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Effect of Bay width on Design Parameters Bending Moment and Shear Force

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ABSTRACT

The economy of a multi-story building depends on the spacing of columns which in turn depends on panel size of slab .This study was carried out to find the effect of bay width on various design parameters like bending moment and shear force of beams and columns, also design load and design axial moment of columns, to find the optimum spacing which leads to the most economical building keeping plot area of 30 m x 30 m (constant) having 6-stories. The entire modelling and analysis was carried out using the finite element method using the STAAD pro tool and was designed as per are IS 456:2000. The four models having different bay widths (7.5 m, 6 m, 5 m, 4.285 m). These models were subjected to general loadings such as live load corresponding to IS 875 parts 1 and 2 respectively; also earthquake loads corresponding to I.S. 1893:2002. The finding was to investigate the behaviour of column and beam as per design load, design axial moment of each story of each model, variation was studied within different model also curves are drawn for design load, axial moment, bending moment, the shear force of beams and columns of each story. The result show all variations of design loads and parameters. However, to reduce the complexity with the increase in population and construction requirement to accommodate more people per unit of land and decrease the cost per unit area of the structure, this research study selected work optimum size and spacing of structural components.

1. Introduction

With increased population and land requirements for residential and commercial purposes in urban areas, multi-storied buildings are becoming common in the construction industry. Compared to low-rise buildings, apartments and multi-store buildings can accommodate more people per unit area of land and decrease the construction cost per unit area. The quantity of steel and concrete requirement for footings, beams, columns, and slabs contributes primarily to the structure's overall cost. Further, these quantities are variable, while the cost of finishing's and building services is constant for the built-up action area. From, economic point of view, it is vital to reduce the quantities of both steel and concrete without compromising quality and design requirements. The total quantity of steel and concrete requirement depends on the spacing of columns, which is the panel size of the slab. If the spacing of columns is more, the number of columns is less. Hence, the quantity of concrete, steel requirement in columns will be less; in turn, bending moment increases, ultimately design may become uneconomical design. While in beam, it would be the opposite. If the spacing of columns is less, the number of columns is more and hence, the quantity of concrete, steel will be more. Therefore reducing the spacing of columns may also lead to uneconomical design., While in case, beams it will be opposite. Since column positioning is not a constraint, it is advisable to arrive at optimum shear force, bending moment, column load, column moment, optimum spacing of columns that results in minimum quantities of steel concrete required to build up an economical design.

The optimal spacing of columns in a building is generally decided by the scale of the project, bearing capacity of the soil, column height, material of construction, required stiffness, Limitations on local building bye-laws, economic span/depth ratios. In this regard, several models were analysed of 6 story buildings for different bay widths and the effect of bay width on various design parameters like shear force, bending moments, axial design load and axial design moment, optimum spacing of columns and Beams were studied, which leads to the most economical building

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being decided. Vyas and Raisinghani, 2007 reported a study on the optimum spacing of columns based on the cost of construction in laboratory buildings. Several engineering laboratory modules for technical institutions have been investigated concerning structural cost per unit floor area. The module with a spacing of columns at 6 m (20 ft.)centre distance along length was cost-effective for laboratory blocks up to two storeys, and columns with 4.27 m centre distance along the length are cost-effective for laboratory blocks more than two storeys high. Detailed cost analysis of structure and material requirement revealed that the volume of M20 cement concrete for R.C.C. structure would be 22.9 % of floor area for laboratory buildings. Vyas and Raisinghani , 2005 determined the optimum spacing of columns and material consumption in library buildings. They observed that optimum spacing between columns is 5.94 m centre to centre both ways, assuming the size of columns as 450 mm × 350 mm. The cost of the library module does not vary much for the 6.86 m spacing of the column. Watts and Etal compared and revealed the similarities and differences between the tallest office buildings at abroad and in turkey in terms of space efficiency. Although there are no universal formulas for responding to the client's needs or local influences and constraints such as climate, code 12 or constructional conditions related to floor slab size and shape, the fundamental design considerations are almost identical in office buildings. N Shanmugasundaram and Prince G.Arulraj (2016) this research work aimed at the behaviour of the built-up steel beams. When built-up sections have smaller depths, they may behave like a beam element, and the bending moment may be predominant. When the depth becomes large, the built-up section may act as a truss wherein the bending moment will be negligible. At moderate depths, both bending moment and axial force may be predominant in the member. A parametric study had been performed for several beams with different geometry sections.

Objectives

1. To model and analyse a six-storey R.C. building for various loads.
2. To prepare different models for different bay widths by keeping plot size constant.
3. To study the effect of bay width on various design parameters.

Project Statement

1. The Analysis and design data shall be as follows:
2. Live load: 2.0 kN/ m^2
3. Floor finish: 1.0 kN/m2
4. Earthquake load: As per I.S. 1893:2002
5. Location: Vijayawada City (Zone, III)
6. Plot Area: 900 m2 (30 mX30 m) Fixed.
7. No. of Bays: 4,5,6,7
8. Story height: 3 m
9. Floors: G + 5 upper floors.
10. Type of construction: R.C.C. framed structure with brick infill walls

Methods Of Analysis

1. Method of analysis of statistically indeterminate portal frames.
2. Method of flexibility coefficients.
3. Slope displacements methods (iterative methods).
4. Moment distribution method.
5. Kane's method.
6. Cantilever method.
7. Portal method.
8. Matrix method.
9. STAAD Pro (work based on this method)

Methodology

The present work-study was based on IS Code (1893:2002); IS: 875 (Part 1) – 1987 for all loads (dead, imposed, special loads and combinations). In this research study, we modelled and analyzed a 6-storey building. Here we prepared four models of 6 story building. Each structure was modelled with different bay widths, keeping the plot area constant, i.e., 30 m x 30 m. For the modelling and analysis, we used STAAD Pro Vi8 software. The detailed modelling analysis is discussed below in various steps:

Step-1 Open STAAD PRO , click on a new project, give the units and select space. A new window opens, create a 6-storey frame of 4,5,6, and 7 bays using the structure wizard in STAAD Pro and provide building dimensions, i.e., length, width, height, and a number of bays along with length, width, and height.

Step-2: Add slab on each storey, select All beams parallel to X and Y and click on icon fill floor grids with plates. All the floor grids are filled with slabs.

Step-3: Select geometry and click on the property, there we gave a cross-section on dimensions of all beams and columns also the thickness of the slab.

Step-4: Assigning supports to the frame, supports, i.e., footings are provided with at the bottom-most column these supports are fixed support.

Step-5: Assigning loads- (Seismic Load, Dead Loads, live loads)- loading this same for all direction.

Step-6:- Selection of Seismic Zone (III).

Step-7:- Formation of load combinations.

Step-8:- Analysed each building frame model using STAAD PRO Vi8 software considering each load combination for (4 model cases) by performing analysis.

Step-9:- Comparative study of design parameters like bending moment and shear force results.

Structural Modelling

Formulation of Models

According to Table below, four types of models are taken in this project. The structure was designed as per IS 456:2000, to study the effect of bending moments, shear force, column load, column moments . We designed a four-bay model which represents the same for all models:

1. Click on the Design Tab.
2. Select concrete design.
3. Select our required code, i.e., I.S.: 456:2000
4. We need to select parameters by clicking on it, like characteristic concrete strength, steel characteristic, strength etc.
5. Now defining those parameters takes characteristic concrete strength as 2500 kN/m2 and steel characteristic strength as 415000 kN/m2, since we are using M20 concrete and Fe 415 steel.
6. Assign the defined parameters to the entire structure.
7. We need to define some commands like design beam, design column, design element and take off.
8. Assign those commands to appropriate members.

Again, press CONTROL + F5 for analysing and designing the structure. after the processing complete STAAD PRO output file gives all the design, forces and concrete steel requirements. Double click on the Design tab to check for a particular beam or column. There we can see design values also concrete design. In this research study, we had noted every value of design bending moment and design shear force of every beam in each story in each model. Also, design column load and design column axial moment of each column in each story of each model. Now we analysed the variations of each parameter with a change of bay width .

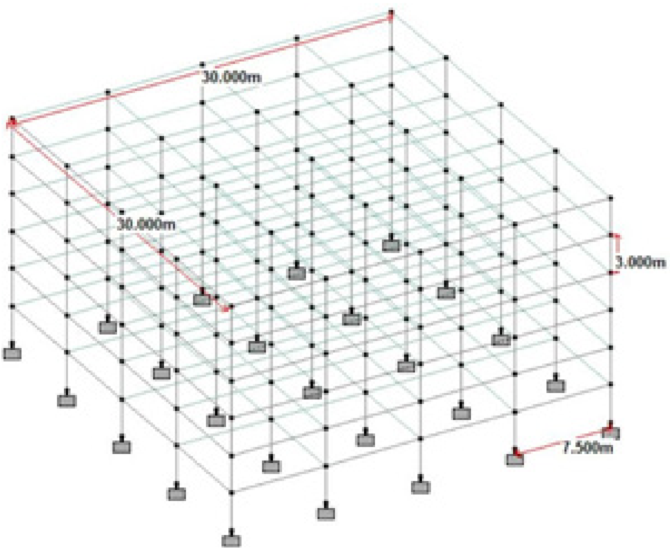
Modelling of frames in STAAD PRO

Modelling was done by using STAAD PRO software. Table 1.1 represents figures

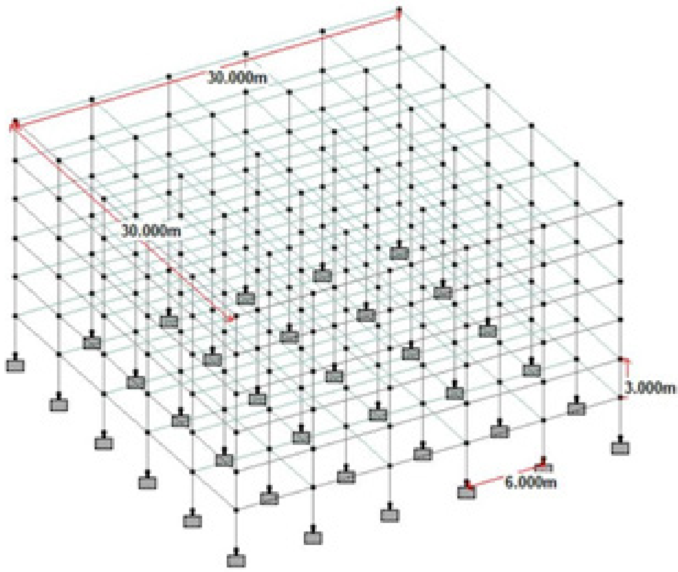
Bay Model	Bay width
4	30/4, 7.5m
5	6 m
6	5 m
7	4.285m

Table: 1.1

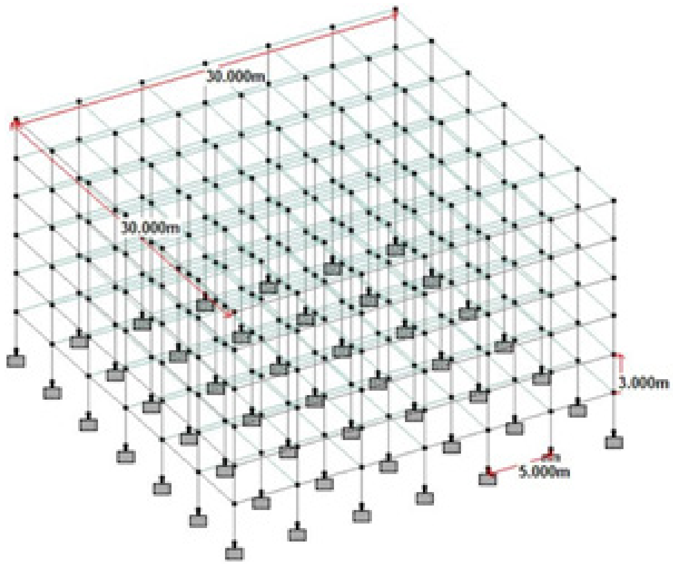
The models of bay frames are created and are as shown below in figures:



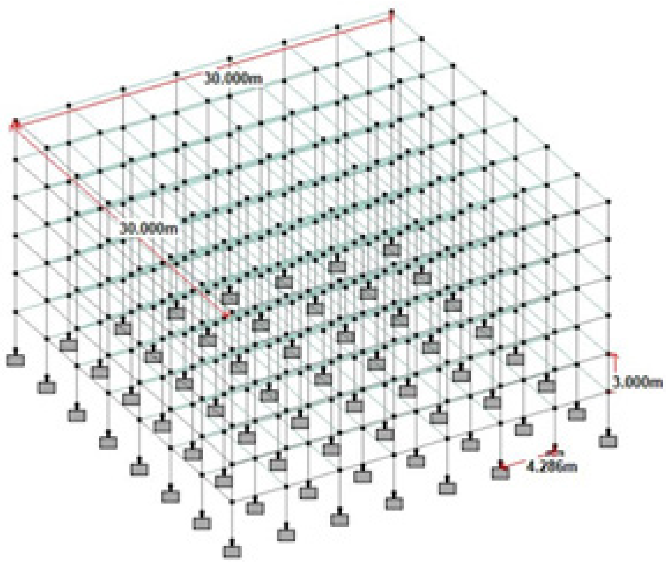
4 Bays Model



5 Bay Model



6 Bay Model



7 Bay Model

Table:1.2 shows some geometric and material of frame and loads on frame relationship with above models.

Component	Description	Data
Floors	G+5	R.C.C. framed structure with brick infill walls
	Size of column	0.4x0.45
	Thickness of Slab	0.150
	Frame height	18 m
	Bay width variation	4 m, 5 m, 6 m and 7 m
	Each story height	3 m
Loads on frame	Self-weight	-
	Floor finish	1KN/m
	Brick wall load	0.23X3X20, 13.8 kN/m
	For Terrace (6th story)	0.23X1X20 , 4.6 kN/m
	Parapet wall load	2.5 KN/m
	Live load	2 (KN/m floor load) as per IS 875 part 2
	Seismic loads	According to I.S. 1893:2002(part-1)
Plot area	Constant for 4,5,6 and 7 Bay	30x30 m
Material Properties	Concrete	All components unless specified in design: M25 grade all.
	Steel	HYSD reinforcement of grade Fe 415 confirming to I.S.: 1786 was used throughout
location	Vijayawada city	ZONE III

Results And Discussion

The beam moment, column moments, and maximum shear force variation were noted. From the results, it was observed that the 5-bay width = 6 m proved to be optimum and efficient. The percentage increment/decrement of a column, beam moments and shear forces are shown below.

Column Parameters

The column design was based on design load and designed axial moments acting on a column . We studied these design loads and axial moment values of each column of each story of all four models.

After observing these values we had observed , how these values changed from one model to another model at the same story.

Since each column had two axial moments, i.e., Bi-axial moments, we took a maximum of two for the study. Now let's see these design values for all four models

4 - Bay Model

This is model has 4 bays, bay width is 7.5 m. The plan of 4 bay model is shown in below fig 5.1.1, in which the column numbers are indicated. All additional graphs and tables will be regarding these column numbers.

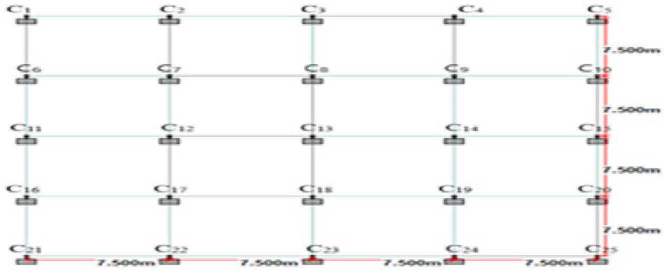


Fig: 5.1.1

Since these models and loadings are symmetric, the design values for symmetric columns would be same. We only reported these values ,to avoid duplicate or symmetric values for the convenience and simplicity of work. The symmetric columns numbers are shown below:

1. 1,5,21,25,
2. 2,4,22,24,
3. 3,23,
4. 6,10,16,20,
5. 7,9,19,17,
6. 8,18,
7. 11,15,
8. 12,14.

Table 1.3: The design axial moments values in kN-m of the 4-bay model is shown below:-

	Story 1	Story 2	Story 3	Story 4	Story 5	Story 6
C1	278.56	290.53	60.85	40.67	172.41	116.35
C2	294.96	259.89	221.17	90.41	55.22	14.82
C3	294.1	258.27	220.33	89.01	54.51	14.47
C6	294.96	259.89	221.17	66.63	37.04	1.55
C7	428.16	282.23	261.47	250.69	90.85	37.92
C8	427.58	281.13	259.37	249.19	89.45	37.52
C11	294.1	258.27	220.33	66.01	36.62	1.55
C12	427.38	281.13	259.37	249.19	89.98	37.06
C13	424.81	274.68	257.505	241.01	88.41	36.6

The variation of design axial moment in each story of the 4-bay model is shown in below graph 5.1.2:

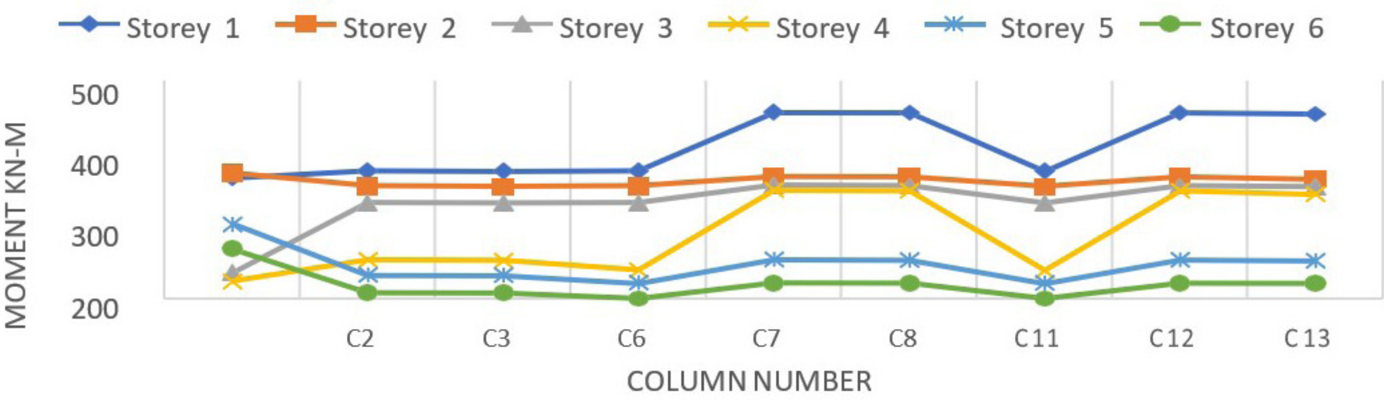


Fig: 5.1.2

The variation of design load in each story of the 4-bay model is shown in graphs 5.1.3:

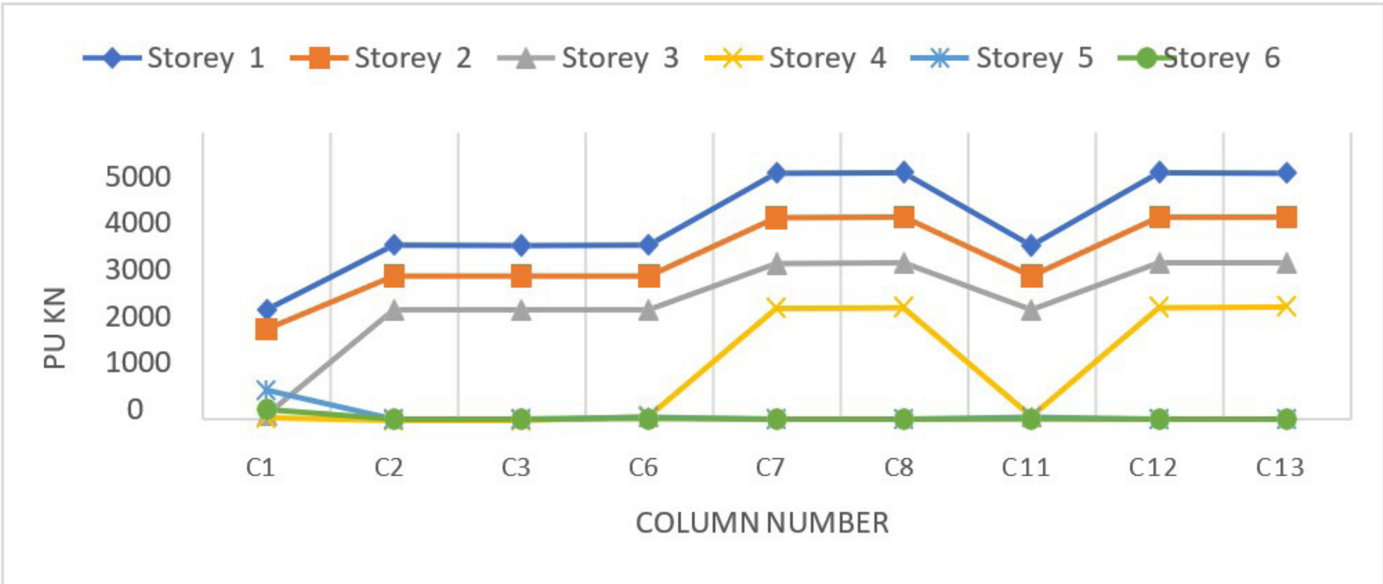


Fig: 5.1.3

In the above Graph we can observe that Design moment values at each storey is maximum at **C7, C8, C12, C13,** these are interior columns.

Table 1.4: The design load values in kN of 4 bay model are shown below:

	Story 1	Story 2	Story 3	Story 4	Story 5	Story 6
C1	1911.26	1574.13	77.09	47.85	513.69	182.08
C2	3043.87	2500.05	1916.84	1.92	0.91	0.5
C3	3042.5	2501.14	1919.17	0	0	0
C6	3043.87	2500.05	1916.84	70.66	35.03	11.72
C7	4309.07	3526.84	2727.44	1948.15	1.36	0.7
C8	4317.93	3538.29	2738.36	1956.43	0	0
C11	3042.5	2501.14	1919.17	69.58	34.49	11.45
C12	4317.93	3538.24	2738.36	1956.43	1.53	0.76
C13	4308.83	3535.55	2740.46	1971.75	0	0

In the above Table, we observed that design load values at each story were maximum at C 7, C 8, C 12, C 13. These are the interior column. Hence, this empirical study was also applied to the other columns of three models (5, 6 and 7 bay).

Beam Parameters

The beam design was based on design bending moments and the design shear force acting on the beam. In this research, we observed design bending moment and design shear force values of each beam of each story of all four models.

After observing these values we had observed how these values changed from one model to another model at the same story.

Since each beam had a different bending moment at other locations, so we took maximum bending moment for our research study (same in the case of shear force)

4-Bays model

This model had 4-bays, the plot area is 30 mx 30 m, and the bay width is 7.5 m which is the length of beams. The plan of 4 bay model is shown in below fig 5.2.1 , in which the beam numbers are indicated using a grid of A, B, C.... and bay numbers 1, 2, 3.... The beam number is a combination of alphabet and number based on its location in the plan. All other graphs and tables are regarding these beam numbers.

Since these models and loadings are symmetric, the design values that came out for the symmetric beam is to be the same. For the convenience and simplicity of work, we reported only these values by avoiding duplicate or symmetric values, i.e., one value is written only once.

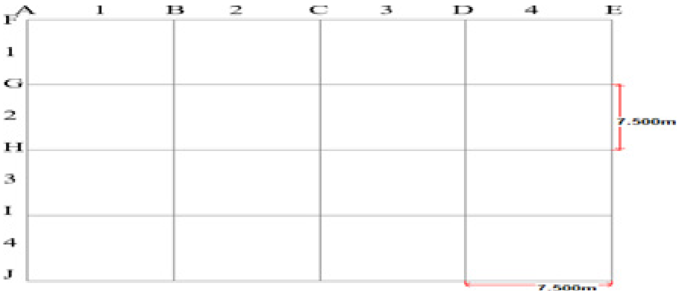


Fig: 5.2.1

Table 1.5: The design bending moments values in kN-m of the 4-bay model is shown below

	Storey 1	Storey 2	Storey 3	Storey 4	Storey 5	Storey 6
A1	193.3	208.41	200.64	119.24	169.96	96.07
A2	190.55	204.78	200.67	187.73	167.98	97.33
B1	217.77	227.08	224.88	215.5	212.75	114.71
B2	214.68	223.38	220.79	211.46	211.47	114.64
C1	217.78	227.22	224.98	215.5	212.72	114.52
C2	214.82	223.32	220.96	211.63	211.46	114.67
F1	193.3	208.41	200.64	119.24	169.96	96.07
F2	190.55	204.78	200.67	187.73	167.98	97.33
G1	217.77	227.08	224.88	215.5	212.75	114.71
G2	214.68	223.38	220.79	211.46	211.47	114.64
H1	217.78	227.22	224.98	215.5	212.72	114.52
H2	214.82	223.32	220.96	211.63	211.46	114.67

In the above table, we also observed that the bending moment was almost the same for all beams of a particular storey. Also, Bending moments varied much for the different storey except the top story because there were no 3 m walls present on the terrace but, 1 m parapet wall was present.

The variation of design bending moment value of beams in each storey of 4 bay model is shown in Fig 5.2.2

In the graph, it's observed that moments are almost similar.

Table 1.6: The Shear Force Values in kN of the 4-Bay model are shown below

	Storey 1	Storey 2	Storey 3	Storey 4	Storey 5	Storey 6
A1	118.26	79.24	120.69	83.72	89.25	69.51
A2	83.33	120.62	119.53	116.09	110.82	69.8
B1	136.22	107.1	107.62	110.06	152.26	74.86
B2	110.31	136.95	136.27	133.8	153.17	75.63
C1	136.22	107.05	107.59	110.03	152.27	74.93
C2	110.27	107.97	136.32	113.84	153.17	75.64
F1	118.26	79.24	120.69	83.72	89.25	69.51
F2	83.33	120.62	119.53	116.09	110.82	69.8
G1	136.22	107.1	107.62	110.06	152.26	74.86
G2	110.31	136.95	136.27	133.8	153.17	75.63
H1	136.22	107.05	107.59	110.03	152.27	74.93
H2	110.27	107.97	136.32	113.84	153.17	75.64

In the above Table, we observed, the shear force is not varying much for the different storey except for the top storey because there are no 3 m walls present on the terrace, but 1 m parapet wall is present.

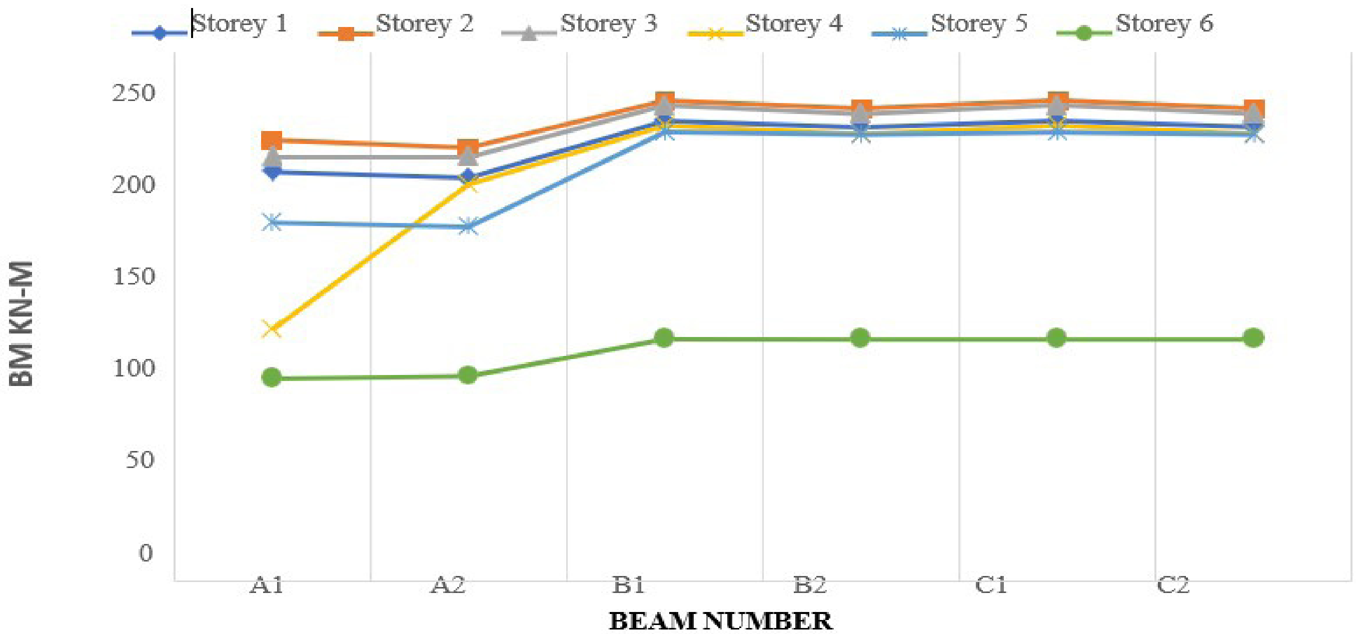


Fig 5.2.2

The variation of Shear Force value of Beams in each storey of 5 Bay model is shown below Fig 5.2.2

Fig 5.2.2

5.3: Comparison of each storey maximum design axial moment of different models of columns

Till now it was observed each value of design axial moment of all columns of all stories of all four models. All 4 model values are compared at once for maximum value at each storey and tabulating them below table 2.1,

	4 Bays	5 Bays	6 Bays	7 Bays
Storey 1	428.16	226.32	159.58	131.62
Storey 2	290.53	202.12	149.99	123.44
Storey 3	261.47	192.1	144.74	118.14
Storey 4	250.69	176.5	130.51	62.14
Storey 5	172.41	111.35	79.09	42.24
Storey 6	116.35	27.62	21.88	16.72

Also, the above data is represented in a Graph below fig 5.3. ,

From the above and graph, we observed that the maximum axial moment value decreases at all stories withthe increase in the number of bays, i.e., decrease in bay width. The 4-bay model has the maximum value because of the higher bay width, whereas the 7-bay model has the lowest. Further, we observed at what bay width we got the optimum value of design axial moment by observing percentage increase in an axial moment with the percentage increase in bay width, which is tabulated below :

	From 7-Bay to 6- Bay	From7-Bay to 5- Bay	From 7-Bay to 4-Bay
% Increase in bay width	16.6	40.02	75.02
% Increase in Axial Moment @ Storey 1	21.24297	71.94955	225.3001
Storey 2	21.50843	63.73947	135.3613
Storey 3	22.51566	62.60369	121.3222
Storey 4	110.0257	184.036	303.4277
Storey 5	87.23958	163.6127	308.1676
Storey 6	30.86124	65.19139	595.8732
Averages	48.89894	101.8555	281.5754

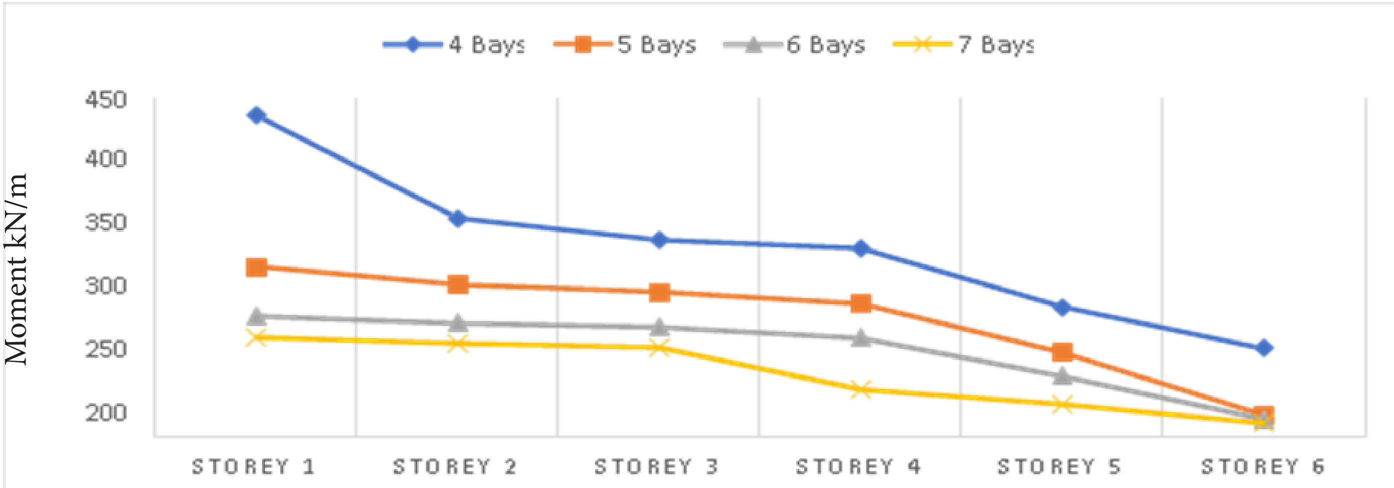


Fig: 5.3.1

From the above Table,

1. It was observed that the bay width is increased by 16.6 % from 7 bays to 6 bays, i.e., 4.285 m to 5 m which leads to an average Increase in Axial moment of 48.89 %.
2. It was observed that the bay width is increased by 40.02 % from 7 bays to 5 bays, i.e., 4.285 m to 6 m which leads to an average increase in Axial moment of 101.85 %.
3. It was observed that the bay width is increased by 75.02 % from 7 bays to 4 bays, i.e., 4.285 m to 7.5 m which leads to an average increase in Axial moment of 281.57 %.

It was observed that 6 m bay width is effective because a 40.12 % increase in bay width leads to a 101.85 % average increase in an axial moment. Whereas in the case of 4 bays, i.e., 7.5 m bay width, 75.02 % increase in bay width leads to a very high increase of 281.57 % increase in an axial moment.

5.4. Comparison of each storey maximum design axial load of different models of columns :

Till now, we observed each value of design load of all columns of all stories of all four models, and now we had compared all 4 model values at once. Taking maximum value at each story of 4 models and tabulating them below table 2.4,

	4 Bays	5 Bays	6 Bays	7 Bays
Storey 1	4317.9	3050.16	2334.06	1865.91
Storey 2	3538.24	2494.06	1908.12	1526.43
Storey 3	2740.46	1902.28	1465.54	83.49
Storey 4	1971.75	1347.57	1046.36	48.57
Storey 5	513.69	379.81	303.89	21.21
Storey 6	132.08	8.77	6.33	5.46

Also, the above data is represented in the form of a Graph Fig 5.3.2

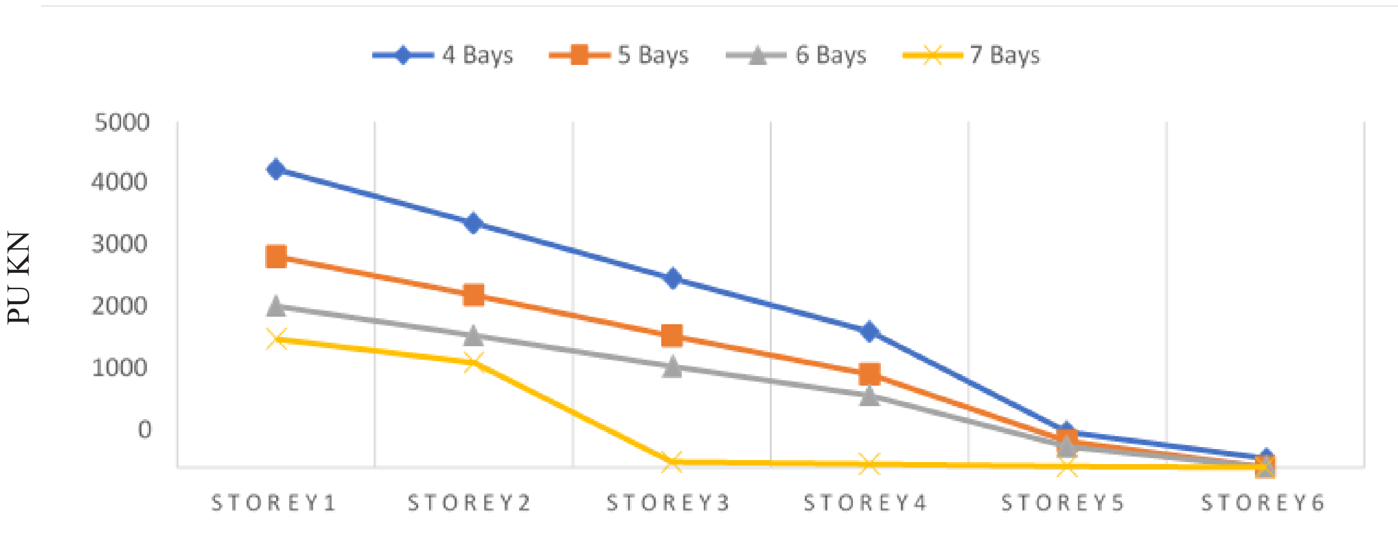


Fig: 5.3

The above graphs represent that the maximum design load value decreases at all stories with the increase in the number of bays, i.e., a decrease in bay width. The 4 Bay model has the maximum value because the of higher Bay width, whereas the 7-Bay model has the lowest value because of the most inadequate Bay width.

Further, we studied at what bay width we got an optimum value of design axial load by studying percentage increase in design axial load with percentage Increase in bay width, and it is tabulated below table 2.5,

	From 7-Bay to 6-Bay	From 7-Bay to 5-Bay	From 7-Bay to 4-Bay
% Increase in bay width	16.6	40.02	75.02
% Increase in Axial Load @ Storey 1	25.08963455	63.46769137	131.4098751
Storey 2	25.00540477	63.39170483	131.7983792
Storey 3	1655.347946	2178.452509	3182.381123
Storey 4	2054.333951	2674.490426	3959.604694
Storey 5	1332.767562	1690.711928	2321.923621
Storey 6	15.93406593	60.62271062	2319.047619
Averages	851.4130941	1121.856162	2007.694219

From above Table,

1. It was observed that the bay width is increased by 16.6 % from 7 bays to 6 bays, i.e., 4.285 m to 5 m which leads to an average Increase in Axial Load of 851.41 %.
2. It was observed that the bay width is increased by 40.02 % from 7 bays to 5, Bays, i.e., 4.285 m to 6 m which leads to an average increase in Axial Load of 1121.85 %.
3. It was observed that the bay width is increased by 75.02 % from 7 bays to 4 bays, i.e., 4.285 m to 7.5 m which leads to an average increase in Axial Load of 2007.69 %.

It was Observed that 6 m Bay width is effective because of 40.12 % increase in bay width leads to 1121.85 % average increase in axial load. Whereas in the case of 4 bays, i.e., 7.5 m bay width, 75.02 % increase in bay width leads to 2007.69 % increase in axial moment, which is very high.

5.4.1: Comparison of each storey Maximum Design Bending Moment of Different models of Beams

Till now, we observed each value of design bending moment of all beams of all stories of all 4 models ,now we compared all 4 model values at once. Taking maximum value at each story of 4 models and tabulating in below table 2.6

	4 Bays	5 Bays	6 Bays	7 Bays
Storey 1	217.78	130.36	101.94	69.73
Storey 2	227.22	137.03	105.59	72.06
Storey 3	224.98	134.39	101.78	69.61
Storey 4	215.50	128	93.48	63.8
Storey 5	212.75	123.99	81.44	56.44
Storey 6	114.71	61.56	38.24	24.73

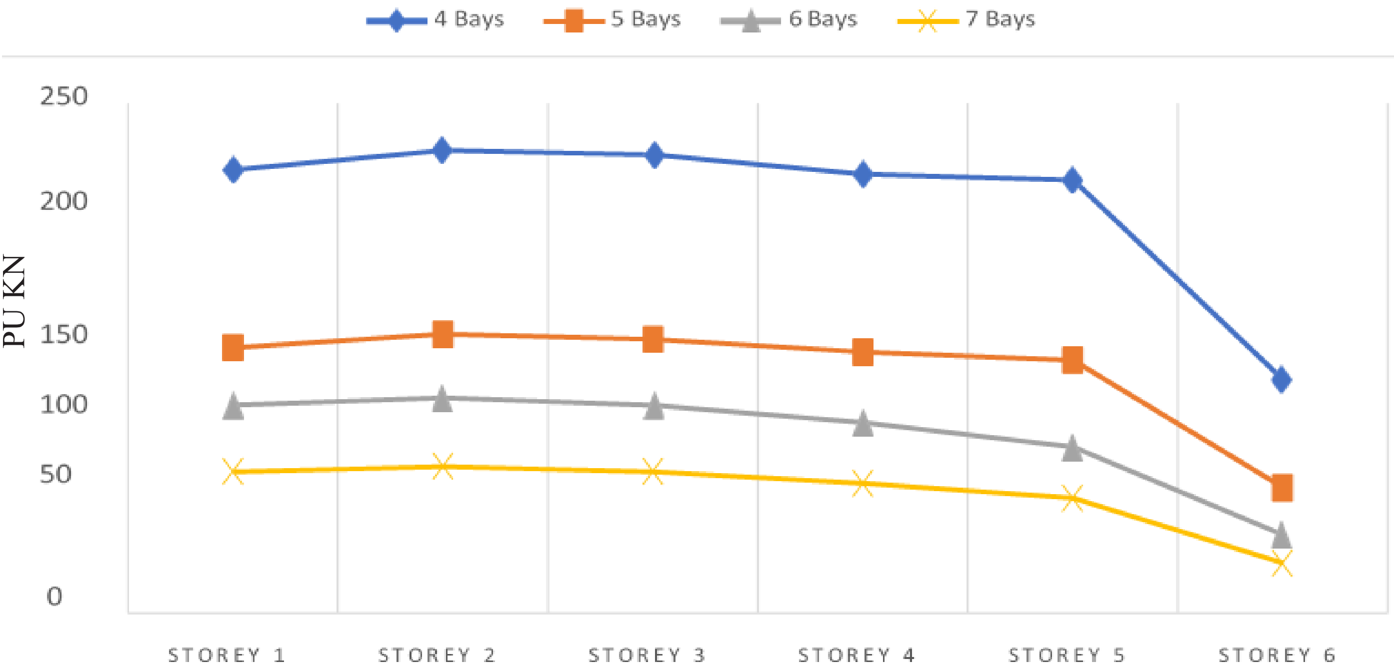
Also, the above data is represented in the form of a Graph Fig 5.4.1,

From the above Table,

1. It was observed that the bay width is increased by 16.6 % from 7 bays to 6 bays, i.e., 4.285 m to 5 m which leads to an average increase in bending moment of 47.39 %.

2. It was observed that the bay width is increased by 40.02 % from 7 bays to 5 bays, i.e., 4.285 m to 6 m which leads to an average increase in bending moment of 106.56 %.

3. It was observed that the bay width is increased by 75.02 % from 7 bays to 4 bays, i.e., 4.285 m to 7.5 m which leads to an average increase in bending moment of 254.9 %.



From the above Table and graph, we observed that the maximum design bending moment value is almost the same at all storeys of 4 models except top storey because there is parapet wall . The 4-Bay model has maximum value because of higher Bay width, whereas 7-Bay model had the lowest value because of lowest Bay width.

Further we observed at what bay width we got an optimum value of design bending moment by studying percentage increase in design bending moment with the percentage increase in bay width, it is tabulated below **Table 2.7**

	From 7-Bay to 6-Bay	From 7-Bay to 5-Bay	From 7-Bay to 4-Bay
% Increase in Bay width	16.6	40.02	75.02
% Increase in Bending moment @ Storey 1	46.19245662	86.94966299	212.3189445
Storey 2	46.53066889	90.16097696	215.3205662
Storey 3	46.21462434	93.06134176	223.2006896
Storey 4	46.52037618	100.6269592	237.7742947
Storey 5	44.29482636	119.6846208	276.9489724
Storey 6	54.63000404	148.928427	363.8495754
Averages	47.3971594	106.5686648	254.9021738

It was observed that 6 m bay width is effective because a 40.12 % increase in bay width leads a to 106.56 % average increase in bending moment. Whereas in the case of four bays, i.e., 7.5 m bay width, 75.02 % increase in bay width leads to 254.9 % increase in bending moment, which is very high.

5.5.1 Comparison of each storey maximum shear force of different models of beams

Till now, we observed each value of design shear force of all beams of all storeys of all 4 models, now we compared all 4 model values at once. Taking maximum value at each storey of models and tabulating them below table: 2.8,

	4 Bay	5 Bay	6 Bay	7 Bay
Storey 1	136.22	99.23	82.43	66.96
Storey 2	136.95	100.65	83.61	69.59
Storey 3	136.27	101.23	82.37	67.12
Storey 4	113.84	97.8	79.73	65.08
Storey 5	152.26	111.24	87.18	70.35
Storey 6	75.64	49.62	38.4	30.54

Also, the above data is represented in the form of a Graph Fig 5.5.1

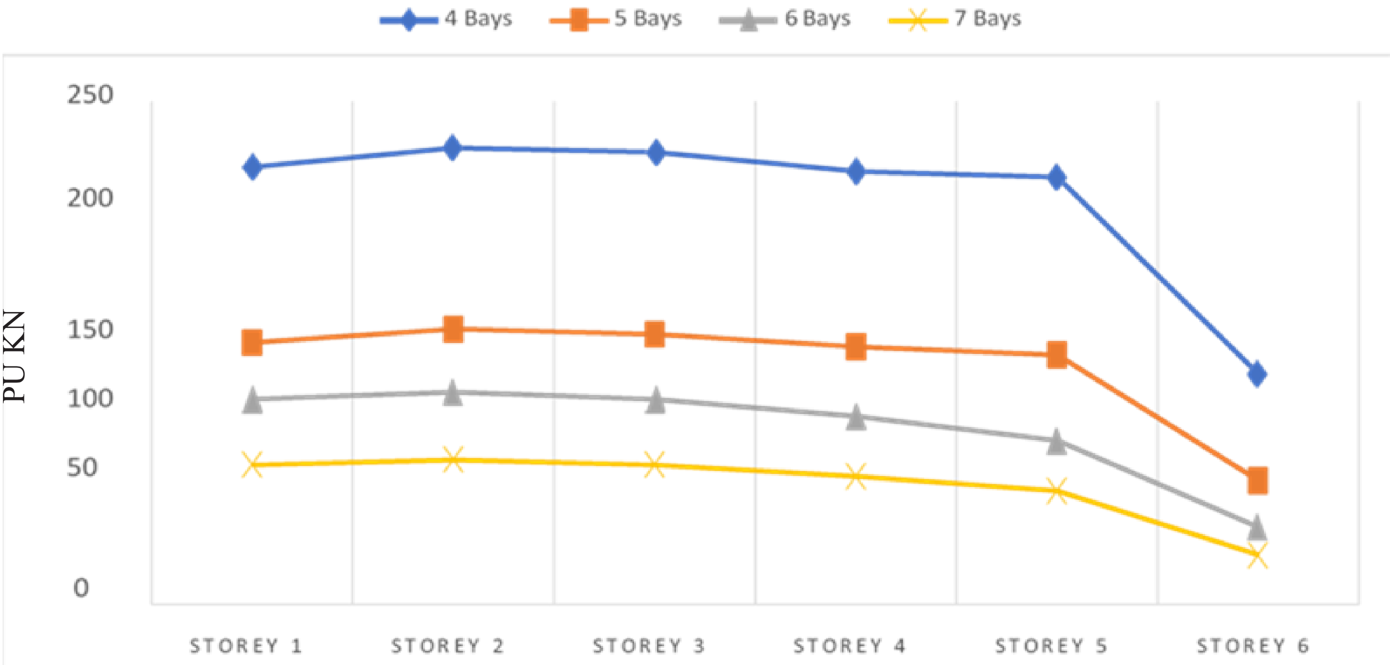


Fig 5.5.1

From the Table and graph, we observed that maximum design shear force is almost the same at all storeys of 4 models except top storey because there is parapet wall. The 4-bay model has maximum value because of higher bay width. In contrast, the 7-bay model has the lowest value because of the lowest bay width.

Further, studied what bay width we can get the optimum value of shear force by studying percentage increase in shear force with the percentage increase in bay width, it is tabulated below Table:-2.9:

	From 7-Bay to 6-Bay	From 7-Bay to 5-Bay	From 7-Bay to 4-Bay
% Increase in Bay width	16.6	40.02	75.02
% Increase in Shear Force @ Storey 1	23.10334528	48.19295102	103.4348865
Storey 2	20.14657278	44.63284955	96.7955166
Storey 3	22.7205006	50.81942789	103.0244338
Storey 4	22.51075599	50.27658267	74.92317148
Storey 5	23.92324094	58.12366738	116.4321251
Storey 6	25.7367387	62.47544204	147.6751801
Averages	23.02352572	52.42015342	107.0475523

From the above Table,

1. It was observed that the bay width is increased by 16.6 % from 7 bays to 6 bays, i.e., 4.285 m to 5 m which leads to an average increase in the in shear force of 23.2 %.

2. It was observed that the bay width is increased by 40.02 % from 7 bays to 5 bays, i.e., 4.285 m to 6 m which leads to an average increase in the shear force of 52.42 %.

3. It was observed that the bay width is increased by 75.02 % from 7 bays to 4 bays, i.e., 4.285 m to 7.5 m which leads to an average increase in the shear force of 107.04 %.

t was Observed that 6 m Bay width is effective because a 40.12 % increase in bay width leads to a 52.42 % average Increase in Shear force. Whereas in the case of 4 bays, i.e., 7.5 m bay width, 75.02 % increase in bay width leads to a very high 107.04 % increase in Shear Force.

4.5:- Steel And Concrete Quantities

The steel and concrete quantities required for all models are tabulated below,

	Steel in kN	Concrete in m^3
4-Bay	417.42	279.5
5-Bay	411.42	305
6-bay	409.8	344
7-Bay	403.07	383

From the above Table, we observed that 5-Bay model gave appropriate values both for concrete and steel, not much high nor much low, i.e., steel 417.42 kN and Concrete 305 m^3. Hence, we can say the 5- Bay model is optimum.

Conclusions

It was observed that the bay width is increased by 16.6 % from 7 bays to 6 bays, i.e., 4.285 m to 5 m which leads to an average Increase in Axial moment of 48.89 %. It was observed that the bay width is increased by 40.02 % from 7 bays to 5 bays, i.e., 4.285 m to 6 m which leads to average increase in Axial moment of 101.85 %. It was observed that the bay width is increased by 75.02 % from 7 bays to 4 bays, i.e., 4.285 m to 7.5 m which leads to average increase in axial moment of 281.57 %. So finally, it can be concluded that 6 m Bay width is effective because a 40 % increase in bay width leads to a 101.85 % average Increase in Axial moment. Whereas in case of 4 bays i.e., 7.5 m bay width, 75.02% increase in bay width leads to 281.57% increase in axial moment which is very high.

It was observed that the bay width is increased by 16.6 % from 7 bays to 6 bays, i.e., 4.285 m to 5 m which leads to an average Increase in an axial load of 851.41 %. It was observed that the bay width is increased by 40.02 % from 7 bays to 5 bays, i.e., 4.285 m to 6 m which leads to average increase in axial load of 1121.85 %. It was observed that the bay width is increased by 75.02 % from 7 bays to 4 bays, i.e., 4.285 m to 7.5 m which leads to average increase in Axial Load of 2007.69 %. So finally, it can be concluded that 6m Bay width is effective, because a 40.12% increase in bay width leads to 1121.85% average Increase in Axial Load. Whereas in the case of 4 bays, i.e., 7.5m bay width, 75.02% increase in bay width leads to 2007.69% increase in axial moment, which is very high.

It was observed that the bay width is increased by 16.6 % from 7 bays to 6 bays, i.e., 4.285 m to 5 m which leads to an average Increase in Bending moment of 47.39 %. It was observed that the bay width is increased by 40.02 % from 7 bays to 5 bays, i.e., 4.285 m to 6 m which leads to average increase in Bending moment of 106.56 %. It was observed that the bay width is increased by 75.02 % from 7 bays to 4 bays, i.e., 4.285 m to 7.5 m which leads to an average increase in Bending moment of 254.9 %. Finally, it can be concluded that 6 m Bay width is effective, because a 40.12% increase in bay width leads to a 106.56 % average increase in bending moment. Whereas in the case of 4 bays, i.e., 7.5 m bay width, 75.02 % increase in bay width leads to a very high 254.9 % increase in bending moment.

It was observed that the bay width is increased by 16.6 % from 7 bays to 6 bays, i.e., 4.285 m to 5 m which leads to an average Increase in Shear Force of 23.02 %. It was observed that the bay width is increased by 40.02 % from 7 bays to 5 bays, i.e., 4.285 m to 6 m which leads to average increase in the Shear force of 52.42 %. It was observed that the bay width is increased by 75.02 % from 7 bays to 4 bays, i.e., 4.285 m to 7.5 m which leads to average increase in Shear Force of 107.04 %. Finally, it can be concluded that 6 m Bay width is effective, because a 40.12 % increase in bay width leads to a 52.42 % average Increase in Shear force. Whereas in the case of 4 bays, i.e., 7.5 m bay width, 75.02 % increase in bay width leads to a very high 107.04 % increase in Shear Force.

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