Static Non-linear analysis and study of 2D frame

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Abstract - *In recent days there is a lot of light thrown on behavior of structure post elastic limits and to understand the maximum permissible limits the structural members could be subjected before the structure reaches the limit where in it shall not be capable to with stand any more load and any repair or rehabilitation of structure stall not induce any structural strength. A case study is carried out to know the effect of designing a reduced cross section member in a structure and it significance on the structural performance on a 2D frame of 2 bay frame of 10 story height, Height of each floor is 3m and Length of each bay is 8m. and each of the beam is replaced with another beam of half the cross section, which can still withstand the applied live load and is analysis and the out put values is compared with standard frame output values.*

Key Words: 2D portal frame, Non linear analysis, sap2000, capacity spectrum, Push over analysis.

1.INTRODUCTION

Non-linear static method of analysis is used on structures with one Degree of freedom. An structure is pushed till it fails And studies as to the Cause of failure, Weather the structure can be repaired or rehabilitated., Point of failure, Plastic behaviour etc.,
Pushover analysis of a structure is post elastic range performance study of , which helps in knowing weaknesses and failure possibilities in a structure / model.

2.Loads

Live load

Wall load = Thickness of wall x height of wall x density of brickwork (excluding beam depth)

= 0.2 x 2.6 x 20

= 10.4 kN/m.

Seismic Loads
Criteria as per IS 1893: 2002
As per this code, Structure has been designated to Zone V.
The Design Base Shear is given by, V = Ah.W
where, Ah =As the proposed building is a Residential building, the Importance factor I has been taken as 1.0.
Since the building lies in Zone V, the zone factor has been taken as 0.36.
The Response reduction factor R has been taken as 5.0 as the structure would be designed as per the provisions of SMRF (Special RC moment Resisting Frame).
Sa / g is the normalized Reaction Spectrum esteem for the structure which is the capacity of the central day and age of vibration of the structure and the sort of the establishing soil, Soil type medium.
W is the Seismic Weight of the building, which has been calculated in accordance with the relevant clause in the IS1893: 2002.
Since the structure is a RCC structure, a damping value of 5% has been considered.
Time period formula is used for analysis, $T = 0.09h/\sqrt{d}$
Where, T = Time period in sec
h = height of building in 30meter
d = base dimension of the building in the direction in which the seismic force is considered

3. 2-D Frame

It is 2 bay 2 dimension frame of 10 story height, Tallness of every floor is 3m and Spacing of column is 8m.

Beam: - 500 X 500mm

Column:- 600 X 600 mm

Concrete:- M30

Steel:- Fe500

Young's modulus:- $5000\sqrt{Fck}$ = 27386127.88

Design in accordance with IS:456-2000

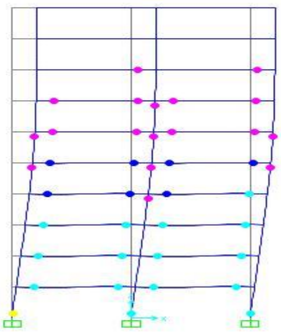

Fig-1 2D frame showing hinges @ Plastic stage(Yellow hinge is plastic hinge).

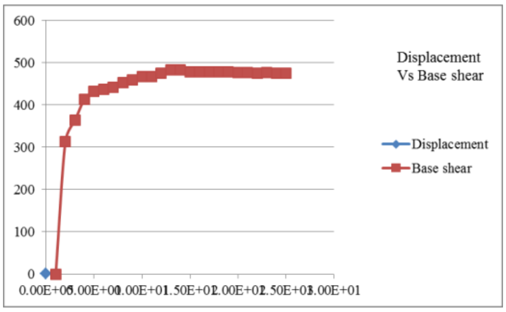

Chart-1 Displacement Vs Base shear .

Outcome:- After The Hinge Crosses the plastic range it Fails at step 14 when the over all structural displacement is 0.422796 m Having base shear @ 478.282 kN.

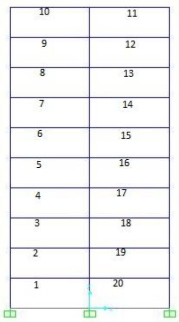

Fig-2 2D frame having beams numbered.

3.1 B1 Frame

Beam1 is replaced by another beam of half the cross section 250 X 250mm.

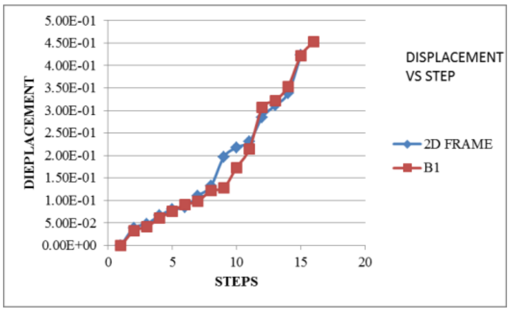

Chart-2 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B1 Frame.

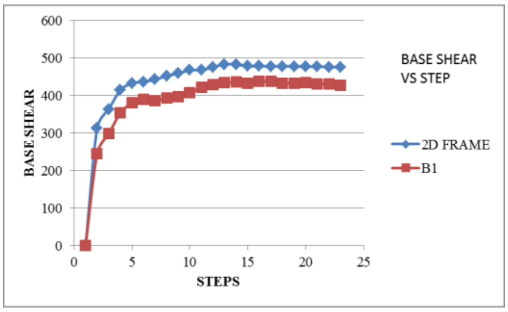

Chart-3 Base shear Vs Analysis steps of 2D Frame and B1 Frame.

3.2 B2 Frame

Beam2 is replaced by another beam of half the cross section 250 X 250mm.

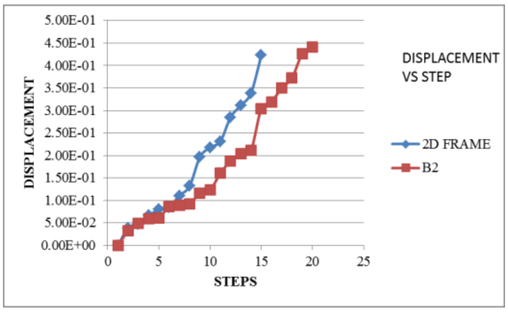

Chart-4 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B2 Frame.

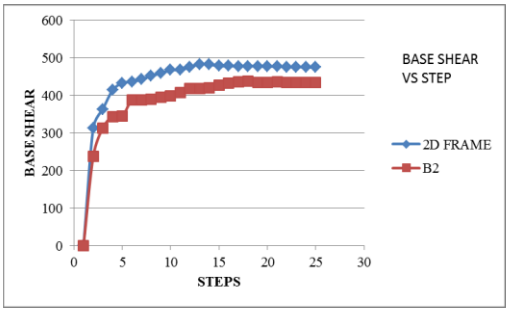

Chart-5 Base shear Vs Analysis steps of 2D Frame and B2 Frame.

3.3 B3 Frame

Beam3 is replaced by another beam of half the cross section 250 X 250mm.

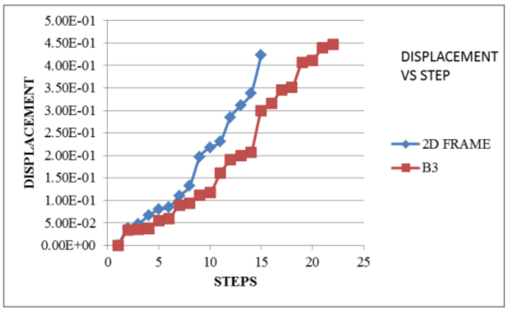

Chart-6 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B3 Frame.

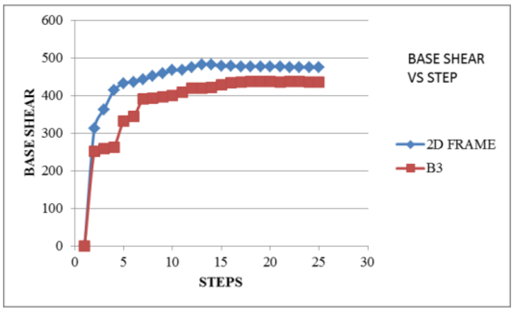

Chart-7 Base shear Vs Analysis steps of 2D Frame and B3 Frame.

3.4 B4 Frame

Beam4 is replaced by another beam of half the cross section 250 X 250mm.

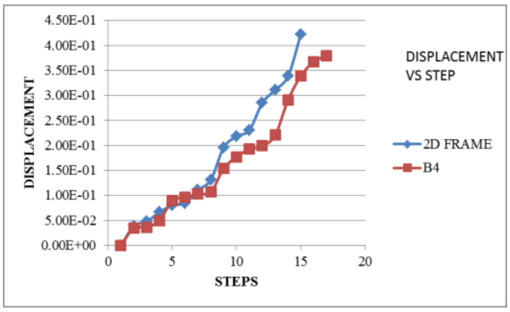

Chart-8 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B4 Frame.

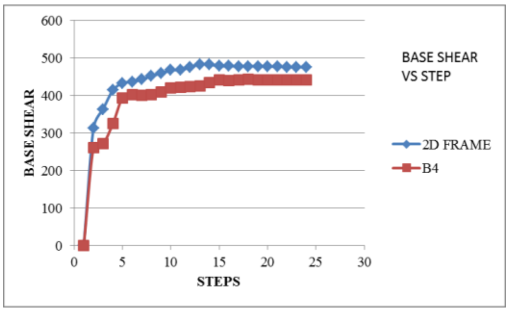

Chart-9 Base shear Vs Analysis steps of 2D Frame and B4 Frame.

3.5 B5 Frame

Beam5 is replaced by another beam of half the cross section 250 X 250mm.

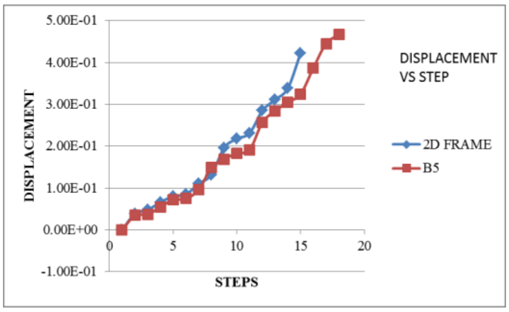

Chart-10 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B5 Frame.

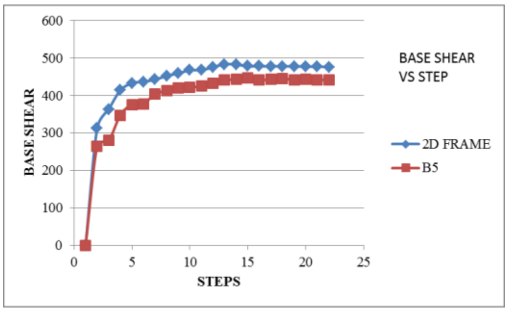

Chart-11 Base shear Vs Analysis steps of 2D Frame and B5 Frame.

3.6 B6 Frame

Beam6 is replaced by another beam of half the cross section 250 X 250mm.

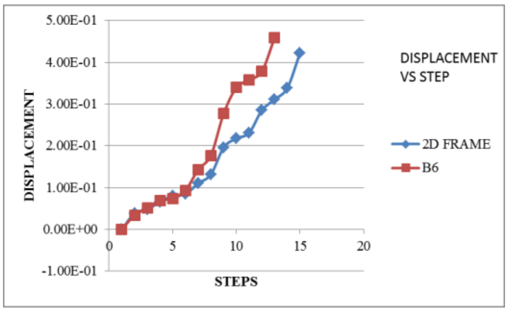

Chart-12 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B6 Frame.

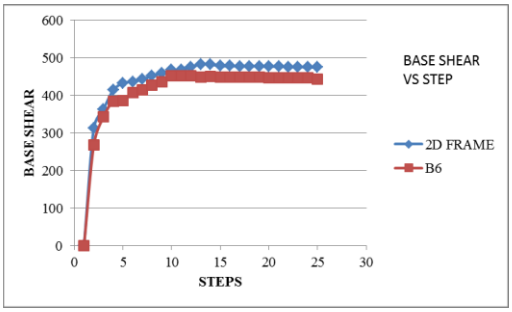

Chart-13 Base shear Vs Analysis steps of 2D Frame and B6 Frame.

3.7 B7 Frame

Beam7 is replaced by another beam of half the cross section 250 X 250mm.

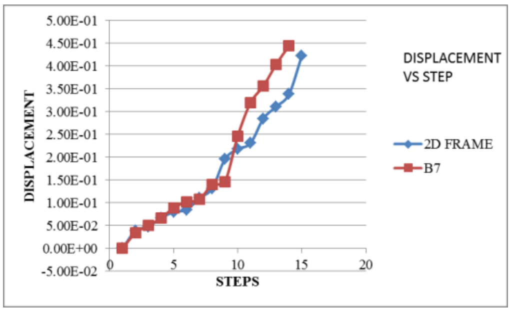

Chart-14 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B7 Frame.

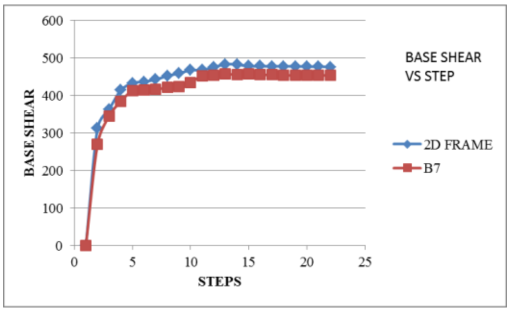

Chart-15 Base shear Vs Analysis steps of 2D Frame and B7 Frame.

3.8 B8 Frame

Beam8 is replaced by another beam of half the cross section 250 X 250mm.

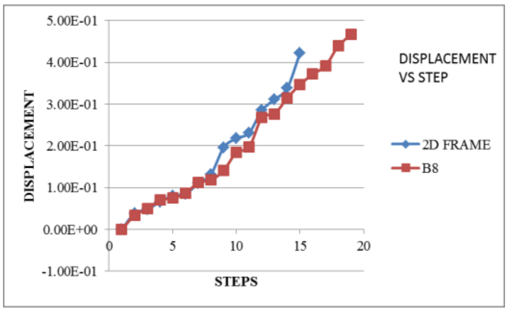

Chart-16 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B8 Frame.

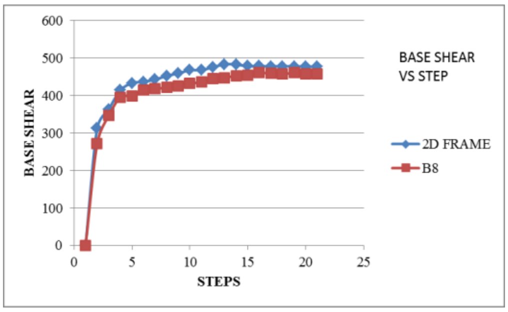

Chart-17 Base shear Vs Analysis steps of 2D Frame and B8 Frame.

3.9 B9 Frame

Beam9 is replaced by another beam of half the cross section 250 X 250mm.

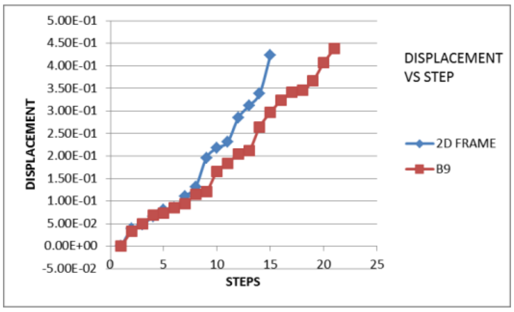

Chart-18 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B9 Frame.

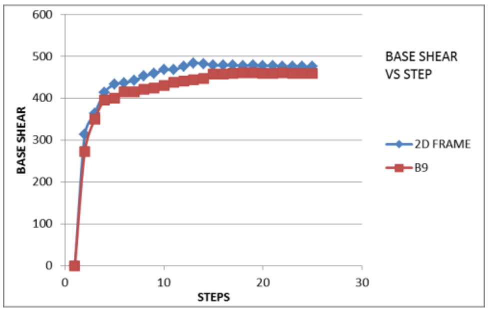

Chart-19 Base shear Vs Analysis steps of 2D Frame and B9 Frame.

3.10 B10 Frame

Beam10 is replaced by another beam of half the cross section 250 X 250mm.

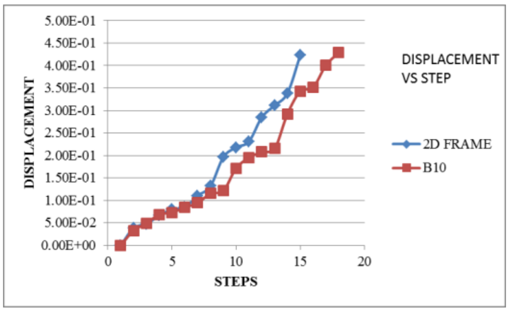

Chart-20 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B10 Frame.

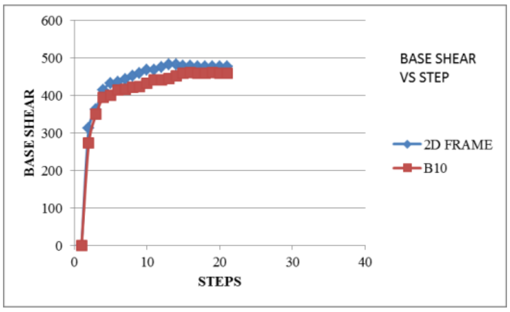

Chart-21 Base shear Vs Analysis steps of 2D Frame and B10 Frame.

3.11 B11 Frame

Beam11 is replaced by another beam of half the cross section 250 X 250mm.

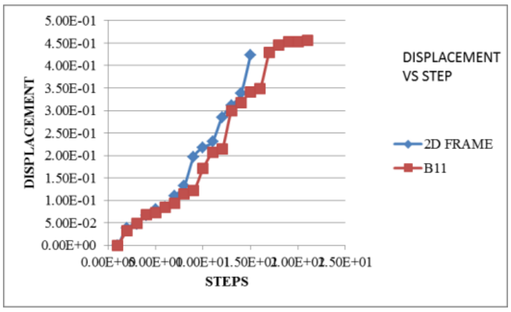

Chart-22 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B11 Frame.

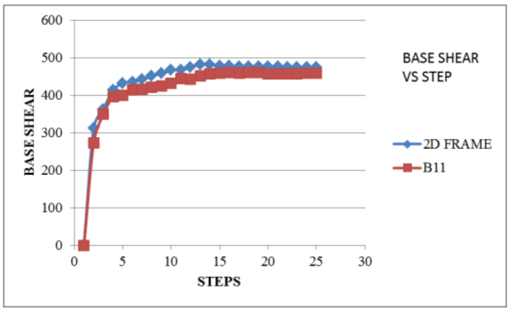

Chart-23 Base shear Vs Analysis steps of 2D Frame and B11 Frame.

3.12 B12 Frame

Beam12 is replaced by another beam of half the cross section 250 X 250mm.

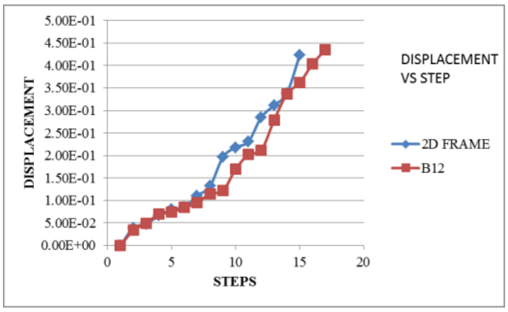

Chart-24 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B12 Frame.

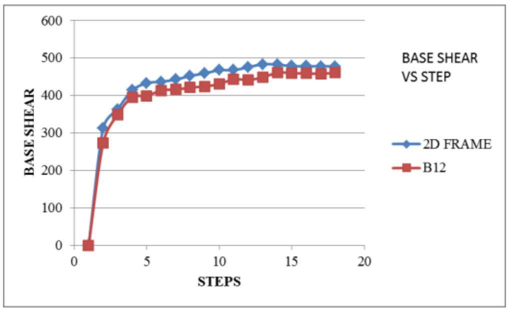

Chart-25 Base shear Vs Analysis steps of 2D Frame and B12 Frame.

3.13 B13 Frame

Beam13 is replaced by another beam of half the cross section 250 X 250mm.

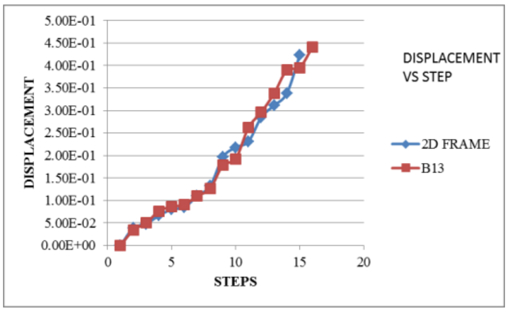

Chart-26 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B13 Frame.

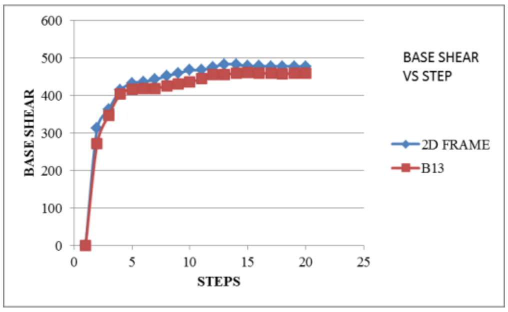

Chart-27 Base shear Vs Analysis steps of 2D Frame and B13 Frame.

3.14 B14 Frame

Beam14 is replaced by another beam of half the cross section 250 X 250mm.

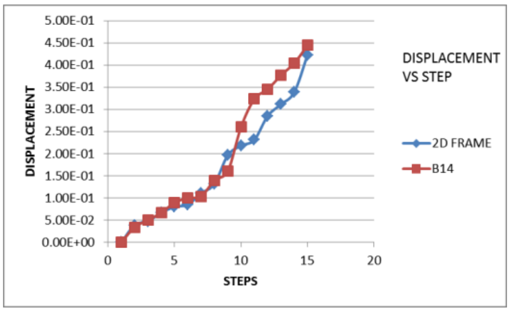

Chart-28 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B14 Frame.

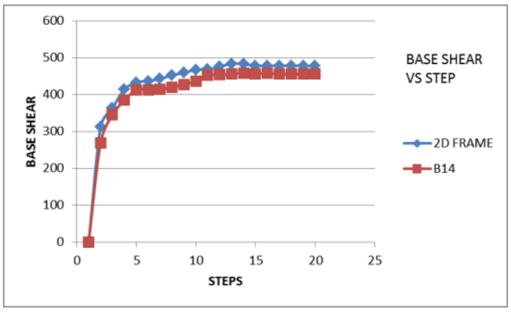

Chart-29 Base shear Vs Analysis steps of 2D Frame and B14 Frame.

3.15 B15 Frame

Beam15 is replaced by another beam of half the cross section 250 X 250mm.

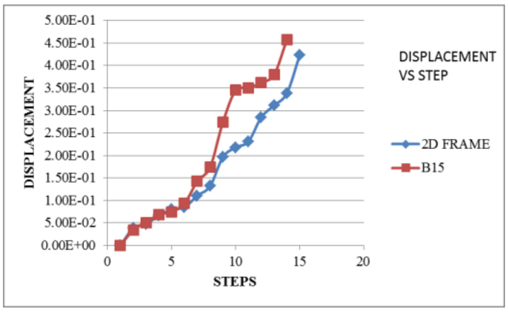

Chart-30 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B15 Frame.

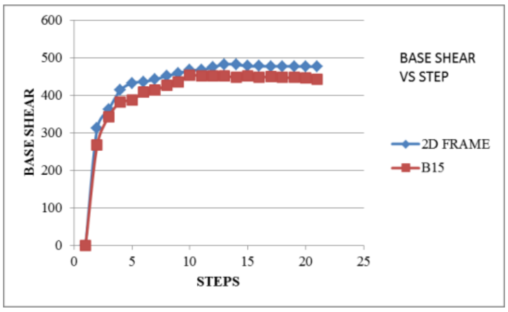

Chart-31 Base shear Vs Analysis steps of 2D Frame and B15 Frame.

3.16 B16 Frame

Beam16 is replaced by another beam of half the cross section 250 X 250mm.

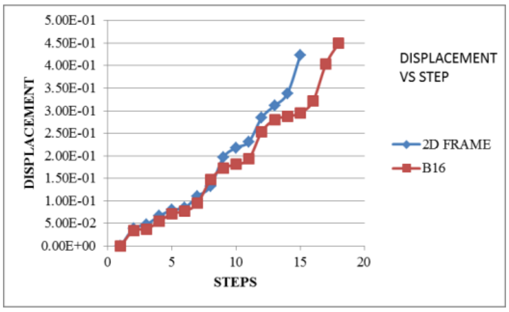

Chart-32 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B16 Frame.

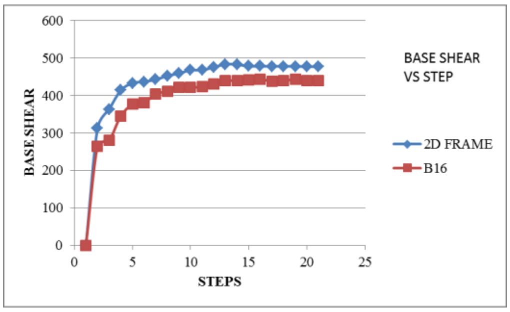

Chart-33 Base shear Vs Analysis steps of 2D Frame and B16 Frame.

3.17 B17 Frame

Beam17 is replaced by another beam of half the cross section 250 X 250mm.

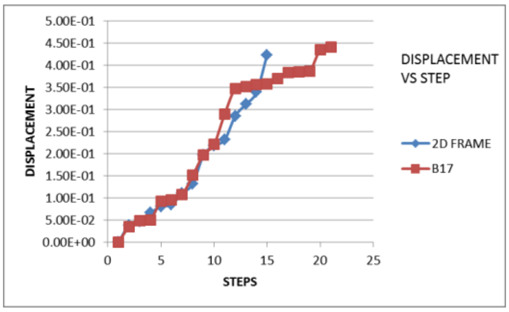

Chart-34 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B17 Frame.

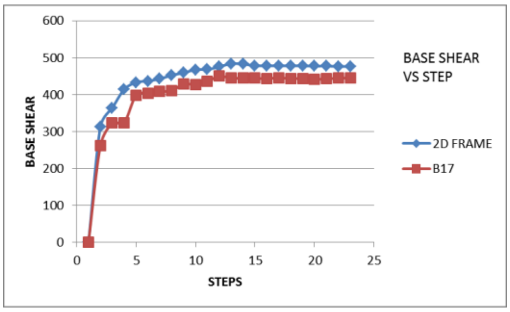

Chart-35 Base shear Vs Analysis steps of 2D Frame and B17 Frame.

3.18 B18 Frame

Beam18 is replaced by another beam of half the cross section 250 X 250mm.

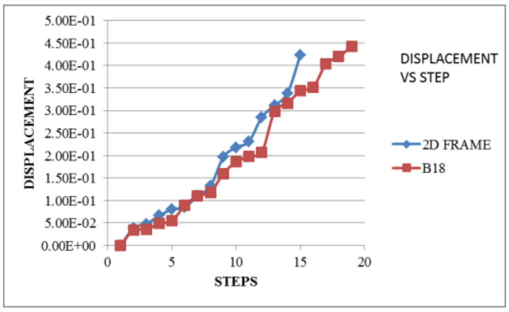

Chart-36 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B18 Frame.

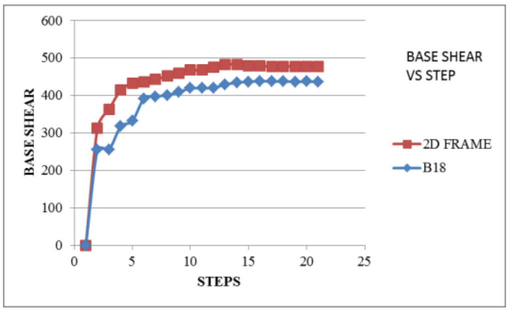

Chart-37 Base shear Vs Analysis steps of 2D Frame and B18 Frame.

3.19 B19 Frame

Beam19 is replaced by another beam of half the cross section 250 X 250mm.

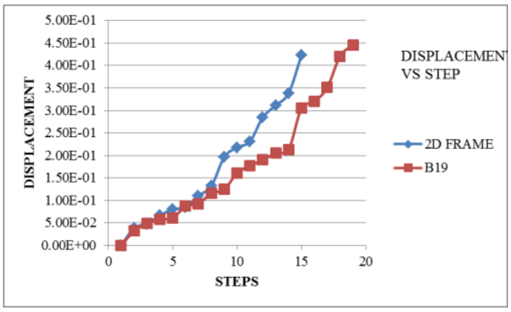

Chart-38 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B19 Frame.

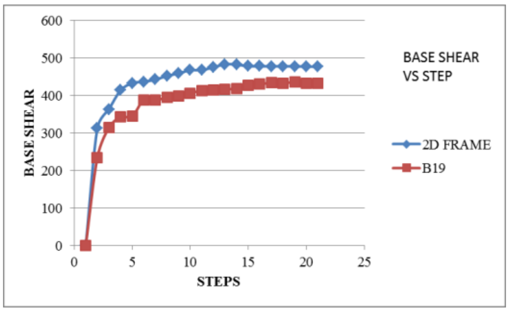

Chart-39 Base shear Vs Analysis steps of 2D Frame and B19 Frame.

3.20 B20 Frame

Beam20 is replaced by another beam of half the cross section 250 X 250mm.

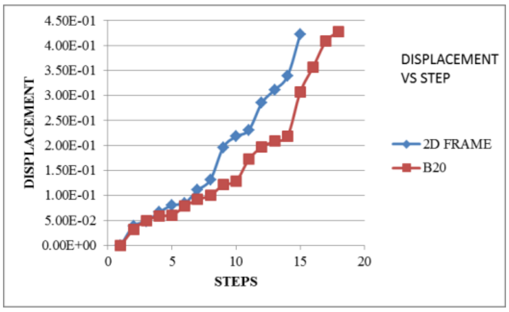

Chart-40 At Joint 11 Displacement Vs Analysis steps of 2D Frame and B20 Frame.

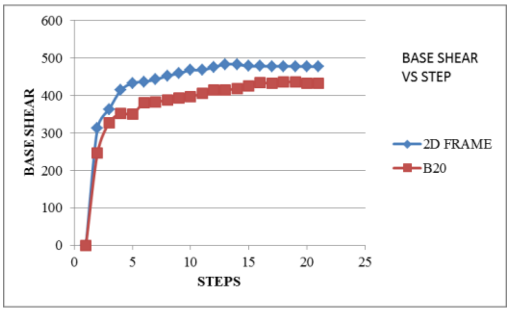

Chart-41 Base shear Vs Analysis steps of 2D Frame and B20 Frame.

3. CONCLUSIONS

- There is a reduction in base shear values up to 11% as the beam of reduced cross section is applied at the lower stories with respect to structure with uniform beam cross section.
- If the beams of reduced cross section is used in higher stories base shear values also increases close to structure with uniform beam cross section.
- For frames B1 to B10 close to pushover force as the beams of reduced cross section is applied at lower stories there is 7% increase in displacement values and it reduces when the higher stories beam is replaced
- For frames B11 to B20 away from pushover force as the beams of reduced cross section is applied at lower stories there is reduction in displacement values and it increases when the higher stories beam is replaced
- It is more advisable to have beams of reduced cross section in lower stories of the buildings.

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