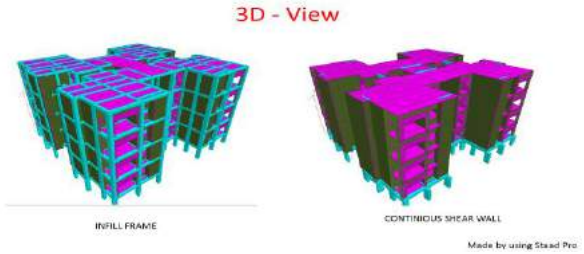
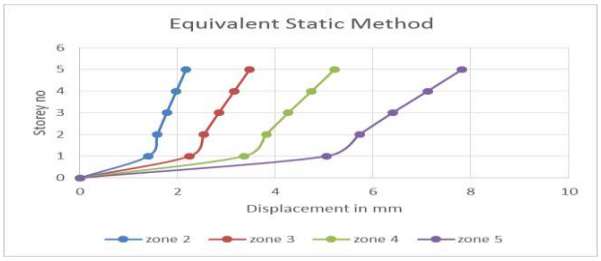


Figure 3. Storey vs. Displacement in different zones between RCC wall and infill.

3. Rcc Structural Wall



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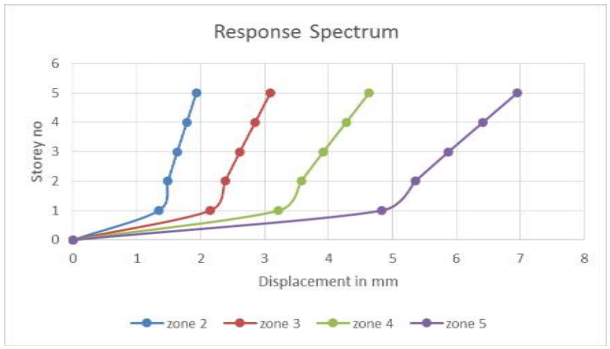

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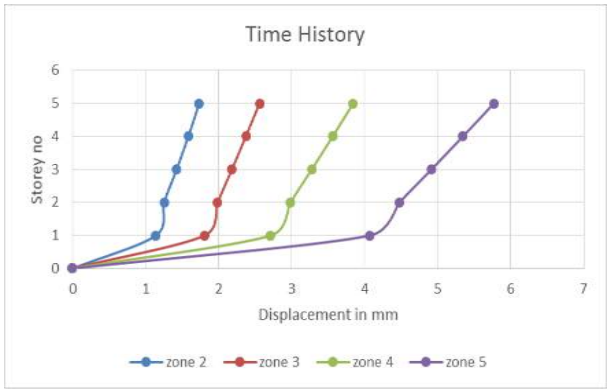

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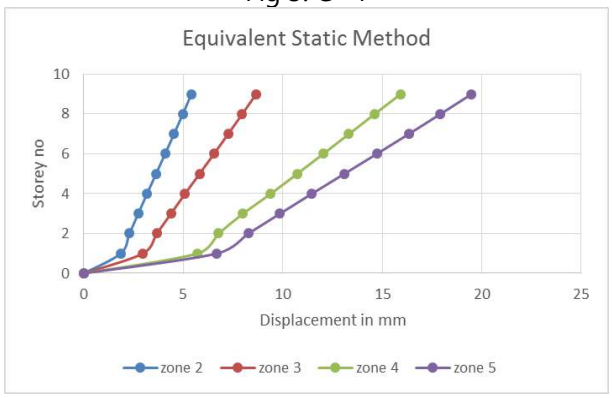
Fig 3. G+4



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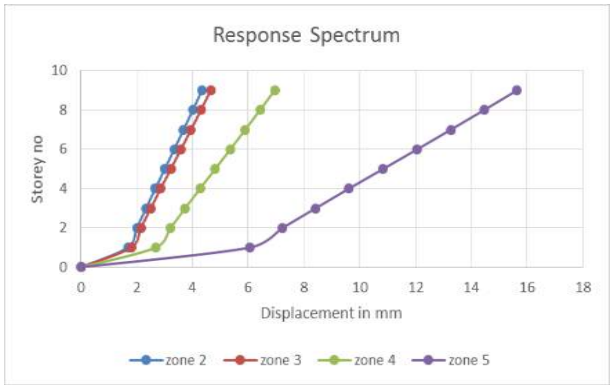

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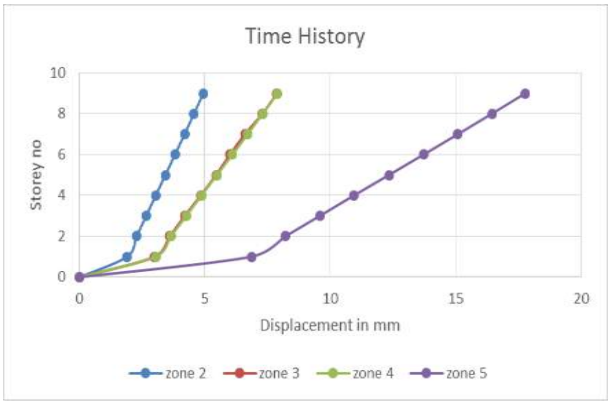

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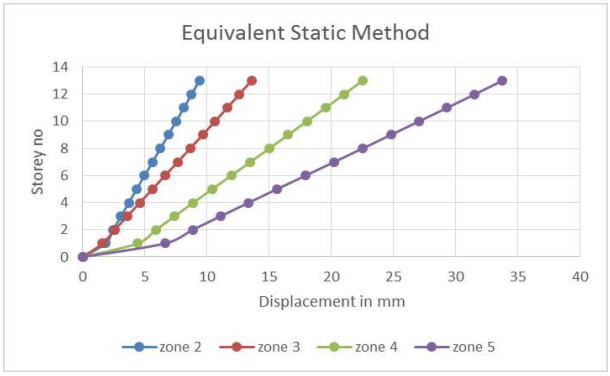
Fig 4. G+8



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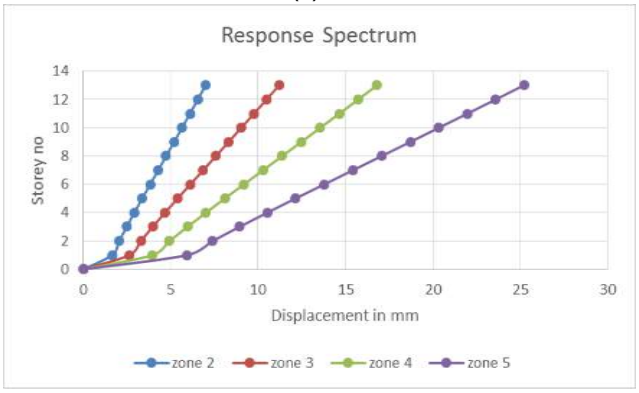

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Fig 5. G+12

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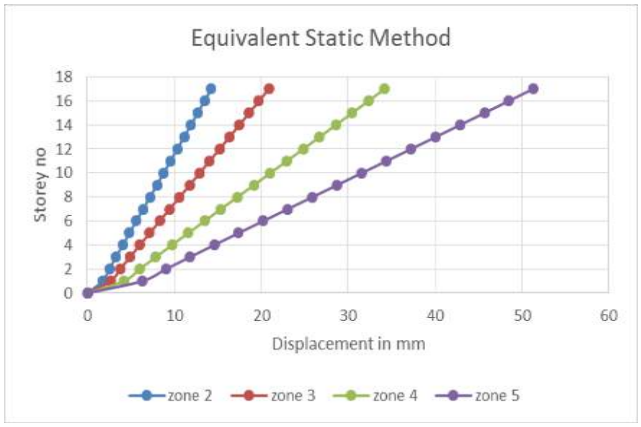

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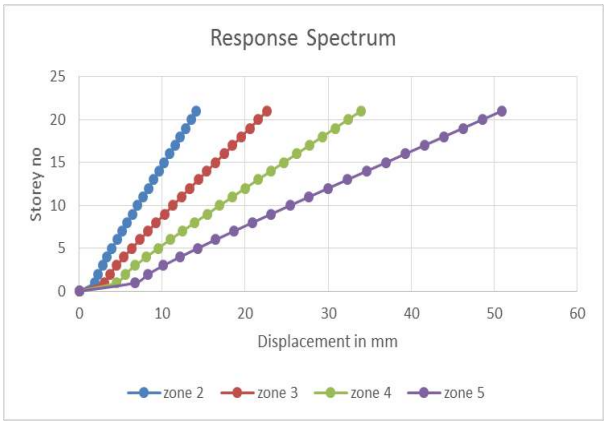

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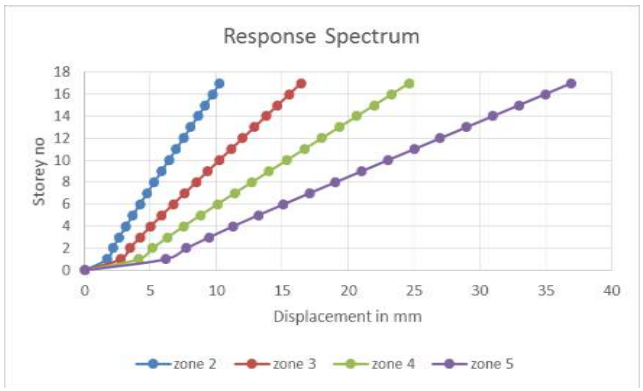

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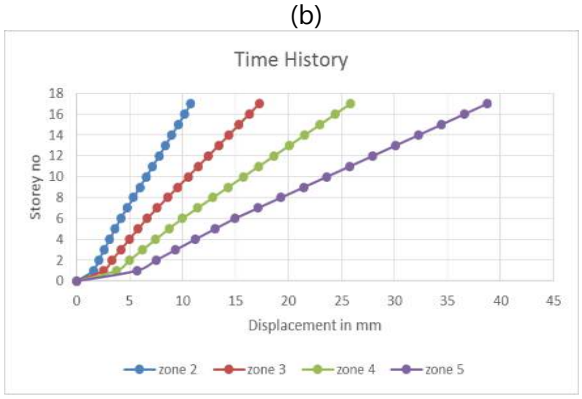

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Fig 6. G+16

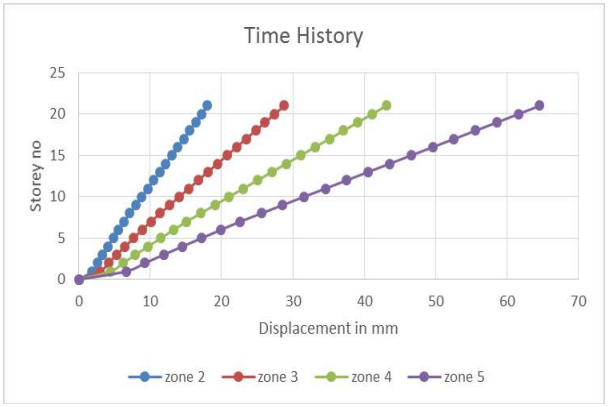

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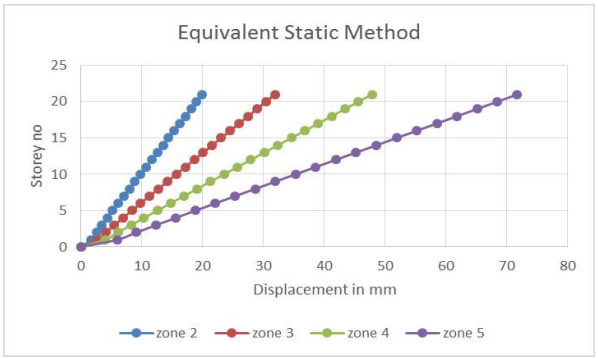
Fig 7. G+20

4. Infill Wall Frame



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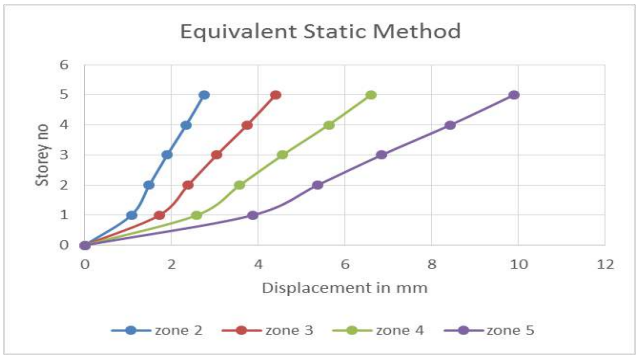

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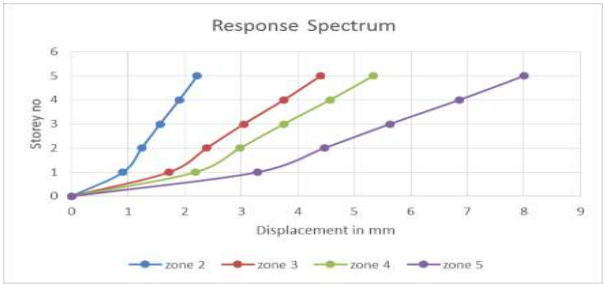

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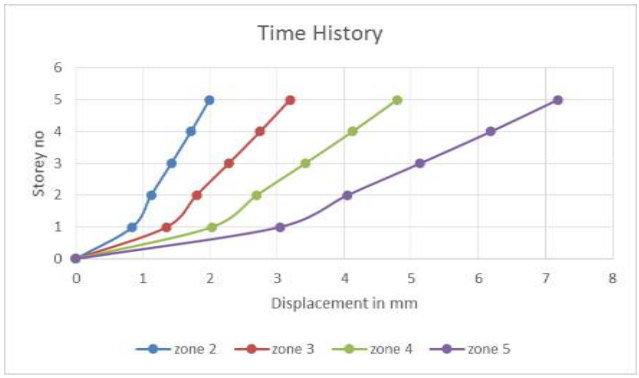

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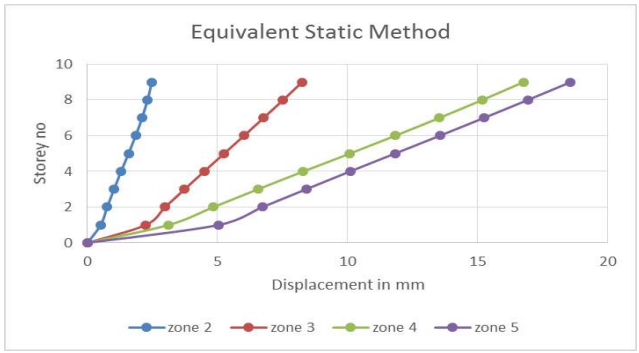
Fig 8. G+4



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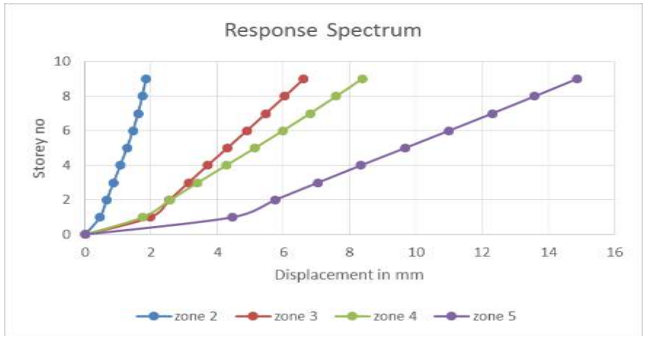

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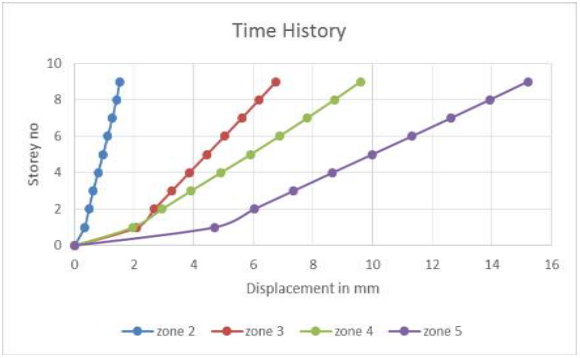

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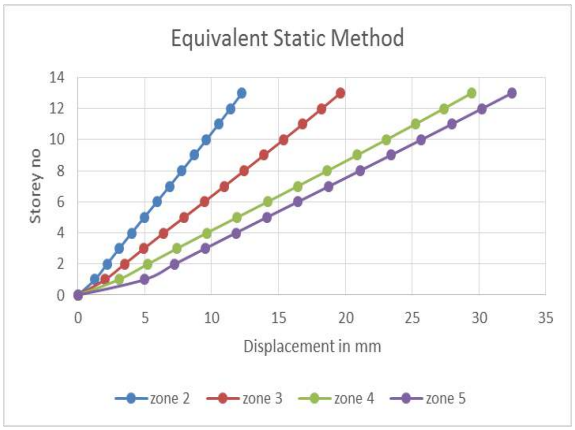
Fig 9. G+8



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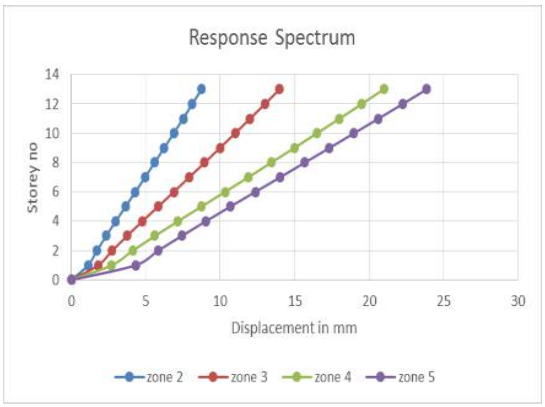

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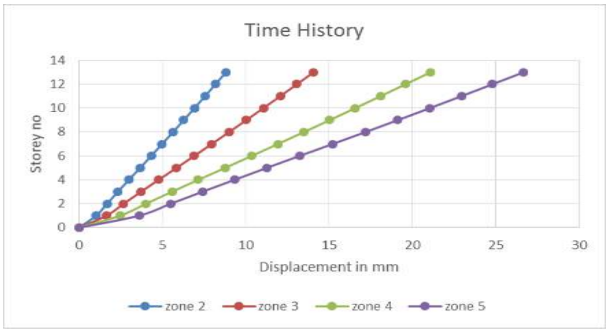

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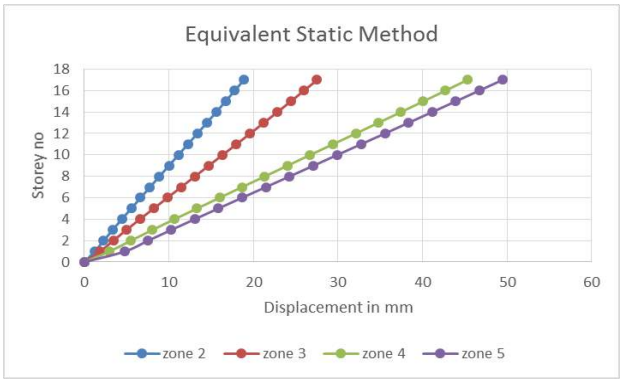
Fig 10. G+12



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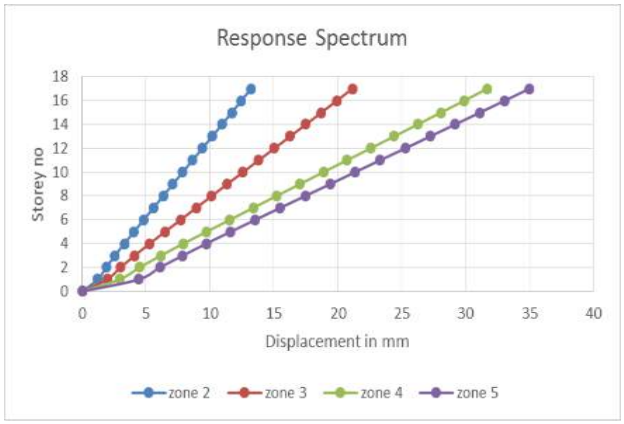

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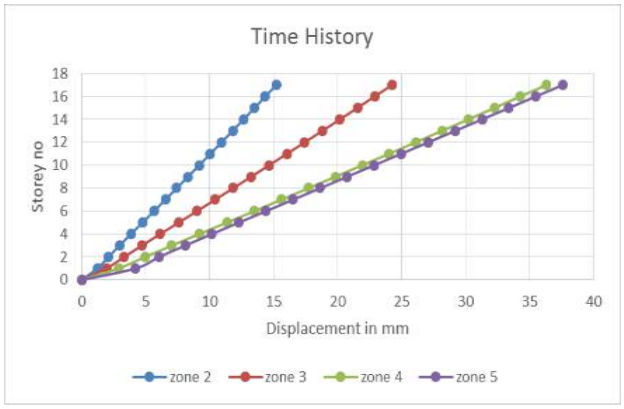

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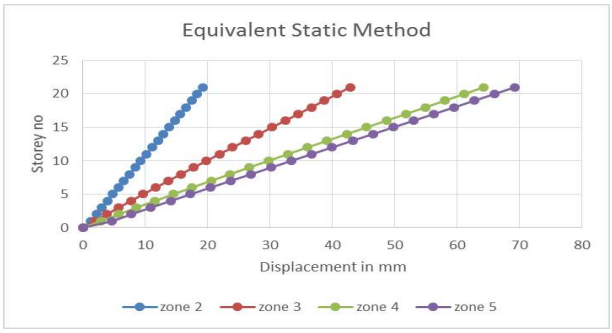
Fig 11. G+16



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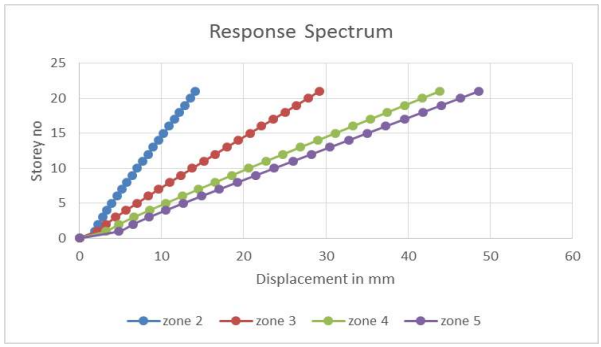

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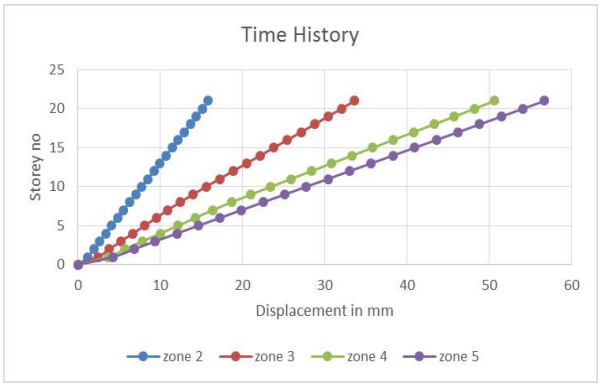

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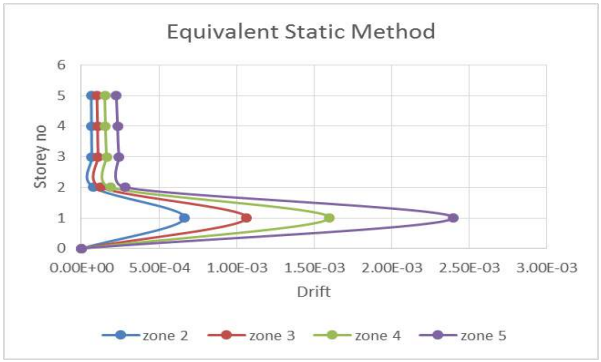
Fig 12. G+20

Storey vs. Drift ratio in different zones between RCC wall and infill frame.

5. RCC STRUCTURAL WALL



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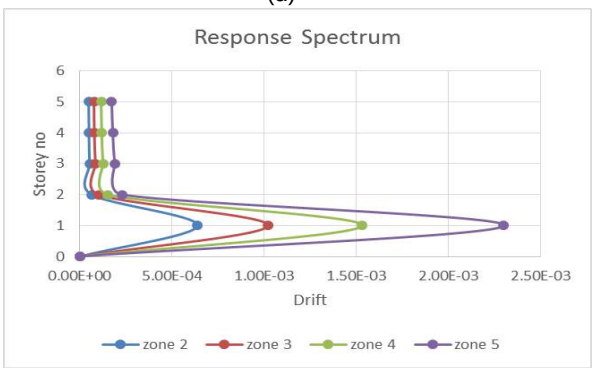

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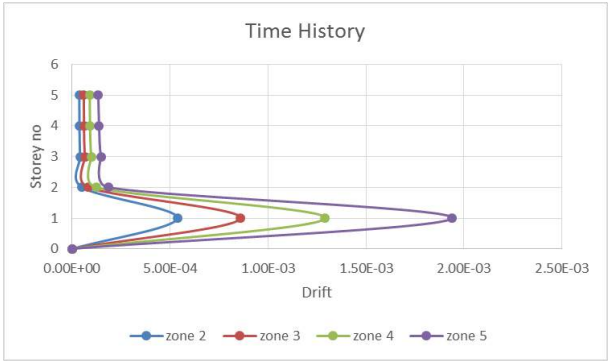

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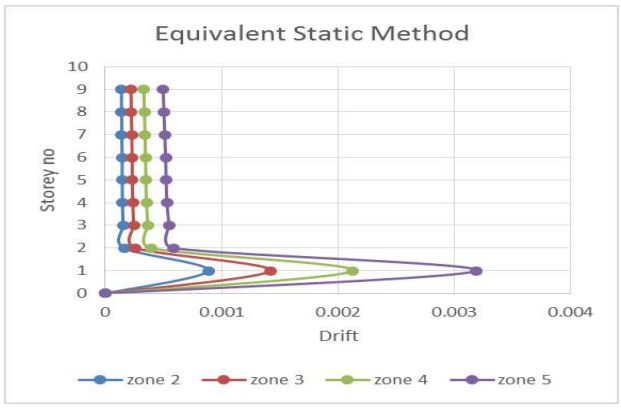
Fig 13. G+4



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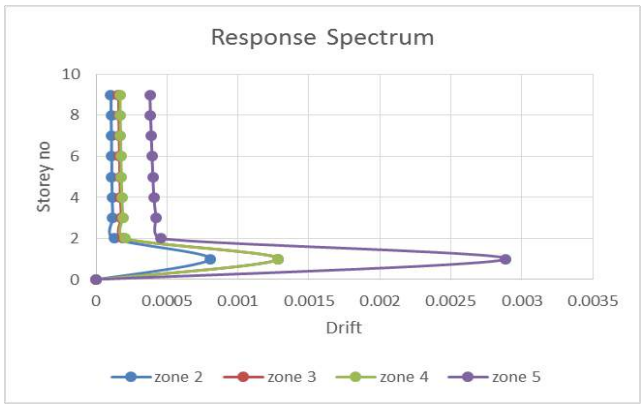

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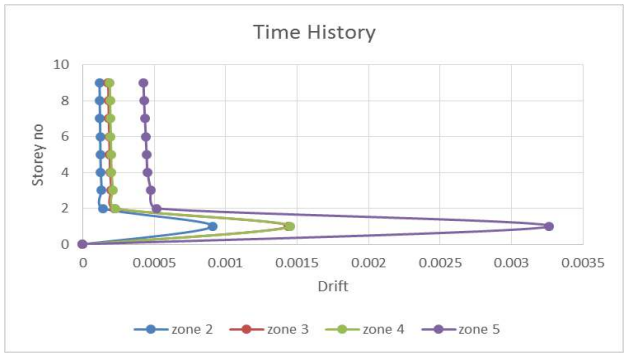

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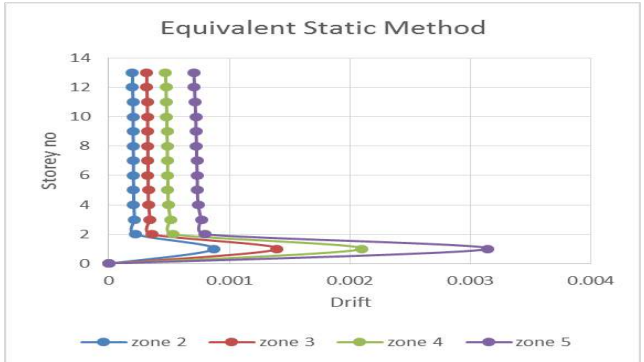
Fig 14. G+8



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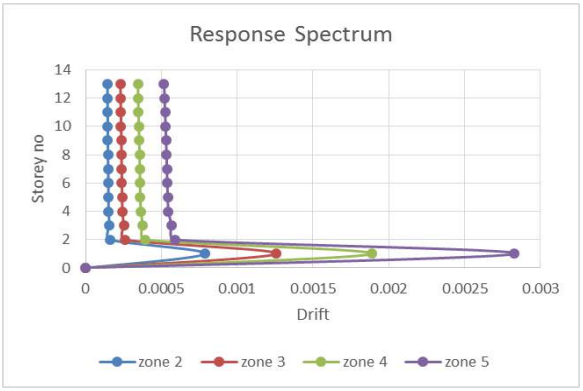

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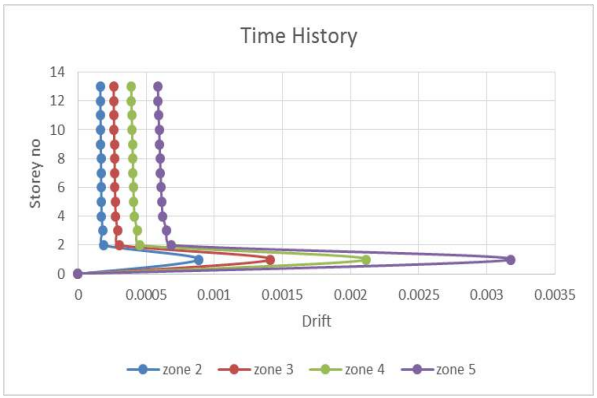

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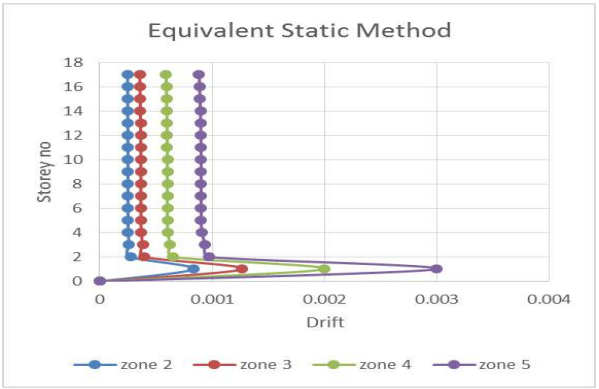
Fig 15. G+12



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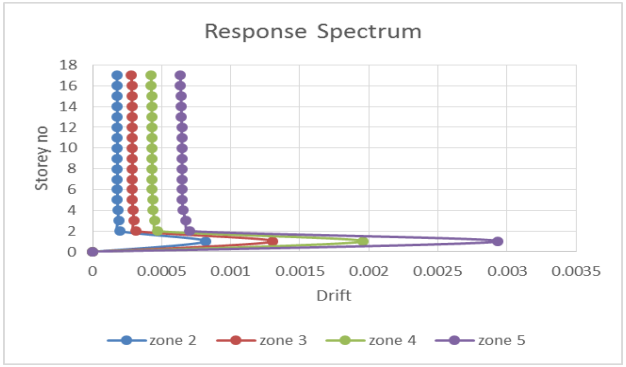

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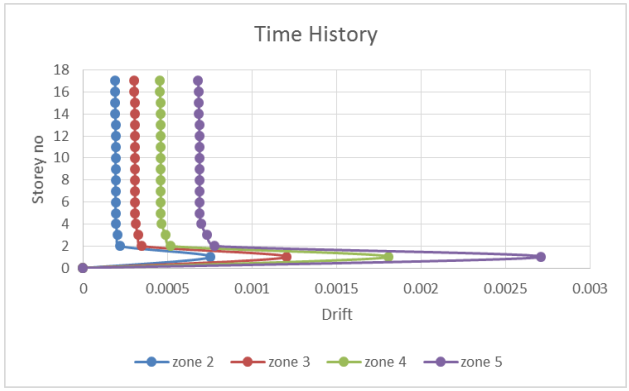

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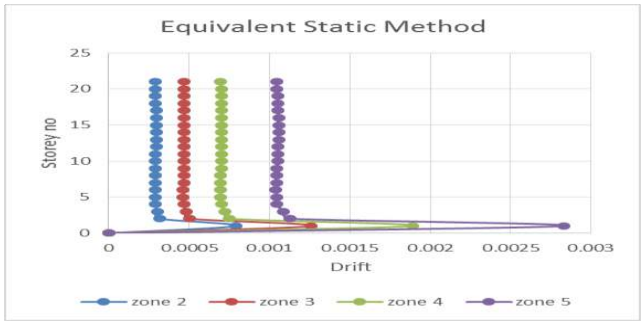
Fig16. G+16



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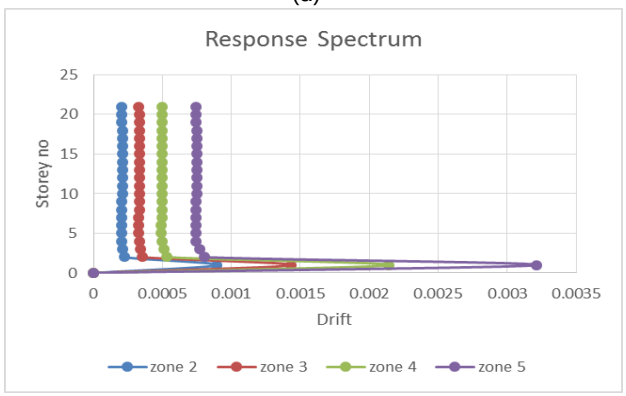

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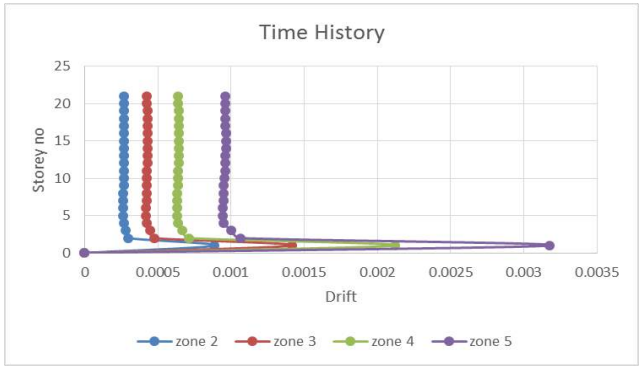

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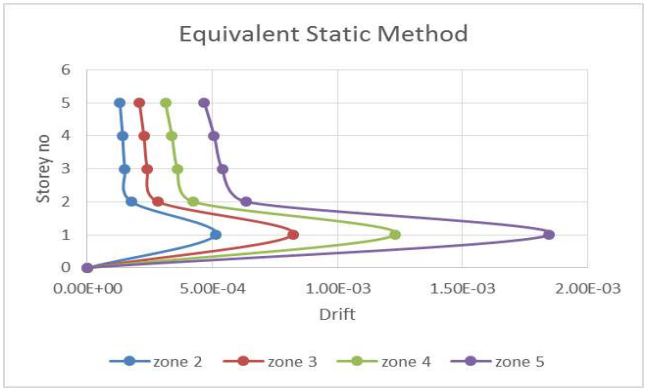
Fig17. G+20

6. Infill Wall Frame



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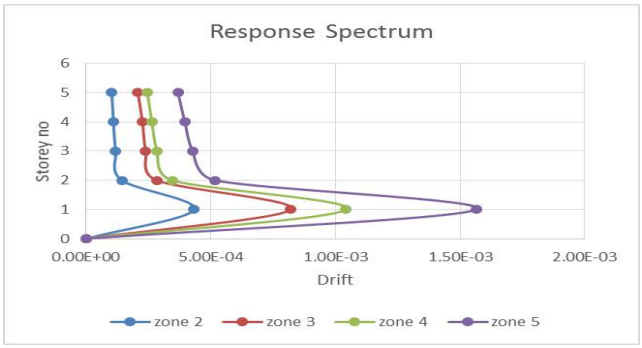

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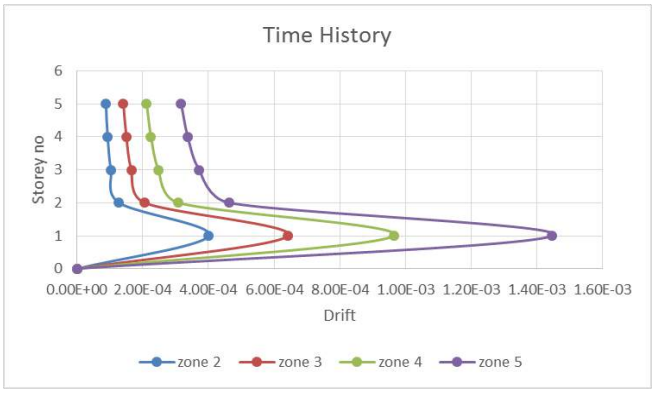

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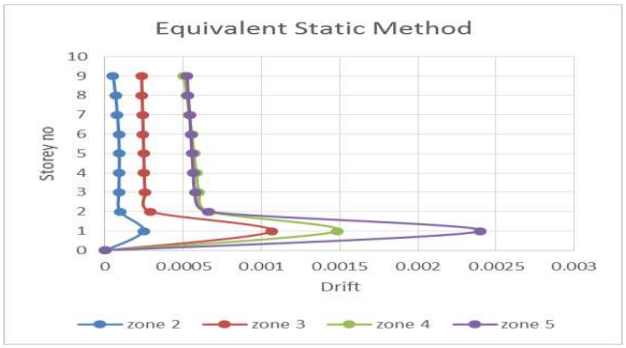
Fig 18. G+4



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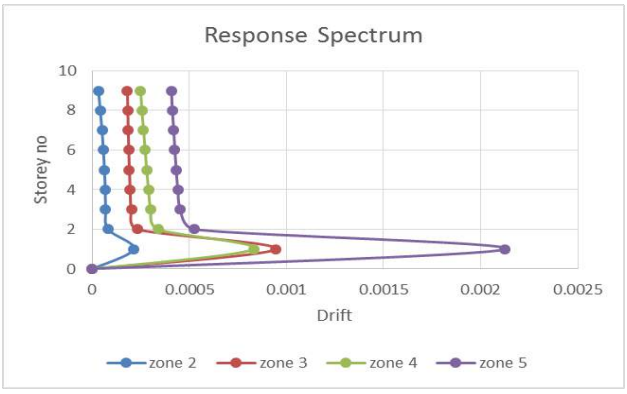

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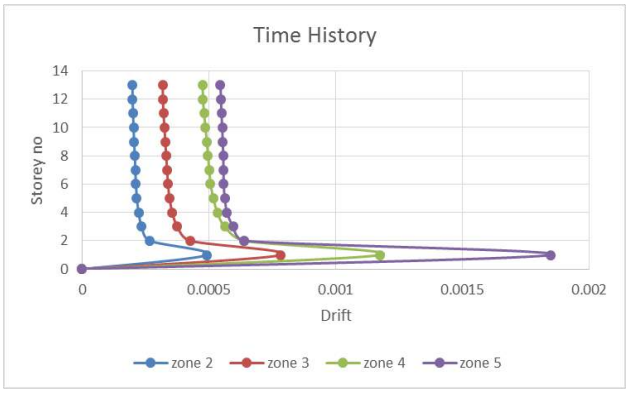

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Fig 20. G+12

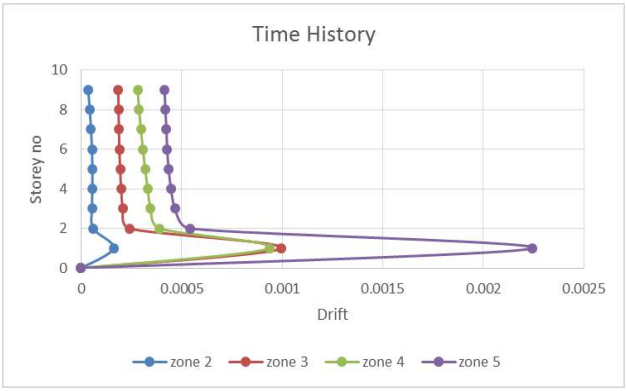

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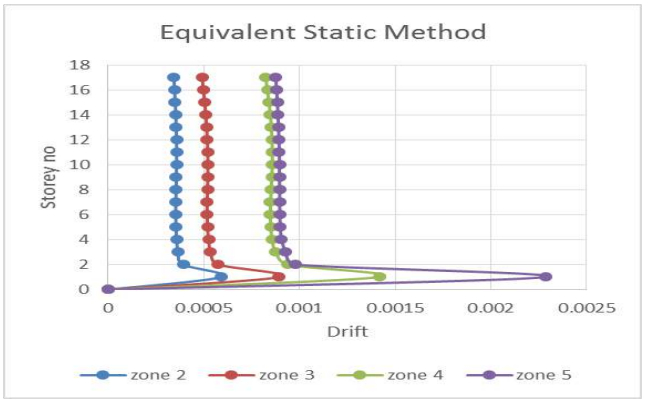
Fig 19. G+8



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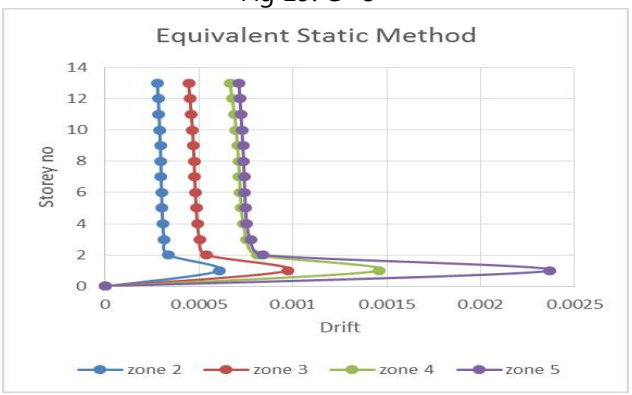

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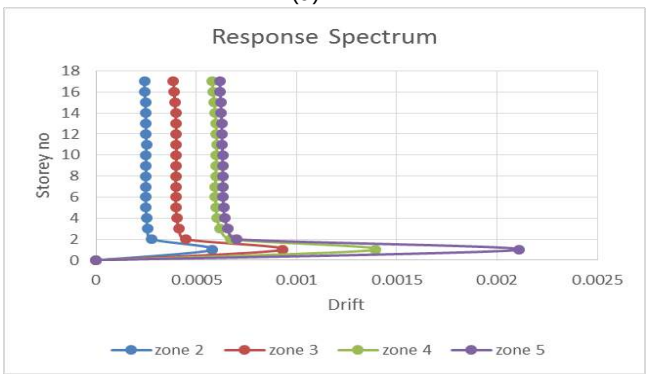

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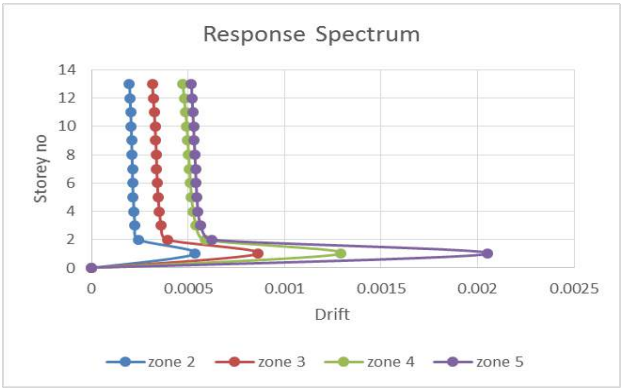

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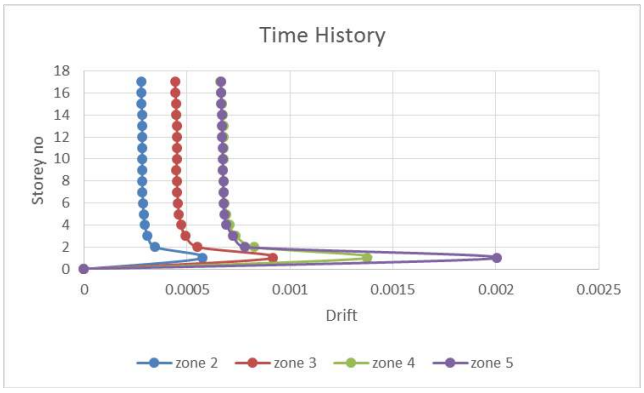

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Fig 21. G+16

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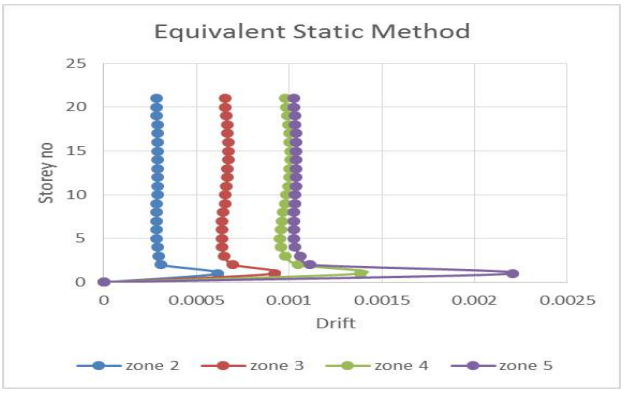

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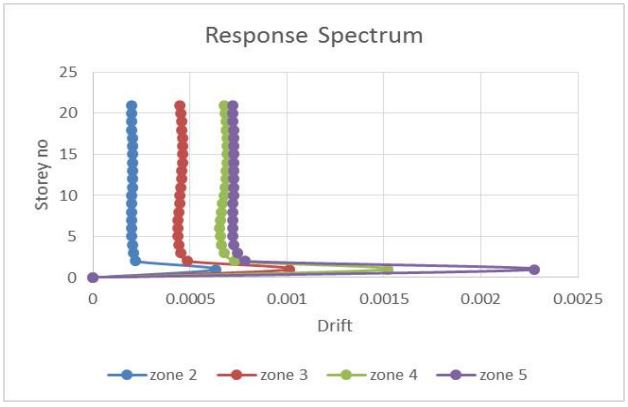

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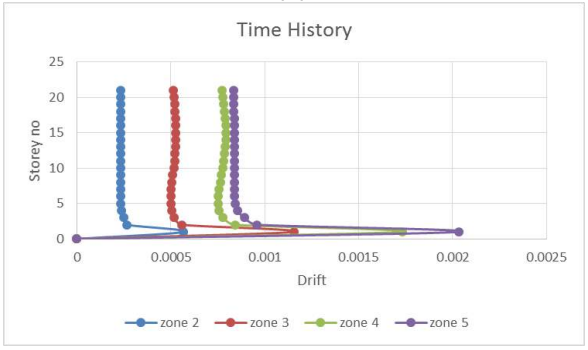

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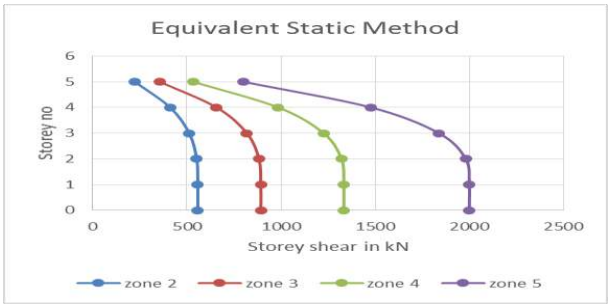
Fig 22. G+20

Storey vs. Storey Shear in different zones between RCC wall and infill frame

7. Rcc Structural Wall



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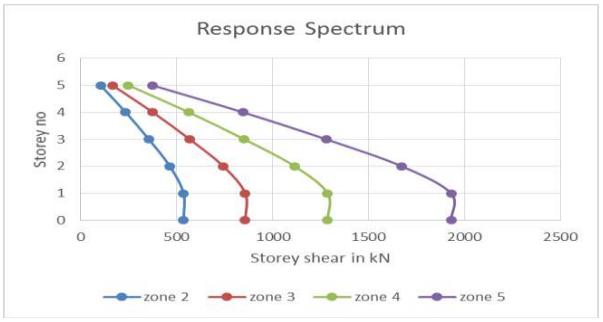

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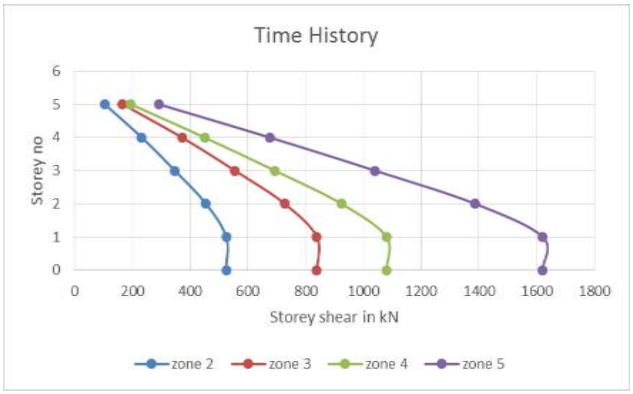

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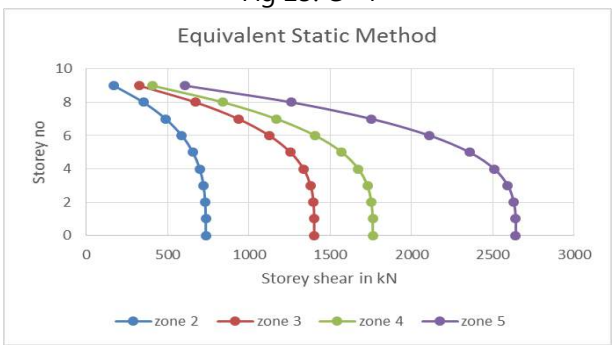
Fig 23. G+4



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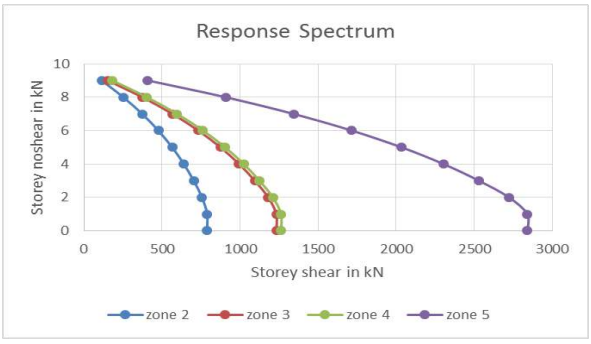

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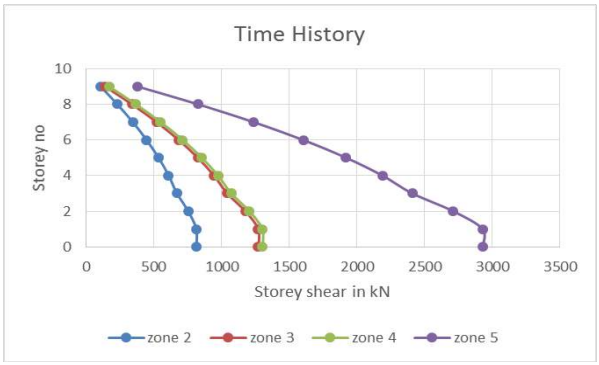

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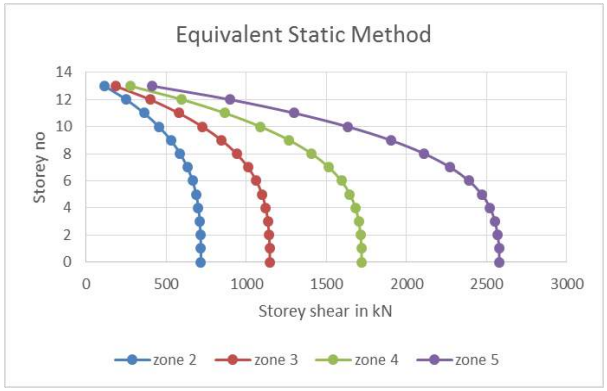
Fig 24. G+8



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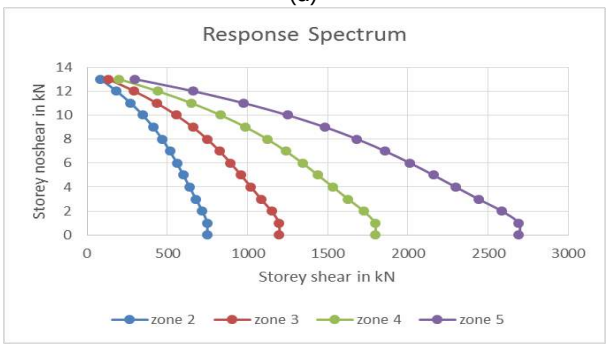

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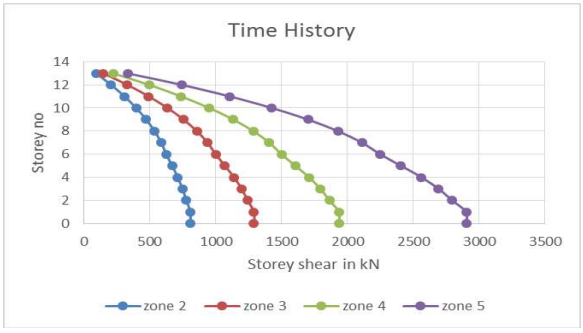

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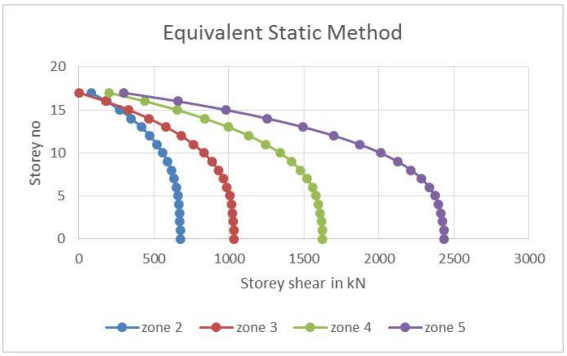
Fig 25. G+12



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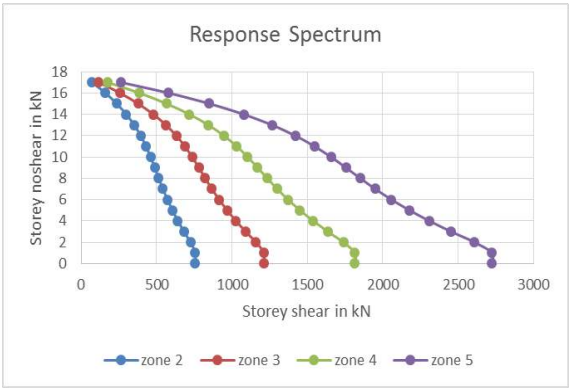

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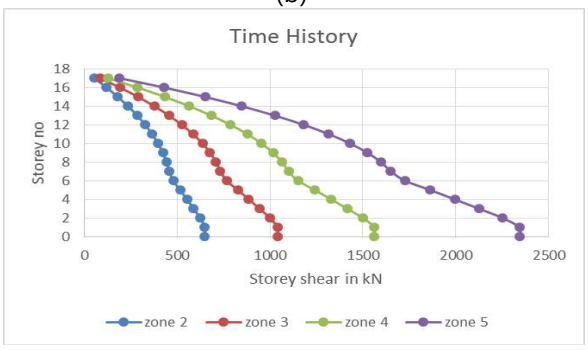

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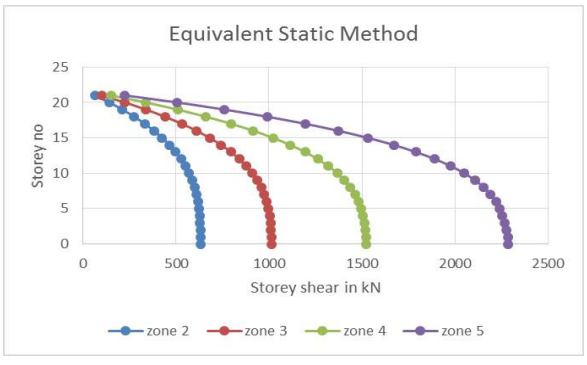
Fig 26. G+16



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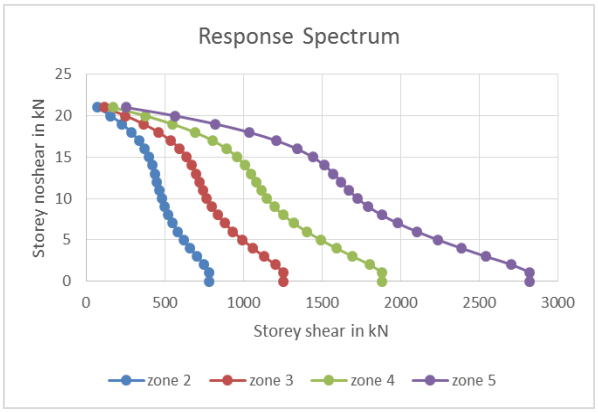

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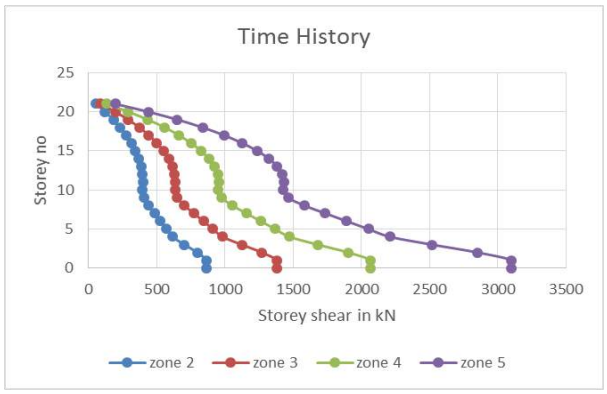

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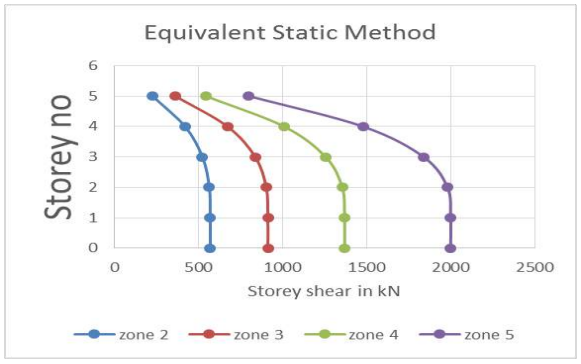
Fig 27. G+20

8. Infill Wall Frame



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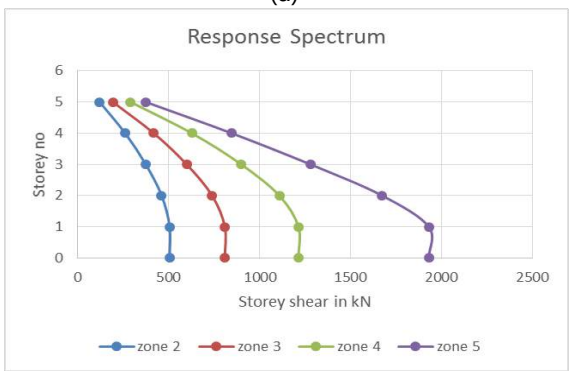

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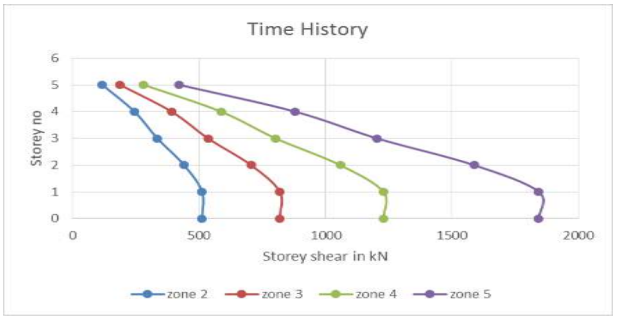

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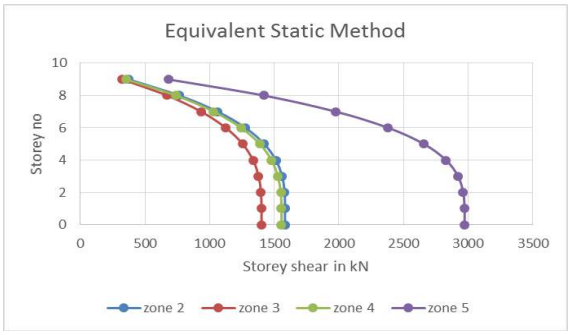
Fig 28. G+4



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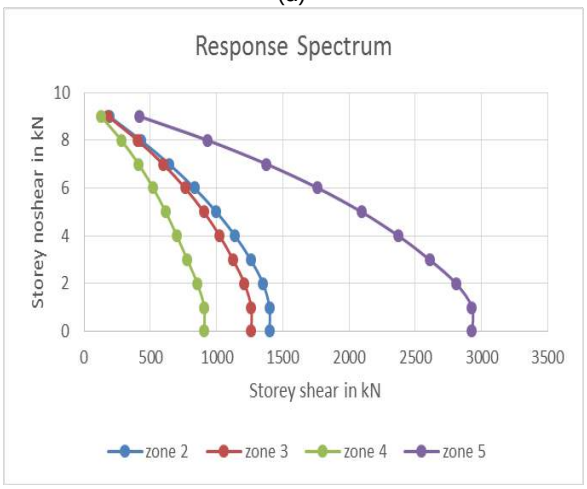

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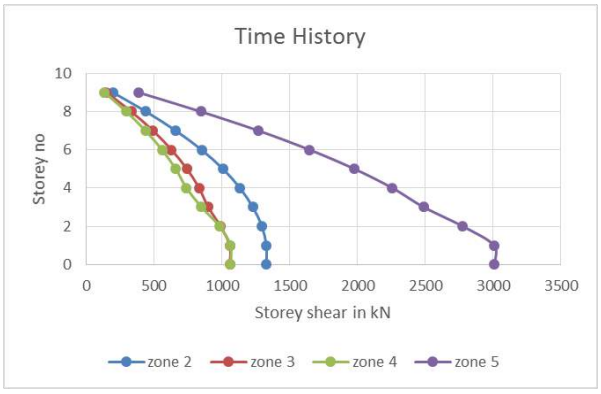

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Fig 29. G+8

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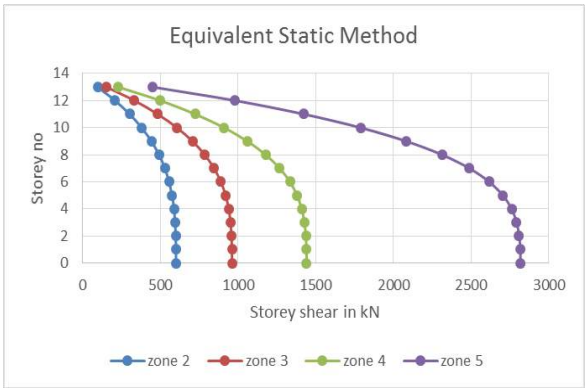

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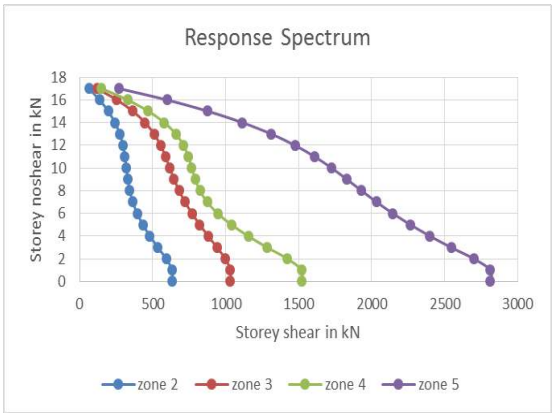

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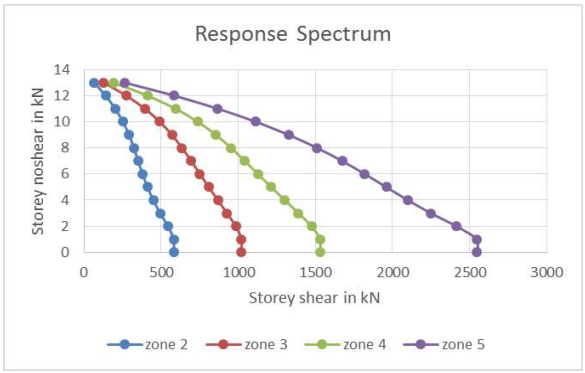

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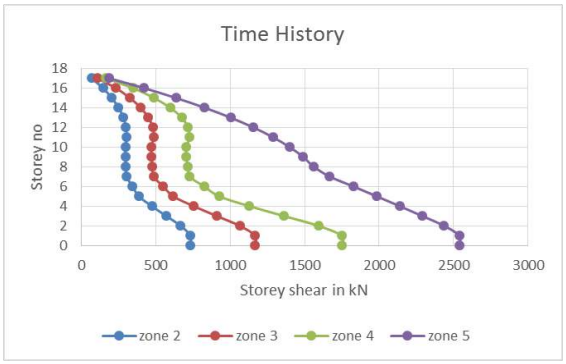

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Fig 31. G+16

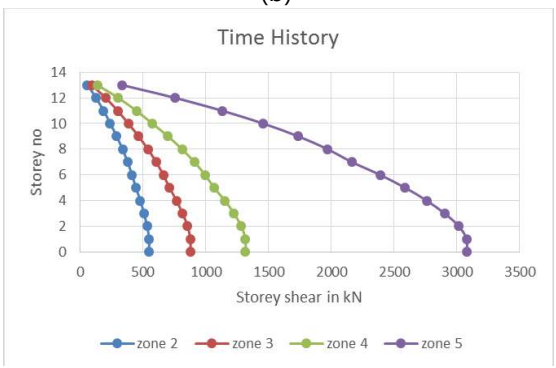

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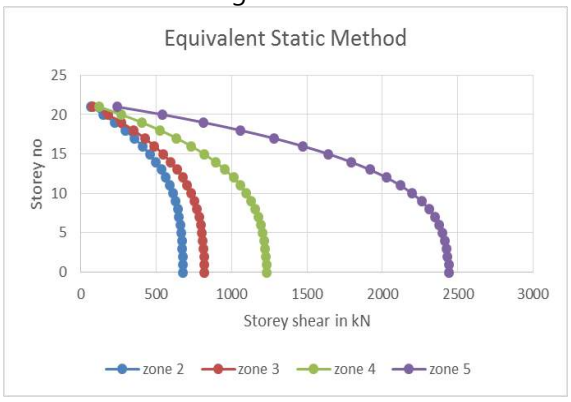
Fig 30. G+12



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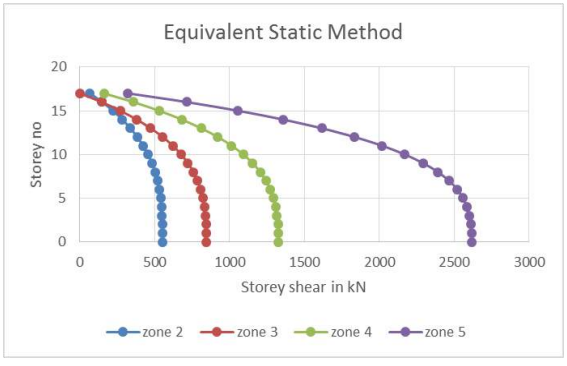

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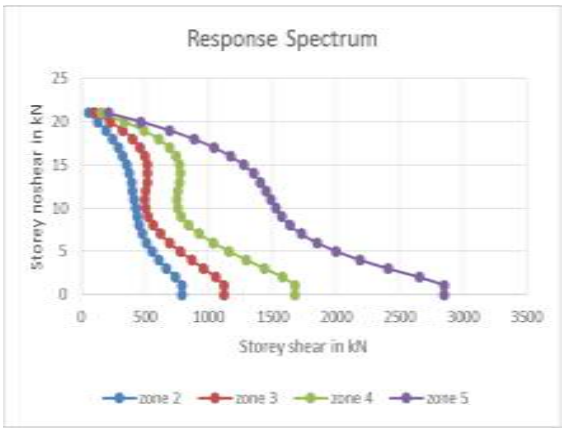

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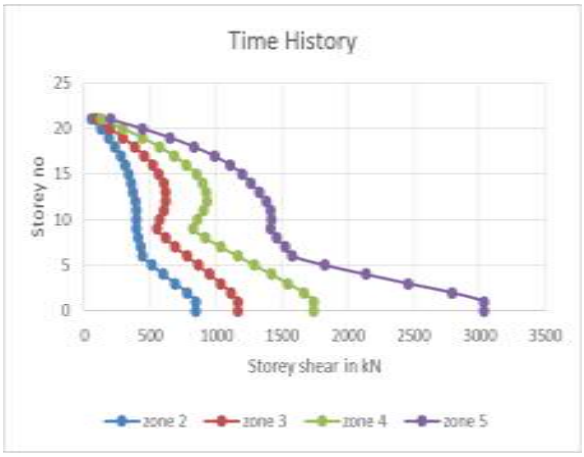

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Fig 32. G+20

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