International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 3600-3606 www.ijaem.net ISSN: 2395-5252

Comparative Study of Industrial Steel Structure (Pre Enengineered Building) and Residential RCC Structure

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Submitted: 15-07-2021 Revised: 29-07-2021 Accepted: 31-07-2021

ABSTRACT: Industrial steel structure (PEB)constructions arevery popular to their advantages over conventional RCC construction.Industrial steel structure Construction the better properties of both steel and concrete along with lesser cost, speedy construction, better quality control, sustainability etc. Hence the aim of the present study is to compare of a G+2 story residential RCC structure and industrial steel structure. Both structures are designed for same loading condition. Beam and column sections are made of either RCC, Steel (PEB) sections. STAAD PRO software is used for analysis and design and analysis results are compared. Cost effectiveness based on material cost for Steel structure and RCC structure determined.
Study concludes that the industrial steel structures (PEB) are best suited types of constructions in terms of material cost.
KEYWORDS: Industrial steel structure (PEB), RCC, Analysis and Design.

I. INTRODUCTION

Building and companies are one of the basic needs of human beings. The construction technology has the beginning from primeval construction technology to present concept of modern house building. The present construction methodology for buildings requires the best aesthetic look, high quality and fast construction, cost effective and innovative touch.

Daily new techniques are being developed for the construction of houses and buildings economically, quickly. The Pre-engineered Building industrial steel structure concept is important. This concept originated in USA in the year 1960's. Since, then after the PEB has used throughout the world, now a day use for warehouse, industrial work.

In industrial steel structurePEB, the total work from designing to manufacturing in factory and then after completion of work, the all PEB building components are brought to the site and erection.

RCC buildings are those which are made up of cement concrete reinforced with steel bars. Reinforcement bars are used to increase the tensile load capacity of the structure. Cement concrete cannot take tensile load, whereas steel is good in tension but weak in compression.

Following are the advantages of RCC construction:

- Materials that are used in RCC construction are easily available in the market.
- It is durable.
- It is resistant to fire and not attacked by termites.
- The reinforced concrete member can be cast to any shape because of the fluidity of concrete.
- "Pre-engineered industrial steel buildings" are those that are totally designed and manufactured in the factory and then shipped to the site for jointing /fixing. In pre - engineered building, usually I shaped members also; called as I beams are used. These beams are usually formed by welding together steel plates in the factory. Some manufacturers tapering the sections mean to decrease the size of web at the bottom.
- Engineers consider the clear span between column, bay spacing, dead loads, live loads, earthquake effect, wind loads, internal crane provision, deflection criteria, etc. for accurately design a pre-engineered building. These building design with normal sizes, spans, bays and heights, and use normal details for fixing protection, roofing, gutters, flashing, windows, doors.
- In Indian manufactures trying to catch up, Comparatively, PEB industrial steel structure is new concept in India. Pre-engineered buildings are generally used for low rise buildings which are ideal for offices, houses,

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showrooms, steel plants, automobile industries, light, utility and process industries, thermal power stations, warehouses, assembly plants, storage, garages, small scale industries, etc. Presently, with the improvement in technology, computer software's are easily available for analysis and design of Pre-engineered building. These buildings require large column free areas. Hence, interior columns, walls and partitions are often eliminated or kept to a minimum.

- Primary framing includes the main frame which is designed according to bending moment diagram. Thus the BM is maximum at mid span and at fixed support. Thus at maximum BM the depth of section is large and depth is reduced depending on BM.
- Purlins, girts and eave struts are the secondary framing members. For these members Cold formed Z and C-shaped members are used to fasten and support the external cladding.

II. PRELIMINARY DATA CONSIDERED FOR THE ANALYSIS:

For completion of this project, plan of existing G+2 Hospital Building is considered of which plan dimensions are 60M X 52M .This building is located at Pune of Maharashtra state. Detailed analysis and design of this RCC and PEB model will be done. Further, detailed comparison of both the structure will be done

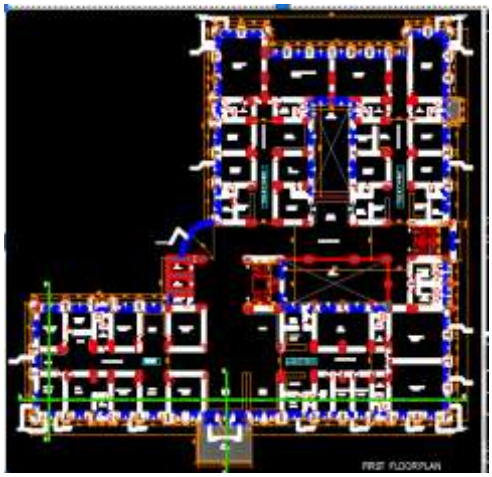
Salient features:

Utility of building : Public building
No of stories : G+2
Shape of the building : L shape
No of staircases : 2
No of lifts : 2

Type of construction : R.C.C framed structure and PEB frame structure
Types of walls : Brick wall

Geometric details:

Total height of building 11.25m
Floor to floorheight 3.75m
Height ofplinth 1.5m



Plan of RCC Structure

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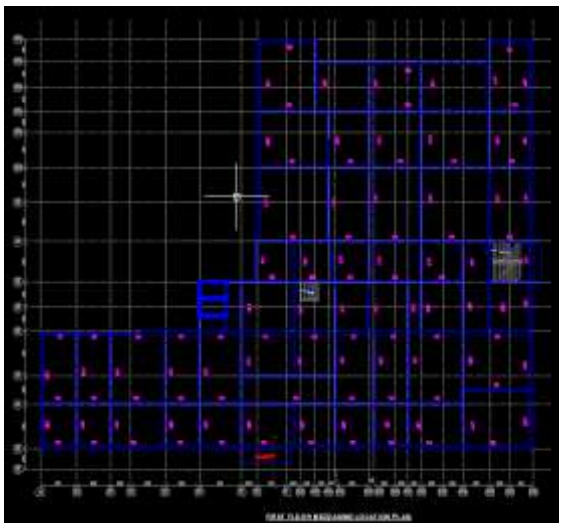

Plan of industrial steel structure (PEB)

III. RESULTS AND DISCUSSION

A comparative study and analysis is performed between RCC structure and Industrial steel structure Pre-engineered building as per specifications in IS 456-2000 and IS 800-1984.A detail study is carried out on the buildings to find out the variations in the structural response of the buildings observed from the parameters like maximum axial force, maximum shear force, maximum moment, compressive stress, tensile stress. Hence the results are discussed and are as shown below.

The various results like maximum axial force, maximum shear force, maximum moment at node and in column and beam are evaluated.

Maximum displacement at node

Table 1- indicates the maximum displacement at node in X, Y, Z direction

Maximum Displacement at Node in X, Y, Z Direction

Table 5.1 Maximum Displacement at Node in X, Y, Z Direction

Direction	RCC structure	Industrial steel structure (PEB)
X	2.451 mm	3.811 mm
Y	0.007 mm	1.21 mm
Z	12.831 mm	7.576 mm

Figure shows the maximum displacement at node, from figure we can observe that, displacement at node in RCC column in X direction is minimum as compared to PEB column. Displacement at node in RCC column in Y direction is minimum as compared to PEB column and Displacement at node in RCC column in Z direction is maximum as compared to PEB column.

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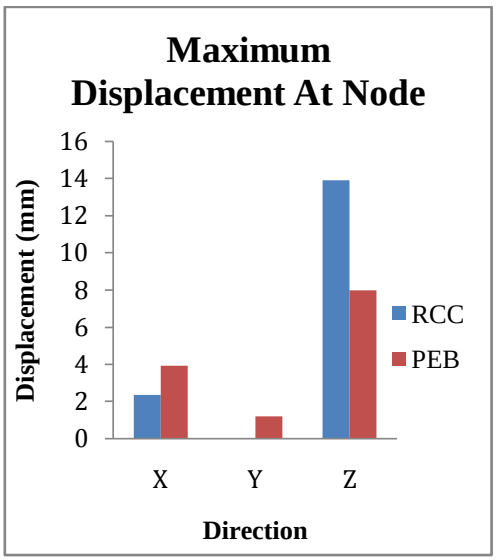

Figure 1 Maximum displacements at node

Maximum Rotation at Node

Table B indicates the maximum rotation at node in X, Y, Z direction

Table 2-Maximum Rotation at Node in X,Y,Z Direction

Direction	RCC	PEB
X	0.130 Deg	0.276 Deg
Y	0.007 Deg	0.032 Deg
Z	0.041 Deg	0.041 Deg

Figure 2shows the maximum rotation at node, from figure we can observe that, rotation at node in RCC column in X direction is minimum as compared to PEB column. Rotation at node in RCC column in Y direction is minimum as compared to PEB column and rotation at node in RCC column in Z direction is maximum as compared to PEB column.

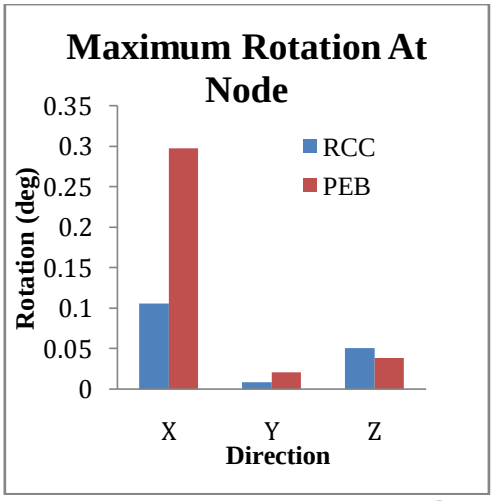

Figure 3 Maximum Rotation at node

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Maximum Support Reaction at Node

Table3shows the maximum support reaction at node at X,Y,Z direction

Table 3- Maximum Support Reaction at Node in X,Y,Z Direction

Direction	RCC	PEB
X	124.310 kN	74.810 kN
Y	2480.780 kN	1986.642 kN
Z	78.280 kN	382.752 kN

Figure shows the support reaction at node, from figure we can observe that, support reaction at node in RCC column in X direction is maximum as compared to PEB column. Support reaction at node in RCC column in Y direction is maximum as compared to PEB column and support reaction at node in RCC column in Z direction is minimum as compared to PEB column.

Maximum Shear Forces in Column

Table 4 shows the maximum shear forces in column in X,Y,Z direction

Table 4- Maximum Shear Forces in Column in X,Y,Z Direction

Direction	RCC	PEB
X	2510.250 kN	1982.868 kN
Y	401.112 kN	145.210 kN
Z	85.385kN	386.850 kN

Figure 5.5 shows the maximum shear forces in column, from figure we can observe that, shear force in RCC column in X direction is maximum as compared to PEB column. Shear force in RCC column in Y direction is maximum as compared to PEB column and shear force in RCC column in Z direction is minimum as compared to PEB column.

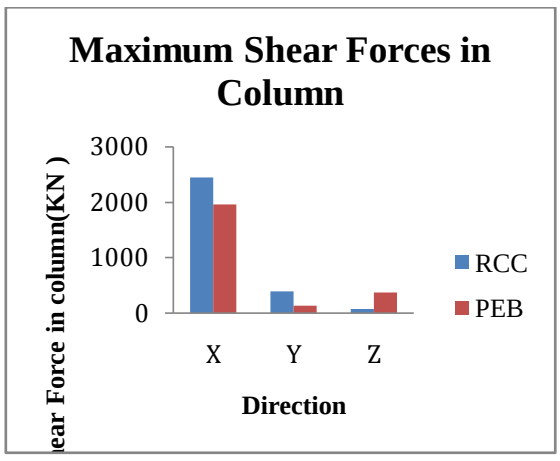

Figure5 Maximum shear forces in Column

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Maximum Moment in Column

Table 6 shows the maximum moment in column in X,Y,Z direction

Table 6 Maximum moment in Column in X,Y,Z Direction

Direction	RCC	PEB
X	2.210 kN-m	18.796 kN-m
Y	119.220 kN-m	341.580 kN-m
Z	310.252 kN-m	256.763 kN-m

Figure 6 shows the maximum moment in column, from figure we can say that, moment in RCC column in X direction is minimum as compared to PEB column. Moment in RCC column in Y direction is minimum as compared to PEB column and moment in RCC column in Z direction is maximum as compared to PEB column.

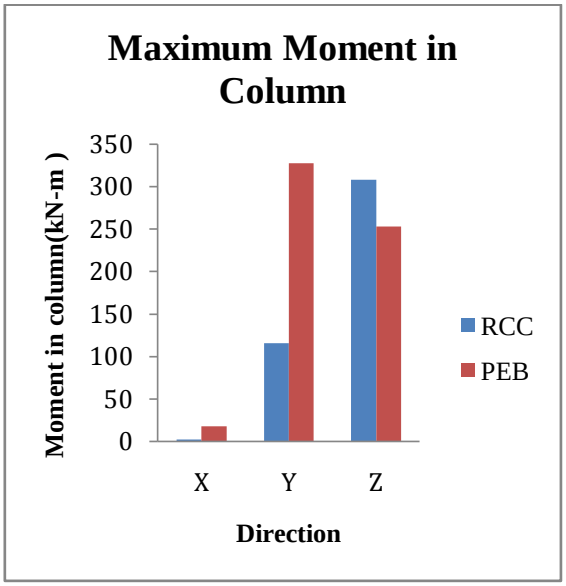

Figure 6 Maximum Moment in Column

CONCLUSION

I. Industrial steel building (PEB) and RCC building has been analysed and designand costs per unit quantities are worked out.
II. Displacement, rotation, moment at node along X direction of Industrial steel structure (PEB) frame is observed 45% more as compared to RCC structure.
III. Displacement, rotation at Node along Z direction of RCC structureis observed 40% more as compared to Industrial steel structure (PEB).
IV. The results show that the response obtains in the form of base Shear is 40% more in case of RCC structure compare to Industrial steel structure (PEB).
V. Moment in Column along X direction and Y direction of Industrial steel structure (PEB) is observed 60% more as compared to RCC structure.
VI. Moment in Column along Z direction of RCC structure is observed 20% more as compared to Industrial steel structure (PEB).
VII. Moment in beam along X direction and Z direction of RCCstructure is observed 72% more as compared to Industrial steel structure (PEB).
VIII. Compressive Stress and tensile stress in Beam of Industrial steel structure (PEB) is observed 42% more as compared to RCC structure.

IX. From the above` results of cost analysis, it has been observed that there is reduction in material cost nearly half of industrial steel structure (PEB) as compared with cost of RCC frame.

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