

Steel Construction

Overview:

Comparison is made between and conventional steel buildings and pre-engineered metal buildings from the Indian scenario.

Introduction:

Steel is the material of choice for design because it is inherently ductile and flexible. It flexes under extreme loads rather than crushing and crumbling. Structural steel's low cost, strength, durability, design flexibility, adaptability and recyclability continue to make it the material of choice in building construction. Today's structural steel framing is bringing grace, art and function together in almost limitless ways and is offering new solutions and opportunities to create challenging structures, which were once thought impossible. Steel structures have reserve strength. Simple "stick" design in the steel framings allows construction to proceed rapidly from the start of erection. Fast construction lowers overhead expenses for construction management services.

Steel is extensively used in the construction of industrial buildings of large spans with or without cranes (medium and heavy buildings), where the concrete construction is not feasible. Steel construction is adapted as an alternative to concrete construction, when construction time is critical, in case of tall residential and low rise non-residential buildings.

Conventional steel construction and reinforced concrete construction in India are going hand-in-hand, in case of low-rise non-residential buildings. Conventional steel construction is also adapted in other countries including United States of America and United Kingdom.

Conventional steel construction is very popular in India from the following considerations:

- Total or partial site fabrication resulting low cost of manufacture
- Suitable for severe service conditions
- Safe design made by reputed design consultants and manufacture conforming to Indian codes and specifications ensure safety, strength and stability
- Fabrication and erection by single agency resulting compatibility
- Quality in construction by carrying out third party inspection or inspection by consultants
- Employing skilled manpower; fitters, gas cutters, welders and riggers, available for carrying out fabrication and erection at site

Variations of pre-engineered metal buildings have been used for about 150 years. Introduction of computer design methods in the 1970s, allowed a transition from pre-engineered rectangular buildings to custom engineered structures. 70% in the low-rise and non-residential construction, is done with the metal building systems in the United States of America .

In the Gulf, pre-engineered metal buildings are popular from the following considerations:

- Less severe conditions
- Inadequate consultants
- Import of materials
- Hiring of manpower

Conventional steel buildings:

Approach towards metal building systems has never been made till recent past as conventional steel construction in India never suffered because of the following considerations:

- Every construction site is a manufacturing unit, which doesn't call for huge investment
- Fabrication is simple , as mostly low tensile steel is used
- Hot rolled sections are used for primary members, not requiring extensive welding and rectification
- Simple connections at the base, cap and other required places
- Fabricator is the erector and hence fabrication and erection are compatible
- Deployment of work force for fabrication and erection is higher, which takes care of social justice
- Low tensile steel is used and hence consumption of steel material is high, leading to less inventory

Tube Products India, Pennar Steels etc are constructing pre-fabricated buildings, using Cold Rolled Form Sections (CRFS). They are not as popular as that of conventional steel buildings. Of course safety, strength and stability are better addressed than that of pre- engineered Buildings.

Pre-engineered buildings:

Of late, Kirby Building Systems, Zamil Steels, Tiger Steels etc started manufacturing metal building systems in India.

- Manufacturing process is automatic. Automation does not ensure quality unless adequate attention is paid in operation and maintenance of machinery.
- Low deployment of work force, depriving employment opportunities to the skilled work force ; Gas-cutters, fitters, riggers and welders
- Low consumption of material by using high strength steel
- Light construction consequent to non-stringent serviceability design considerations

Conventional steel buildings vis-à-vis pre-engineered buildings:

Description	Conventional steel buildings	Pre-engineered buildings
Design	-Consultant -Conservative	-Manufacturer -Tendency is always to make the building light
Material	-Primary members :hot rolled sections -Low strength material -High ductile Material -Secondary members: hot rolled sections -Covering: asbestos cement and galvanized steel sheets	-Primary members : mostly built up sections from hot rolled plates -Medium & High strength material -Low ductile Material -Secondary members: cold formed sections thin members 1.5mm to 2.5mm -Covering; color coated sheets
Fabrication	-Holes are drilled -Gas cutting / shearing -MMA / SA welding	-Holes are punched -Gas cutting/shearing -Auto welding

	-Less manufacturing time for the primary members -Components are relatively free from distortion, sweep, buckling	-More manufacturing time for primary members, built-up from thin plates. -Components are to be rectified from distortion, sweep, buckling
Stability	-Bracing; hot rolled sections	-Bracing; rod / wire rope
Erection	-Site welding / bolting	-Site bolting
Inspection	-Consultant / Third party	-In house

Serviceability Design Considerations:

Horizontal deflection

Structural element	Type of loading	Deformation	Conventional bldgs (IS 800)	Preengineered Bldgs Practice
Metal panels / bare frame	Lateral wind	Horizontal deflection or drift	H/325	H/45- H/60
Bare frame top pendent operated	Crane lateral / wind	Drift at runway elevation	H/325	H/60-H/100
Bare frame top crab operated	Crane lateral / wind	Drift at run way elevation	H/325	H/100
Runway beam	Crane lateral	Horizontal deflection	**	L/400
Grits	Wind	Horizontal deflection	L/180 *	L/120
Wind columns	Wind	Horizontal deflection	H/325	H/120

Vertical deflection

Structural element	Type of loading	Deformation	Conventional buildings IS 800	Pre-engineered buildings MBMA
Purlins	DL+LL or DL+WL	Vertical deflection	Perpendicular <L/45 Parallel < L/60 L/180 *	Positive drainage L/240
Steel joists	LL	Vertical deflection	L/325 (DL included)	L/240
Girders	LL	Vertical deflection	L/325 (DL included)	L/240
Roofs	DL+LL	Vertical deflection	L/325 (DL included)	L/240

Runway beam	Crane vertical static load	Vertical deflection	L/500 Manual operated L/750 < 50 T L/1000 > 50 T	L/600 CMAA cl ABC, L/800 cl D L/1000 cl EF L/450 under hung
-------------	----------------------------	---------------------	--	---

* Indian practice for Cold Roll Formed Sections

** Indian practice to ensure very low deflection by providing surge girder

- ✓ Pre - engineered buildings designed as above, cannot match conventional steel buildings, from the serviceability concerns

Design of pre-engineered buildings is in no way different from that of conventional steel buildings. Manufacturing processes adapted in the pre-engineered buildings, such as auto welding, cold roll forming etc are also adapted in conventional steel construction. Erection by high strength friction grip bolting is adapted, when specified in design, in conventional steel construction also, as in the case of pre-engineered buildings.

Pre-engineered buildings did not find a way in India in the past. Pre-engineered buildings jeopardize Indian interests as the design is not taking care of severe service conditions, resulting in less safe, low strength and less stable buildings. Pre-engineered buildings are light and are not generating adequate work to skilled work force. Automation is also causing low employment. Pre-engineered buildings consume less steel material resulting in large inventory.

Conclusion:

Owners or their consultants are advised to study the merits and demerits before they would take a decision to go for the pre-engineered buildings. They are further advised to specify the design criteria including serviceability concerns for the metal building system, furnish applicable design loads, check the designs independently using reputed/ branded soft wares (not relying on the computer outputs given by manufacturers) and conduct thorough inspection at the manufacturing units. Inspection during erection (may be by a different agency) is also a must so that defects in manufacture, if any, could be rectified. Non -compliance of the above shall definitely jeopardize the owners requirements.

P Appa Rao

Can be reached at papparao@rediffmail.com

Post Graduate in structural engineering , having thirty four(34) plus years experience, mostly in steel construction

Presently, chief consultant, T I M Consultants Private Limited, Hyderabad

- Former additional chief engineer(structural),head of structural department, M N Dastur Private Limited, Chennai
- Former joint general manager (projects), Binny Engineering Limited, Chennai
- Former design supervisor, Zamil Steels(P E B Division), K S A
- Former construction manager, Kirby Buildings Systems India Limited