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"COMPARATIVE STUDY OF RC FRAMES UNDER SEISMIC FORCES"

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ABSTRACT: A tall building concept is became possible with the new innovations, modern technologies invented, and due to all other current parameters. Because of its multipurpose use it's becoming popular but an essential need for current situations like scarcity of land available, increase in population, and etc. This all needs and importance are now possible but at the same time these all also brings new challenges for an engineer. Engineers have to check these possibilities in many directions. One of its directions is to check the building for its seismic behavior before implying it. These seismic conditions are static and dynamic. In this study the focus is made on both static and dynamic condition. For static Linear/Equivalent Static Method and for dynamic Response Spectrum Method is performed. This can be done easily but accurately on the software available in engineering market.

In this study the focus is made on the seismic behaviour of RC frames under different conditions. The main aim of this study is to analyse RC frames having different structural conditions and compare them under seismic forces. The structural conditions of the frames to be analyzed are the all frames have same symmetrical plan area but are also categorized in varying height in equally increasing order. The reason for categorizing in height is to check the behavior of frames under seismic forces for some important parameters, if such chances arise of being failed then suggest ideas to avoid or minimizing the failures.

The second and important parameter to check is that to get an optimum location of shear wall within the frames. The parameters for which frames are being analyzed and all other important points are illustrated and explained in detail in further part of the paper.

Codes referred:
IS 456-2000, IS1893:2002, IS 875 (Part-1), IS 875 (Part-2), IS 875 (Part-1)

KEYWORDS: ***Linear Static Analysis, Response Spectrum Analysis, Shear Wall, Displacement, Base shear.***

OBJECTIVES

- To determine the effects of lateral forces that comes on RC frames for static and dynamic condition.
- To obtain the optimum location of shear wall.
- To check and compare the parameters for static and dynamic condition. Parameters are base shear, maximum storey displacement, axial forces, shear forces, and beam moments.
- To check the behavior of all frames in equally varying floors for both static and dynamic condition.

INTRODUCTION:

A tall building is a structure defined differently in terms of height depending upon the place where it is located. Tall buildings became possible with enormous inventions and modern technologies. The reasons like lack of land available for development, increasing density of population made it possible but an essential need in current situation in all over the globe. Because of its multipurpose uses and its use to control urban spreading with their small footprints for large population; it's becoming an only chance. Sometimes tall buildings more about power, prestigious status where they'll give a clear sign of a being a developed city or a country. These all could be implemented by traditional RC construction and also by composite and hybrid type construction; this study refers only RC construction.

To reach all the needs and importance to implement this; comes with some critical engineering challenges. In this study the only focus is made on its seismic behavior. The main aim of this study is to analyse RC frames having different conditions and compare them under seismic forces. The

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conditions of the frames to be analysed are; the frames have same symmetrical plan area but having a varying floor in increasing manner. The reason for adopting a varying floor is to check the behavior of frames to varying floors and if some failure chances occurred then to suggest remedies for same. The second and most important condition is the location of shear wall. Different location of shear walls so placed to finalize the optimum location of shear wall in safety point of view.
As the increase in height of building it demands more critical situations to be analysed. The situations in terms of loading conditions which would be act on the frames while seismic action or an earthquake takes place. Hence in this study frames are analysed for both static and dynamic condition. In static Linear/Equivalent Static Method and in dynamic Response Spectrum Method are performed. These all conditions are analysed with one another to get the safe condition for frames to avoid and sometimes to minimize the damage of frames under seismic forces. More about the frames and parameters to which all frames to be checked are explained in detail in methodology.

METHODOLOGY

- The RC frames are such selected that have increasing floors i. e. 10 storeys, 15 storeys and 20 storey. Each storey frame is further divided into four categories namely one frame is of no shear wall and remaining three frames have shear walls at three different locations respectively.
- The parameters for which results to be checked are namely base shear, maximum storey displacement, maximum storey drift, axial forces, shear forces, and beam moments. Location of beams for checking beam moments and columns to check axial forces are mentioned in problem formulation.
- First the Linear/Equivalent Static Analysis is performed and corresponding results are separated and then Response Spectrum Analysis is applied to the same frames.
- According to the behaviour of frames or models the results and observations are taken and also illustrated for each parameter.
- For analyzing the frames/models ETAB'S software is used because of its easy use and accuracy.

PROBLEM FORMULATION:

Plan : 30m X 40m

No. of bays in X direction :7

No. of bays in Y direction : 9

Width of bays in X,Y direction : 5

Height of each storey : 3m

Support conditions : Fixed

No. of stories : 10, 15,and 20 storey

Material Properties:
Grade of concrete : M25

Grade of steel : HYSD415

Density of concrete : 25 kN/m^3

Density of steel : 76.97 kN/m^3

Density of brickwork : 20 kN/m^3

Member Properties
Column :600mm X 700mm

Beam : 250mm X 450mm

Width of brickwork : 230mm

Width of shear wall : 250mm

Thickness of slab : 125mm

General Loading:
Dead load : by software

Live loads:

On typical floor : 3kN/m^2

On terrace : 1kN/m^2

Floor finish : 1 kN/m2

Wall load : 7.65 kN/m^2

Seismic Parameters:
Type of soil : Medimum

Importance factor : 1.2

Response reduction factor : 5

Seismic zone :III

Seismic zone factor : 0.16

Location : Solapur

Modelling:
Total 24 models are prepared. In which 12 models are prepared for Linear Static Analysis and 12 models are prepared for Response Spectrum Analysis. In that four models are prepared for each 10 storey, 15 storey and 20 storey models. This format is also repeated for both analysis. Details about location of shear walls, plan and elevation are shown below.

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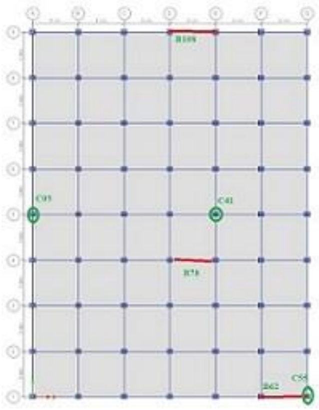
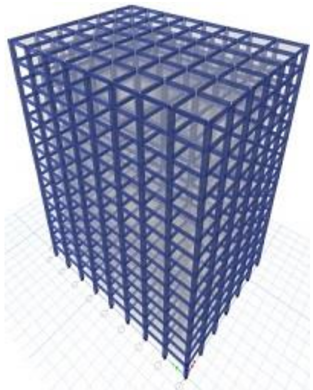
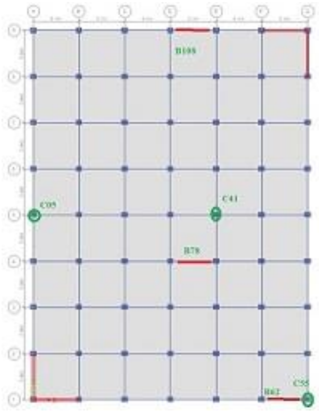


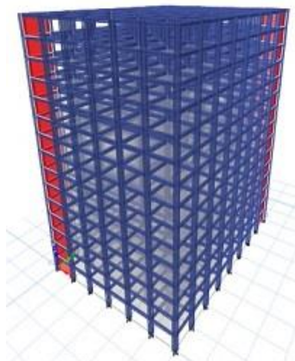
Plan without shear wall -Model A



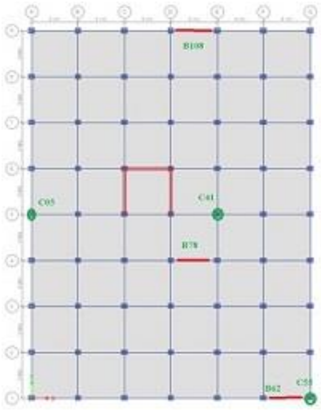
3D Elevation Model -A



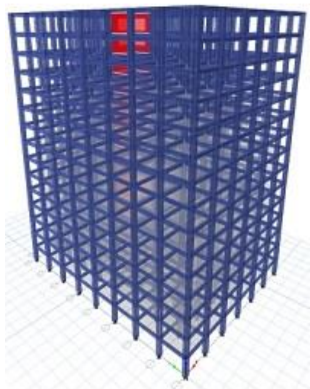
Plan with shear wall -Model B



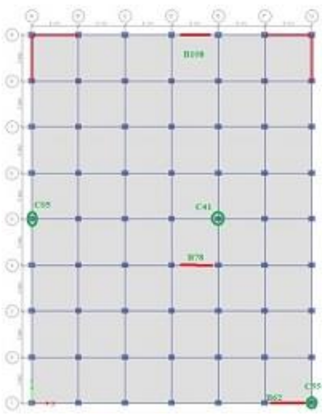
3D Elevation Model -B



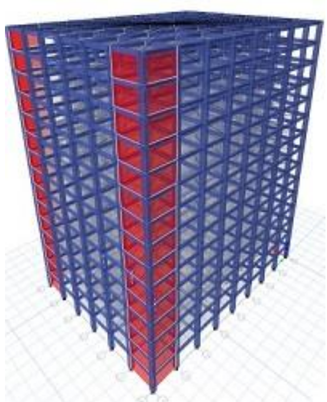
Plan with shear wall -Model C



3D Elevation Model -C



Plan with shear wall -Model D

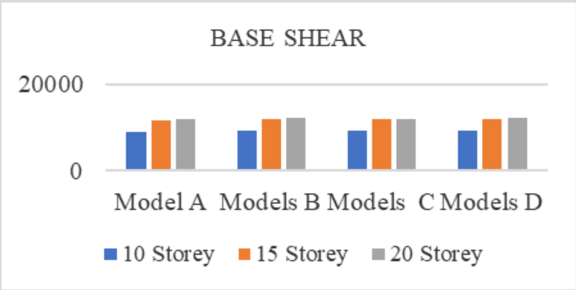


3D Elevation Model -D

RESULTS:

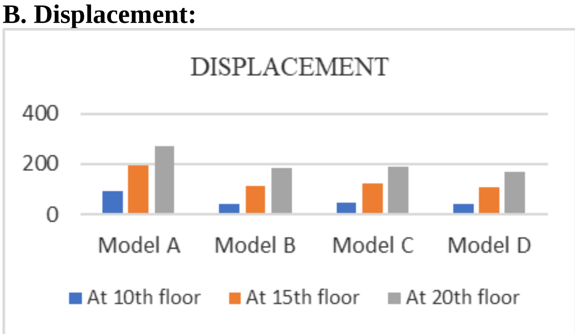
I. Linear Static Analysis

A. Base Shear



MODELS	10 STOREY	15 STOREY	20 STOREY
MODEL A	9133.9392	11854.3985	11971.72
MODEL B	9291.2194	12055.8903	12173.91
MODEL C	9251.8994	12011.145	12123.36
MODEL D	9291.2194	12042.5135	12173.91

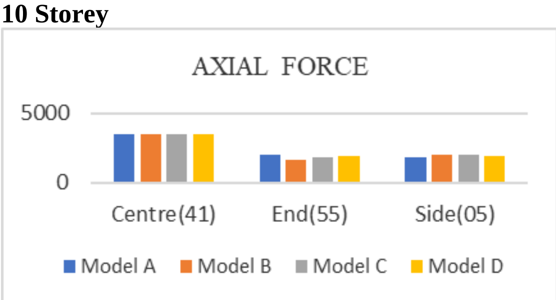
B. Displacement:



Displacement	At 10th floor	At 15th floor	At 20th floor
Model A	92.807	193.31	271.01
Model B	44.308	115.62	183.688
Model C	48.908	121.97	187.547
Model D	40.13	107.04	169.287

C. Axial force

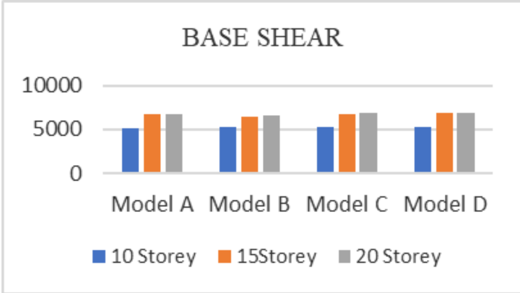
10 Storey



Column No.	Model A	Model B	Model C	Model D
Centre(41)	3543.79	3543.63	3535.44	3543.69
End(55)	2004.82	1698.9	1806.94	1901.3
Side(05)	1794.08	2045.35	2023.51	1949.52

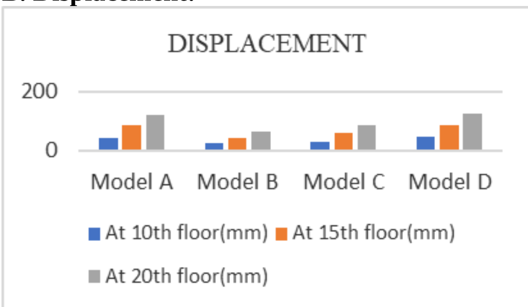
II. Dynamic Analysis

A. Base Shear



MODELS	10 STOREY	15 STOREY	20 STOREY
MODEL A	5175.16	6717.48	6783.9745
MODEL B	5267.32	6483.83	6567.3765
MODEL C	5288.89	6798.86	6861.1031
MODEL D	5265	6824.07	6898.5504

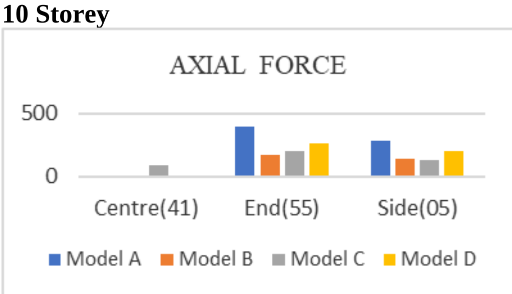
B. Displacement:



Displacement	At 10th floor(mm)	At 15th floor(mm)	At 20th floor(mm)
Model A	41.993	86.003	119.261
Model B	26.152	42.902	64.41
Model C	29.533	58.2	85.98
Model D	46.994	87.213	124.255

C. Axial force

10 Storey



Column No	Model A	Model B	Model C	Model D
Centre(41)	0.8134	0.1	91.89	0.1399
End(55)	394.78	170.61	204.12	266.79
Side(05)	279.81	137.71	133.24	201.87

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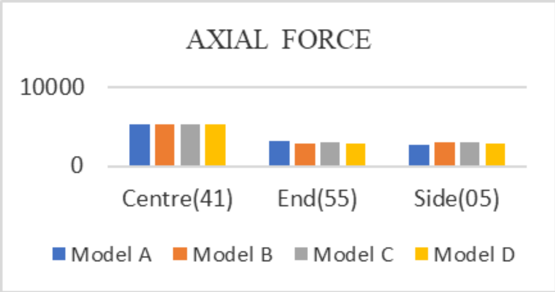
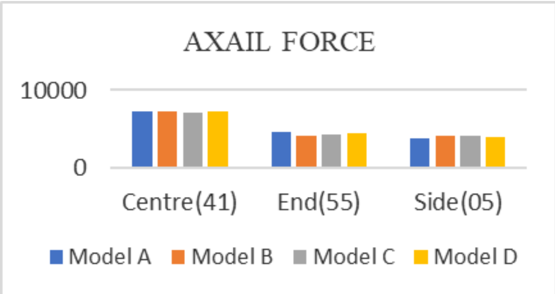
15 Storey



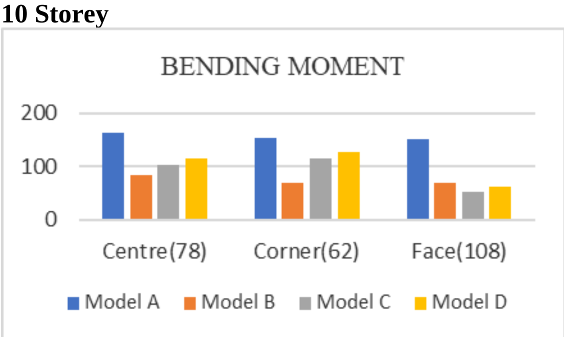
Column No.	Model A	Model B	Model C	Model D
Centre(41)	5400.93	5399.62	5334.33	5400.06
End(55)	3272.67	2846.57	3003.71	2922.16
Side(05)	2702.92	3046.41	3001.66	2922.16

20 Storey



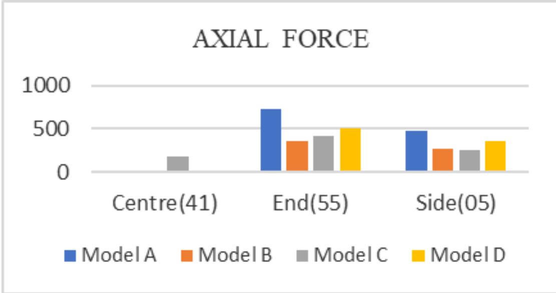
Colum No.	Model A	Model B	Model C	Model D
Centre(41)	7247.367	7243.247	7029.483	7244.227
End(55)	4566.677	4091.861	4272.39	4450.007
Side(05)	3745.579	4125.931	4027.304	3993.857

D. Bending Moments
10 Storey



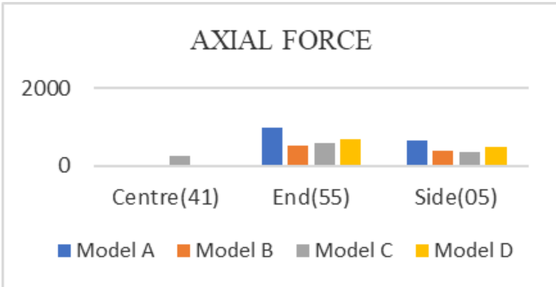
Beam No.	Model A	Model B	Model C	Model D
Centre(78)	163.771	82.9228	103.723	116.26
Corner(62)	152.468	70.2271	114.494	128.201
Face(108)	150.356	69.5192	52.4325	63.1632

15 Storey



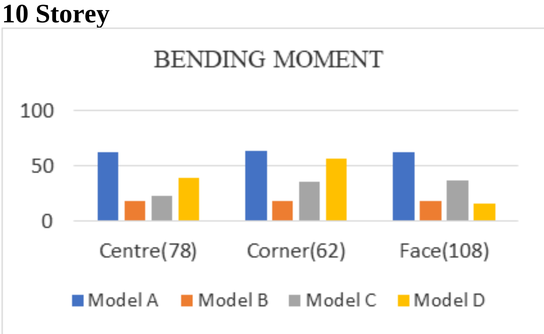
Column No	Model A	Model B	Model C	Model D
Centre(41)	2.25	1.5245	181.53	1.8337
End(55)	730.35	358.91	415.98	501.89
Side(05)	482.01	274.48	255.93	360.86

20 Storey



Column No	Model A	Model B	Model C	Model D
Centre(41)	8.2429	5.9254	242.5241	6.7856
End(55)	973.7407	519.7381	596.4895	696.2215
Side(05)	645.1774	386.5451	369.5393	496.3358

D. Bending Moments
10 Storey



Beam No	Model A	Model B	Model C	Model D
Centre(78)	61.9605	18.0423	22.3621	39.0867
Corner(62)	63.00799	17.898	35.5697	56.0959
Face(108)	61.9605	17.8645	36.3639	15.3624

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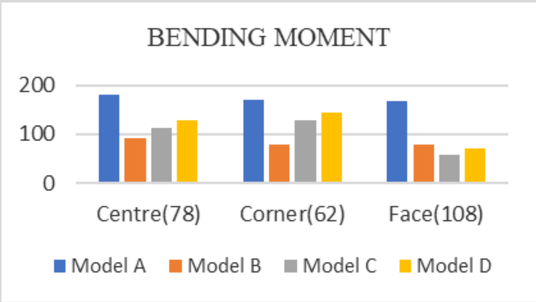
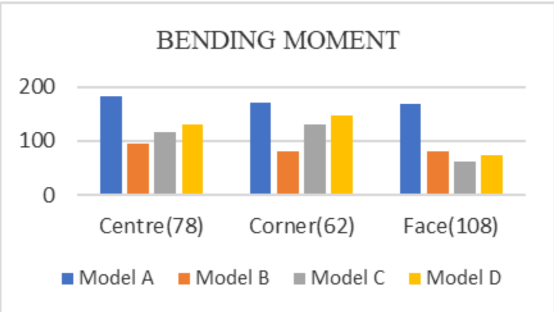
15 Storey



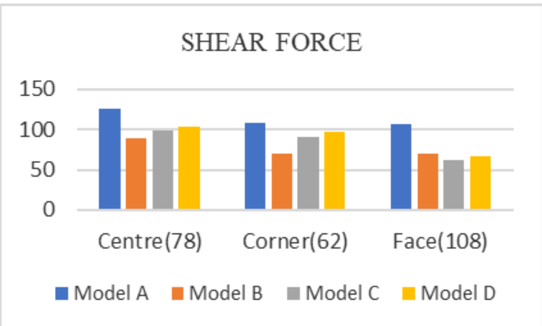
Beam No.	Model A	Model B	Model C	Model D
Centre(78)	180.366	91.3106	113.887	128.85
Corner(62)	169.182	78.809	127.519	144.334
Face(108)	166.946	78.3951	58.382	70.41

20 Storey



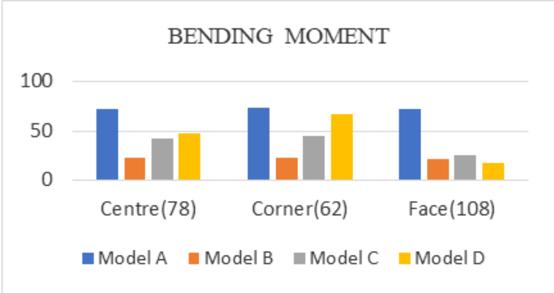
Beam No.	Model A	Model B	Model C	Model D
Centre(78)	182.4568	93.9502	115.9069	131.3001
Corner(62)	171.1354	81.4561	129.6653	146.8304
Face(108)	169.0296	81.5574	60.8018	73.0872

E. Shear Force
10 Storey



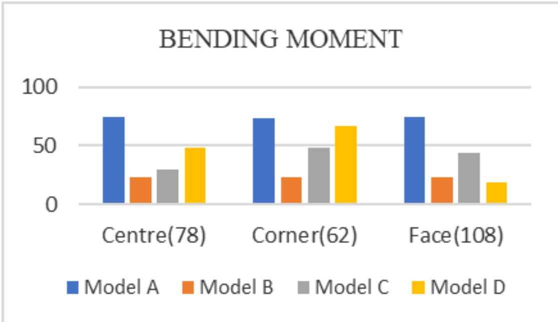
Beam No.	Model A	Model B	Model C	Model D
Centre(78)	126.065	88.461	98.137	103.967
Corner(62)	107.838	69.895	90.318	96.643
Face(108)	107.112	69.572	61.567	66.604

15 Storey



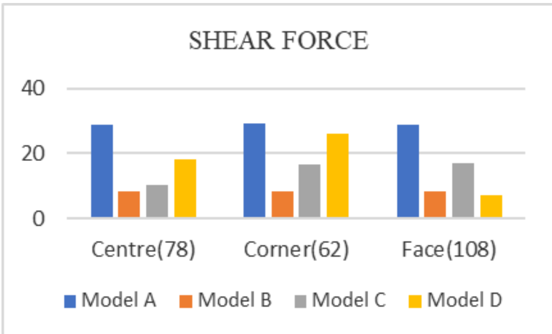
Beam No	Model A	Model B	Model C	Model D
Centre(78)	72.303	22.2734	42.5474	46.9374
Corner(62)	73.3009	22.3875	44.701	66.8136
Face(108)	72.303	21.9816	25.1201	18.0479

20 Storey



Beam No	Model A	Model B	Model C	Model D
Centre(78)	74.2612	23.1236	29.1938	48.3441
Corner(62)	73.8044	22.6906	48.0391	67.1622
Face(108)	74.2612	23.4195	44.2834	19.0539

E. Shear Force
10 Storey



Beam No	Model A	Model B	Model C	Model D
Centre(78)	28.8188	8.3229	10.4017	18.1798
Corner(62)	29.1006	8.3461	16.4089	25.8782
Face(108)	28.8188	8.3091	16.9134	7.1625

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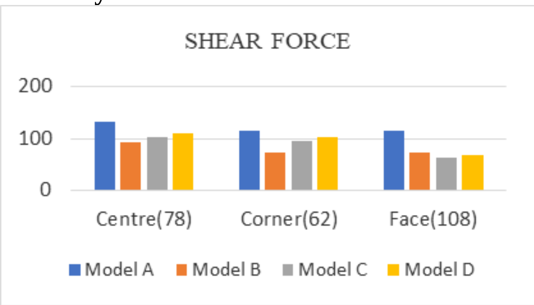
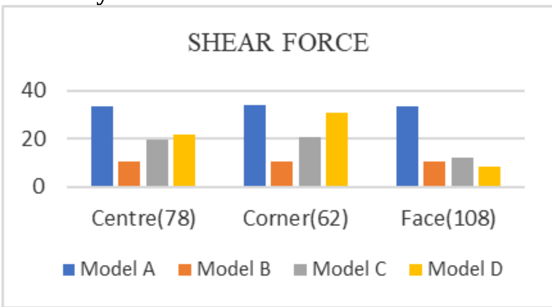
15 Storey



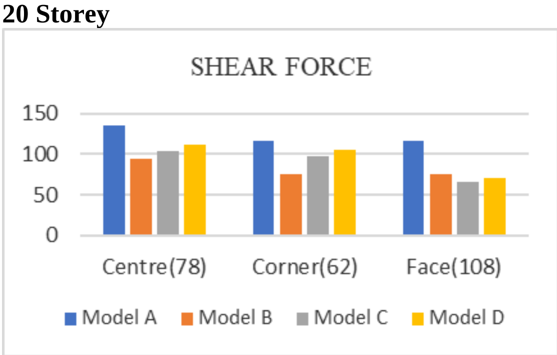
Beam No.	Model A	Model B	Model C	Model D
Centre(78)	133.78	92.363	102.867	109.8237
Corner(62)	115.55	73.857	96.329	104.088
Face(108)	114.82	73.72	64.334	69.99

15 Storey



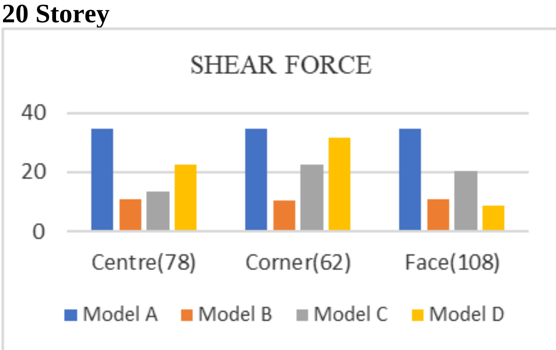
Beam No	Model A	Model B	Model C	Model D
Centre(78)	33.6292	10.3596	19.7893	21.8312
Corner(62)	33.8163	10.4398	20.6216	30.8321
Face(108)	33.6292	10.3093	11.7902	8.4146

20 Storey



Beam No.	Model A	Model B	Model C	Model D
Centre(78)	134.7575	93.5919	103.8088	110.9638
Corner(62)	116.4515	75.0785	97.3192	105.2396
Face(108)	115.7988	75.2009	65.4606	71.246

20 Storey



Beam No	Model A	Model B	Model C	Model D
Centre(78)	34.5404	10.7554	13.5775	22.4859
Corner(62)	34.6114	10.6419	22.5291	31.4968
Face(108)	34.5404	10.8639	20.5972	8.841

CONCLUSION:

- ❑ To determine the effects of lateral forces on RC frames for both static and dynamic conditions.
- ✓ Based on loading condition there is more effect has been seen for maximum storey displacement as compared to other parameters.
- ✓ In case of Base shear for static condition values of base shear are observed more than dynamic.
- ✓ The values of bending moments, Shear forces are giving more values for static condition than dynamic.
- ❑ To obtain the optimum location of shear wall.
- ✓ For static condition model D is preferable.
- ✓ For dynamic condition model B is preferable.
- ❑ To compare the frames for parameters namely base shear, maximum displacement, column forces, beam moment and beam shear force.
- ✓ For base shear values are observed more for static analysis than dynamic analysis.
- ✓ Beam moments and shear forces are observed more in static than dynamic analysis.
- ❑ To check the behaviour of all frames in equally varying height under static and dynamic conditions.
- ✓ Base shear values difference between 10 and 15 storeys are observed more than in between 15 and 20 storey frames for both static and dynamic analysis.
- ✓ Maximum storey displacements are increased as the height of frames are increased.
- ✓ Axial forces are increased as the height of frames are increased.
- ✓ Beam moments and shear forces are observed very negligible changes.

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