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Study on Pre-fabricated Modular Steel Structures

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ABSTRACT: Recent devastating earthquakes of 7.8 term that encompasses several different types of buildings. These many losses are due to poor building techniques and heavy building materials. In the developed countries like Japan, China, etc. the earthquakes do not affect the lives and destroy the houses. This is because they use the pre-fabrication building techniques and steel or aluminium frame structures rather than heavy concrete building structures. The prefabricated house is constructed by light steel frame to sandwich panels for the building envelope materials, as a standard module for space series combination of components, the bolt connection, and the new concept of environmental protection economic activities in prefabricated house. The prefabricated components are brought to the site and erected using building block type construction. Work is never delayed by curing time or missing materials and can be completed for 30 to 45 working days. Further study shows that it can also lower the total cost of the project by 12 percent as compare to the traditionally build house using traditional materials such as CHB (Concrete Hollow Blocks).

This paper includes the study on steel structures and pre-fabricated structures. In a general survey, many people were asked about the types of houses they prefer; one common reply was earthquake resistant and economical houses. This paper also includes analysis and research on the quality, strength, environment friendly, costing and the comparison between the traditional buildings and pre-fabricated buildings. The study aims to introduce and to provide more knowledge about modular house to educate the market and to address the concern of every sector of the society especially the depressed areas of the society.

KEYWORDS: pre-fabrication, aluminium frame structures, earthquake resistant structures, economical houses, environment friendly, steel structures.,

I. INTRODUCTION

The word Prefab is used as a short for prefabricated buildings Prefab is a broad term that encompasses several different types of buildings. Technically, any home that has sections of the structure built in a factory and then assembled on site can fall under the prefab designation. The prefabricated house is constructed by light steel frame to sandwich panels for the building envelope materials, as a standard module for space series combination of components, the bolt connection, and the new concept of environmental protection economic activities in prefabricated house. In this competitive world, no countries want to be backward and less developed than any other. Nowadays, the developed countries are in the front of development of sciences and technologies such that they are looking for the probability of lives in another planet.

The world became so advanced that they even don't have time to look after the housing and constructional works. But there are also some countries in this globe which even are not providing the shelter for their people. People of some countries like Nepal, India, Bangladesh, etc. don't have a roof to hide themselves from heat and cold. Moreover, the recent earthquake of 7.8 magnitudes in Nepal destroyed many houses. The research from many agencies and expertise shows that the most of the destroyed buildings were traditionally built and the materials used were not tested or certified. As we all know, in building the conventional and traditional buildings, it takes much more time and the costing is also very high. Also, there will be more wastes and environment will be polluted; labors are also not safe while construction traditional buildings. If these many problems are there in following the conventional trend, why should not we look for the easier and best way for constructional work? Yes. We have to follow the new techniques i.e. Pre-fabricated Modular and steel structures.

Modular construction technique is a process in which a building is constructed off-site, under controlled environmental conditions, and it uses the same materials and design structures to the same codes, standards and building bye-laws as



conventionally built facilities but in a short time as compared to conventional house construction. Buildings are manufactured in “modules” that when put together on site, they look exactly like conventional built. Modular construction can be used for building temporary or permanent building such as construction of camps, schools and classroom, civilians and also for military facilities as well as industrial facilities.

II. RELATED WORK

Stefan J. Weidemann., (2015), paper entitled “Modular Pre-fabrication versus Conventional Construction as a Cost Effective Alternative or the Construction of the Single Family Detached Housing in the Montreal Area”, stated that Conventional wisdom would lead one to believe that the production of prefabricated housing under controlled conditions using mass production technology and employing a generally semiskilled workforce would result in a product less expensive or at least competitively priced to that of conventionally built homes. Indications were appeared to support the contentions made so often by the prefabrication industry that their product is more cost effective than conventional construction **Svetlana Brzev., (2014)**, paper entitled “Precast concrete construction”, stated that According to WHE reports, no major efforts have been reported regarding seismic strengthening of precast concrete buildings. However, seismic strengthening of precast frame buildings was done in Uzbekistan (WHE Report 66). The techniques used include the installation of steel straps at the column locations and reinforcing the joints with steel plates to provide additional lateral confinement of the columns. **Yingchen et.al., (2010)**, paper entitled “Decision support for construction method selection in concrete buildings: Prefabrication adoption and optimization”, stated that to choose prefabrication is highly based on experience and familiarity and personal preference rather than rigorous data. Methodical assessment of an appropriate construction method for a concrete project has been found deficient. This paper showcases a tool called construction method selection model. It helps to detect and evaluate the feasibility of a project in prefabrication at early stages. **Shahzad et.al., (2014)**, paper entitled “Prefab content versus cost and time savings in construction projects; A regression analysis”, stated that the study has successfully established the fact that proportion of prefab content has a significant relationship with the cost performance and time performance of the project. The study has quantified the benefits of employing prefab technology in light to medium commercial building projects by concluding that 77% prefab content in light to medium commercial buildings can result in 100% or more cost performance and similarly 74% prefab content can result in 100% or more time performance. Findings of this study are likely to encourage the uptake of prefab technology in construction process. However, factors other than prefab content might be responsible for the cost and time performance such as quality of project management, site characteristics, procurement strategies etc. are recommended for further investigations.

2.1 Objectives of the work

Based on literature review the following objectives are derived

1. To reduce the construction time and it's cost.
2. To minimize the wastes and make it environment friendly.
3. To replace the traditional or conventional way of construction with modern tools technique.
4. To build light weight building and make earthquake resistant and resistant to adverse climate.
5. To minimize the in-site construction.
6. To minimize the usage of construction ingredients

III. CONSTRUCTION METHODS

The steps involve in the construction method for the case study are the following;

1. Earthwork and foundation preparation.
2. Site installation of the shipping containers.
3. Site installation of staircases, floor, joists, and other structures.
4. Site installation of floorboards and railings.
5. Site installation of roof structure and coverings.
6. Mechanical and Electrical (M&E) and fittings installation.



Fig-3.1: Earthwork and foundation preparation



Fig- 3.2: Site installation of the shipping



Fig-3.3: Site installation of staircases, floor, joists



Fig- 3.4: Site installation of floorboards



Fig-3.5: Site installation of roof structure coverings

**Fig-3.6:** Mechanical and Electrical fittings

IV. CASE STUDY

The case study is the construction of 72 lecturer office units using an innovative and revolutionary construction technique known as the Modular craft system. The system is jointly developed by Portland Group of Companies and University Malaysia Pahang (UMP). The case study is also part of University Malaysia Pahang's new Green Policy of using recycled industrial commodities and adapting to sustainable building construction technologies, in line with global efforts toward protection of the environment. The Modular craft system comprises the use of shipping containers as the basic building module combined with Primer-X a thermal insulation coating or G-Bricks that used in masonry works. The essential products in the Modular craft system package are made of recycled material and are the results of extensive research carried out by University Malaysia Pahang (UMP). The case study that involves the important use of Primer-X on shipping containers demonstrates the habitability of shipping containers despite our equatorial climate. The creations of custom built buildings are mobile, sustainable, environmentally friendly and greater efficiency by the drastic reduction of construction time when compared to conventional construction method. The Modular craft system also significantly reduces the use of reinforced concrete or other labor intensive construction methods and minimize on site disruption

Table-4: Summary of the case study

Particulars	Descriptions
Application	Office
Location	Malaysia
Year constructed	2014
Projected period	5 month
Cost of project	RM3.5 million
No of modular units	72 units
Contractor /manufacturer	Both contractor & manufacturer
Benefits	High quality, Environment friendly



Fig-4: The image of the case study

V. ADVANTAGES DISADVANTAGES AND APPLICATIONS

5.1 ADVANTAGES

- Prefabricated components speed up construction time, resulting in lower labor costs.
- There are less wasted materials than in site built construction.
- Construction time is reduced and buildings are completed sooner, allowing an earlier return of the capital invested.
- The mechanization used in prefabricated construction ensures precise conformity to building code standards and greater quality.
- On-site construction and congestion of site is minimized.
- Better quality control can be achieved in a factory assembly line setting than at the construction site.
- Time spent due to bad weather or hazardous environments at the construction site is minimized.
- Less wastage of construction material.
- Worker safety and comfort level are higher than in site-built construction.

5.2 DISADVANTAGES

- Leaks can form at joints in prefabricated components.
- Transportation costs may be higher for voluminous prefabricated sections.
- The requirement to transport manufactured homes or modules to their intended site can mean that prefabrication potential may be limited for infill projects in inner city areas.
- Higher initial construction cost.
- Lack of background research information.
- Time consuming in the initial design development

5.3 APPLICATIONS

- Modular construction technique can be used to build large modular buildings such as office complexes, stations, schools, medical and health complexes, etc.
- Modular construction technique can also be adopted for building medium residential buildings as well as high rise buildings, cafeterias, public toilets and other uses that are usually associated with brick and mortar buildings.
- As modular construction technique saves time, it can be used for disaster management such as earthquakes, hurricanes, and other World calamities that require emergency shelters and housing for displaced persons as in the case of Refugees crises in some parts of the world that require emergency shelters, hence modular construction technique is best suited to address shelter problems as the process is past compare to on-site construction technique.

VI. CONCLUSION

1. Earthquake resistant structures can be constructed with low investment and less time.
2. The use prefab materials obviously reduce the waste produced in sites.



3. Construction is fast and quick
4. Environmental risks are reduced.
5. Number of labor can be reduced.
6. Worker can assure their safety

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