A GUIDE TO PEB, vol 1:

Suitability and Applications of PEB

TOTAL SOLUTIONS FOR CUSTOMIZED STEEL BUILDINGS

ACERO BUILDING SYSTEMS

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1.1 Are PEB's functional and suitable?

The PEB (Pre-Engineered Building) concept was developed in the USA after World War II, in response to the demand for fast economic growth and then later transferred to other industrialized countries. PEB consists of a complete steel framed building system, with pre-designed components to best suit the unique customer requirements. This is a complete building shell with structural systems including mezzanine floors, crane systems, canopies, fascias and interior partitions. The final product is a building that can be finished internally to serve the required function and accessorized externally to achieve a distinct architectural style.

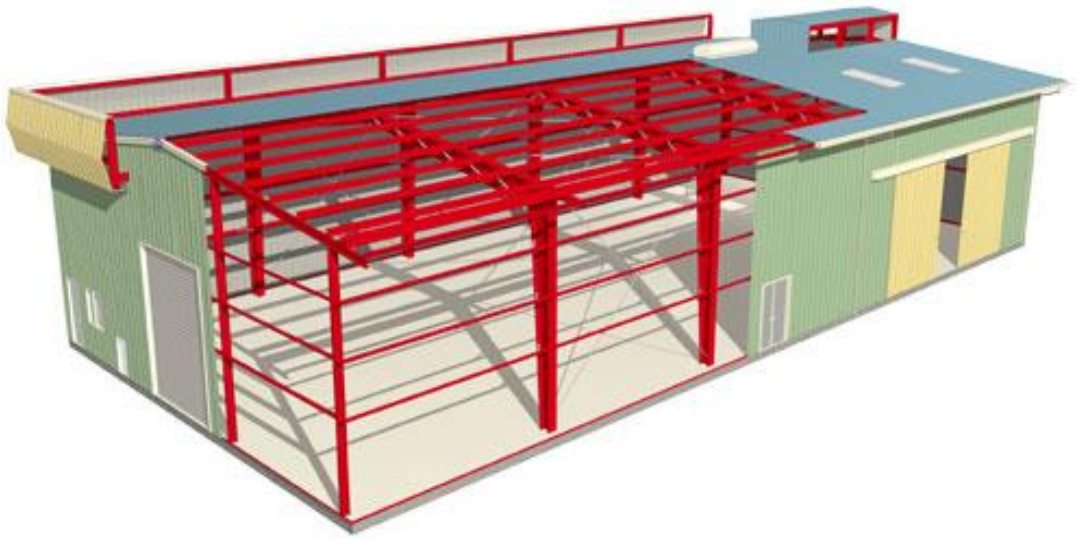
From excavation to occupancy, no other building system matches the pre-engineered building in speed and value for those who demand quality at a reasonable price. The PEB system plays an active role in converting complex and expensive structural steel building designs into simpler and more economical designs, without sacrificing the utility, quality or basic function of these buildings.

The PEB system offers multiple advantages to the end-user, the most notable are low initial investment, fast construction time, low maintenance cost, large clear spans, infinite choice of layouts, inherent resistance to earthquakes, ease of expansion and unique attractive appearance.

If the customer requirements cannot be satisfied by using the standard economical structural systems, ACERO has the flexibility and capability of supplying the customer with alternate custom-building systems. The performance of PEB over the last years and the booming business expansion which the PEB industry is experiencing lately, prove that the PEB components act together as a system, for maximum efficiency, precise fit and a high-quality product.

The PEB industry is part of a continuous thinking machine. Setting up plans, targets and performance standards for the production of engineering work and the development of new systems to improve and increase product reliability and presenting a clear vision for the economy, diversity, versatility and aesthetic features of PEB as an advantage for this industry's growth.

Sample PEB model with elements:



1.2 What is the meaning of a Pre-Engineered Building?

Pre-engineered should not be confused with prefabricated. The name **Pre-engineered building** was adopted for the following reasons:

- Pre-set methods for connecting and welding (standardized connections)
- Utilization of pre-determined stock sizes
- Optimized design, detailing and fabrication, resulting in most economical (lower weight) and fast delivery (reduced engineering time and fabrication time)

1.3 What type of building can utilize the PEB system?

The PEB system has developed a unique architectural approach that is conducive to the release of innovative ideas in design and erection of buildings. This approach is supported by numerous applications, major and minor, carried out by professional and skilled personnel. Since 1946 more than 60% of single-story construction buildings in the USA are PEB. The standard PEB product line includes over 1,300 different components, which may be custom designed and manufactured to fit customer requirements accurately.

Applications of PEB include (not limited to) the following:

Industrial Buildings	Factories	Warehouses	Workshops	Commercial Showrooms
Sports Halls	Recreational Buildings	Shade Structures	Gas Stations	Agricultural Buildings
Grain Storage	Institutional Buildings	Aircraft Hangars	Supermarkets	Distribution Centers
Restaurants	Office Buildings	Labor Camps	Refineries	

The wide range of PEB applications give this industry the cutting edge of market share. Nevertheless, PEB's have some limitations when exposed to more than the maximum span and loads possible. Therefore, according to the building utility and types of applied loads, the proper pattern of building can be selected, meeting the limitations and satisfying other requirements induced by the customer.

For special conditions, it is possible for the consultants to obtain direct advice from Metal Building Manufacturers on the most economical framing solutions for their building requirements. Some vital considerations that are required when selecting the building application, such as design loads, width, bay spacing, eave heights and among others. For PEB, ACERO standards are as follows:

- Design load is indicated to be:
  Live Load = 0.57 KN./m^2
  Wind Load = 130 Km/Hr, these loads satisfy 95% of all the loading conditions usually required in most applications.
- Bay spacing set at 7.5 m as the most practical. Bay spacing as low as 5 m and as high as 10 m can be accommodated.
- Eave heights as high as 30 m can be accommodated in special buildings. The eave height is a critical issue when selecting the type of building for the appropriate application.

The PEB system offers multiple advantages to the end-user, the most notable are low initial investment, fast construction time, low maintenance cost, large clear spans, infinite choice of layouts, inherent resistance to earthquakes, ease of expansion and unique attractive appearance.

1.4 Why choose PEB instead of Conventional Steel?

The term pre-engineered building (PEB) is well known to engineers who traditionally design their buildings with conventional steel instead of built-up members used in the PEB system.

The broad range of applications in the metal construction industry gives PEB an enormous advantage over any other system. The PEB manufacturer's capacity and capability to design, supply and erect a building for any project requiring fabricated steel members, offer a time and cost saving solution to consultants who generally prefer to have one contract, instead of sub-contracts, which make it difficult to control. PEB can be used even where conventional steel has been typically dominating. Applications that PEB has gained ground against over conventional steel structures are heavy industrial and commercial buildings such as: Large Manufacturing Plants, Mill Buildings, Buildings less than 3 stories, Warehouses and Office Buildings. The engineering work of Structural Steel fabricators is limited to the estimation and preparation of erection and shop drawings for fabrication of assigned projects, design is rarely done by the manufacturer.

The following shows a comparison between PEB and Structural Steel, intending to familiarize design groups with the basis of the PEB concept, its high versatility and practicality, and the advantages to designers and consultants.

Feature	Pre-Engineered Steel Buildings	Conventional Steel Buildings
Design Criteria	A.I.S.C., M.B.M.A., A.W.S.	A.I.S.C., A.W.S., J.I.S., D.I.N.B.S.
Structural Base Material	All primary & secondary steel used by ACERO PEB System has a minimum yield strength of 50 KSI (34.5 Kn./cm^2).	In 90% of the cases the primary and secondary steel used has a minimum yield strength of 36 KSI.
Foundation	Simple design, easy to construct and lightweight.	Extensive, heavy foundations required.
Delivery	Average 6 to 8 weeks.	Average 5 to 6 months.
Sourcing & Coordination	Building is supplied complete with cladding and all accessories, including erection if desired, all from one source of supply.	Many sources of supply. Project Management time required to coordinate suppliers and sub-contractors.
Structure Weight	About 30% lighter through the efficient use of steel. Primary framing members are (varying depth) tapered built-up plate sections with large depths in the areas of highest stress. Secondary members are light gage (light weight) cold formed (low labor cost) "Z" or "C" shaped members. Z purlins/girts can be lapped. Lapping reduces the deflection and allows double thickness at the points of higher stresses (support points).	Primary steel members are selected from standard hot rolled "I" sections, which in many cases are heavier than what is required by design. Members have constant cross-sections along the entire span, regardless of local stress magnitude. Secondary members are selected from standard hot rolled "I" and "C" sections, which again are heavier than required.

Design	Quick and efficient since standardization of PEB has significantly reduced design time. Specialized computer analysis and design programs reduce design time and optimize material required. Drafting is also computerized with minimal manual drawings. Design, detail drawings and erection drawings are supplied free of charge by the manufacturer. Approval drawings may be prepared within 10 days to 3 weeks. Consultant in-house design and drafting time is significantly reduced, allowing more time for coordination and review, and increasing margins in design fees. Since most of the PEB are pin based, the cost is reduced due to smaller sections at the base with smaller base plates and foundations (in absence of moments).	Each conventional steel structure is designed from scratch by the Consultant, with fewer design aids available to the Engineer. Maximum engineering required on every project. Generalized computer analysis programs require extensive input / output and design alterations. Drafting is manual or only partially automated. Much Consultant time and expense is devoted to design and drafting, as well as coordination and review.
Accessories Windows, Doors, Ventilation	Designed to fit the system, with standardized, interchangeable parts, including pre-designed flashing and trims. Mass produced for economy. All available with the building.	Every project requires special design for accessories and special sourcing for each. Flashing and trims must be uniquely designed and fabricated.
Erection	Easy, fast, step by step. Erection costs and time are accurately known, based upon extensive experience with similar buildings.	Slow, extensive field labor required. Typically, 20% more expensive than PEB. In most of the cases, the erection costs and time are not estimated accurately.
Architecture	Outstanding architectural design can be achieved at low cost. Conventional wall and fascia materials, such as concrete, masonry and wood, can be utilized.	Special architectural design requires research and high cost.
Overall Price	Price per square meter may be as much as 40% lower than conventional steel.	High price per square meter.
Changes	Very flexible, tailor made, accepts changes and revisions easily. Future expansion simple, easy and cost effective. One supplier to coordinate changes.	Changes, revisions and additions can be difficult due to extensive redesign and coordination among suppliers and sub-contractors.
Performance	All components have been specified and designed specifically to act together as a system, for maximum efficiency, precise fit-up, and performance in the field. The experience with similar buildings, in actual field conditions world-wide has resulted in design improvements over time which allow dependable prediction of performance.	Components are designed for use in alternative configurations. Design and detailing errors are possible in assembling diverse components into unique buildings. Each building design is unique, prediction of components performance together is uncertain. Materials which have performed well in some climates may not in others.
Responsibility	Single source of supply results in total responsibility for one supplier, including design liability.	Multiple responsibilities can result in questions of who is responsible when components do not fit properly, insufficient material is supplied, or materials fail to perform, particularly at supplier interfaces. The Consultant carries total design liability.

1.5 Why use steel for Low Rise Construction and not Concrete?

A few advantages of why PEB is favored over reinforced concrete.

- The shorter erection period permits an earlier recovery of capital.
- A wide span frame is possible, providing column-free interior spaces with a wider range of potential uses.
- Steel structural members offer the absolute accuracy of dimensions and uniform quality possible.
- Concrete has a very low tensile strength, requiring the use of tensile reinforcing.
- Forms are required to hold the concrete in place until it hardens sufficiently. In addition, false-work or shoring may be necessary to keep the forms in place for roofs, walls, and similar structures until the concrete members gain sufficient strength to support themselves. Formwork is expensive. Its costs run from one to two-thirds of the total cost of a reinforced concrete structure, with average values of about 50%.
- The low strength per unit of weight of concrete leads to heavy members. This is an increasingly important matter for long span structures where concrete's large dead load has a great effect on bending moments.
- Similarly, the low strength per unit of volume of concrete means members will be relatively large, an important consideration for tall buildings and long span structures.
- The properties of concrete vary widely due to variations in its proportioning and mixing. Furthermore, the placing and curing of concrete is not as carefully controlled as production of other materials such as steel.
- Other characteristics that can cause problems are concrete's shrinkage and creep.
- Cost comparison studies have revealed that the overall construction cost of structural steel buildings is generally more economical than reinforced concrete structures.

The following table shows some important advantages for the use of Pre-Engineered Steel Buildings instead of Reinforced Concrete Buildings.

Feature	Steel	Concrete
Fabrication	In shop-controlled conditions	Mostly done at site in variable conditions
Material Specifications	Precise and fixed	Variable, Non-homogeneous
Dimensions	Precise and accurate measurements	Potential for significant errors
Capacity	May carry up to 6 times its weight	Carried load almost equal to its weight
Material Foundations	Lighter	Variable
Erection	Faster	Slower
Clear Spans	Larger	Smaller
Buildings Height	Higher	Shorter
Changes	Movable, Expandable	Difficult to modify
Fire Resistance	Needs more protection	Good Resistance
Applications	Industrial, Commercial	Houses, Villas and Parliaments

1.6 What are the material Specifications and Design Codes that ACERO uses, and do they comply with international Standards?

Pre-Engineered Building systems mainly make use of built-up sections, cold formed elements as well as some hot rolled sections. ACERO follows universally recognized codes of practice in the analysis, design and fabrication of its products.

These codes are widely used by the construction and buildings design industries as authentic source of tested procedures, and as basis for acceptable quality for design, materials, fabrication and construction standards.

All materials used in the fabrication of Pre-Engineered Building systems, are new, unused and meet or exceed the physical requirements of the PEB system design and fabrication processes, as well in accordance with the materials manufacturer's standards and procedures. Our quality control department tests the material ordered for inventory to meet the design criteria for strength and to ensure that these materials possess the qualities (including weldability) required by the fabrication process of each specific component of PEB system.

The procedures and calculations used in ACERO PEB design and fabrication are made in reference to the following codes:

- Main frames members (Hot Rolled or Built-up) shall be designed in accordance with the American Institute of Steel Construction (AISC), as specifications for the design, fabrication and erection of Structural Steel for Buildings.
- Cold-Formed members shall be designed in accordance with the American Iron and Steel Institute (AISI), as specification codes applied for the design of cold-formed steel structural members.
- All welding shall be done in accordance with the American Welding Society (AWS) codes. All welders are qualified for the type of welds performed on the steel members.
- Manufacturing dimensional tolerances shall be in accordance with MBMA and AISC as defined in the ACERO Quality System.
- The materials of the steel members used in the PEB manufacturing are conforming to American Society of Testing Materials (ASTM) specifications or equivalent standards.