<u>SUNTECH ENGINEERING</u>

<u>PRE ENGINEERED BUILDING(PEB)</u>

In structural engineering, a pre-engineered building (PEB) is designed by a manufacturer to be fabricated using a pre-determined inventory of raw materials and manufacturing methods that can efficiently satisfy a wide range of structural and aesthetic design requirements. Within some geographic industry sectors these buildings are also called Pre-Engineered Metal Buildings (PEMB) or, as is becoming increasingly common due to the reduced amount of pre-engineering involved in custom computer aided designs, simply, Engineered Metal Buildings (EMB).

Pre-engineered steel buildings can be fitted with different structural accessories including mezzanine floors, canopies, fascias, interior partitions etc. and the building is made water proof by use of special mastic beads, filler strips and trims. This is very versatile buildings systems and can be finished internally to serve any functions and accessorized externally to achieve attractive and unique designing styles. It is very advantageous over the conventional buildings and is really helpful in the low rise building design.

Pre-engineered buildings are generally low rise buildings however the maximum eave height can go up to 25 to 30 metres. Low rise buildings are ideal for offices, houses, showrooms, shop fronts etc. The application of pre-engineered buildings concept to low rise buildings is very economical and speedy. Buildings can be constructed in less than half the normal time especially when complemented with the other engineered sub systems.



The most common and economical type of low rise buildings is a building with ground floor and two intermediate floor plus roof. The roof of low rise buildings may be flat or sloped. Intermediate floors of low rise buildings are made of mezzanine systems. Single storied houses for living take minimum time for construction and can be built in any type of geographical location like extreme cold hilly areas, high rain prone areas, plain land obviously and extreme hot climatic zones as well.

Historically, the primary framing structure of a pre-engineered building is an assembly of **I-shaped** members, often referred as **I beam**. In pre-engineered buildings, the **I beams** used are usually formed by welding together steel plates to form the **I** section. The **I beams** are then field-assembled (e.g. bolted connections) to form the entire frame of the pre-engineered building. Some manufacturers taper the framing members (varying in web depth) according to the local loading effects. Larger plate dimensions are used in areas of higher load effects.

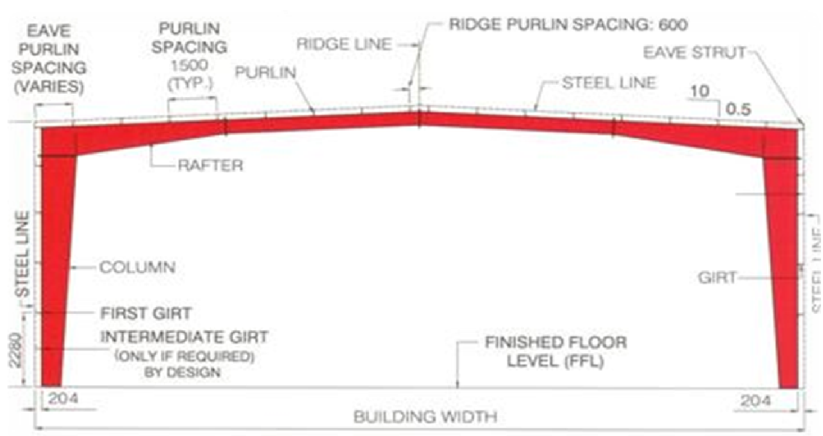
A Pre-Engineered Steel Buildings is composed of two distinct subsystems:

- The Pre-Engineered Steel Building Structure
- The Panels & Panel Accessories

The Pre-Engineered Steel Building Steel Structures (PEBSS)

The PEB Steel Structure of a Pre-Engineered Steel Building generally accounts for over 80% of the weight of the Pre-Engineered Steel Building. This 80% is an average and may change plus or minus 10% depending on the presence of mezzanines, crane runway beams, type of Panels used and the amount of building accessories that are included in a building. The unit of measure for PEB Steel Structures is metric ton (MT). As a general average, one square meter (1 m^2) of PEB Steel Structure weighs 25 kg. Thus one MT of PEB Steel Structure = 400 (1000/25) m^2 of building foot print. The PEB Steel Structure is made up of frames, secondary members and steel standard buyouts.

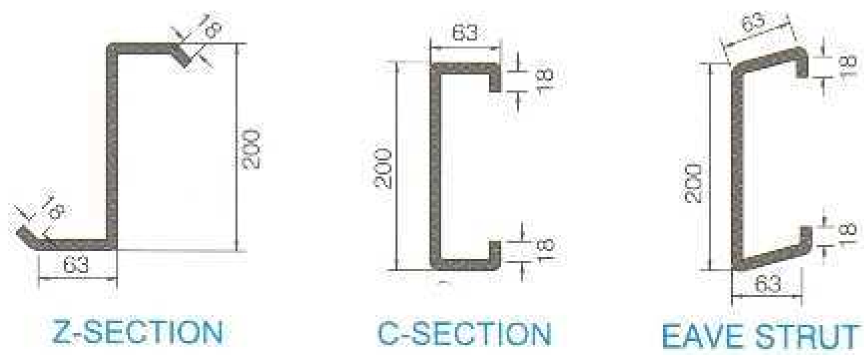
- **Frames** in the PEB industry often refer to primary built-up & hot rolled members. Constant depth or tapered depth **built-up members** generally account for over 90% of the weight of frames while hot rolled members generally account for the remaining 10%.



- **Secondary Members** in the PEB industry refer mostly to longitudinal roof and wall members that are roll formed from galvanized coils or press broken from narrow galvanized sheets. The raw material of these members is stocked in five thicknesses: 1.5, 1.75, 2.2, 2.25 and 2.5mm.

  The following building components are considered secondary members

  - **Z" sections** acting as longitudinal roof purlins and longitudinal wall girts that connect to columns & rafters and support exterior roof and wall panels.
  - **Eave struts** located at the building eaves (corner of roof and wall sheeting along sidewalls also providing bracing for frames and supporting roof and wall panels.
  - **"C" sections** used primarily in framed openings and as a transition member between partial block walls and wall panels.
  - **Mezzanine Deck** (0.7mm thick) used to support concrete slabs in second level flooring.
  - **Base angles**, **gable angles**, **and mezzanine edge angles.**
  - **Valley gutters** (0.9mm thick) in Multi Gable Buildings.



- **Steel Standard Buyouts (SBO):** These are items that are required in almost every PEB Steel Structure. They are manufactured by others and stocked by the PEB manufacturer. They include Anchor Bolts, Connection Bolts, Sag Rods and Cable Bracing Components.

The Panels & Panel Accessories (PPA)

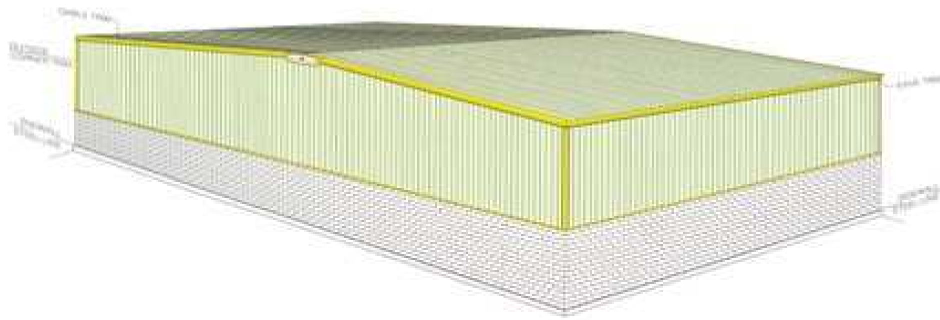
Panels & Panel Accessories include single skin panels, sandwich panels, trims and flashing, panels standard buyouts and building accessories. Although all roofs have panels, walls are often partially or fully open for block wall, precast panels or access.

- **Single Skin Panels** are trapezoidal ribbed sheets roll formed from thin mill finish or prepainted aluzinc coated steel and aluminum coils and cut-to-length to meet the requirements of a specific building.

- **Sandwich Panels** have a polyurethane foam core sandwiched between two single skin metal panels (or an exterior single skin metal panel and an interior aluminum faced laminate). **SUNTECH** does not produce sandwich panels but has an exclusive arrangement, with the largest producer of sandwich panels in the UAE, for the purchase and resale of sandwich panels, to provide its Customers with a single source supply responsibility. The engineering drawings for the sandwich panels are done by **SUNTECH** so are the production of trims and the supply of all sandwich panels accessories such as fasteners, bead mastic, purlin tape, etc.

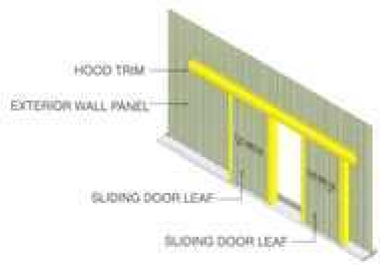
- **Trims and Flashing** include eave trim, eave gutters, downspouts, gable trim, curved eave panels, flashing around building accessories, etc. which are produced from prepainted aluzinc coated steel or aluminum sheets that are bent to the required shape using roll formers, presses, or folding machines.

They weather seal the building and contribute to the neat finish appearance of a PEB.

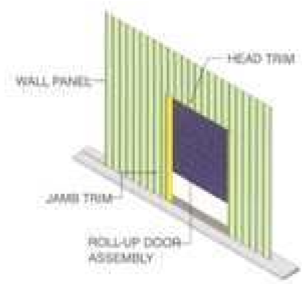


COMMON FLASHINGS AND TRIMS AT ROOF AND ENDWALLS

- **Building Accessories** and special buyouts (SBO's) include sliding doors, rollup doors, personnel doors, fiberglass insulation, sandtrap louvers, windows, ridges ventilators. Some are produced in-house. Some are purchased from suppliers and included in our single source supply.



DOUBLE SLIDE DOORS



ROLL UP DOORS

- **Panel Standard Buyouts** are items that are produced by others and stocked as finished items by the PEB manufacturer. They include sheeting fasteners (carbon steel and stainless steel), bead mastic, pop rivets, foam closures, skylights, etc. These are packed by us for a specific building and shipped to the jobsite with the panels.

Why Pre-Engineered Buildings (PEB's)

Mill section structural steel buildings gained acceptance in the USA during the early half of the 20th century. **Engineers** were able to design steel buildings using standard published properties and load tables of hot rolled steel mill sections produced by most American steel mills. **Contractors** preferred steel buildings to wood and concrete buildings because most quality requirements were handled by the fabricator leaving the contractor with the sole responsibility of erecting the steel structure. **Developers and Owners** favored steel buildings because they were more economical, faster to construct and required less maintenance than reinforced concrete buildings which gave them a better return on investment.

PEB's use a pre-determined narrow range of raw material inventory to produce an infinite range of building geometries to satisfy virtually unlimited design requirements, functional considerations and aesthetic tastes.

COMPONENTS OF A PEB

- **Built-up I – Sections** (often tapered) which are used to produce the columns, rafters & beams of rigid frames, bearing frames, mezzanine structures, cranes runways, roof monitors, roof platforms, catwalks, fascias, parapets, canopies, roof extensions, etc.)

- **Hot rolled I - Sections, channels, tubes and angles** that are used in limited quantities in the PEB Steel Structure.

- **Galvanized cold-formed "Z", "C" and angle shaped secondary structural member**s (roof purlins, eave struts, wall girts, base channels, base angles, gable angles, etc.)

- **Structural Sundry Items** (Anchor Bolts, Connection Bolts, Expansion Bolts and Sag Rods).

- **Profiled, mill finish and prepainted, roof & wall panels and trims & flashings** which include eave gutters, downspouts, ridge panels, curved eave panels, etc.

- **Panel Accessories** such as sky lights, wall lights, ridge ventilators, power ventilators, fiberglass insulation, personnel doors, double sliding doors, roll-up doors and sand trap louvers.

- **Panel Sundry Items** (sheeting fasteners, foam closures, bead mastic, pop rivets, etc.)

Applications of Pre Engineered Buildings (PEB)

- WAREHOUSES
- FACTORIES
- WORKSHOPS
- OFFICES
- GAS STATIONS
- VEHICLE PARKING SHEDS
- SHOWROOMS
- AIRCRAFT HANGARS
- METRO STATIONS
- SCHOOLS
- RECREATIONAL
- INDOOR STADIUM ROOFS
- OUTDOOR STADIUM CANOPIES
- BRIDGES
- RAILWAY PLATFORM SHELTERS

Advantages of Pre Engineered Buildings

REDUCED CONSTRUCTION TIME: Buildings are typically delivered in just a few weeks after approval of drawings. Foundation and anchor bolts are cast parallel with finished, ready for the site bolting. Our study shows that in India the use of PEB will reduce total construction time of the project by at least 50%. This also allows faster occupancy and earlier realization of revenue.

LOWER COST: Due to the systems approach, there is a significant saving in design, manufacturing and on site erection cost. The secondary members and cladding nest together reducing transportation cost.

FLEXIBILTY OF EXPANSION: Buildings can be easily expanded in length by adding additional bays. Also expansion in width and height is possible by pre designing for future expansion.

LARGE CLEAR SPANS: Buildings can be supplied to around 80M clear spans.

QUALITY CONTROL: As buildings are manufactured completely in the factory under controlled conditions the quality is assured.

LOW MAINTENANCE: Buildings are supplied with high quality paint systems for cladding and steel to suit ambient conditions at the site, which results in long durability and low maintenance coats.

ENERGY EFFICIENT ROOFING AND WALL SYSTEMS: Buildings can be supplied with polyurethane insulated panels or fiberglass blankets insulation to achieve required “U” values.

ARCHITECTURAL VERSTALITY: Building can be supplied with various types of fascia, canopies, and curved eaves and are designed to receive pre-cast concrete wall panels, curtain walls, block walls and other wall systems.

SINGLE SOURCE RESPONSIBILTY: As the complete building package is supplied by a single vendor, compatibility of all the building components and accessories is assured. This is one of the major benefits of the Pre-Engineered Building systems.

Comparison Between PEB BUILDINGS & CONVENTIONAL STEEL BUILDING

PROPERTY	PEB BUILDINGS	CONVENTIONAL STEEL BUILDINGS
STRUCTURE WEIGHT	Pre-engineered buildings are on the average 30% lighter because of the efficient use of steel. Primary framing members are tapered built up section. With the large depths in areas of higher stress.	Primary steel members are selected hot rolled "T" sections. Members have constant cross section regardless of the varying magnitude of the local stresses along the member length.
	Secondary members are light weight roll formed "Z" or "C" shaped members.	Secondary members are selected from standard hot rolled sections which are much heavier.
DESIGN	Quick and efficient: since PEB's are mainly formed by standard sections and connections design, time is significantly reduced. Basic design based on international design codes are used over and over.	Each conventional steel structure is designed from scratch with fewer design aids available to the engineer.
	Specialized computer analysis design programs optimize material required. Drafting is also computerized using standard detail that minimizes the use of project custom details.	Substantial engineering and detailing work is required from the very basic is required by the consultant with fewer design aids.
	Design shop detail sketches and erection drawings are supplied free of cost by the manufacturer. Approval drawing is usually prepared within in 2 weeks.	Extensive amount of consultant time is devoted to the alterations that have to be done.
	PEB designers design and detail PEB buildings almost every day of the year resulting in improving the quality of designs every time they work	As each project is a new project engineers need more time to develop the designs and details of the unique structure.
DELIEVERY	Average 6 to 8 weeks	Average 20 to 26 weeks

FOUNDATIONS	Simple design, easy to construct and light weight.	Extensive, heavy foundation required.
ERECTION SIMPLICITY	Since the connection of compounds is standard the learning curve of erection for each subsequent project is faster.	The connections are normally complicated and differ from project to project resulting tin increasing the time for erection of the buildings.
ERECTION COST AND TIME	Both costs and time of erection are accurately known based upon extensive experience with similar buildings.	Typically, conventional steel buildings are 20% more expensive than PEB in most of the cases, the erection costs and time are not estimated accurately.
SEISMIC RESISTANCE	The low weight flexible frames offer higher resistance to seismic forces.	Rigid heavy frames do not perform well in seismic zones.
OVER ALL PRICE	Price per square meter may be as low as by 30 % than the conventional building.	Higher price per square meter.
ARCHITECTURE	Outstanding architectural design can be achieved at low cost using standard architectural details and interfaces.	Special architectural design and features must be developed for each project which often requires research and thus resulting in higher cost.
SOURCING AND COORDINATION	Building is supplied complete with all accessories including erection for a single "ONE STOP SOURCE".	Many sources of supply are there so it becomes difficult to coordinate and handle the things.
COST OF CHARGE ORDER	PEB manufactures usually stock a large amount of that can be flexibly used in many types of PEB projects.	Substitution of hot rolled sections infrequently rolled by mills is expensive and time consuming.
BUILDING ACCESSORIES	Designed to fit the system with standardized and inter changeable parts. Including pre designed flashing and trims. Building accessories are mass produced for economy and are available with the building.	Every project requires different and special design for accessories and special sourcing for each item. Flashing and trims must be uniquely designed and fabricated.

Design of Pre Engineered Buildings (PEB)

The main framing of PEB systems is analyzed by the stiffness matrix method. The design is based on allowable stress design (ASD) as per the American institute of Steel Construction specification or the IS 800. the design program provides an economic and efficient design of the main frames and allows the user to utilize the program in different modes to produce the frame design geometry and loading and the desired load combinations as specified by the building code opted by the user. The program operates through the maximum number of cycles specified to arrive at an acceptable design. The program uses the stiffness matrix method to arrive at an acceptable design. The program uses the stiffness matrix method to arrive at the solution of displacements and forces. The strain energy method is adopted to calculate the fixed end moments, stiffness and carry over factors. Numerical integration is used.

Design Cycle

The design cycle consists of the following steps:

1. Set up section sizes and brace locations based on the geometry and loading specified for the frame design.

2. Calculate moment, shear, and axial force at each analysis point for each load combination.

3. Compute allowable shear, allowable axial and allowable bending stress in compression and tension at each analysis point.

4. Compute the corresponding stress ratios for shear, axial and bending based on the actual and allowable stresses and calculate the combined stress ratios.

5. Design the optimum splice location and check to see whether the predicted sizes confirm to manufacturing constraints.

6. Using the web optimization mode, arrive at the optimum web depths for the next cycle and update the member data file.

7. At the end of all design cycles, an analysis is run to achieve flange brace optimization.

Frame Geometry

The program has the capability to handle different types of frame geometry as follows

Frames of different type's viz. rigid frames, frames with multiple internal columns, single slope frames, lean to frames etc.

Frames with varying spans, varying heights and varying slopes etc.

Frames with different types of supports viz. pinned supports, fixed supports, sinking supports, supports with some degrees of freedom released.

Unsymmetrical frames with off centric, unequal modules, varying slopes etc.

User specified purlin and girt spacing and flange brace location.

Frame Loading

Frame design can handle different types of loadings as described below:

All the building dead loads due to sheeting, purlins, etc. and the self-weight of the frame.

Imposed live load on the frame with tributary reductions as well.

Collateral load such as false ceiling, light fixtures, AC ducting loads, sprinkler systems and many other suspended loads of similar nature.

Design Codes

Following are the main design codes generally used:

AISC **:** American institute of steel construction manual
AISI **:** American iron and steel institute specifications
MBMA **:** Metal building manufacturer's code
ANSI **:** American national standards institute specifications
ASCE **:** American society of civil engineers
UBC **:** Uniform building code

IS **:** Indian standards