

Cost Comparative Study of PEB with Conventional Method for Industrial Building

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Abstract

In this, industrial shed has been designed (only primary framing members) using conventional steel bldg. concept and PEB concept and the comparison of design results of that structure had been carried out in details. The Present work involves the comparative revise of Pre-Engineering Buildings (PEB) and Conventional steel Building (CSB). Conventional Steel Building is old concept which takes lots of time, quality and typical erection factor to modify that issues Pre-Engineering concept is developed. It introduced to the Indian market in 1990's.PEB

Concept is totally versatile not only due to its quality, prefabrication, and light weight and economical construction. The study is achieved by time and cost performance in industrial construction for pre engineered building.

I. INTRODUCTION

Technological development over the year has contributed hugely to the improvement of excellence of life through various new products and services. One such revolution was the pre-engineered buildings. Steel is that the fabric of choice for vogue as a product of its inherently ductile and versatile. In structural engineering, a pre-engineered building (PEB) is meant by a maker, to be made-up employing a pre-determined record of raw materials and urban strategies that may expeditiously satisfy a large variety provides structural and aesthetic style. PEB can exist fitted with fully completely different structural accessories similarly as mezzanine floors, canopy fasciae, periphery partitions, etc. The thought of PEB is that the frame maths that matches the shape of the inner stress diagram thus optimizing material usage and plummeting the overall heaviness of the structure. The overall planning is completed at

the manufacturing plant and therefore the building parts delivered to the location in knockdown condition. These mechanisms are then fixed at the location and raised with the assistance of cranes.

II. LITERATURE REVIEW

2.1 Syed Firoz, Sarath Chandra Kumar B and S. Kanakambara Rao, 2012

Declared that the pre-built steel building framework development has incredible favorable circumstances to the single story structures, pragmatic and productive option in contrast to regular structures, the System speaking to one focal model inside numerous controls. Pre-engineered building makes and keeps up progressively multidimensional, information rich perspectives through a task support is at present being actualized by Staad ace programming bundles for structure and designing.

Choosing steel to plan a pre-built steel structures building is to pick a material which offers minimal effort, quality, strength, plan adaptability, versatility and recyclability. Steel is the fundamental material that is utilized in the Materials that are utilized for Pre-built steel building. It nullifies from provincial sources. It additionally implies picking dependable mechanical items which arrive in a colossal scope of

shapes and colours; It implies deciding to focus on the standards of supportability. Boundlessly recyclable, steel is the material that mirrors the goals of supportable improvement.

2.2 Jatin D. Thakar,2013

explicit that Pre-Engineered product place of 25m, 30m, and 40m width and 6m eave height have been analyzed & Planned by utilizing STAAD Pro.2007 to comprehend the conduct of Pre-Engineered structure and to check in which case it accomplish the economy in steel amount by shifting narrows dividing as 4.5m, 5.5m, 6.5m, &7.5m. Design is done based on IS: 800. Yield stress of thesteel is assumed as 540 Mpa in the PEB warehouse. The load case considered in modeling are dead load, live load, wind load and seismic load along with the various combinations as specified in the IS. Examination results are watched for base response, section minute, beam minute, dislodging at edge, removal at mid-range. Analysis results also are compared for every bay spacing.

2.3 G. SaiKiran, A. Kailasa Rao, R. Pradeep Kumar,2014

declared that as of late, the presentation of the Pre Engineered Building (PEB) idea in the plan of the structures has helped in streamlining structure. The adaptability of the PEB in the spot of the Conventional Steel Building (CSB) structure idea brought about numerous focal points, including economy and simpler manufacture. Right now, mechanical structure (WareHouse) is dissected and planned by the Indian measures, IS 800-1984, IS 800-2007 and furthermore by alluding MBMA-96 and AISC-89. Right now, structure with length 187m, width 40m, with clear stature 8m and having R-Slope 1:10, is considered to do analysis& plan for 2D outlines (End outline, outline without crane and casing with 3 module cranes). The economy of structure is examined as far as its weight correlation, between the Indian codes (IS800-1984, IS800-2007) and American code (MBMA-96), and between the Indian codes (IS800-1984, IS800-2007).

III. METHODOLOGY

3.1 PEB – The Newest Trend in Building Construction

India being a developed nation enormous residence building creation is captivating place in variety of part of the country. Since 30% of Indian inhabitant's life within towns and city as a consequence construction is more in the urban places. The obligation of accommodation is tremendous but there will always be a scarcity of house ease of use as the present masonry building technology cannot meet the rising demand each year. Hence one has to consider for alternative construction system like pre-engineered steel buildings. India has an installed steel capacity of 35 to 40 million tonnes & noticeable steel consumption is approximately 27 to 30 million tonnes. There is extra capacity of flat steel foodstuffs available in India mainly of hot and cold rolled sheets. These steel components can be utilized in the construction of pre-engineered building components.

Pre-fabricated building comes into continuation in 1960's. It had ceiling, floor, frame etc. These parts were put together to make the whole construction. This made building easier. Steel building is used in all kinds of applications and their demand is increasing. There are mainly two categories in steel buildings-

- 1) Conventional Steel Building [CSB]
- 2) Pre-Engineered Building [PEB]

3.2 Advantages of PEB

Following are a number of the advantages Pre-Engineered Building Structures:

- **Faster Project Construction:**
Buildings are usually constructed in just 6 to 8 weeks after approval of drawings. PEB will thus reduce total manufacture time of the project by at least 30%. This allows faster occupancy and earlier realization of revenue.
- **Lower Cost:**

Because of systems move toward, considerable saving is achieved in design, developed and erection cost.

- **Flexibility of Expansion:**

These know how to be easily expanded in length by adding additional bays. Also expansion in width and height is possible by pre conniving for future expansion.

- **Larger Clear Span:**

Buildings can be complete to around 90m clear spans. This is one of the most important advantages of PEB giving column free space.

- **Quality Control:**

Buildings are manufactured completely in the factory under controlled conditions, and hence the quality can be assured.

- **Low Maintenance:**

PEB Buildings have high quality paint systems for cladding and steel to suit ambient circumstances at the site, which in turn gives long durability and low maintenance coats.

- **Energy Efficient for Roofing:**

Buildings are complete with polyurethane insulated panels or fiber glass blankets insulation to achieve required “U” values (overall heat transfer coefficient).

- **Erection:**

Steel member are bring to site in CKD conditions, thereby avoiding cutting and welding at site. As PEB sections are lighter in weight, the minute member can be very with no trouble assembled, bolted and raised with the help of cranes.

3.3 Components of PEBs

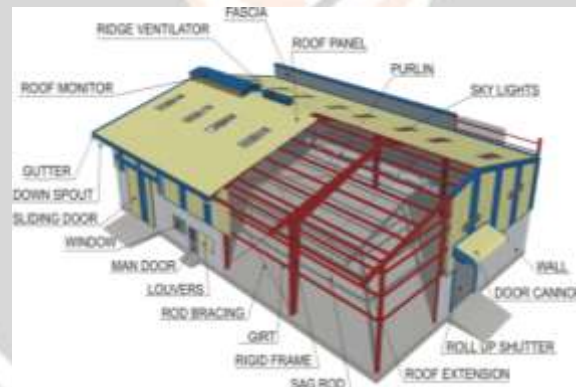


Figure 1. Components of PEBs

3.3.1 Primary Components

1. Main Frame

It typically includes the most elements of the building. It includes tapered columns and rafters. These tapering sections are factory-made wherever the webs are fillet welded to flanges. Then the splice plates are connected to the ends of tapering members. The PEB frame is then rising by connecting the member by the employment of bolts. The columns be ready to be what is more tapered or of uniform depth. The webs are connected to the flanges by continuous fillet fastening. The bottom plates, splices, stiffeners etc. are welded at manufactory on the structural members.

2. Columns

Their main perform is transferring the vertical loads to the footing. However conjointly some a part of lateral load is additionally transferred by the columns. Sometimes these area unit created out of bed of ‘I’ sections that area unit found to be not the maximum amount of cheap as alternative sections. Its depth goes on increasing from bottom finish to the highest finish of column. The column is formed of ‘I-section’ consisting of flanges and web connected to every alternative by attachment.

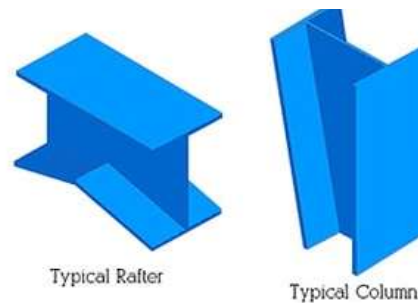


Figure 2. Typical Columns & Rafter Used in PEB

3. Rafters

These are the series of disposed members (beams) which stretch commencement ridge to wall plate, eave and are generally designed to support the roof and to take the loads.

3.3.2 Secondary Components

Girts and purlins kind the secondary parts that are used as a web for ramparts and panels of roofs. The purlins are used on roofs and girts are on walls. The most operate of the diminished member is that it acts as struts that facilitate in answer acting the a part of masses that act on the building like blustery weather and seismic masses and that they supply lateral bracings to the flanges in compression of the members of the most frame thereby mounting the capability of the frame. The secondary parts are pre galvanized or painted at plant with minimum of thirty five microns of corrosion defence primer.



Figure 3. Sections used for Purlin and Girt

3.3.3 Accessories

1. Anchor Bolts

These are used to anchor the members to the ground of concrete, concrete foundations or to alternative supports. These bolts area unit typically mentioned those at the beneath of the columns. This area unit formed with circular rods with thread at prime for bolting and bent at below for footing.



Figure 4. Anchor Bolts

2. Turbine Ventilator

It's rotating ventilator of roof that works on wind energy. If the wind load flanked by outside & at intervals the building is completely different, the air moves from facet to facet its gap and upholds the equilibrium condition. The most important use of victimisation these is that they recuperate the movement of air and suffocation is being eliminated.



Figure 5. Turbo Ventilator

3. Walking Doors

These are sometimes 920mm or 1840mm wide x 2140mm high that are made from electro galvanized steel. Even door fixtures are providing.

4. Aluminium Windows

These are designed for fitting aspect(in conjunction with beside) at the side of (together with) double side wall panel; self-scintillating pre glazed clear glass. The quality size is 1000mm x 1000mm.

5. Sheeting

The sheets that are used for the development of steel structures consists of a base metal absolute from either galvalume coated steel orthodox to ASTM 792 M grade,345B or aluminium orthodox to ASTM B 209M. By weight, the coating of galvalume is fifty six p.c aluminium& around forty four p.c metal. The external surface is coated with 25µ of primer of epoxy in conjunction with extremely intent on aboard end of polyester. The inside exterior is coated with 12µ of primer of epoxy in conjunction with changed polyester. The durability of sheet is around 550MPa.



Figure 6. Sheets Used for PEB

IV. THEORETICAL STUDY OF PEB

Table 1: Comparison Between the Conventional Steel Building and Pre Engineered Building

Properties	Conventional Steel Building	Pre-Engineered Building
Design	Requires serious descriptions with modifications.	Needs specialised Computer style.
Codes Used For Design	Codes aren't updated and ancient codes given by IS are used.	International style odes like AISC, AISI MBMA and AWS are used everywhere the planet.
Foundations	Widespread footings are required.	Easy to manage and light weight style work.
Structural Weight	Conventional steel section are used that are heavier than pre-engineered section	Efficient use of steel at totally different element of section that reduces the burden

		from 20% to 40%
Erection	Sections are required to be changed as per site conditions.	Pre casted sections are designed as per the location necessity.
Overhead Space	Use of normal sections limits the overhead space.	It could vary consistent with convenience.
Inside Space	Large span CSB with interior columns reduces the within area.	Interior column are fully eliminated thanks to that the within area increase.
Aesthetic	Average in terms of aesthetic expertise.	Aesthetically sensible.
Seismic Resistance	Rigid and significant structural members don't perform well against the seismic reactions.	Lightweight support has the flexibility to perform well against seismic reactions.
Safety And Responsibility	Responsibility Multiple provider units in inefficient management of artifact and sections.	Order is consummated by one provider results in higher management of fabric and sections.
Performance	Faulty connections could results in poor performance.	Higher performance because of economical bracing system.
Economy	Economical in terms of value however uneconomical in terms of erection time.	Economical in terms of erection time and economy.
Demount Ability	May take longer for demounting.	Less time needed for demounting.
Computer Software	Not a lot of development is offered just in case of typical building.	Computer programs are offered for the planning of PEB. Style estimation, detailing, drawing etc. are often generated inside no time exploitation this package.
Delivery Speed	Very slow delivery. It takes twenty to twenty six weeks to construct five hundred MT typical building once culmination of style.	Quicker delivery. It takes six to eight weeks to construct five hundred MT pre-engineering building once culmination of style.
Clear Span	Maximum clear span offered by the standard building members is 40 m only.	Member of PEB buildings can give massive clear span up to one hundred to one hundred twenty m with none intermediate support
Building Accessories	Use of specially designed makes it troublesome to search out its replacement and increase the price complexness of project.	All part of PEB is interchangeable at cheap value.

4.1 Design of Pre-Engineered Buildings

The stiffness matrix methodology is used to examine the principal framing of pre-engineered building systems. As per the Indian Standard 800 or American institute of steel building specification design is predicated on the Allowable Stress Design (ASD). Design program provides associate degree economic and efficient style of the most frame and permits the client to form use of the program in numerous modes to provide the frame design pure mathematics and load and also the desired load combination as nominative by the code opted by the user. The program operates from finish to finish the most variety of cycles nominative to attain a suitable style. The program uses the stiffness matrix methodology to attain a suitable style. The program uses the stiffness matrix methodology to attain the answer of displacements and forces. The strain energy methodology is adopted to calculate the fastened finish moments, stiffness and carry over factors. Numerical integration is employed.

4.2 Design Cycle

Design cycle consist of following steps -

- Set up section sizes and brace locations supported the pure mathematics and loading specified for the frame style.
- Calculate moment, shear, and axial force at every analysis purpose for every load combination.
- Calculate permissible shear, permissible axial and permissible bending stress in compression and tension at every analysis purpose.
- Compute the corresponding stress ratios for shear, axial and bending supported the particular and permissible stresses and compute the combined stress ratios.
- Design the optimum splice location and check whether or not the anticipated sizes explain to producing constraints.
- Using the web improvement mode, attain the optimum net depths for the subsequent cycle and update the member record.
- At the tip of all style cycles, associate degree analysis is to run the attain rim brace improvement.

4.3 Critical Success Factors and Problems With PEB in Recent Market Situation



Figure 7. Critical Success Factor

- **Increased Technical Ability**

Technical capability is the important base and a necessity for living within the industrial competition. Mostly, the businesses that cannot invest in their own in-house R&D section, they're largely type associate degree alliance with reputed corporations so as to supply a lot of excellent product. Hence, instead of invest in their own R&D that abundant quantity is utilize in shopping of product and rewarding the businesses with the profit related to the members. PEB construction isn't ex gratia for prime go up buildings because it isn't the perfect selection for the manufacturing plant buildings to sustain terribly so much on top of the bottom dead masses and live masses. Hence, the engineering experience offers low-rise manufacturing plant buildings and its aesthetic demand with massive spanning capability and

different operational uses so as to put the corporate in an exceedingly higher competition to handle competition.

- **Standardization and Modularization**

All have a primary aim to be succeed, i.e., to make a structure fulfilling the customer's specifications. So, to extract the profit out by fulfilling the customer's want, you wish to develop some production methods like standardisation and modularization of the building parts. It conjointly allows higher transportation coming up with that adds to the advantages of standardization and modularization.

- **Closer Alignment between Manufacturing Arm and other Supply Chain Partners**

There is repetitive method of producing and supply. Hence, the producing arm and provide arm ought to produce a harmonies relationship. This arises the necessity of offer chain management which can facilitate to strengthen the alliances with subcontractors and raw-material suppliers which might lead to a reduction of provision price for the corporate. This can bring overall economy to the project.

- **Price Competitiveness**

Steel fabrication is often finished expensive machineries are also as low price machineries too. This enables open competition and no barrier like condition for brand new comers. Hence, not a single company has clear whole advantage because the competition on value ranges from Rs.75-95/kg. Hence, major deciding issue is that the delivering charges charged by the businesses. Thus it's a significant decisive concern.

- **End User Needs**

End user wants to be known well and derive edges out of it; you wish to develop and modify the assembly and provide chain methods to remain in forefront of the competition. This will be done collaborating with offer chain partners, taking the irregular client feedback and shaping strategic alliances with the massive builders to forecast their own product demand.

- **Develop Suitable Marketing Strategies**

To develop promoting methods, it's essential to understand the market restrained for PEB. Once distinctive the market retainers, it ought to be lessened by educating public concerning the advantages of PEB. To attractiveness the shoppers with engaging promoting strategy to numerous residential customers which might open a wholly new dimension for them? This may promote the complete awareness still as trust over the corporate which might be a serious differentiating issue.

4.4 Comparative Case Study of PEB and Convectional Building

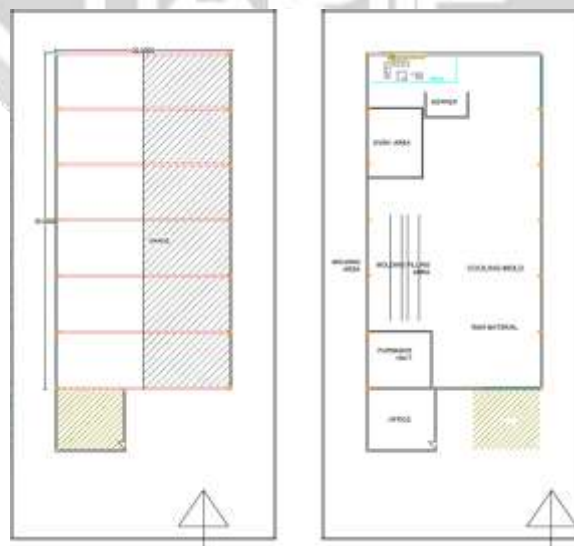


Figure 8. Plan for PEB and Convectional Building

Table 2: Structural Geometry of PEB Building

Sr. No	Description	PEB	CSB
1	Area of building	20x38 m	20x38 m
2	Length	38 m	38 m
3	Width	20 m	20 m
4	Pitch	1/12	1/12
5	Slope	5°	5°
6	Height of Brick wall	4 m	4 m
7	Height of structure	12 m	12 m

- **Estimation of Steel in PEB Building**

Total area of building 760 sq. meter. In this building used ISMB 300, rafter, purlin, wall purlin and accessories.

Table 3: Steel in PEB Building

Sr. No	Description	Quantity in kg	Amount
1	Column ISMB 300	4950.4	272272
2	Rafter	176.8	9724
3	Purlin	20155.2	1108536
4	Wall Purlin	212.48	11686.4
	Total	25494.88	1402218.4
	Accessories 2%		280443.68
	Delivery 3%		42066.2
	Total		14,72,728.28/-

- **Estimation of Steel in CSB Building**

Total area of building 760 sq. meter. In this building used ISMB 300,

Table 4: Steel in CEB Building

Sr. No	Description	Quantity in kg	Amount
1	Column ISMB 300	23514.4	1293292
2	Girder	5127.2	281996
3	Gusset plate 14mm	33.012	1815.66
4	Angle 75x75x5	957.6	52668.0
5	Filter beam	1237.6	68068
	Total	30869.812	1697840/-
5	Accessories 2%		33956.79
6	Delivery 3%		50935.2
7	Total		17,82,732/-

The various inferences made from the studies are described below.

- ✓ **Material Take off**

PEB structures are lighter than CSB structures, the software analysis it was found that the PEB roof structure is almost 30% lighter than the CSB structure. Regarding the secondary members, light weight Z purlins are used for PEB structure whereas heavier hot-rolled sections are used for CSB structure.

- ✓ **Design**

PEB design is rapid and efficient compared CSB design. Basic design steps are followed and optimization of materials while software analysis is possible for PEB, increasing the quality of design, CSB design is done with fewer design aids and each project needs to develop the designs which require more time. Connection design is also lesser for PEB when measured up to CSB.

- ✓ **Foundation**

Support reaction for PEB is much lesser than CSB as per the analysis. Hence, light weight foundation can be adopted for PEB which leads to simplicity in design and reduction in cost of construction of foundation. Heavy foundation will be required for CSB structure.

✓ **Delivery of materials**

For PEB, delivery is done in around 6 to 8 weeks and for CSB it is 20 to 26 weeks.

✓ **Erection**

Erection procedure is standard for all the projects and it is done free of cost by the manufacturer which results in faster and cost effective erection for PEB. Erection of CSB differs from project to project and separate labour has to be allocated, leading to 20 percent more expense than PEB.

✓ **Earthquake Resistance**

Low weight flexible frames of PEB offer higher resistance to earthquake loads than rigid heavy frames of CSB.

✓ **Cost**

PEB costs 21% lesser than cost for CSB. Outstanding architecture can be achieved at low cost for PEB. Single sourcing and co-ordination of PEB is highly cost effective than multiple sourcing system of CSB. Building accessories are mass produced for PEB which also leads to economy.

✓ **Change of order**

Due to standardized design, PEB manufacturers are able to stock large amount of elements and accessories which can be flexibly used in many types of PEB construction. Hence change of order can be fulfilled easily at any stage of construction. Cost for change of order is also lesser in this case. In case of CSB, change of order is expensive and time.

✓ **Future Expansion**

Single sourcing of PEB is advantageous for future expansion whereas multiple sourcing of CSB poses difficulty. Future expansion is easy and simple for PEB whereas it is most tedious and costly for CSB.

✓ **Performance**

All components of the PEB system are specially designed to act together as a system for highest efficiency. PEB designs are revised regularly with respect to the actual field conditions and in accordance with various country codes, which resulted in improved standardized designs leading to high performance of the structure. CSB system components are conventionally designed for a specific project and the performance depends on how the individual project is designed.

✓ **Advantages of PEB**

The concept of Pre-Engineered Buildings is extensively used for the construction single story industrial steel buildings. This system has many reimbursement than the conventional construction concepts that have been using. PEB systems have numerous compensation including cost effectiveness, quality control, speed in construction, ease in expansion, and achievement of large span, long durability, exceptional architecture, and consistency of materials, standardization of design, single sourcing and co-ordination, speed in delivery. By understanding the preliminary design concepts, it is easy to achieve the design of PEB system.

✓ **Applications**

Pre-Engineered Building concept have wide applications including warehouses, factories, offices, workshops, gas stations, showrooms, vehicle parking sheds, aircraft hangars, metro stations, schools, recreational buildings, indoor stadium roofs, outdoor sports ground canopies, railway platform shelters, bridges, auditoriums, etc. PEB structures can also be designed as re-locatable structure.

V. RESULT AND DISCUSSION

5.1 Assessment & Maintenance of Pre-Engineered Buildings

The scope of exploitation PEB ranges from showrooms, low height industrial complexes, industrial building and workshops, stadiums, schools, bridges, fuel stations, craft hangers, exhibition

centres, railway stations and railway applications. Sturdiness of any structure is principally depends on its element and its regular maintenance work.

5.1.1 Maintenance Period of PEB

Periodic maintenance of PEB depends upon the environmental zone and pollution level during which the building is found. In PEB, the core maintenance is needed for the steel roofing and protective cover. Within the wet areas, buildings ought to be taken abundant care because the wet presents within the air breakdowns the paint. The maintenance amount of PEB Frequency of maintenance relies upon the environmental zone during which the building is found. Table 5.1 shows the maintenance amount for PEB in several locations. Table 5.1 Maintenance time for PEB in several locations.

Table 5: Maintenance Period For PEB In Different Locations

Sr. No	Building Location	Maintenance
1	Within 5 km of the sea.	Every 3 months
2	High pollution industrial area.	Every 3 months
3	Medium pollution industrial area	Every 4 months
4	Areas of high humidity.	Every 4 months
5	Low pollution industrial area.	Every 6 months
6	Dry desert regions.	Every 6 months

5.1.2 Maintenance Procedure

A maintenance procedure varies from building to putting together and depends upon building style, material specifications and access provisions. It's additionally necessary to confirm that the leak proof performance of the building isn't compromised. Preventive maintenance of PEB begins now once a project is erected. Waste and little things like screws, pop rivets, drill bits or any metal objects are removed by sweeping with a soft nylon brush. Massive things like flat solid cut-off are removed by hand to avoid damaging the surface of the roof panels. Sand and mud shall be removed by washing with clean potable water and a soft nylon brush. To remove saline deposits that become crusted on the panels of buildings settled in high pollution industrial areas or on the point of marine environments ought to be washed with the gentle detergent else to the initial washing water. Various substances like oil, grease, tar; wax etc. is removed with mineral spirits, followed by a detergent solution & a clean potable water rinse. Abrasive or Caustic cleaners could harm the paint and metal layers.

5.1.3 Safety Measures Throughout Maintenance

A completed roof of a steel building may be a safe surface, except close to the edges and roof openings, or if it becomes slippery because of wet

The following steps ought to be maintained in maintenance:

- No walking on wet floors, gutters
- No stepping on skylights
- Availability of fireproof extinguishers
- Use ladders that's one meter on top of the step-off
- Site safety procedure and emergency contacts.
- Uses of private protection instrumentation, modern tool sand machineries are necessary.
- Use of passive restraint mechanisms like sky internet fall protection system considerably reduces risk throughout maintenance.
- Comfortable precautions ought to even be taken toward electrical safety and dangerous substances.

VI. CONCLUSION

In this study concluded points are listed in below

- Most attractive economy in civil engineering construction can be achieved by optimum use of steel of high grade and composite form of construction with improved materials.
- Pre engineered buildings have vast advantages over conventional buildings. PEB structures are lighter structures. As PEB is 30% lighter than CSB structures.

- Generally PEB requires 6-8 weeks for its delivery. It requires maximum 15 to 25 days for its erection.
- PEB structures are higher resistance against earthquake loads. PEB structure cost is 25-30% lesser than CSB structures.
- PEB manufacturers are able to stock large quantity of elements and accessories which can be used in many types of PEB construction.
- PEB structures can be erect in other places, by using same components. But the main condition is loads and environmental circumstances must be same.
- There is no requirement of incessant maintenance work for PEB structures. There is 25 years of assurance certificate is provided by manufacturer. We can erect same structure from at other place by using same material.

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