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Comparison between Hinge and Fixed Support in Pre-Engineered Building

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ABSTRACT:In recent years, the introduction of Pre Engineered Building (PEB) concept in the design of structures has helped in optimizing design. The adoptability of PEB in the place of Conventional Steel Building (CSB) design concept resulted in many advantages, including economy and easier fabrication. Long Span, Column free structures are the most essential in any type of industrial structures and Pre Engineered Buildings (PEB) fulfills this requirement along with reduced time and cost as compared to conventional structures. The present work involves the Comparison Between Hinge And Fixed Support In Pre-Engineered Building. In the present study PEB frame are analysed and designed for different supports condition using STAAD-pro. PEB building layout of length 60m and different span widths is 20m, 30m. Bay length is maintained 6m along the length. Wind analysis has been done manually as per IS 875 (Part III) – 1987. Dead load has been done as per IS : 875 (Part 1) – 1987. Live load has been done as per IS :875 (Part 2) – 1987.

KEYWORDS:Pre-Engineered-Buildings , Staad Pro , Hinge and Fixed support , IS code

I. INTRODUCTION

1.1 General Introduction

Steel is the material of choice for design because it is ductile and flexible. Steel members have high strength per unit weight and the properties of the steel members mostly do not change with time. Also addition and alteration can be made easily in steel structures. The concept of PEB is the frame geometry which matches the shape of the internal stress (bending moment) diagram thus optimizing material usage and reducing the total weight of the structure. The complete designing is done at the factory and the building components are brought to the site in knock down condition. These components are then fixed/ jointed at the site and raised with the help of cranes. Loads and the load combinations adopted for carrying out the analysis of the structure is well defined in the further portions. A section depicting the importance of the software used and the software procedure followed is included. Final portion explains the results obtained from the software analysis of the case study and the inferences from the literature studies. The paper aims at developing a perception of the design concepts of PEB structures and its advantages over CSB structures.

Steel is material which has high strength per unit area. Hence it is used in construction of structures with large column-free space. Most of the industrial structures require this criterion. The industrial structures enclosures may be brick masonry, concrete wall or GI sheet coverings. The wall generally non bearing but sufficiently strong enough to withstand lateral force caused due to wind and earthquake. The design of industrial building including of structural frame, column base, foundation, purlins, sag rod, tie rod, gantry girder, bracing, connection of member etc. A combination of standard hot-rolled section, cooled form section, profiled sheet, steel rod etc. are used for the construction of industrial structures. The industrial steel building is categorized as pre-engineering building and conventional steel building according to the design concepts. The project starts with the discussion of methods adopted in the study. Introduction to PEB system, Load and load combinations adopted for carrying out the analysis of the structure is well defined in the further portion

1.2 Pre-engineered building:

Pre-Engineered Building concept involves the steel building systems which are predesigned and prefabricated. As the name indicates, this concept involves pre-engineering of structural elements using a predetermined registry of building materials and manufacturing techniques that can be proficiently complied with a wide range of structural and aesthetic design requirements. The basis of the PEB concept lies in providing the section at a location only according to the requirement at that spot. The sections can be varying throughout the length according to the bending moment diagram. This leads to the utilization of non-prismatic rigid frames with slender elements. Tapered I sections made with built-up thin plates are used to achieve this configuration. Standard hot-rolled sections, cold-formed sections, profiled roofing sheets, etc.

1.3 Building type Primary framing system

- Depth built-up—I section, with the large depths in areas of higher stress according to the Bending Moment Diagram;
- Secondary structural member (roof purlins ,eave struts and wall girts)which are lightweight cold-formed —Z and —C members or open shaped web steel joists;
- Roll formed profiled sheeting (roof and wall panels)

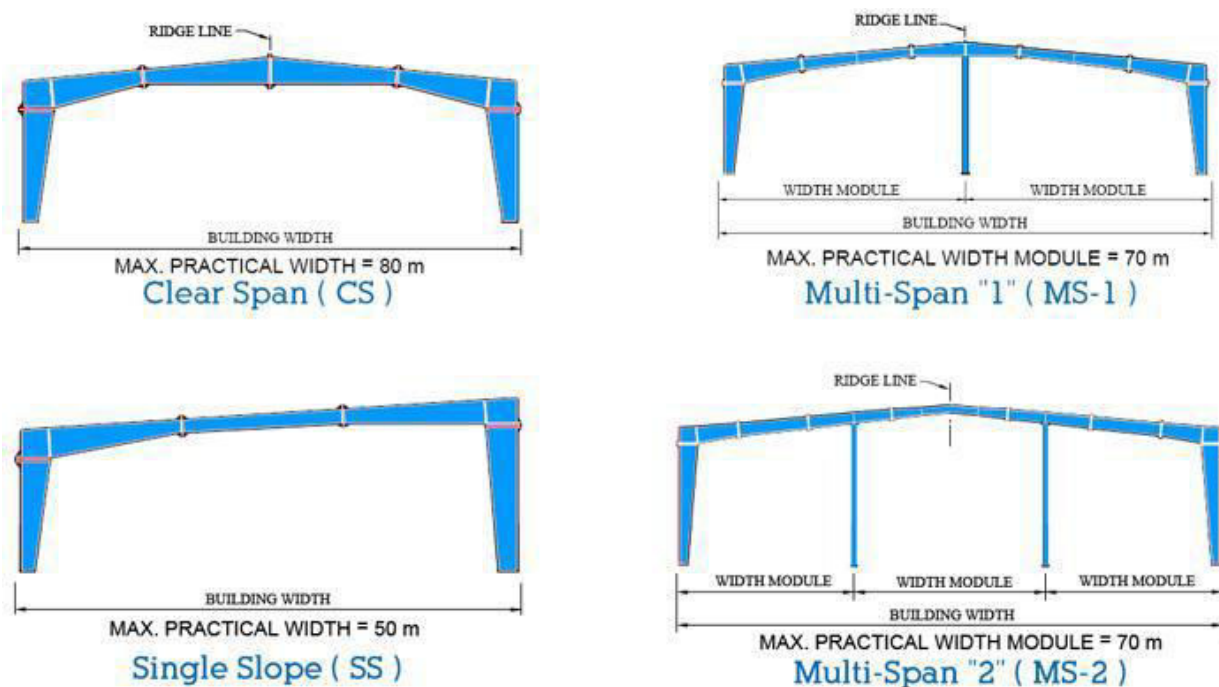


Fig.1 1. Pre Engineered Buildings types

The entire primary framing members and secondary structural members are pre-sheared, pre-punched, pre-drilled, pre-welded and pre-formed in the factories before shipping to site for erection are shown in Fig: 1.4. Quality of building part is assured as buildings are manufactured completely in the factory under controlled conditions. At the job site, the pre-fabricated components are then fixed and jointed with bolt connections. Saving of material on low stress area of the primary framing members makes Pre-engineered Buildings more economical than conventional steel buildings especially for low rise buildings spanning up to 60.0 meters with eave heights up to 30.0 meters. Furthermore,

Pre-engineered Building system focuses on using pre-designed connections and pre-determined material stock to design and fabricate the building structures, thus significantly reduces the time for design, fabrication and installation.

1.4 Advantages of PEB:

Following are some of the advantages Pre-engineered building structures-

1. **Construction Time:** Buildings are generally constructed in just 6 to 8 weeks after approval of drawings. PEB will thus reduce total construction time of the project by at least 40%. This allows faster occupancy and earlier realization of revenue. This is one of the main advantages of using Pre-engineered building.
2. **Large Clear Spans:** Buildings can be supplied to around 90m clear spans. This is one of the most important advantages of PEB giving column free space.
3. **Quality Control:** Buildings are manufactured completely in the factory under controlled conditions, and hence the quality can be assured.
4. **Low Maintenance:** PEB Buildings have high quality paint systems for cladding and steel to suit ambient conditions at the site, which in turn gives long durability and low maintenance coats.
5. **Lower Cost:** Because of systems approach, considerable saving is achieved in design, manufacturing and erection cost.
6. **Flexibility of Expansion:** These can be easily expanded in length by adding additional bays. Also expansion in width and height is possible by pre designing for future expansion.

1.5 Necessity of present work.

- Long Span, Column free structures are the most essential in any type of industrial structures and PEB fulfil this requirement with reduced time and cost as compared to CSB
- In conventional steel building we provide constant cross-sectional area. It means were stress concentration is less there also we provide larger area. Hence to optimizing of steel quantity.

1.6 Objectives:

1. The present work aims at comparison of Pre-Engineered steel building by different support condition i.e (Pinned and fixed support). An attempt is made to compare the structure in terms of following points
2. To determine the quantity of steel required for fixed support and pinned support for different spans and height to width (i.e H/W) ratios.
3. To determine the size of foundation required for pinned support and fixed support for different spans and H/W ratios.
4. To determine the quantity of R.C.C for pinned support and fixed support for different spans and H/W ratios.
5. Overall cost comparison of pinned support and fixed support for different spans and H/W ratios.
6. To determine up to which H/W ratios pinned support and fixed support is economical.
7. Validation to STADD-pro result with manual design is done.

II LITERATURE RIVIEW

2.1 Syed Firoz, et. al; (2012) observed that, The pre-engineered steel building system construction has great advantages to the single storey building, practical and efficient alternative to conventional buildings, the system representing one central model within multiple disciplines. Pre-engineered building creates and maintain in real time support is currently being implemented by Staad Pro Choosing steel to design a Pre engineered steel structures building is to choose a material which offers low cost, Strength, durability, design flexibility, adaptability and recyclability. Steel is the basic material that is used in the materials that are use for Pre- engineered steel building. It negates from regional sources. It also means choosing reliable industrial products which come in a huge range of shapes and colors, it means rapid site installation and less energy consumption. It means choosing to commit to the principles of sustainability



2.2.C.M. Meera (2013) , has carried out a comparative study of PEB and CSB concept. The study is achieved by designing a typical frame of a proposed Industrial Warehouse building using both the concept and analyzing the designed frames using the structural analysis and design software Staad Pro. The designing of industrial warehouse includes designing of the structural element including principal rafter or rooftruss, column and column base, purlins, sag rods, tie rods, gantry girder, bracing, etc. A combination of standard hot-rolled sections, cold-framed Industrial building can be categorized as Pre-Engineered Building (PEB) and Conventional Steel Building (CSB), according to the design concepts. The paper starts with the discussion of methods adopted in the study. Loads and the load combination adopted for carrying out the analysis of the structure is well defined in the further portions. A section depicting the importance of the software used and the software procedure followed is included. Final portion explains the results obtained from the software analysis of the case study and the inferences from the literature studies. The paper aims at developing a perception of the design concept of PEB structures and its advantages over CBS structure.

2.3 G. Durga Rama Naidu (2014) has carried out Comparative Study of Analysis and Design of Pre-Engineered Buildings and Conventional Frames. Pre-engineered steel structures building offers low cost, strength, durability, design flexibility, adaptability and recyclability. Steel is the basic material that is used in the materials that are used for Pre-engineered steel building. It negates from regional sources. Infinitely recyclable, steel is the material that reflects the imperatives of sustainable development. Based on the analytical and design results thereon of conventional and pre-engineered steel buildings.

2.4 Prof. P. S. Lande et. al;(2015) analyze and design of Conventional Steel Building and Pre-Engineered Building has been carried out and conclude that PEB structure can be easily designed by simple design procedures in accordance with country standards. Low weight Flexible frames of PEB offers higher resistance to wind load. Cold Formed steel section over hot rolled section as purlin is almost lighter than 32%. Pre Engineered Building weight is 35% lesser than weight of conventional steel building. Pre-Engineered Building construction gives end users a much more economical and better solution for longspan structures where column free areas are needed. The study is achieved by designing 3D frame of a Industrial Warehouse building using both the concept and analyzing the frame using the Staad Pro software. The economy of structure is discussed in terms of its weight comparisons.

III. METHODOLOGY

In the present study PEB frame are analysed and designed for different support condition using STAAD-pro.

PEB building layout of length 60m and different spans widths is 10m, 20m, 30m. Bay length is maintained 6m along the length. The height (H) to Width (W) ratio varied i.e H/W= 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7 etc for each span. Slope of pitch is constant for every span and height to width ratio is 50.

Specification of Design loads.

All dead load, Live load, Wind load will be conforming to IS: 875-1987

and design will be conforming to IS: 800-2007.

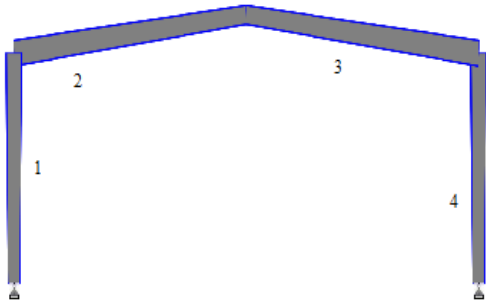


Fig. 3.1 Elevation of 10m span frame

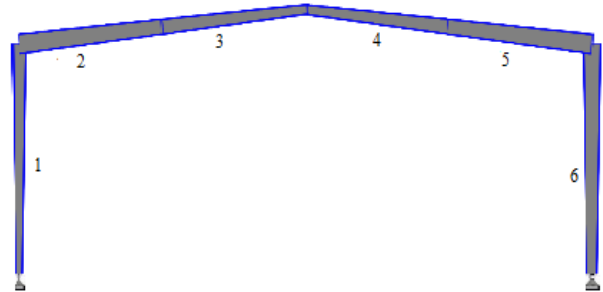


Fig. 3.2 Elevation of 20m span frame

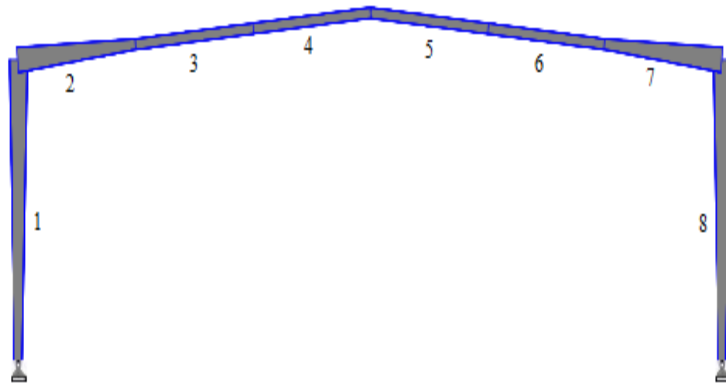
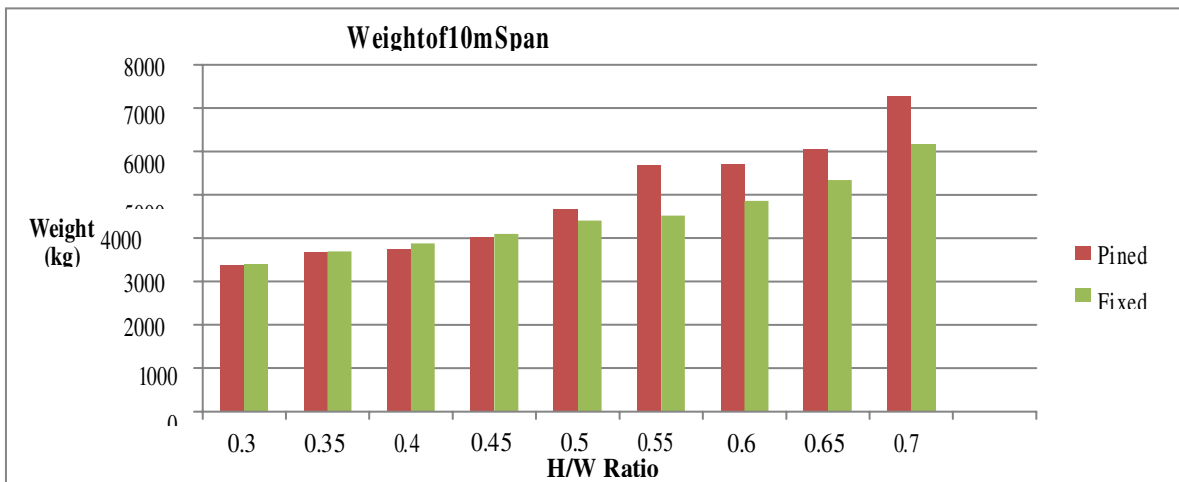


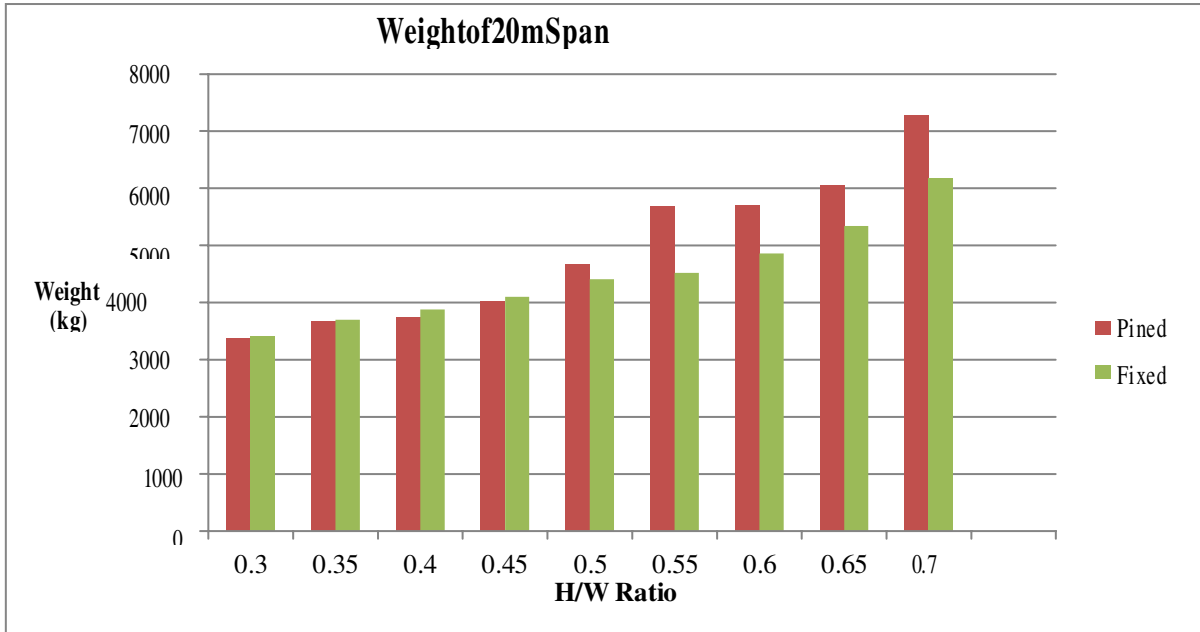
Fig. 3.3 Elevation of 30m span frame

3.1 Graphical representation

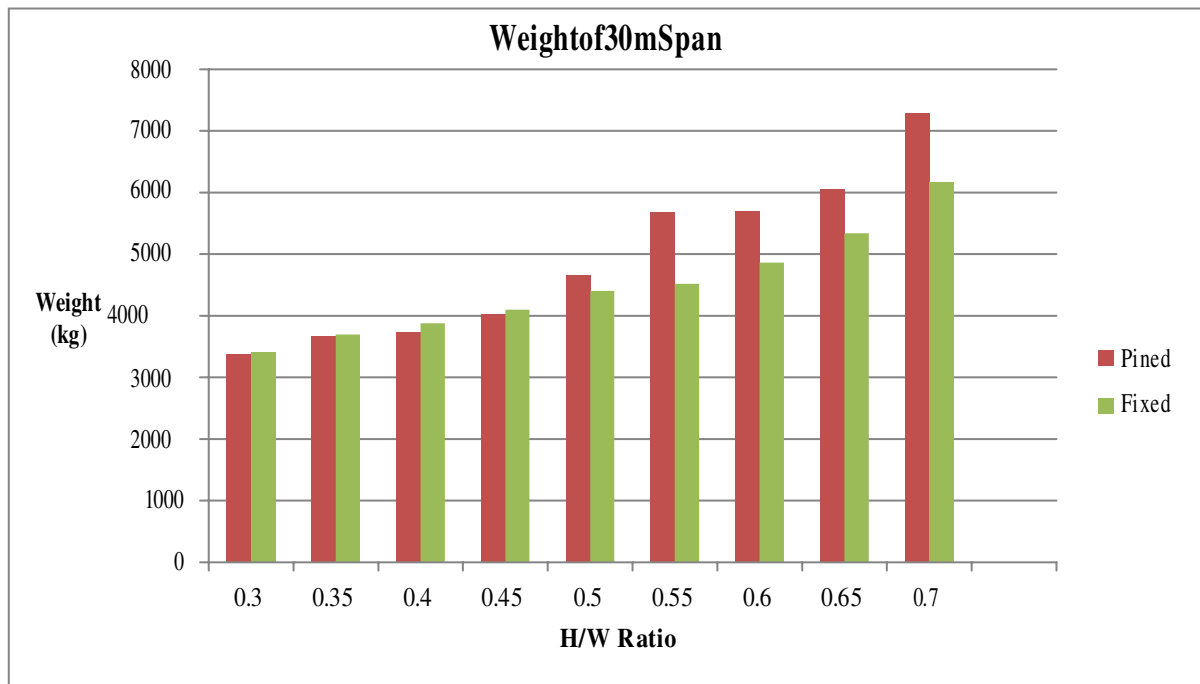




Graph No.1- Weight of 10m span frame



Graph No.2 Weight of 20m span frame



Graph no. 3 weight of 30 m span frame

IV. CONCLUSION

In the present work an attempt is made to optimize the quantity of steel in PEB one storey gable industrial shed with pinned and fixed supports. Based on the analytical and design result the following conclusions are drawn.

- Pinned support take 15% more steel than fixed support beyond 0.45 H/W ratio.
- From above conclusions we can use fixed support beyond 0.45 H/W ratio.
- For 20m span total quantity of R.C.C work required for pinned support is up to 15% less than fixed support.
- For 30m span total quantity of R.C.C work required for pinned support is up to 35% less than fixed support.
- For 30m span frame up to 0.5 H/W ratio pinned support is economic by 10% to 12% but beyond 0.5 H/W ratio fixed support become economical up to 9% to 12%.

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