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LIGHT-TRANSMITTING OPTIC FIBRE PRECAST WALL

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ABSTRACT

The precast component of a building, or any structure, is commonly employed in the construction industry. Almost the entirety of the structure is made up of a wall. An advancement in precast walls is the see-through concrete partition. The structure and its surroundings may greatly benefit from precast walls that are able to let in natural light. A building with a light-transmitting precast wall may save money on its power bill, make better use of natural light, and improve its curb appeal. Despite letting in some natural light, the prefabricated wall remains just that: precast. Therefore, this paper investigates the light-transmitting optic fibre precast walls as a new innovative product for the construction industry. Experimental investigations in the form of compressive tests, water absorption tests, and lux tests were conducted to investigate the strength of the light-transmitting fibre optic precast walls. The optical fibre is the component that allows the precast wall to transmit light. It is possible to use optical fibre as a reinforcing element in a precast wall. This will result in a stronger precast wall than would be possible using conventional methods. In order to create a sustainable building business, optical fibre is a useful technological advancement.

Keywords: Light transmitting; Optic Fibre; Precast; wall

1. INTRODUCTION

Nowadays, there are projects that apply the IBS element in the construction industry. IBS elements consist of many structural members such as walls, beams, columns, slabs, stairs, and roofs. A wall is the most abundant building element and is an important part of the building. It is the element that divides the interior of a building and provides privacy and protection for the building's occupants. A wall also consists of many specific types and uses, such as load-bearing walls, non-load-bearing walls, cavity walls, shear walls, partition walls, panel walls, veneered walls, and faced walls (Bida et al., 2021). Therefore, a wall is a building element that is very suitable for innovation to realise the green concept. It is also very suitable to be the main component in IBS, namely precast walls.

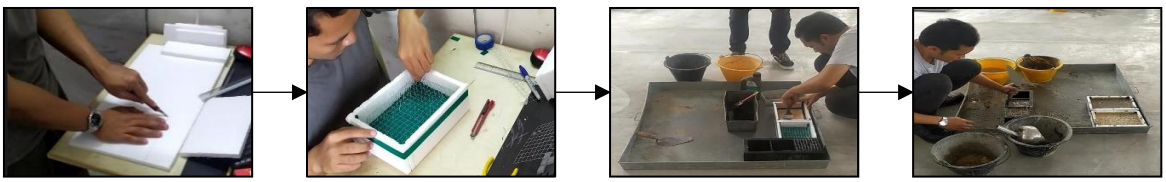
Optical fibres are the most used as a sensing or transmitting aspect, thereby minimising the use of artificial lighting, and substituting the ordinary precast wall with a light-transmitting optic fibre precast wall (Shenoy et al., 2022). In order to achieve the green concept of development, the light-transmitting optic fibre precast wall will make the building greener by reducing the consumption of electricity during the daytime. Therefore, the implementation of the light-transmitting optic fibre precast wall will save cost, and time, and sustain the environment.

2. LITERATURE REVIEW

The lightweight precast wall was invented to make the lightest precast wall in the construction industry (Mohd.Ismail et al., 2007). The lightweight precast wall will ease the transportation and installation of precast walls. There is no need for a lot of machinery to be used while transporting and installing. Lightweight precast wall is ideal building materials for building construction (Dunn, 2017). It is composed of cement, fly ash, and water and replaces traditional concrete aggregate with a stable, slowly degrading low-density foam. Foam that is much lighter than concrete is added to make low-density concrete with very small air gaps (Dunn, 2017).
Its advantages include a decrease in deadload due to the manufacturing process. The manufacturing process for lightweight precast walls is a bit different because the mixture will expand and become porous to achieve the lightweight; increased construction rates; the installation process will be shortened; and the transport and handling costs will be cheaper due to the ease of handling the material (Mohd.Ismail et al., 2007). The disadvantages are that inadequate water may result in a lack of cohesiveness between particles and reduction of strength of the concrete. Therefore, this paper investigates the light-transmitting optic fibre precast walls as a new innovative product for the construction industry.

3. METHODOLOGY

In this study, lab experiments were conducted to evaluate the performance of the innovative product. Before conducting the experiment, the prototype needed to be built as the specimen for the experiment. Figure 1 shows the preparation process of materials for the prototype. Portland cement, sand, water, optical fibre, BRC, and Styrofoam were used to create the prototype product of the light-transmitting wall optic fibre. After the prototype development was complete, the results of the compressive test, water absorption test, and lux test were analysed. For the compressive test, the compressive machine was used to measure the strength of the light-transmitting precast optic fibre wall prototype. Then, the lux test was conducted to measure the light measurement test using the specimen box of a prototype of a light-transmitting precast wall. Lastly, water absorption tests were conducted to measure the absorption of the concrete.



1. The fibre optic was cut to the required length (5cm)

2. Embed the fibre optic into the Styrofoam uniformly according to the BRC

3. Greasing the mould to avoid the concrete sticking to the mould during the dismantling process

4. Mixing and pour the concrete and let it cure for 24 hours before dismantling

Figure 1 Preparation Process of Light-Transmitting Optic Fibre Precast Wall Prototype

4. FINDINGS

4.1 Compressive Strength

The light-transmitting optic fibre precast wall has a higher compressive strength compared to conventional concrete. Due to the lack of optical fibre, this study only has one cube test. The compressive strength of the light-transmitting optic fibre cube and conventional cube is 11.8 MPa and 9.3 MPa as shown in Table 1.

Type of Cube Test	Compressive Strength (MPa)	Max Load (kN)
Light-Transmitting Cube	11.8	82.93
Conventional Cube	9.3	65.13

Table 1 Result for Compressive Test

4.2 Water Absorption

The limit at which a liquid may enter the microstructure of a material is known as its porosity, and it plays a significant role in defining the substance's utility. The light-transmitting cube has lower water absorption compared to the conventional cube, and even though the light-transmitting cube was assumed to have more water absorption because of the porous nature of the optical fibre. This is proven by the water absorption test that has been carried out. Table 2 shows the results of the water absorption test.

Type of Cube Test	Compressive Strength (MPa)		Percentage of Absorption (%)
	Before	After	
Light-Transmitting Cube	1428.07	1550.35	8.56
Conventional Cube	1384.57	1514.35	9.37

Table 2 Result of Water Absorption Test

4.3 Lux Test

The lux test was carried out to find out the performance of a light-transmitting optic fibre precast wall prototype. The test was carried out in two environments, control environment using artificial light, and the natural environment using sunlight. Plate 1 shows the light-transmitting precast wall prototype transmitting the light. The lux for indoor and outdoor is 36 lux and 40 lux, respectively, as shown in Table 3.

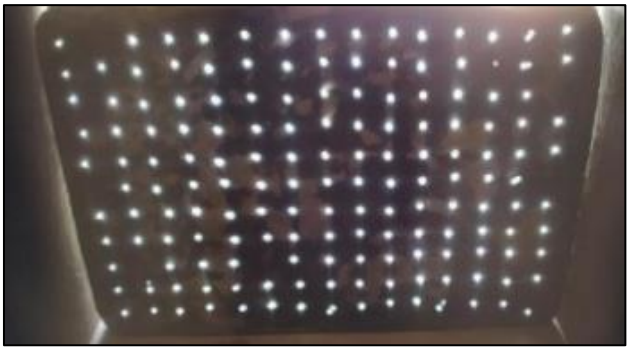


Figure 1 Prototype Box for Lux test

Type of Environment	Lux (lx)
Indoor	36
Outdoor	40

Table 3 Result for Lux Test

Optical fibre functioning transmits light through the concrete and is able to become reinforcement concrete. Composition of optical fibre and concrete creates a higher strength compared to normal concrete.

5. DISCUSSION

The results of the light-transmitting optic fibre precast wall tests were presented in a separate tabulation under three different tests (compressive test, water absorption test, and lux test). To recap, the results from the tests show that the usage of optical fibre in the concrete had strengthened the concrete compared to the normal concrete components. The light-transmitting optic fibre precast wall consists of the optical fibre embedded in the precast wall. By implementing the light-transmitting optic fibre precast wall, the consumption of energy will be reduced. Initially, during the daytime, the building with the light-transmitting optic fibre precast wall will use natural light to light the room without depending on artificial light. With that, it also complies with the green building criteria, especially on the energy efficiency attributes. Besides the function that can transmit light, optical fibre also increases the aesthetic value of the building. During the day, the interior of a building with a light-transmitting optic fibre precast wall will appear more appealing due to the light that optical fibre transmits from the outside. When night comes, the exterior of the building will look more aesthetic because the optical fibre will transmit the light from the inside of the building. This feature can be applied by the interior designer and the landscaper. The light-transmitting optic fibre precast wall can also be the decoration part of the building.

6. CONCLUSION

Light-transmitting optic fibre precast wall is one of the innovations with a brilliant innovation, which is the combination of precast wall and light-transmitting optic fibre concrete. The light-transmitting optic fibre precast wall should be able to perform its primary function as a precast wall, particularly when installed in housing development. The function of the light-transmitting optic fibre precast wall is to reduce electricity consumption during the day, make greening the housing, and sustain the green environment concept.

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