Recent Trends in Civil Engineering and Built Environment Vol. 4 No. 3 (2023) 372-378

RTCEBE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/rtcebe
e-ISSN :2773-5184

Performance of Strength Hollow Core Wall Panel in the Precast Concrete System

Muhammad Izzuddin Aziz[1], Abdul Halim Abdul Ghani[1]*

[1]Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

*Associate Professor, Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

DOI: https://doi.org/10.30880/rtcebe.2023.04.03.040
Received 06 January 2022; Accepted 15 May 2023; Available online 31 December 2023

Abstract: To increase the construction industry's productivity, the Industrialized Building System (IBS) has been put in place. Hollow Core Wall Panel (HCWP) is one of the IBS components in the precast concrete system. Due to this case, the strength of HCWP is important to guarantee the performance of IBS. Therefore, this study was about to determine the optimum strength of concrete between HCWP and Normal Brick Wall (NBW) cast in-situ and also to investigate surface hardness between HCWP and NBW. The specimen test collected from IBS plant at Acotec Sdn. Bhd. in Bandar Tenggara, Johor where the sample specimen size dimension collected is 300 mm x 300 mm x 100 mm. The laboratory test conducted after the sample was collected. A compressive strength test used to determine the HCWP's strength, then a non-destructive concrete testing procedure known as the rebound hammer test was used to assess the concrete's strength. From the analysis that have been done, HCWP is higher than Normal Brick Wall (NBW) for the compressive strength test and rebound hammer test.

Keywords: HCWP, Compressive Strength, Rebound Hammer

1. Introduction

The construction industry in Malaysia has been presented with the IBS. Presently, the construction industry that was once just utilize customary strategies have been moved to a more imaginative strategy which is Industrialized Building System, where undertakings are generally founded more on the item based. IBS is a development framework that assembled utilizing pre-assembled segments. A formwork is named one of the IBS segments. Furthermore, the development technique for IBS is the place where the segments are produced off-site or industrial facility and once finished it will be conveyed to building locales for gathering and erection [1].

In general, IBS is a system in construction industry that presented where pre- assembled part is fabricated efficiently utilizing machine, formworks and mechanical equipment off site and will be shipped off the building site to collect the segment into building structure [2]. Precast concrete is cast and cured in a manufacturing plant under controlled conditions, then shipped to a construction site and

*Corresponding author: abdulhalim@uthm.edu.my

installed quickly with less site disruption, often in just several days. Precast is a time-saving alternative to site cast concrete which must cure for about 30 days to gain its full strength and stability and reduces labor on-site and the risk of weather delays [3]. Precast concrete is manufactured in a facility using advanced mix designs and superior vibrations, requiring less concrete, cement, and steel [4]. Due to the manner of mix design and reinforcing, the strength performance of HCWP may differ from that of conventional concrete.

This research of study carries out the performance of HWCP in precast concrete system to determine the strength of concrete.

2. Literature Review

Precast (also known as "prefabricated") construction refers to structures in which the majority of the underlying pieces are normalised and manufactured at plants located outside of the structure, then shipped to the site for assembly. These parts are fabricated by mechanical strategies dependent on mass creation to construct countless structures in a brief time frame for minimal price [5]. Hollow core wall panel are precast prestressed units delivered on longline beds utilising slide shaping or expulsion methods. Panel widths are typically 1200 or 2400 mm and thicknesses fluctuate from 150 to 300 mm, centers shift fit as a fiddle contingent upon the hardware, and in number contingent upon the presentation necessities [6]. The projecting bed is for the most part up to 200m long and either steel or concrete. Insert are cast into the panels a role as needed for association with the design. Panels are saw-sliced to length on the bed to suit the specific application. Panels are accessible with an assortment of completions and tones. Surfaces may be either plain, finished, ribbed or uncovered total contingent upon the project requirements and the locality.

For HCWP, it comprises of different hollow-core precast panel units. In spite of the absence of cross over and shear support, HCWP can withstand huge sidelong burdens gave the association subtleties are changed. The lightweight and high-strength wall panel is built of crude materials with fortifications, center added substances, and glue specialists. Design for hollow core wall panels has voids in the thickness of the precast wall panel run in heading all through the entire length of the panels [7]. The panels are kept along with an uncommon grout that has similar actual properties as the panels, which disposes of panel breaks. The panels are both solid and light, simplifying them to deal with and introduce. The smooth surface of the board simply requires a 2 mm thick skim coat finish for painting and tilling tasks once introduced. During on location establishment of covered up wiring, ducting, and pipe works, the panels can be cut, nailed, screwed, or reinforced like wood.

3. Materials and Methods

The specimen which is HCWP was collected from IBS plant at Acotec Sdn. Bhd. in Bandar Tenggara, Johor where the sample specimen size dimension is 300 mm x 300 mm x 100 mm.

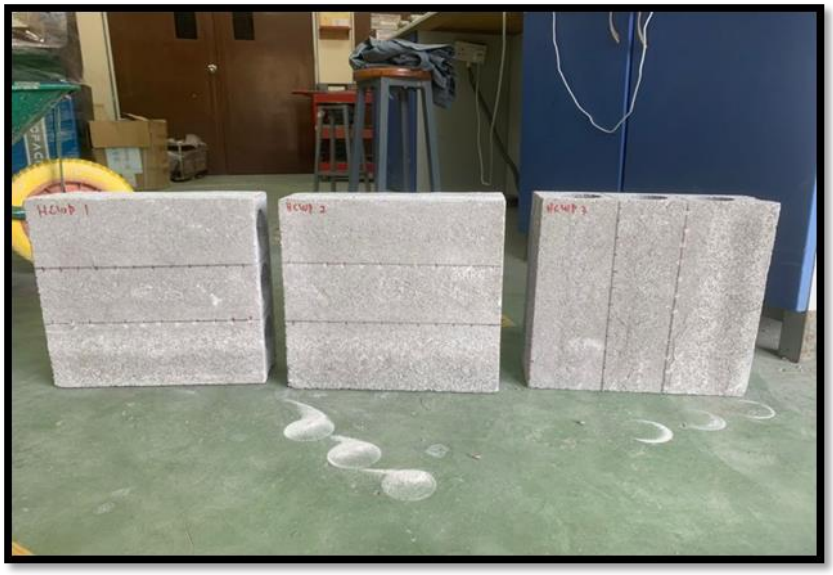

Figure 1: HCWP samples with dimension 300 mm x 300 mm x 100 mm

3.1 Raw Materials for Normal Brick Wall (NBW)

Preparation of materials for sampling was carried out to guarantee that the samples of normal brick wall (NBW) met all of the standards required. Cements, clay brick, and sand were some of the materials utilised in the construction.

- Cements

  Ordinary Portland Cement was the most widely used type of cement in Malaysia and around the world, and it was also the most expensive. OPC was manufacturing in accordance with the quality requirements defined in the Malaysian Standard, MS 522: 1: 1989 Specifications for OPC (Malaysian Standard for OPC Manufacturing Quality).

- Clay brick

  The type of brick that has been used are clay brick. Bricks made of clay are among the first man-made materials that have lasted through ages of harsh climates and warfare as seen by the numerous specimens that can be found all over the world today.

- Sand

  It is a fine quality white-grey sand that is utilised in the construction of concrete and masonry structures. It can also be used for a variety of other tasks such as plastering, bricklaying, and RCC. This sand has a better grain form and a smooth texture, and it requires less moisture because water has already been trapped within its particles during the manufacturing process.

- Water

  The tap water threat provided by Syarikat Air Johor (SAJ) was employed in this study throughout the process of combining sand cement block. Any particle or pollutant was completely absent from the water.

3.2 Methods

Table 1 displays the results of a series of tests involving two different types of wall panels that conducted compressive strength test and rebound hammer to analyze it.

Table 1: Testing series for HCWP and NBW

Type of testing	Testing series designation	Wall width (mm)	Wall length (mm)	Wall height (mm)	No. of specimens	The volume of wall sample (m^3)
Compressive Strength Test	HCWP	100	300	300	3	0.009
	NBW	100	300	300	3	0.009
Rebound Hammer Test	HCWP	100	300	300	3	0.009
	NBW	100	300	300	3	0.009
		total			12	0.036

Compressive testing was performed on the HCWP and NBW samples at the UTHM laboratory using a compressive test machine, and rebound hammer testing was performed using a Schmidt hammer in the UTHM laboratory.

4. Results and Discussion

The results and discussion section present data and analysis of the study. This section can be organized based on the stated objectives, the chronological timeline, different case groupings, different experimental configurations, or any logical order as deemed appropriate.

4.1 Compressive Strength Test

To attain the specified minimum strength of 3.45 MPa for individual unit wall samples and 4.14 MPa for average three-unit wall samples, a mortar mixture was created using a combination of ingredients. The goal of conducting a compressive test is to determine the compressive strength of both the sample and the partition wall in question. Following the completion of the brick wall process, the plastering process was carried out on the brick wall sample in order to provide a smooth surface for running the compressive test, as the loading should be distributed evenly across the testing sample. The results of the compressive strength tests performed on the HCWP and NBW specimens are shown in Table 2.

Table 2: Compressive strength test of HCWP and NBW

Type of sample	Number of samples	Compressive strength (MPa)	Average Compressive Strength (MPa)
HCWP	HCWP 1	11.2	11.3
	HCWP 2	11.3	
	HCWP 3	11.4	
NBW	NBW 1	4.2	5.97
	NBW 2	5.8	
	NBW 3	7.9	

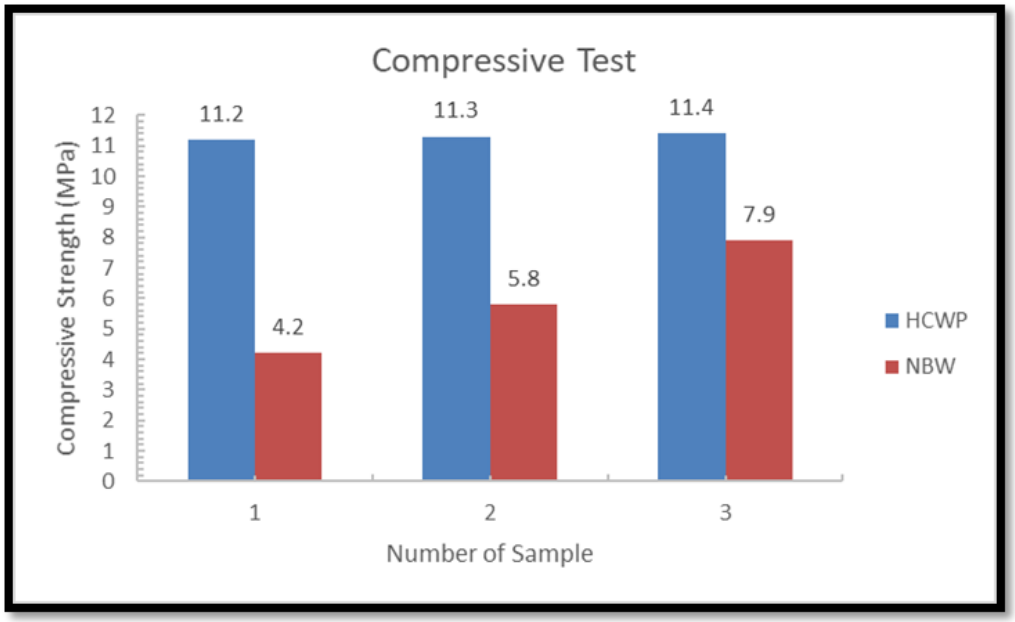

Figure 2: Compressive test data for HCWP and NBW

The results of compressive strength testing were analyzed in Figure 2, and it was discovered that the HCWP was significantly higher than the regular brick wall. The results demonstrate consistency of high compressive strength, with the lowest strength HCWP 1 having 11.2 MPa and the lowest strength of NBW having 4.2 MPa as the lowest compressive strength. In comparison, the highest compressive strength achieved by HCWP is 11.4 MPa, whereas the highest compressive strength achieved by NBW is 7.9 MPa. The compressive strength of NBW, on the other hand, shows an increase, whilst the HCWP has consistent results. In this study, the strength of each wall sample has been determined to be acceptable because it does not fall below the minimum strength of a non-load bearing wall, which is 4.14 MPa wall strength according to [8]. Many factors, such as chemical characteristics, the mixing method, and human error, might influence the difference in compressive strength between two samples of material.

4.2 Rebound Hammer Test

The rebound hammer test was used to estimate the compressive strength of the concrete by establishing a relationship between the rebound index and the compressive strength, as well as to assess the uniformity of concrete. The test was conducted on three samples of each HCWP and NBW.

Table 3 below shows result obtained from the rebound hammer test. The highest strength for both HCWP and NBW which is 45.5 MPa and 31.1 MPa respectively. Surface hardness of HCWP is one of the factors that affecting compressive strength. The type of material used to manufacture HCWP, a concrete mixture, is the reason why its surface hardness is higher than that of NBW. The result of rebound hammer for NBW lower than HCWP is possible because of the testing performed is exposed to the joint of brick wall which is mortar.

Table 3: Rebound hammer test on HCWP and NBW

Type of sample	Number of samples	Compressive strength (MPa)	Minimum rebound number (MPa)	Maximum rebound number (MPa)
HCWP	HCWP 1	35.1	27	38
	HCWP 2	45.5	33	40
	HCWP 3	35.1	26	35
NBW	NBW 1	28.2	25	32
	NBW 2	26.2	21	32
	NBW 3	31.1	21	34

The accuracy of the rebound hammer method for estimating concrete strength cannot be guaranteed to be particularly high, and the probability of correctly predicting concrete strength in a structure is less than 25 percent in most cases [9]. If the relationship between rebound index and compressive strength can be discovered through tests on core samples taken from the structure or standard specimens made with the same concrete materials and mix proportions as the structure, then the accuracy of the results and the confidence in them are greatly increased, as is the confidence in the results themselves. Figure 3 below show the bar chart result for compressive strength between HCWP and NBW.

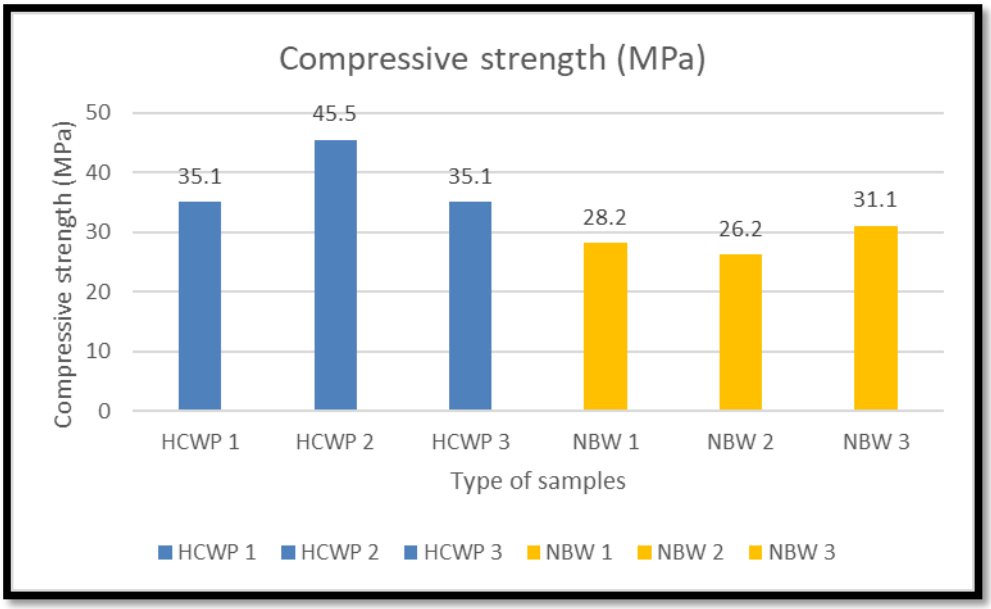

Figure 3: Compressive strength for HCWP and NBW

5. Conclusion

As the conclusion, this study investigates the performance of strength hollow core wall panel in the precast concrete system. They are compared to a conventional brick wall to better exploit the strength properties of partition walls and to each other to improve non-load bearing wall performance in an IBS system. HCWP produced more compressive strength than NBW because it met or exceeded the ASTM C172 minimum requirements. Compared to the NBW sample, the HCWP sample has higher compressive strength, is lightweight, and requires less construction time and money. For the future studies, it is recommended to study the microstructure and chemical composition in the precast concrete system to identify the admixture contains in precast concrete to withstand the load higher than conventional method.

Acknowledgement

The authors would like to thank the Faculty of Civil Engineering and Built Environment (FKAAB), Universiti Tun Hussein Onn Malaysia (UTHM) and especially to Acotec Sdn. Bhd. for their contribution and support in making convenience for this research to the end.

References

[1] S. S. Kamaruddin, et al, "Industrialised Building System Readiness Formwork. Procedia-Soc. Behaviour", Sci, 105, 106, 2013

[2] Khalil et al, "A review on industrialised building system issues in Malaysia. MATEC Web of Conferences", 47, 0–3, 2016

[3] A. A. Shaari, et al, "Safety of Precast Concrete Installation for Industrialised Building System Construction. International Journal of Applied Engineering Research" ISSN 0973-4562 Vol 11, No. 13 pp 7929-7932, 2016

[4] Eadukondalu, "Study of Lateral Structural Systems in Tall Buildings. International Journal of Applied Engineering Research" ISSN 0973-4562 Vol 13, No 15 pp. 11738-11754, 2018

[5] N. H. A. Hamid & J. B. Mander, "Lateral Seismic Performance of MultiPanel Precast Hollowcore Walls", 2010

[6] O. S. Dosumu & O. A. Adenuga, "Assessment of Cost Variation in Solid and Hollow Floor Construction in Lagos State", Department of Building, Faculty of Environmental Sciences, University of Lagos, Akoka, Lagos, Nigeria, 2013

[7] N. H. A. Hamid & J. B. Mander, "Lateral Seismic Performance of Multi-Panel Precast Hollowcore Walls", 2010

[8] ASTM C129, 2017 Edition, June 1, - "Standard Specification for Nonloadbearing Concrete Masonry", 2017

[9] ASTM C805, 2013 Edition, February, – "Standard Test Method for Rebound Number of Hardened Concrete", 2013