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Impact Prefabrication Technology (Pre Engineering) and Equipments on Profitability in Construction Industry

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Abstract - The world is technologically progressing quicker than ever. The factors that govern development have altered significantly recently and will continue to do so in the future. The set of catalytic forces that are accelerating the pace of social change around the world includes a rapid rise in education levels, high rates of technological innovations and applications, ever faster and less expensive communication that breaks down physical and social barriers both within and between nations, increased availability and easier access to information, and the further opening up of global markets.

It has been demonstrated that using conventional building techniques will not help you do this. The main tenets of fast track construction have been mechanisation and parallel working. Fast-tracking the tasks without prior preparation will almost always lead to significant errors and re-working. Therefore, a number of factors, including technology, planning, information, education, and employable skills, will be crucially important in determining how growth will go in the future.

One of the finest uses of fast track construction is preengineering. The pre-engineered building idea uses predesigned and prefabricated steel building systems.The current building approach demands the greatest aesthetic appearance, high quality and speedy construction, as well as a cost-effective and unique touch. Pre-engineered steel structures are one alternative construction method to consider. Pre Engineered Building (PEB) concept introduction in structure design in recent years has aided in design optimisation. This study goes into great depth about the use of pre-engineering in quick construction.

Keyword - Time, Fast Track Construction, Pre engineering building

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INTRODUCTION

Because employing the PEB approach results in a 20% lower project cost than using the conventional way, the PEB method is more cost-effective than the latter. Compared to traditional, PEB erection takes less time. In the case of PEB, welding is not necessary because the material is transported on-site and only bolting is carried out.

In PEB, tapered sections are utilised, whereas uniform sections are used in the traditional approach, requiring more steel. As a result, PEB constructions are significantly lighter than traditional steel buildings. Future growth is not conceivable with the standard technique, but it is simple to accomplish using PEB.

Concept

Pre-engineered and pre-fabricated steel building systems are part of the PEB concept. The PEB concept's foundation is on the provision of sections just as needed at a given area. The "Bending Moment Diagram" allows the parts to alter throughout the length. As a result, non-prismatic stiff frames with skinny parts are used. To create this design, tapered I sections composed of thin plates that have been built up are employed. Utilising the least expensive portion results in efficient cost and steel savings.

You may suppose that the profile steel decking has a Young's modulus of 210 GPa and a design strength of 0.93 times the characteristic strength or specified yield strength. In PEB, decking and cladding are often made of steel or aluminium. The affordable, simple, and easy-to-install tough-fastened, lapped-seam roofing is prone to leaks because fasteners are embedded in it. Therefore, modern buildings feature standing-seam metal roofs, which are made of metal panels that run vertically on the roof deck. Each panel of a standing-seam roof has two seams that stand up vertically and are sealed by being snapped or crimped together. This prevents the infiltration of roofing materials.

Traditional building requires more time than PEB structure does. To finish a typical structure, a lot of money is needed, not to mention a lot of manpower. All of this is surpassed by PEB construction, which makes the job of PEB building producers simple.

A PEB construction is undoubtedly the most economical option. But it is also prized for its potential to be recycled. Practically any material may be recycled. It is simple to disassemble the prefabricated building if you need to for whatever reason. There won't be much waste in it.

A PEB structure may be built quickly and easily. The building frame is essentially created from scratch at the factory, and it is then put together on the construction site. As a result, PEB is the ideal choice and aids in business growth.

Pre-engineered structures can be swiftly built, making them the preferred construction technique for the government's infrastructure push. The PEB technology is the best option since it is simple and produces results quickly. As a result, demand is increasing in both the public and private sectors. This comprises cold storage, multi-story buildings, industrial sheds, and storage facilities.

Housing is in ever-greater demand due to the growing population. PEB saves the day since it is a quick building method and provides design flexibility. Pre-fabricated structures are becoming more and more popular all around the world, and India is no exception. In the following years, the pre-fab sector is expected to change the market.

Pre-engineered structures are favoured in earthquake-prone areas since they are comparatively earthquake resistant and extremely durable. PEB structures were only utilised in a few industries, but today they are appearing everywhere.

Today, all types of structures, including low rise, medium rise, and skyscrapers, employ PEB. The advantages of prefabricated constructions are displacing those of conventional construction.

For steel constructions, PEB technology offers the crucial design freedom. This is significant since no other building style offers this amount of benefit.

Starting Era

Because of the enormous advantages that pre-engineered structures have to offer, they have become quite popular. It is simple to assemble, affordable, and demountable for recycling. Pre-engineered structures may also withstand fires in addition to this. The earliest instance of metals being used in building construction, according to the evidence available, dates to the late 18th century. Fire outbreaks in British cotton mills were renowned for resulting in severe damage. As a result, at the end of the eighteenth century, metal, primarily cast iron, was used to make the framework and columns of mill buildings.

Standardised engineering building designs were originally sold as PEBs in the 1960s. The main frame component of a pre-engineered building has traditionally been an assemblage of I-shaped members, sometimes known as I-beams.

Pre-engineered buildings, which were first developed in the early years of this century, are currently used in close to 70% of all single-story non-residential construction. Applications include everything from little vehicle parking shelters to low-rise, multi-story structures with clear spans of 90 metres or more. Pre-engineered construction techniques have been used for almost all imaginable building purposes..

Pre-Engineered buildings were largely used in North America and the Middle East. Since that time, the usage of pre-engineered buildings has become increasingly common throughout Asia and Africa, where the PEB construction idea is now well-liked and respected. Pre-engineered structures are now being used by an increasing number of well-known worldwide contractors and designers who previously only selected conventional structural steel buildings. They now benefit from the quicker building cycle brought about by this approach, as well as considerable cost reductions. From excavation through occupation, no other construction method compares to the Pre-Engineered construction system in terms of speed and cost.

Pre-engineered steel structures have several benefits, which are largely to blame for the industry's phenomenal rise over the past 50 years..

These advantages include:

1. Low Initial Cost	2. Superior Quality
3. Fast Project Construction	4. Functional Versatility
5. Architectural Flexibility	6. Low Maintenance Costs.[1]

Present Era

In the 1960s, the esoteric phrase "Pre-Engineered Buildings" was coined. The structures were referred to as "pre-engineered" because, like their forebears, they were based on pre-established engineering designs for a finite number of pre-configured configurations. This time period was important for the development of metal buildings due to a number of variables. Previously, the greatest clear-span capacities of metal structures were continually growing due to advancing technology. When rigid-frame construction was initially developed in the late 1940s, it could only span 40 feet. Buildings of 50, 60, and 70 feet might be constructed in a short period of time. In the late 1950s, sturdy frames with spans of 100 feet were manufactured, and ribbed metal panels were made available, allowing the structure to shed its previous, worn-out corrugated aspect.

In order to allow for some design originality, Strand-Steel Corporation produced collared panels at the beginning of the 1960s. Around the same period, Butler produced the first factory-insulated panels, Strand-Steel pioneered continuous span cold-formed Z purlins, and the first metal roof with UL approval also hit the market. The earliest metal structures created using a computer also

With the introduction of computers in the early 1960s, the design possibilities nearly reached infinity. In the late 1950s and early 1960s, a new metal-building boom resulted from the interaction of all these elements. The structures might legitimately be referred to as pre-engineered as long as buyers could restrict typical designs. The term "pre-engineered building" started to be used somewhat misleadingly until the industry began to provide custom-designed metal buildings to meet the unique demands of each customer

While "Pre-Engineered Building" is still a commonly used phrase, the industry now prefers to refer to their product as "Metal Building Systems."

During the Second World War, portal frames' fundamental structural design was created. Although they have been utilised in spans as long as 80 metres, portal frames typically have a 30 to 40 metre span. But it is profitable when you take the utilisation of multi-bay constructions above 40 metres in span into account.

Pre-engineered steel structures are ones that are designed, fully constructed in the factory, and transported to the site in a Completely Knocked Down (CKD) condition. All components are then assembled and erected at the site with nut-bolts, shortening the construction period.

Additionally, steel constructions are easier to disassemble and have higher strength-to-weight ratios than Reinforced Cement Concrete (RCC). Pre-Engineered Buildings feature bolted connections and may thus be put back together after being taken apart.

Need of PEB in India :

- The PEB structure is currently popular worldwide due to its many benefits. In the upcoming years, the PEB market in India is anticipated to expand. Pre-fabricated construction is presently one of the most popular technologies since it has several benefits. Cost-effectiveness, speedy construction, sustainability, toughness, recyclability, and design adaptability are a few of these.
- The cost and time efficiency of prefabricated structural components results in long-term financial savings. Furthermore, technological improvements have made labour incredibly simple for Indian construction organisations. Indian PEB building firms employ technology that directly benefits clients. Construction is seeing a surge as a result of the ease and rising popularity of PEBs in order to meet consumer demand.
- Traditional building is a time-consuming procedure in comparison to PEB structure. To finish a typical structure, a lot of money is needed, not to mention a lot of manpower. All of this is surpassed by PEB construction, which makes the job of PEB building producers simple.
- Obviously, a PEB construction is the most economical option. But it is also prized for its potential to be recycled. Practically any material may be recycled. It is simple to disassemble the prefabricated building if you need to for whatever reason. There won't be much waste in it.
- Building a PEB structure is simple. The building frame is essentially created from scratch at the factory, and it is then put together on the construction site. Due to this, PEB is the best option and helps the business to expand.
- Pre-engineered structures can be swiftly built, making them the preferred construction technique for the government's infrastructure push. The PEB technology is the best option since it is simple and produces results quickly. As a result, demand is increasing in both the public and private sectors. This comprises cold storage, multi-story buildings, industrial sheds, and storage facilities.
- The need for homes is always rising as the population grows. PEB saves the day since it is a quick building method and provides design flexibility. Pre-fabricated structures are becoming more and more popular all around the world, and India is no exception. In the following years, the pre-fab sector is expected to change the market.
- Pre-engineered structures are favoured in earthquake-prone areas since they are comparatively earthquake resistant and extremely durable. PEB structures were only

utilised in a few industries, but today they are appearing everywhere..

- All types of structures, including low rise, medium rise, and skyscrapers, are currently constructed using PEB. The advantages of prefabricated constructions are displacing those of conventional construction.

OBJECTIVE

- To study Need of PEB system in current infrastructure
- To study and analysis the engineering properties of PEB Members
- To analyze the impact on quality and tine of PEB and Conventional Structures by taking suitable case study shifted and/or expanded as per the requirements in future.

DATA ANALYSIS

Case Study : **Details**: It is a well-known maker of automobile components both in India and internationally. For the last twelve years, we have been providing the two-wheeler, stationary engine and gearbox system demands of numerous local and international clients on four continents. They offer tailored solutions for our clients' designs while taking their demands and requirements into consideration. Our clientele comprises top car OEMs from countries like India, Europe, the UK, the US, and ASEAN..

SR NO.	ITEM PARTICULAR(UNIT RATE)I	UOM-UNIT RATE ITEM	QTY	RATE	VALUE	INDEX RAW MATERIAL	SOURCE OF INDEX RAW MATERIAL	UOM(INDEX RAW MATERIAL)
1	Primary-Built Up Section	MT	164.42	63861	10500025.62	345 Mpa High Grade Steel ASTM A572 Grade 50-HR	JSW/ISPAT/SAIL/ESSAR	MT
2	Primary-HR Hollow Section	MT	9.371	60667	568510.45	250 Mpa Black Steel-HR Hollow Sections	SAIL/TATA/JSW	MT
3	Bracing &Other Hot Rolled Sections	MT				250 Mpa Black Steel-HR Hollow Sections	SAIL/TATA/JSW	MT
4	Anchor Bolt	MT	0.84	56680	47611.2	250 Mpa Black Steel-HR Angle,Channels,Rods	TATA/SAIL/ESSAR	MT
5	High Strength Nuts &Bolts	MT	2.80	90000	252000	ASTM A325	POOJA FORGE/SOUVENIR	MT
6	Walkway	MT	7.85	58588	459915.8	345 Mpa High Grade Steel ASTM A572 Grade 50-HR	SAIL/TATA/JSW	MT
7	Cage Ladder	MT	0.416	68000	28288	250 Mpa Black Steel-HR Angle,Channels,Rods	SAIL/TATA/JSW	MT
8	Chequered Plates	MT	4.34	41000	177940	250 Mpa Black Steel-Chequered Plate	SAIL/TATA/JSW	MT
9	High Strength Nuts &Bolts	MT	0.42	90000	37800	ASTMA 325	POOJA FORGE	MT
10	Handrails	MT	2.57	78600	202002	250 Mpa Black Steel-HR Hollow Sections	NA	MT
11	Framed Opening	MT	0.07	65543	4588.01	Light Guage Cold Form,Min Yield Strength 345 Mpa,275GSM	JSW/ISPAT/UTTAM	MT
12	Purlins/Grits/Other Roll Form Members	MT	70.92	65543	4648309.56	Light Guage Cold Form,Min Yield Strength 345 Mpa,275GSM	JSW/ISPAT/UTTAM	MT
13	MS Bolt &Nuts-Electroplated	MT	1.06	80000	84800	ASTM A307	POOJA FORGE/SOUVENIR	MT
14	Standing Seam-Roof Sheeting (Galvalume)-0.6mm TCT-Bare(Including clips)	MT	46.76	70592	3300881.92	Galvalume-0.6mm TCT, 345Mpa	JSW/ISPAT	MT
15	Wall Cladding/Wall Sheeting-0.5mm TCT-Coloured	MT	11.86	73097	866930.42	Pre painted Galvalume-0.5mm TCT-550 Mpa	JSW/ISPAT	MT
16	Screws &Sealant	Sq.m	9464.97	50	473248.5	CLASS 3	Corroshield/Atul/ANABOND	Sq.m
17	Rollup Doors ,Personal Doors	LS	0.182	20700	3767.4	MS Painted	NA	LS
18	Insulation 50mm Fiberglass,Density =24kg/m^3 With One Side Aluminium Foil & Other Side White Vinyl Finish & GI Wire Mesh No 20@3/4 Inch * 3/4 Inch With 1mm Zinc Coating	Sq.m	8861.86	215	1905299.9	Insulation Fibre Glass 50mm thick,24kg/m^3 density with AL foil on one side and Vinyl finish on other side	U.P.TWIGA/Oven Scoming	Sq.m
19	Sky Lights	Sq.m	584.48	958	559931.84	Extruded Poly Carbonate 2mm thick	AMPILITE/Palram /SABIC	Sq.m
20	UPVC Down Spout Assembly (150mm dia)	RMT	118.72	215	25524.8	NA	NA	RMT
21	SS Gutter With Accessories (1.5mm thk.)	RMT	171.69	3200	549408	NA	NA	RMT
22	Louvers Fixed Blades-26A Painted Galvalume	Sq.m	102.64	1850	189884	Pre painted Galvalume-0.5mm TCT,550 N/mm^2	JSW/ISPAT	Sq.m
	GRAND TOTAL OF PROJECT				2.5 cr			

Economical Study of Conventional Steel Structure

Sr No	Description	Weight /Area	Rate
A.	Weight Of New shed Size-46.88x112.77mtr	200892.9kg 54 rs/kg	10848216.6
B.	Labour Charges Rate For Structural Steel	Rate Of Labour-30rs/kg	6026787
C.	Rate Of Installation Of Roofing Sheets-10573.3 sqm	Rate Of Installation Of Roofing Sheets Rs.125/- sqm	1321664.4

D.	Base Plate (20mm thick)-168 Nos.	7910 kg 54 rs/kg	427140
E.	Top Plate (16mm thick)-336 Nos.	9002 kg 54 rs/kg	486108
F.	MS Plate (10mm thick)	3948 kg 54 rs/kg	213192
G.	MS Plate (8mm thick)	12628 kg 54 rs/kg	681912
H.	Wastage 6 %	7291 kg	393714
I.	Pre coated flashing 770 rmt	530 rs/m	408100
J.	Fabrication of purlin (50x50x6)	Fabrication charge Rs 20	1019200
K.	Cladding sheet (1060x2.500 mm)	2448.6 sqm 350 rs/sqm	857010
L.	Gable cladding(over all cost)		701932
M.	NLC crimpling (1060x1x50)	700m 352 rs/m	246400
N.	Polycarbonate sheets 1060x2.5 mm	148.4 m 1350 rs/m	200340
O.	Turbo ventilators 24 inches sup-rim, Double bearings	56 nos. 5800 rs per	324800
P.	Corner fleshing(0.200+0.200)	140 m 120 rs/m	16800
Q.	L Fleshing(0.200+0.200)	840 m 120 rs/m	100800
R.	Ridge plain(0.300+0.300)	350 m 120 rs/m	42000
S.	Anchore Bolt		47611.2
T.	High Strength Nuts & Bolts		200000
U.	Walkway		570000
V.	Cage Ladder		30000
W.	Handrails		300000
X.	Framed Openings		60000
Y.	MS Bolt &Nuts-Electroplated		100000
Z.	Wall Cladding/Wall Sheeting-0.5mm TCT-Coloured		1055600
A1.	Rollup Doors ,Personal Doors &Windows		4553
A1.	Rollup Doors ,Personal Doors &Windows		4553
A2.	Insulation 50mm Fiberglass,Density=24kg/m^3 With One Side Aluminium Foil & Other Side White Vinyl Finish & GI Wire Mesh No 20@3/4 Inch * 3/4 Inch With 1mm Zinc Coating		2250634.42
A3.	Sky Lights		743652.36
A4.	SS Gutter With Accessories (1.5mm thk.)		752698.65
A5.	Louvers Fixed Blades-26A Painted Galvalume		365824.15
GRAND TOTAL			**3,07,96,690cr**

Comparative Statement of PEB

Comparative Statement of PEB and Conventional

Sr No	Description	PEB Rate	Conventional Rate
1	Weight Of New shed Size-46.88x112.77mtr	-	10848216.6
2	Labour Charges Rate For Structural Steel	-	6026787
3	Rate Of Installation Of Roofing Sheets-10573.3 sqm	-	1321664.4
4	Base Plate (20mm thick)-168 Nos.	-	427140
5	Top Plate (16mm thick)-336 Nos.	-	486108
6	MS Plate (10mm thick)	-	213192
7	MS Plate (8mm thick)	-	681912
8	Wastage 6 %	-	393714
9	Pre coated flashing 770 rmt	-	408100
10	Fabrication of purlin (50x50x6)	-	1019200
11	Cladding sheet (1060x2.500 mm)	-	857010
12	Gable cladding(over all cost)	-	701932
13	NLC crimpling (1060x1x50)	-	246400
14	Polycarbonate sheets 1060x2.5 mm	-	200340
15	Turbo ventilators 24 inches sup-rim, Double bearings	-	324800
16	Corner fleshing(0.200+0.200)	-	16800
17	L Fleshing(0.200+0.200)	-	100800
18	Ridge plain(0.300+0.300)	-	42000
19	Anchor Bolt	47611.2	47611.2
20	High Strength Nuts & Bolts	252000	200000
21	Walkway	459915.8	570000
22	Cage Ladder	28288	30000
23	Handrails	202002	300000
24	Framed Openings	4588.01	60000
25	MS Bolt &Nuts-Electroplated	84800	100000
26	Wall Cladding/Wall Sheeting-0.5mm TCT-Coloured	866930.42	1055600
27	Rollup Doors ,Personal Doors &Windows	3767.4	4553

28	Insulation 50mm Fiberglass,Density=24kg/m^3 With One Side Aluminium Foil & Other Side White Vinyl Finish & GI Wire Mesh No 20@3/4 Inch * 3/4 Inch With 1mm Zinc Coating	1905299.9	2250634.42
29	Sky Lights	559931.84	743652.36
30	SS Gutter With Accessories (1.5mm thk.)	549408	752698.65
31	Louvers Fixed Blades-26A Painted Galvalume	189884	365824.15
32	Primary-Built Up Section	10500025.62	-
33	Primary-HR Hollow Section	568510.45	-
34	Bracing &Other Hot Rolled Sections	10250	-
35	Chequered Plates	177940	-
36	Purlins/Grits/Other Roll Form Members	4648309.56	-
37	Standing Seam-Roof Sheeting (Galvalume)-0.6mm TCT-Bare(Including clips)	3300881.92	-
38	Screws &Sealant	473248.5	-
39	**Grand Total Of Project**	**Rs.2,50,10,250**	**Rs.3,07,96,690**

TIME FACTOR

Faster building is currently the most crucial component of an industry. 'Fast-Track' initiatives are introduced with the time issue in mind. The PEB idea is highly helpful for meeting deadlines or time constraints in steel constructions. Since the structure is "State of the Art," pre-fabricated, and made of light weight steel, there is no need for welding during construction. Welding free site leads takes less time and is more accurate, improving the structure's quality. Use of low weight steel facilitates handling, maintenance, and erection. Cranes used for erection have a smaller capacity and need less time overall.As we previously stated, bolting is the primary method of PEB assembly. By employing machine screw tightening rather of welding, connecting time is cut in half. The time needed for finding, sorting, and handling was reduced since manufactured PEB members were stacked in an assembly flow manner. It prevents members from becoming lost.

CONCLUSION

Pre-engineered steel buildings are affordable, strong, long-lasting, flexible in terms of design, adaptable, and recyclable. Pre-engineered steel buildings are made mostly of steel as its primary component. It contradicts local sources. Steel is the material that best matches the requirements of sustainable development since it is endlessly recyclable. Due to the effective utilisation of steel, pre engineered structures are typically 30% lighter. The main components of the framework are tapering built-up sections. With the substantial depths in the stress-prone places.

Pre-engineered structures save time since they are mostly made of pre-designed standard parts and connections. International design codes are frequently used to inform basic design. programmes for specialised computer analysis and design to optimise material are needed. Additionally, computerised drafting uses common information to reduce the need for project-specific specifics. Manufacturers provide free erection drawings and design shop detail sketches.

Typically, approval drawings are generated within two weeks. Pre-engineered building designers work on pre-engineered building designs and details practically every day of the year, which helps them continuously improve their designs.simple, lightweight, and easy to assemble. Connections are straightforward, which reduces the amount of time it takes to develop a structure.

Based on significant experience with comparable buildings, both costs and construction time are precisely understood. The erection procedure is simpler, quicker, and requires far less equipment. Flexible low-weight frames are more resistant to earthquake forces. The cost per square metre is 30% less than for a traditional structure.

Prefabrication reduces activities involving repetitive body movements, ergonomic challenges, and ergonomic problems, according to a study of the prefabrication process. Additionally, 92% of workers reported that using prefabrication preassembly reduced material handling hazards on the job site and reduced the need for scaffolding, which would reduce the risk of falls on the job site.

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