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Analysis And Design Of Pre-Engineering Building

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Abstract : Steel is one of the best material for design due to its inherent properties like ductility and flexibility. It is very flexible under extreme loads rather than crumbling and crushing. Steel mostly used in construction of industrial buildings. Pre-engineered steel buildings can be fitted with different accessories including mezzanine floors, canopies, fascia's, partitions etc., and the building is designed as a waterproof by the use of special mastic beads, filler strips and trims. In this case study, analysis and design of Pre-engineered building has been done and compared with the conventional building. Based on static and dynamic analysis, the building has been designed. IS800-2007, IS1893 (PART-III), SP16 and IS 875 Part III (1987) codes are used for the analysis. An efficient pre-engineered building can be lighter than conventional building up to 35 percent. By the pre-fabrication, the quality of the material has been checked thoroughly before errection.

Keywords: Steel, Dynamic analysis, PEB

I. INTRODUCTION:

Steel structures constructed over a structural idea of main members, secondary members, roof and wall sheets linked to one other, and numerous other building components are known as pre-engineered steel buildings (PEB). Skylights, wall lights, turbo vents, ridge ventilators, louvres, roof monitors, doors & windows, trusses, mezzanine levels, fascias, canopies, crane systems, insulation, and other structural and non-structural improvements may be added to these structures dependent on the customer's needs. All of the steel structures have been specifically engineered to be lower in weight and more durable. Over the past four decades, steel building designs have grown more versatile, resilient, and adaptable, making steel one of the most popular building materials.

The I beams used in pre-engineered structures are normally constructed by welding steel plates together to create the I section. The I beams are then field-assembled (e.g., bolted connections) to create the pre-engineered building's whole frame. According to the local loading effects, some manufacturers taper the frame members (changing in web depth). In places with greater load effects, larger plate diameters are employed.

Secondary structural components such as cold formed Z- and C-shaped members might be employed to attach and support the exterior cladding.

The building's exterior cladding might be made of roll-formed profiled steel sheet, wood, tensioned fabric, precast concrete, masonry block, glass curtainwall, or other materials.

While pre-engineered structures may be modified to fit a broad range of structural purposes, standard features provide the most cost savings. Pre-engineered buildings that are well-designed may be up to 30% lighter than traditional steel structures. Less steel means less steel, which means a possible cost reduction in the structural structure.

II. HISTORY OF PRE-ENGINEERED BUILDINGS

2.1 GENERAL

Metal structures have been around for about 150 years, when British metal construction businesses invented them. In 1832, Walker Construction Company introduced the self-supporting barrel roof design, and Morewood and Rogers supplied warehouses to California during the 1850 gold rush. In 1853, Hemming and Company delivered six churches to the diocese of Melbourne, Australia. When packed, these church structures weighed roughly 50 tonnes and had a steel frame coated in galvanised corrugated sheets. For air circulation, an air gap was created between the outer steel and the internal hardwood skin.

Metal structures are known for their fire resistance, which is one of their most appealing features. Surprisingly, it was for fire resistance that engineers started using metal in the first place. Metal was first used as a construction component in 1796, when it was used to replace wood. Cotton mills in the United Kingdom were known for their flammability, which resulted in catastrophic consequences. As a result, the Dithering tonne Flax Mill was built with cast-iron columns and framework around the end of the eighteenth century.

2.2 DURING WORLD WAR II

During WWII, there was a need for "ready to assemble" structures that could be containerized and exported as barracks and maintenance facilities. Pre-engineered steel structures, which could be bolted together and did not need on-site welding, were manufactured in large numbers as a result. It was evident at the conclusion of the war that the industry would not be able to return to its pre-war product offers. Metal structures were going to be around for a long time. The postwar construction boom provided an opportune chance to mass-produce structures for a wide range of non-residential uses. Metal construction businesses discovered that forming alliances with local builders throughout a region, or even the nation, was an efficient method to get a building structure to the end user.

It was evident at the conclusion of the war that the industry would not be able to return to its pre-war product offers. Metal structures were going to be around for a long time. The postwar construction boom provided an opportune chance to mass-produce structures for a wide range of non-residential uses.

2.3 PEB FORT HISTORY

Peb Fort (T. Panvel), also known as Vikatgad, is located near the hamlet of Maldunga, some nine miles north-east of Panvel, on a 1,000-foot-high hill. It had two routes that met a bit from the entryway, which was about twenty feet below the summit of the hill, when Captain Dickinson inspected it in

1818. The entrance was erected over and practically at the top of a very steep ravine, with a channel on either side of a substantial brick retaining wall thirty feet high and roughly as wide at the top diverting the water from its natural flow. The perpendicular height of the gateway's threshold was about eighteen feet. The slope continued steeply beyond this entrance, perhaps eighty feet beyond the doorway, to a platform on a projecting section of the hill at the head of the ravine. There was a difficult 100-foot climb from this platform to the summit of the hill, where there had formerly been a fort. Peb, like Malang Gad, is encircled by a cliff for the most part, with the main works, in addition to those previously described, located at the north and south ends of the hill, commanding the sections of the hill that were considered accessible. The land on the top of the hill was quite uneven, and all that remained of the previous fort was a shabby wall of loose stones. Outside the entrance, there was an excellent reservoir and a Ganapati shrine in addition to two structures and a few cottages. A big chamber encased with solid masonry and a sturdy door was claimed to have been used as an ammunition and store-room under the cliff, around 100 yards from the temple. The fort was in ruins in 1862, with inadequate drinking water and insufficient food supplies.

The fort may be reached after a six-mile hike from Neral station. At the foot of the hill, there is a goddess named Pebi, who seems to be the fort's deity based on her name. A deity named Mhasoba is half way up the hill, and two caves and a rock-cut cistern are approximately a quarter mile further. There are the foundations of big structures as well as a cistern that is twenty cubits square and four cubits deep that holds water all year. Apart from the major structures, there are the ruins of forty to fifty little homes.

III. LITERATURE REVIEW

Various studies of conventional steel structures and pre-engineered buildings are reviewed in the literature. This section contains a summary of the literatures examined as part of the study.

Sagar D Wankhade et al [1] compared CSB and PEB on various dimensions such as 14m x31.5m, 20m x50m, and 28m x70m with bay spacing of 5.25m, 6.25m, and 7m with a column height of 7m. PEB has a total weight of 116.31kN and a truss weight of 183.45kN.

BK Raghu et al. [4] described the optimization of PEB based on numerous factors that determine the structure's cost, such as gable inclination, span, and bay spacing. These parameters are modified systematically, and the gable frame is developed for the common loads DL, LL, EQ, and WL in each instance. The amount of steel in each scenario is calculated, and the structure that regulates the least amount of steel is proposed; nevertheless, there may be minor differences depending on the data entered, such as earthquake and wind zones, steel grade, soil type, frame with particular cranes, and multi-spans.

IV. CONCEPT OF PRE ENGINEERED BUILDINGS

4.1 PEB CONCEPT

Steel structures constructed over a structural idea of main members, secondary members, roof and wall sheets linked to one other, and numerous other building components are known as pre-engineered steel buildings (PEB). Skylights, wall lights, turbo vents, ridge ventilators, louvres, roof monitors, doors & windows, trusses, mezzanine levels, fascias, canopies, crane systems, insulation, and other structural and non-structural improvements may be added to these structures dependent on the customer's needs. All of the steel structures have been specifically engineered to be lower in weight and more durable. Over the past four decades, steel building designs have grown more versatile, resilient, and adaptable, making steel one of the most popular building materials.

4.2 CLASSIFICATION OF STEEL BUILDING

Steel is the material of choice for styling since it is naturally ductile and adaptable. Instead of crushing and disintegrating under hyper-loads, it bends. Despite its cheap value, structural steel's strength, durability, stylistic flexibility, ability, and recyclability make it the fabric of choice in building construction. Today's steel frame is transferring elegance, art, and performance in practically unlimited ways, providing new solutions and chances to construct complex buildings previously considered impossible. Structures made of steel have a reserve strength. The use of a simple stick design inside the steel framings allows building to go quickly from the start.

4.3 WHY PEB

Today's construction sector is being transformed by pre-engineered structures. What are the advantages of pre-engineered structures and buildings? One of the most important benefits of PEBs is that they may be built much quicker than traditional structures. This implies that building owners will be able to generate money and profits considerably more quickly. Another significant difference is the price. A PEB may be much less expensive than a traditional construction. Other advantages include ease of installation, increased structural stability, cheaper costs for environmental management owing to thermal efficiency, improved space use due to column-free designs, and extension – even relocation – flexibility.

V. COMPONENTS OF PRE ENGINEERED BUILDINGS

5.1MAJOR COMPONENT OF PEB

"A PEB steel structure is a structural concept that connects main elements, secondary components, and cover sheets." It may also be equipped with different structural components such as mezzanines, fascias, canopies, and crane systems, depending on the needs of the user.

Columns, rafter, and beams are popular primary members (BUILT-UP) that are often made from high strength materials like Galvalume. The major frame built up parts are constructed utilising these components and beam welding equipment, arc welding machines, and other welding machines.

Steel purlins and girts are secondary components (cold-form) of pre-engineered structures. Purlins are used to support roof panels, while girts are used to provide a support frame for wall cladding on side walls and end walls.

Steel deck supports are attached to main mezzanine beams via joists in a conventional mezzanine design. In industrial structures, crane systems handle all material handling.

A pre-engineered building is a metal structure that is planned and produced in a factory, then brought to the job site and assembled and erected using nut bolts and anchor bolts.

5.2 COMPONENTS OF PRE -ENGINEERED BUILDINGS

Pre -Engineered Buildings are Steel Structures built over a structural concept of:

Primary Framing System

Secondary Framing System

Roof Sheeting

Wall Cladding

Accessories

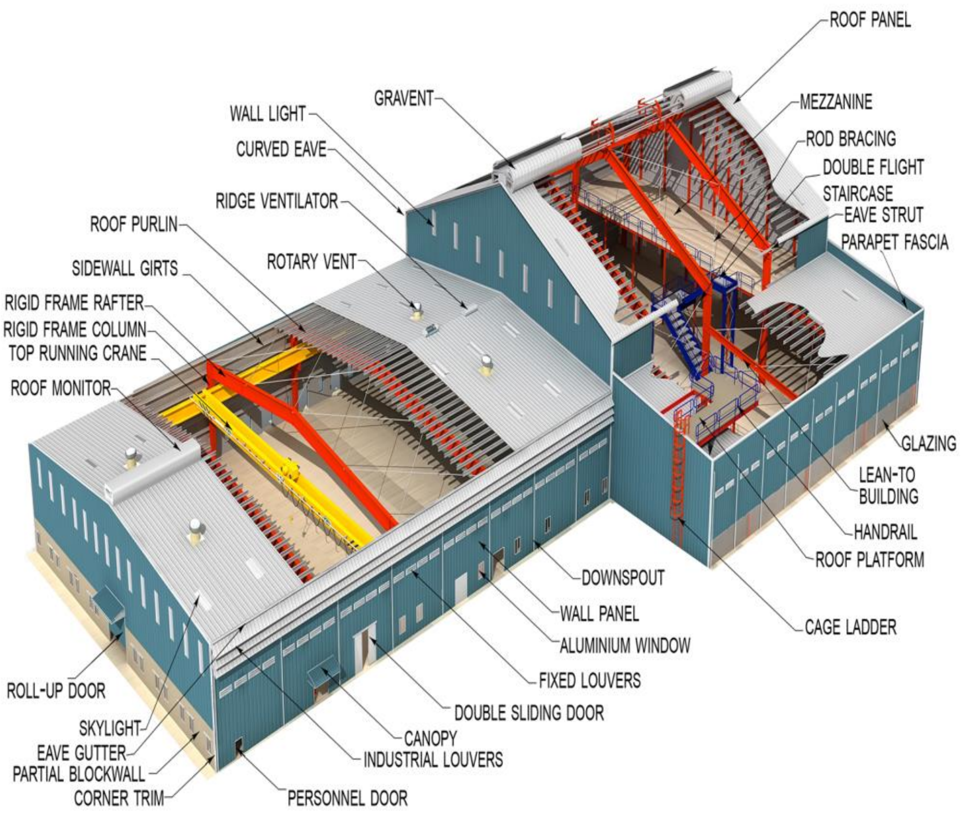


Fig 1 : components of peb structure

5.2.1 PRIMARY FRAMING SYSTEM

Primary framing consists of all structural elements which transfer load to the foundation and comprise of:

Main framing

End Wall Frames

Wind Bracing

Crane Brackets

5.2.1.1 MAIN FRAMING:

The strong steel structure of the building is referred to as main framing. The PEB rigid frame is made up of tapered rafters and tapered columns. Splice plates are welded to the tapered section's ends. The frame is put together by fastening the connecting section's splice plates together. I section was built up to construct the principal structural frame components (Column and Rafters).

The column's primary function is to convey vertical loads to the foundation. However, the columns also convey a portion of the horizontal motion. Generally, I section columns are used in pre-engineered buildings because they are the most cost-effective.

Rafter: A rafter is a sloping structural part that runs from the ridge to the down slope perimeter and is meant to support the roof deck and its accompanying loads.

These frame systems are made to the specifications of the customer.

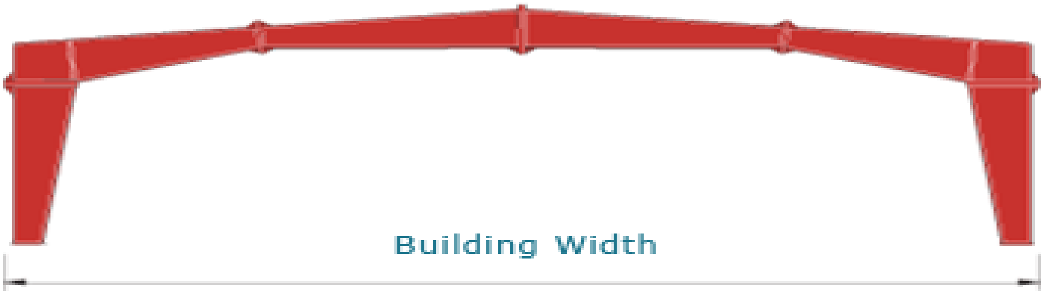


Fig 2 : main frame

These fundamental members are available in a variety of common ready-made forms as well as as channels for the more complex primary frame system. End Wall Frames, Crane Brackets, and Wind Bracing are further components of a major frame system. Other than the basic frame system, a Pre-Engineered Building might include secondary framing, sheeting, and a variety of add-ons to meet the needs of the customer. Crane beams, canopies, trusses, fascias, roof extensions, and mezzanine levels are examples of add-ons.

5.2.1.2 END WALL FRAMES

End wall frames are an important component of the primary framing system, which is an important part of Pre-Engineered Buildings. The weight of the building is distributed evenly by the intermediate column of the end wall frame. A Pre-Engineered Building's basic frame system is the most important component. On each side of the ridge line, one section of a major frame system is usually comparable to the other. The structural systems, including the principal frame system, come in a variety of shapes and sizes to suit the needs of the customers. End wall frames come in two varieties: expandable rigid frames and post end beams, depending on the client's needs for future extension.

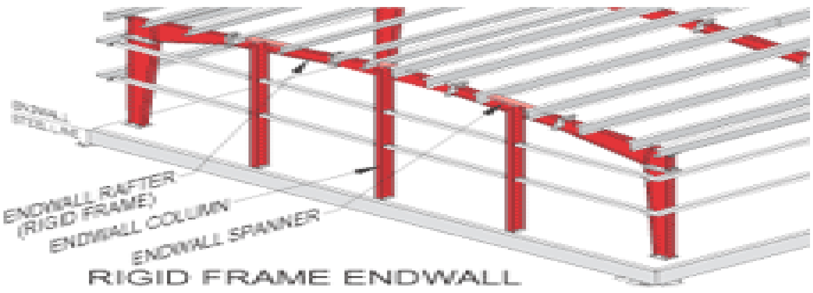


Fig 3 : end wall frame

5.2.1.3 WIND BRACING

Wind Bracings are cross primary supporting components that evenly distribute loading or seismic stresses on columns and support all structural units in a Pre-Engineered Building. Steel has largely replaced the heavier traditional structural elements and concrete structures in modern building construction. Steel structures have grown in popularity owing to its durability, versatility, and agility. Wind bracing is an important part of a major frame system because it provides vertical support for the complete pre-engineered structure. Wind bracing consists of intersecting brackets on the interior and outside of the building, as well as on the roof walls, in

one or more inlets, depending on the span and overall weight of the structure. Wind bracing, like the other structural parts of a basic frame system, is made as durable and light weight customised components based on the customer's taste and function..

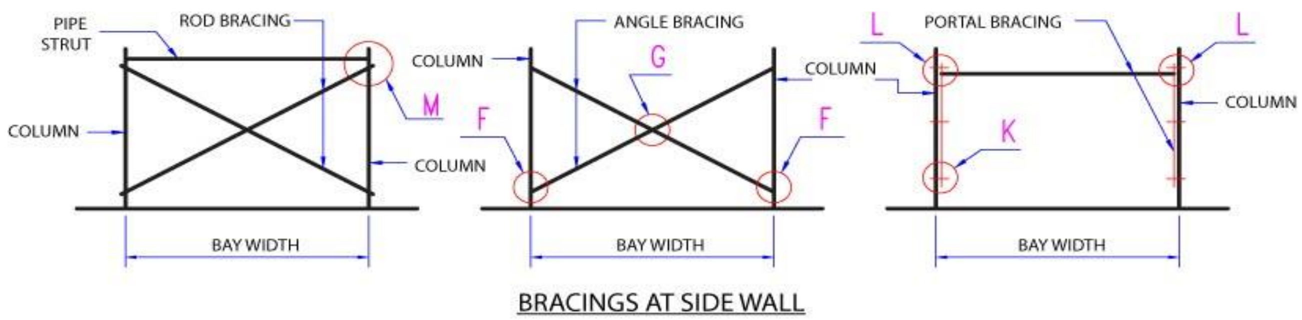
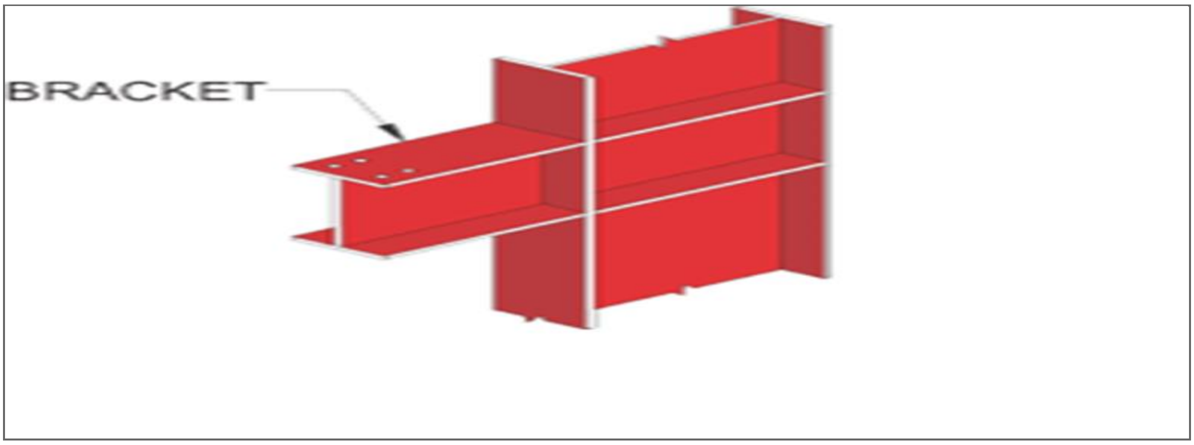


Fig 4 : bracings

5.2.1.4 CRANE BRACKETS

Crane brackets are one of the most important structural components of a major frame system. Crane brackets are the most common effective elements for supporting crane beams. Crane brackets are affixed to the columns in a basic framing system and support the weight of the crane joists or crane beams. Crane brackets attached to vertical columns are used instead of overhead crane brackets. Crane brackets are the most cost-effective components for supporting crane joists in vertical columns. The crane brackets may also be used in inlets on their own. The crane brackets must be supported by solid columns, and the area above the crane bracket must be clear of any impediments. Strong connecting and fastening bolts secure crane brackets. Crane brackets are pre-engineered elements of a structure that are designed to be utilised with strong beams. On columns, crane brackets may be easily inserted and modified.



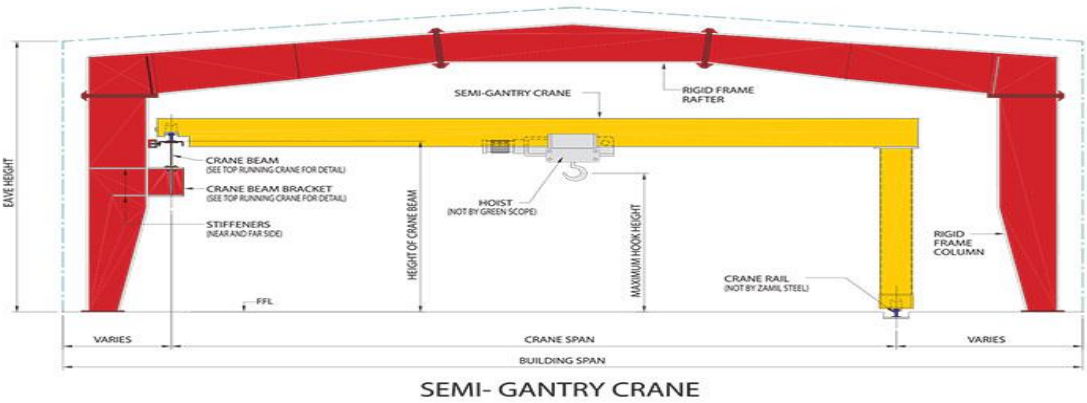


Fig 5 : crane brackets

VI. STRUCTURAL SYSTEMS

6.1 BUILDING BASIC PARAMETERS

Building Width :

This is defined as the distance between the outside of one side wall's Main Framed Column and the outside of the other side wall's Main Framed Column, regardless of the major framing system utilised.

The distance between the outside line of one side's Gable End Column (End Wall Column) and the outside line of the opposite side's Gable End Column (End Wall Column) is known as the building length. It's possible to make it any length.

Height of the structure:

The eave height is the distance between the bottom of the main frame column base plate and the top outer point of the eave strut, which is normally the distance between the bottom of the main frame column base plate and the top outer point of the eave strut. The distance between the completed floor level and the top of the eave strut is the eave height when columns are recessed or raised from the finished floor.

The distance between the centre lines of two adjacent interior main framed columns is known as bay spacing.

Roof Slope refers to the angle of the roof in relation to the horizontal. 1:10 is the most typical roof slope. Any roof slope that is practicable is conceivable.

The distance between the Finished Floor level and the bottom of the knee joint is known as the Clear Height.

The length of the interior bay

The distance between two adjacent interior main frame columns' centre lines. 6 m, 7.5 m, and 9 m are the most typical bay lengths.

Bay length at the end

The distance between the outside of the end wall columns' outer flange and the centre line of the first inner frame column.

6.2. FRAMING SYSTEM:

6.2.1. Clear Span (CS)

Clear span construction is designed as a rigid frame that has high strength and durability. Steel is both. The frame requires no interior supports, resulting in an extremely versatile and economical building.The maximum practical width or span is up to 90 meters, but it can also be extended up to 150 meters in case of Aircraft Hangars.

Fig 6 :clear span framing system

With no inner bracing or columns, it's simple to divide up portions for different purposes, rearrange them as required, or just leave it open.

You'll want a clear span design if you require a lot of open space within your structure. Metal frame structures with clear spans are often utilised for:

- Factories

- Warehouses
- Athletic facilities
- Agricultural buildings
- Storage

Arched Clear Span:

The Rafter is curved, and the column is an RF column. It does not have a ridge line or a summit. For aesthetic purposes, a curved roof rafter is employed. The greatest practical range is 90 metres, however it may be increased to 120 metres if necessary.

Fig7 :arched clear span

6.2.2 MULTI-SPAN BUILDINGS

Without a lateral expansion joint, multi-span frames up to 6 spans or 150 metres are investigated. A twin column expansion joint is supplied for frame widths greater than the aforementioned. Exterior columns are made up of tapering or straight built-up parts that are pinned or secured at the base depending on the building's eave height. The rafters are built-up parts that run the length of the building and have a stiff (moment) connection at the top. Both ends of interior columns are usually pinned. Interior downspouts (provided by others) are assumed to be at bay spacing when valley gutters are constructed. If internal drainage is not permitted, bigger valley gutters may be provided, depending on the roof's drained area.

Fig 8 :multi span buildings

6.2.3 SPACE SAVER BUILDINGS

Building with a single gable clear span and straight columns. Wall girts are flush mounted.

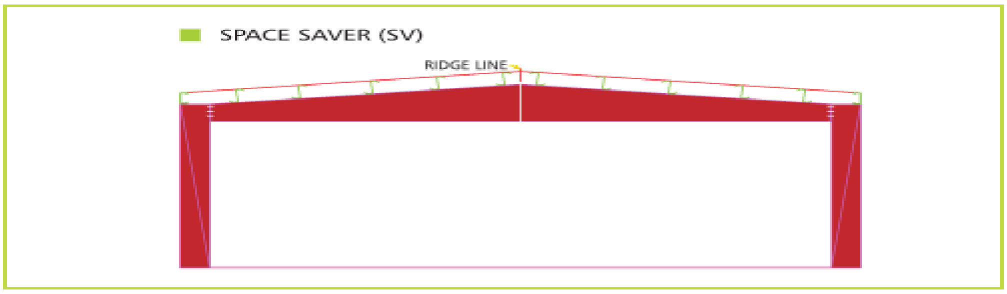


Fig 9 :space saver buildings

The frame width is between 6m – 18m and eave height does not exceed 6m.
Straight columns are desired.
Roof slope of ≤0.5:10 are acceptable.
Customer requires minimum air volume inside the building especially in cold storage ware houses.

VII. ACCESSORIES IN PRE-ENGINEERED BUILDINGS

7.1 ACCESSORIES

Turbo Ventilators

Ridge Ventilators

Louvers

Skylight Panels

Insulation

Sliding or Roll up Door

Stair Case

7.1.1 TURBO VENTILATORS

Circular ventilators made of Galvalume sheet or stainless steel with variable dia. These ventilators are mounted on the roof and spin due to natural wind. In industrial buildings, this is a critical component for air ventilation.

Fig 10 : turbo ventilators

The wind is blowing. Because of its low capital costs, versatility, high air displacement capacity per ventilator, and overall dependability, air ventilators are employed all over the globe. The air ventilator is built to resist winds of up to 100 kilometres per hour. It's constructed of stainless steel or aluminium, so it's almost maintenance-free, and it comes with a ten-year warranty. The air ventilator is lightweight, weighing less than 3 kg. This allows for installation anywhere on the roof without requiring any structural adjustments.

7.1.2 RIDGE VENTILATORS

At the ridges of the roof, elongated ventilators made of Galvalume sheet are installed. This is the most significant part of the air ventilation system. It may be fastened in a continuous pattern along the building's crest or at a predetermined interval. The Ridge vent enables the building's heat and humidity to escape.

Fig 11 : ridge ventilators

7.1.3 POWER VENTILATORS

The whirlwind low profile extract ventilator has a one-piece base and throat with a spun aluminium non-return shutter. When there is no wind, it is positioned on top of the roof panels to provide ventilation.

Fig 12 : power ventilator

7.1.4 LOUVERS

Louvers are composed of steel or aluminium and come in a variety of designs. The louvre blades are built in such a manner that they aid in air ventilation while also preventing dust and water from entering the structure. Louvers are created, delivered, and fitted according to the needs of the customer.

Fig 13 : louvers

CONNECTIONS

To provide cost-effective structural solutions, PEB systems primarily employ factory-welded built-up I-sections and cold formed Z-sections or C-sections rather than hot-rolled ready-made sections.

CHS (Circular Hollow Sections), SHS (Square Hollow Sections), and RHS (Rectangular Hollow Sections) are also connected using factory welded and filed bolted connections to create special PEB constructions.

The load route and the behaviour of structural steel links are both complicated. There are several sophisticated analytical processes that may be used as references. To comprehend the behaviour of connections, a vast information source is accessible.

Steel is ductile by definition. It is best practise to design the connection for a greater strength requirement than the member strength requirement for better structural performance under seismic loads.

Bolted Connections :

Forces are transferred from one member to another through connections. While both welded and bolted connections may be employed in steel buildings, bolted connections are more prevalent due to their simplicity of manufacturing, buildability, and ability to tolerate small site alterations. The stress distribution in the connection and the forces in the bolts are both reliant on the stiffness of the bolts and the connecting steel parts, thus the performance of a bolted connection is difficult (end plates, cleats, etc.).

One of the biggest advantages of PEB Structural connections is the high strength bolted connections and installation techniques based on known safe and rapid construction procedures.

PEB structural connections for a multi-story structure with built-up BOX columns are depicted in the diagram below.

One of the biggest advantages of PEB Structural connections is the high strength bolted connections in the field and installation techniques based on recognised safe and rapid erection procedures.

Fig 14 : bolted connections

Design of bolted connections

A bolt is a metal pin with a nut-receiving head on one end and a threaded shank on the other. The connecting bolts are classed as follows based on load transfer:

Type of Bearing

Friction Type of Grip

Black bolts have unfinished shanks, which are rough as produced during rolling, while turned bolts have a hexagonal shank that has been converted into a circular form. In the event of a turned bolt, the bolt hole diameter is just 1.5 mm greater than the shank diameter. These bolts are utilised in unique situations, such as joining machine elements that are subjected to dynamic loads. The diameter of the bolt hole is greater in black bolts, and they are employed in the majority of jobs. A black bolt is designated by the letters M16, M20, etc., which stand for black bolts with nominal diameters of 16 mm, 20 mm, and so on.

TERMINOLOGY

The following concepts should be known while dealing with bolted connections:

Pitch of the Bolts (p) is the center-to-centre spacing of bolts in a row, measured in the load direction.

The gauge distance (g) is the distance measured at right angles to the load direction between two successive bolts of adjacent rows.

Edge Distance (e): This is the distance between the bolt hole and the plate's adjacent edge.

TYPES OF BOLTS:

1) Unfinished Bolts

2)High Strength bolts

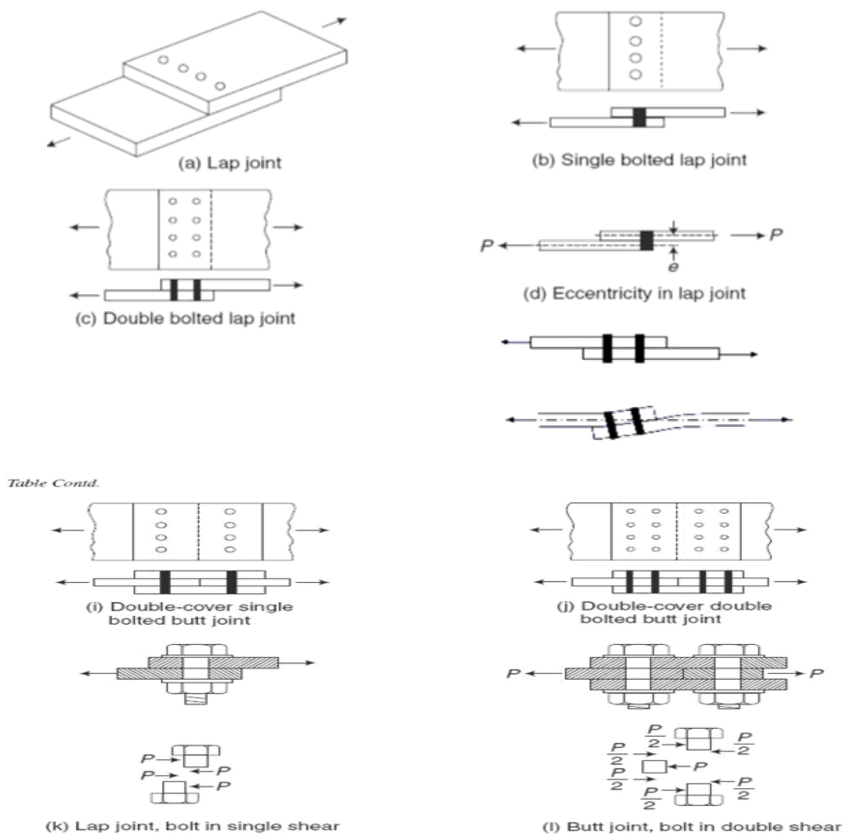


Fig. 4.6 *Types of bolted joints*

VIII. DESIGN METHODOLOGY

8.1 DESIGN METHODOLOGY:

Method Used : Stiffness Matrix Method

Standard Code used :

AISC

ASCE

IS : 800

Software used : Staad.Pro v8i, ETABS, RAM Steel , MBS

Load Considerations and Calculations: The loads that are addressed in the PEB design are the same as those that are evaluated in the design of a typical building structure. The following are some of them:

Calculating the dead load: It consists of self-weighted purlins, roof and wall sheeting, insulation, and other structural components.

Calculations for Live and Imposed Loads: For various types of live loads, it should be considered according to IS 875 (Part 2).

Calculating Wind Loads: Consider the basic wind speed as a function of the structure's area. IS 875 (Part 3) is used to compute design wind pressure. The wind load on the roof may be UDL, and the calculation can be done according to IS875 (Part 3)

Calculating Seismic Loads: Earthquake loads have an impact on structural design in seismically active locations. IS 1893-2002 may be used to determine the seismic load (Part 1).

Other Loads on the Move: It might be a Mono Rail or a Moving EOT Crane load, for example.

Load Combinations : As per IS 1893 – 2002 (Part 1)

7(DL ± LL)

7(DL ± EL)

3(DL + LL ± EL)

8.2 DESIGN OF PRE ENGINEERED BUILDINGS (PEB)

The stiffness matrix approach is used to examine the major frame of PEB systems. The design is based on the American Institute of Steel Construction's (AISC) Allowable Stress Design (ASD) standard or the IS 800. The design programme allows the user to design the main frames in an economical and efficient manner, and it allows the user to use the programme in various modes to produce the frame design geometry and loading, as well as the desired load combinations, as specified by the building code chosen by the user. To arrive at an acceptable design, the software runs through the maximum number of cycles provided. To arrive at an appropriate design, the software use the stiffness matrix approach. To solve for displacements and forces, the application use the stiffness matrix approach. To compute the fixed end moments, stiffness, and carry over factors, the strain energy technique is used. The method of numerical integration is applied.

8.2.1 DESIGN CYCLE

The stages in the design cycle are as follows:

1. Determine section sizes and brace placements depending on the frame design's geometry and loads.

2. For each load combination, calculate the moment, shear, and axial force at each analysis point.

3. Calculate the maximum shear, axial, and bending stresses in compression and tension at each analysis point.

4. Based on the actual and permitted stresses, compute the relevant stress ratios for shear, axial, and bending, and determine the combined stress ratios.

5. Determine the best splice position and verify that the estimated sizes match the production limitations.

6. Update the member data file with the ideal web depths for the next cycle using the web optimization mode.

7. At the conclusion of each design cycle, an analysis is performed to optimise the flange brace.

8.2.2 FRAME GEOMETRY

The application can handle many different forms of frame geometry, as seen below.

There are several sorts of frames, such as stiff frames, frames with numerous internal columns, single slope frames, lean to frames, and so on.

Frames having various spans, heights, and slopes, for example.

Frames have various sorts of supports, such as pinned, fixed, sinking, and supports with certain degrees of freedom released.

Unsymmetrical frames having off-centric, uneven modules, changing slopes, and other features

Purlin and girt spacing, as well as the placement of the flange brace, were set by the user.

IX. FABRICATION AND ERRECTION

9.1 Metal fabrication is the building of metal structures by cutting, bending, and assembling processes

Structural steel products are hot rolled and welded steel structures that are custom-designed and built in a workshop for use in heavy industries, power plants, oil and gas, petrochemical industry, high rise/commercial buildings, airports, and other specialised structures. We are one of the most forward-thinking steel structure fabricators, and we are always working to expand our product and service offerings, including project execution.

9.1.1 Cutting is done using hand-held torches (such as oxy-fuel torches or plasma torches), sawing, shearing, or chiselling (all having manual and powered variations), and numerical control (CNC) cutters (using a laser, mill bits, torch, or water jet).

9.1.2 Bending is accomplished using hammers (manual or motorised), press brakes, and other similar equipment. Press brakes are used by modern metal fabricators to coin or air-bend metal sheet into shape. Hard stops are used on CNC-controlled backgauges to position cut pieces in the precise position for bend lines. Programming the CNC-controlled press brakes is now more easier and more efficient thanks to off-line programming tools.

9.1.3 The components are joined together by welding, adhesive binding, riveting, threaded fasteners, or even additional bending in the form of a crimped seam. Fabrication often begins with structural steel and sheet metal, as well as welding wire, flux, and fasteners to put the cut parts together. Both human labour and automation are routinely utilised in manufacturing operations, as they are in other industries. A fabrication is a product that is created as a consequence of fabrication. Fab shops are metal shops that specialise in this sort of work. Other popular methods of metalworking, such as machining, metal stamping, forging, and casting, produce comparable end products in terms of shape and function, but they are not categorised as fabrication.

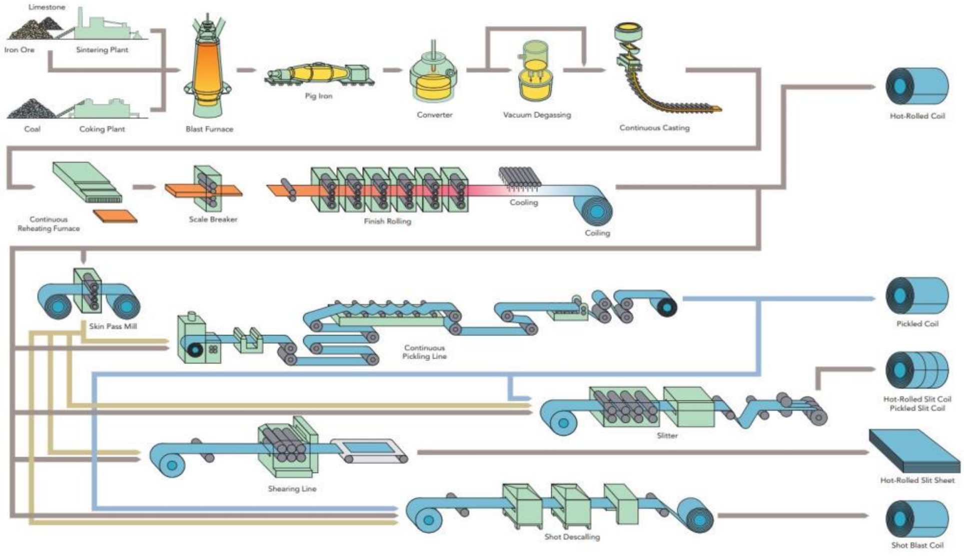


Fig 15 : metal fabrication process

9.2 RAW MATERIALS

Standard raw materials used by metal fabricators are:

Plate metal

Formed and expanded metal

Tube stock

Welding wire/welding rod

Casting

9.3 PROCESS OF FABRICATION

9.3.1 CUTTING AND BURNING

It is necessary to trim the raw material to size. This is accomplished using a number of techniques.

Shearing is the most prevalent method of material cutting.

Metal-cutting band saws contain reinforced blades and a feed system to ensure uniform cutting. Similar to mitre saws, abrasive cut-off saws, also known as chop saws, contain a steel-cutting abrasive disc. Cutting torches can quickly and easily cut huge portions of steel.

Burn tables are CNC cutting torches that are commonly fueled by natural gas. Water jet cutters and plasma and laser cutting tables are also prevalent. Plate steel is put onto a table, and sections are cut off according to the programme. The support table is constructed out of a grid of replaceable bars. Some of the more costly burn tables also include CNC punching capabilities, with a carousel of various punches and taps. Robots move the cutting head in three dimensions around the material to be cut in structural steel fabrication using plasma and laser cutting.

Fig 16 : metal cutting process

9.3.2 FORMING

Forming is the process of transforming a flat sheet metal work item into a three-dimensional component. [2] A raw material piece is generated by applying force to an item without adding or subtracting material in this process. [3] The force must be strong enough to modify the form of the item from its original state. Tools like as punches and dies may be used to regulate the forming process. Machines may also be used to control the quantity and direction of force. Machine-based forming, for example, may combine forming and welding to generate long lengths of manufactured sheeting, most typically in the form of linear grating (used principally for water drainage). [4]

The right tooling and machines provide a repeatable shape that may be utilised to make items in a variety of sectors, including jewellery, aerospace, automotive, construction, civil, and architectural.

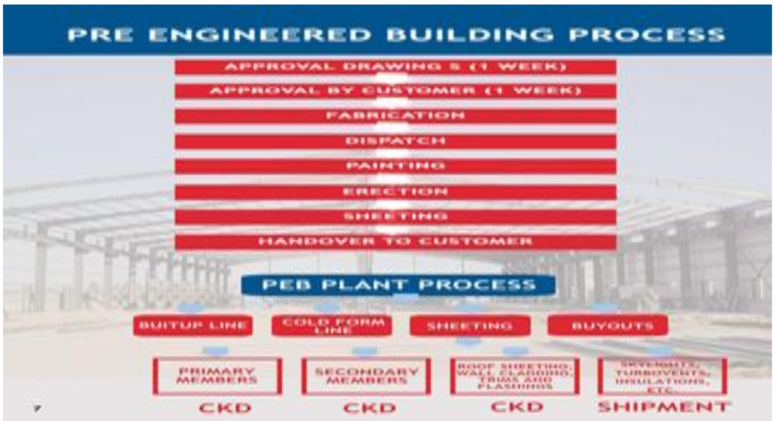


Fig 17 : metal building process

ADVANTAGES AND DISADVANTAGES

Advantages of PEB:

There are several benefits to pre-engineered buildings, including the following:

• The biggest benefit is quality control, since all structural members are designed ahead of time, standards of various codes are taken into account, and these components are manufactured in the factory under the supervision of a Quality Control Engineer.

• Lower costs owing to design, manufacturing, and on-site construction cost savings.

• Reducing construction time via the use of software to design structural components.

• Low Maintenance owing to the application of standard grade paints over steel members, which enhances the capacity to endure and, as a result, lowers the maintenance costs when compared to traditional steel buildings.

• Quick erection since all parts are prefabricated and expert personnel is employed to join the various components.

• Manufacturers typically provide a warranty term of 20 years for PEBs. PEB

QUICKER BUILDING TIME: Buildings are often completed in a matter of weeks once the blueprints have been approved. The foundation and anchor bolts have been cast parallel to the final surface and are ready for site fastening. According to our research, using PEB would save the entire construction time of a project in India by at least 50%. This also provides for quicker occupancy and revenue generation.

LOWER COST: The systems approach results in considerable cost savings in terms of design, manufacture, and on-site construction. The secondary parts and cladding nest together to save money on shipping.

EXPANSION FLEXIBILITY: Buildings may simply be extended by adding extra bays. Pre-designing for future extension also allows for increase in breadth and height.

LARGE CLEAR SPANS: Buildings may be provided with clear spans of up to 80 metres.

QUALITY CONTROL: Because structures are totally constructed in a factory under regulated circumstances, quality is guaranteed.

LOW MAINTENANCE: High-quality paint systems for cladding and steel are provided with buildings to fit the site's ambient conditions, resulting in long-lasting and low-maintenance finishes.

ENERGY EFFICIENT ROOFING AND WALL SYSTEMS: To obtain needed "U" values, buildings may be equipped with polyurethane insulated panels or fibreglass blanket insulation.

ARCHITECTURAL VERSATILITY: Buildings may be constructed to accept precast concrete wall panels, curtain walls, block walls, and other wall systems and can be provided with a variety of fascias, canopies, and curved eaves.

COMPATIBILITY OF ALL BUILDING COMPONENTS AND ACCESSORIES: Because the whole building package is provided by a single vendor, compatibility of all building components and accessories is guaranteed. One of the most significant advantages of pre-engineered construction systems is this.

Disadvantages of PEB

Although pre-engineered buildings offer numerous benefits in the realm of industrial construction, they do have certain disadvantages, which are as follows:

• Corrosion / Rusting Sensitive: If the steel utilised or the paint used to cover steel parts is of poor quality, the structure might be damaged, reducing the structure's lifespan.

• Structure Insulation Expenses, since insulating the building to an acceptable standard will increase your construction costs.

• Appearance: When left exposed, steel sections may be unsightly.

X. CONCLUSION

Steel is a low-cost, strong, durable, design flexible, adaptable, and recyclable material that may be used to develop a Pre-engineered steel structures building. Steel is the most common material utilised in the construction of preengineered steel structures. It contradicts regional sources. It also entails selecting dependable industrial equipment in a wide choice of forms and colours, as well as quick site installation and reduced energy use. It entails making the decision to follow the principles of sustainability. Steel is the material that symbolises the imperatives of sustainable development since it is infinitely recyclable.

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