TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 12221 - 12224

A Feasibility Study on the Use of Structural Insulated Panels in the Construction Industry

[1]Panjehpour, [2]Parikshit Dhawotal
[1], [2] Department of Civil Engineering, INTI International University, Malaysia
[1]mdpanjehpour2006@yahoo.com

Article Info
Volume 82
Page Number: 12221 - 12224
Publication Issue:
January-February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 23 February 2020*

Abstract
The construction industry is growing at a fast pace in today's developing society. Rapid construction of buildings has always been human wish. Structural insulated panel (SIP) is a viable solution as a component of prefabricated house, particularly for wall and floor systems. This research focuses on the feasibility of SIP by scrutinising the significant parameters associated with the use of SIP in pre-, during and post-construction phases. The parameters discussed in this paper are cost, quality, recycled materials, construction time and maintenance. A survey was conducted in two sections of demographics of respondents and technical aspects of use of SIP in the construction industry. A descriptive statistics method was adopted for presenting quantitative descriptions in forms of charts and histograms. The survey results indicate a remarkable demand for SIP in the construction industry and the need for conducting workshop as the effective ways of raising awareness among construction professionals on recent advancements of structural insulated panel.

Keywords: *precast concrete, prefabrication, structural insulated panel*

I. INTRODUCTION

Rapid construction of buildings has always been a dream for society. Considering the increasing complexity of the construction industry and the turbulent environment within which projects are being carried out, delays and cost-overruns are common problems. The use of traditional building materials is no longer viable to overcome the issues faced by today's construction industry. The need to erect and develop buildings within a given timeframe and budget is increasing exponentially. Prefabricated house is a solution as it is factory-made using off-site technology and can be easily transported and assembled on site [1-3].

The design of prefabricated structural insulated panel (SIP) is a key into developing prefab home. SIP can reduce projects construction time and budget in a mass production due to its light weight and higher compressive strength than traditional building wall And floor [4-6]. SIP is a type of sandwich panel which is labour-intensive and energy-efficient and improves the sustainability of building [1, 4, 5, 7, 8]. The common issues regarding design of SIP are bearing loads in vertical and lateral directions and also the types of static and dynamic load [9, 10].The lateral load is important for high rise buildings as the wind load increases with height [11]. This research aims to investigate the viability of using SIPs for both floor and wall as a replacement for traditional building methods. This feasibility study focuses on SIP application as precast wall-floor system and provides various data collected through a survey using quantitative method.

II. TYPES OF DATA COLLECTED

A computer-aided survey was conducted with questionnaires in two sections, namely section A and section B. Section A collects demographic information about the background of the respondents including gender, type of organisation, current job status in the company, working experience and the

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 12221 - 12224

type of project they have been involved in. Section B contains respondents' view on factors associated with implementation of SIP in the construction industry and ways of raising awareness about SIP among construction professionals. The questions were mostly close-ended and respondents had a restricted choice of answers. The question styles were in form of Yes or No, scaled questions and multiple choice questions. The target population with sample size of 110 consisted of contractors, consultants, civil engineers, architects and project managers were used.

III. Data Analysis

The data are analysed in sections A and B for demographics and structural insulated panel respectively. Microsoft Excel was used to analyse the data tabulated automatically by Google forms. The mean score (MS) methods and descriptive statistics in form of charts and histograms were used for data analysis. Data collected from section B were analysed using mean score method based on Likert scale. Lower mean score denotes higher influence of SIP panels over traditional building methods.

$$MS = \left(5 - \frac{\sum(f \times s)}{n}\right) (1 \leq MS \leq 5)$$

Where,

f = response Frequency

s = score assigned by the respondents to each criterion

n = total number of respondents

The descriptive statistics method was adopted as it aids in presenting quantitative descriptions in various form such as chart and histograms.

IV. Survey Results

A. Section A – Demographics

The targeted population for this research includes consultancy firms and contractors. The respondents were 52.2% from contractors and 47.8% from consultancy firms. Therefore the contractors' portion is slightly greater than that of consultancy firms'. 56% of respondents were male while the remaining 44% were female. The Respondent's current position, years of experience and types of project they are involved are shown in Figures 1-3 respectively.

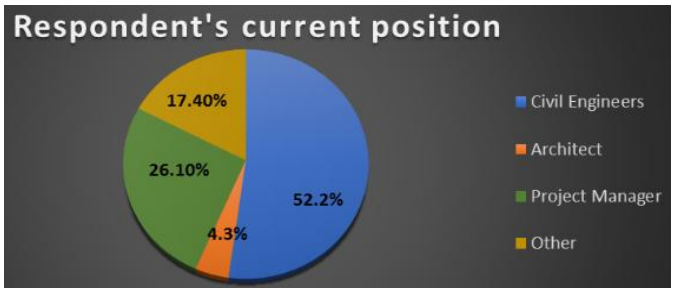

Figure 1. Respondent's current position

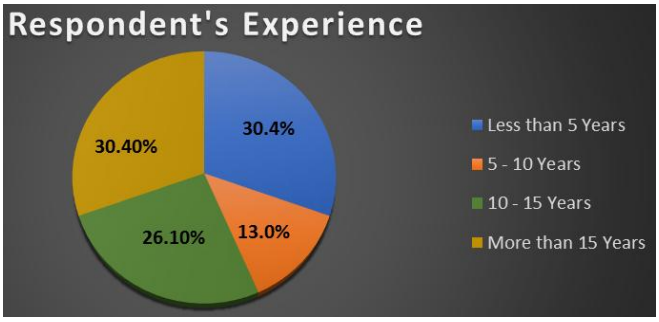

Figure 2. Respondent's experience in the construction industry

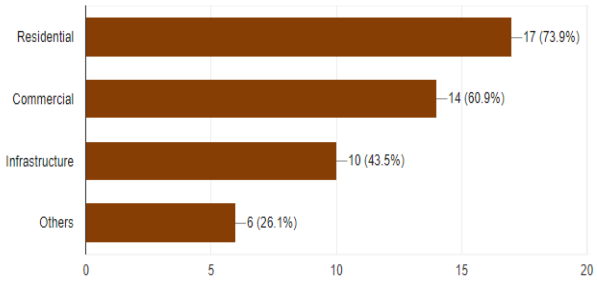

Figure 3. Types of project the respondents are involved

B. Section B - Structural Insulated Panels

This section of the questionnaire was designed to obtain the perspectives and opinions of the major players of the construction industry on the implementation of SIP in the construction industry. All questions were analysed using descriptive statistics expect one, whereby mean score was applied as a tool for data analysis. The respondent's awareness of SIP is shown in Figure 4. In addition, the percentage of respondents with replacement of traditional wall and floor with SIP in 5 levels of strongly disagree, disagree, neutral, agree and strongly agree are shown in a bar graph in Figure 5.

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 12221 - 12224

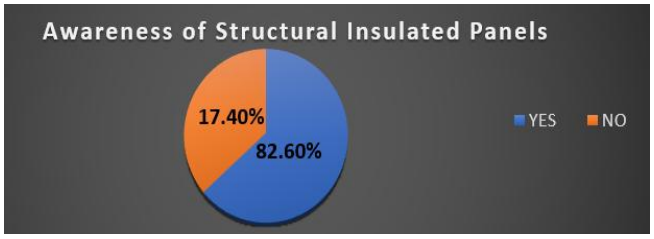

Figure 4. Respondents who are aware of SIP

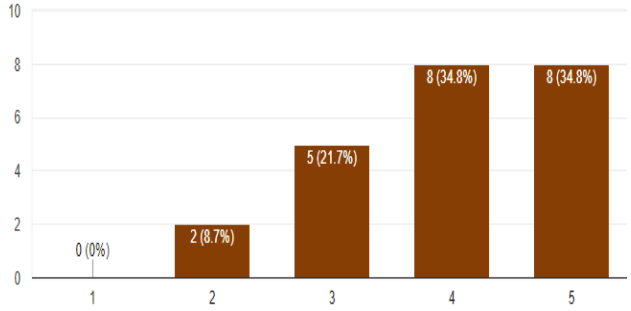

Figure 5. Replacing traditional building methods with SIP

Factors associated with implementation of SIP in construction: Through this question various factors of SIP implementation which influence the construction industry were analysed. The respondents were requested to rate several factors provided based on a scale of 1 to 5, whereby 1 was the least influencing and 5 the most. The data were analysed using the mean score data analysis tool whereby, lower mean score denotes higher influence of SIP over traditional building methods. From the graph in Figure 6 it can be concluded that the use of SIP instead of traditional building methods is more effective since it comes with many benefits and will therefore improve the overall performance of the construction industry in a long run.

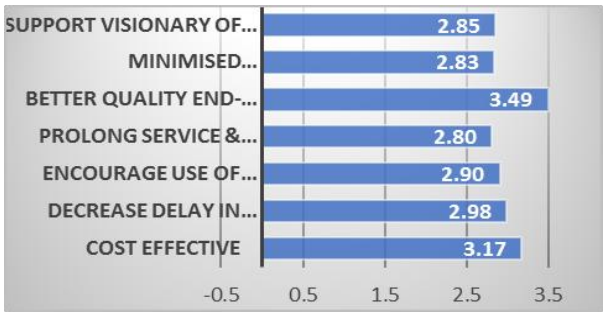

Figure 6. Factors associated with implementation of SIP in construction

Ways to raise awareness: The question was used to assess on how to enhance the knowledge of construction professionals on recent advancements of SIP. Figure 7. illustrates that workshops was the most selected approach followed by formal trainings.

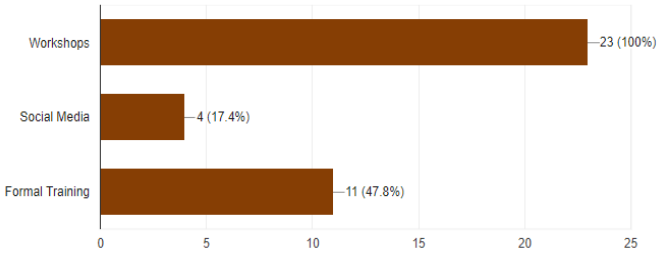

Figure 7. Bar charts illustrating best approach to enhance knowledge on SIP

V. Conclusion

The viability of the SIP is significantly governed by its components and materials. SIP can be a viable substitution for traditional building wall and floor. Being prefabricated, SIP has the superiority over conventional wall and floor. A large amount of material is wasted from traditional building methods while due to the prefabrication of SIP panel by off technology, the excess material can be recycled or sent to a proper landfill avoiding pollution. Prefabs SIP panel has a great financial savings compared to traditional methods. Even though cost of raw materials for SIP is almost expensive, its long terms benefits are considerable. Because of mass production, manufactures often purchase raw materials in bulk at a discounted price. The use of SIP shrinks time needed in order to complete a project and lessens expended energy. Moreover, less labour is needed to perform the job at hand. Since SIP is prefabricated in factories, it has a consistent quality and follows specific standards which are controlled by engineers at the factory. There is a remarkable demand for SIP in the construction industry and need for conducting workshop as an effective way of raising awareness among construction professionals on recent advancements of structural insulated panel.

VI. ACKNOWLEDGEMENT

The authors appreciate the scientific supports from the Centre for Advanced Concrete Technology (CACT).

January - February 2020
ISSN: 0193 - 4120 Page No. 12221 - 12224

VII. REFERENCES

[1] L. E. M. Anson JMK, "Howes R. Industrialized housing construction - The UK experience," *Advances in Building Technology*, vol. 23, pp. 383-9-, 2002.

[2] PANJEHPOUR, "A review of prefab home and relevant issues," *CONSTRUCŢII,* vol. 1, 2013.

[3] R. E. Smith, *Prefab Architecture: A Guide to Modular Design and Construction.*: John Wiley and Sons, 2011.

[4] M. Brown, Hurst, T., "Structural insulated panel system," United States Patent, 2011.

[5] Y. L. V. Panjehpour1, "Structural Insulated Panels: Past, Present, and Future," *Journal of Engineering, Project, and Production Management*, vol. 3, pp. 2-8, 2013.

[6] F. Yeoshua, "Elastica of sandwich panels with a transversely flexible core - A high-order theory approach," *International Journal of Solids and Structures*, vol. 46, pp. 2043-2059, 2009.

[7] M. Akay, Hanna, R. , "A comparison of honeycomb-core and foam-core carbon-fibre/epoxy sandwich panels," *Composites*, vol. 21, pp. 325-331, 1990.

[8] K. P. Dharmasena, Wadley, H. N. G., Williams, K., Xue, Z., Hutchinson, J. W., "Response of metallic pyramidal lattice core sandwich panels to high intensity impulsive loading in air," *International Journal of Impact Engineering*, vol. 38, pp. 75-289., 2011.

[9] Y. Frostig, Thomsen, O. T., "Non-linear thermo-mechanical behaviour of delaminated curved sandwich panels with a compliant core," *International Journal of Solids and Structures*, vol. 48, pp. 2218-2237, 2011.

[10] D. Miller, C. Lewis, I. A. Mercuri, R., "Carbon foam structural insulated panel," United States Patent, 2010.

[11] T. S. Borjen Yeh, Xiping Wang, Tom Williamson, "Lateral Load Performance of Structural Insulated Panel (SIP) Diaphragms," United States Department of Agriculture2019.