R&D PROJECT ON “DEVELOPMENT OF HIGH STRENGTH LIGHTWEIGHT CONCRETE WITH AND WITHOUT LIGHTWEIGHT AGGREGATE”

Objective:

This project aims to enhance buildability in the building and construction industry by carrying out a systematic and extensive R&D to develop cost-effective high strength lightweight concrete with and without aggregate (HSLWC) for various matching applications such as with energy-saving features to improve or maintain good indoor thermal environment in buildings, fire-proof, sound-proof and floating structures etc. One of the key deliverables of this project is to develop HSLWC for non-structural application for large panel external walls, partition walls, volumetric precast components and closed cell bath units with weight below 1000kg/m³ while satisfying other performance requirements. The study also includes the assessment of HSLWC for structural applications.

Main Achievements to-date:

- Techniques for production of various types of cost-effective HSLWC with density ranging from below 1000 to 2000 kg/m³ and compressive strength ranging from 10 to 90 MPa have been successfully developed without using lightweight fine aggregate and expensive lightweight coarse aggregate (such as Liapor from Germany).

- Foamed concrete has also been produced with density and strength to match the current state-of-the-art of the development of lightweight aggregate concrete (LWAC) including high strength LWAC, up to grade 60 MPa.

- With such a high strength lightweight foamed concrete, it would now be possible to combine foamed concrete with lightweight aggregate which offers the possibility of a material giving high reduction in weight and significant thermal insulation, yet having sufficient strength for many applications. In other words, more choice of types of LWC is available based on cost and application for compressive strength up to 60 MPa.

- Following the successful development of the HSLWC, low-cost lightweight wall panels were produced and they were found to satisfy the performance criteria of BS 5234:Part2:1992. A pilot test was carried in which the low-cost lightweight wall panels were produced and erected on site in June 2005 at the Centre for the Arts at National University of Singapore (see Figure 1). The performance of these installed walls is being monitored. To date, the performance is good.

- In a further development, the incorporation of hollow cores into walls to further reduce its weight was revisited and an optimization methodology has been derived to yield the best design for producing light and strong hollow core walls by extrusion. The optimization methodology is in the process of being patented.

- An innovative cost effective technique to minimize/control cracking at joints of precast wall panels, has also been invented and patent filed. This invention also doubles up to prevent water leakage at the joints of external precast wall panels.

- To address the concern of water ingress into HSLWC and encourage its use in external wall and wet areas, a technique to speedily and effectively waterproof the concrete in-situ has been invented. The technique is in the process of being patented.

- The combination of all the above techniques collectively offer a solution for cost-effective use of HSLWC for non-structural application in wet and outdoor conditions,
such as external walls and closed cell bath units, with weight below 1000kg/m$^3$ while satisfying other performance requirements.

- A portable adiabatic temperature rise (ATR) chamber (see Figure 2) has been invented to accurately track the concrete temperature rise under adiabatic condition, due to the heat liberated from the hydration reactions. Knowledge of this heat generation can be used to advantage leading to a speedy and cost-effective mass production of precast wall panels. An International Patent Application (PCT) has been submitted for the invention.

Figure 1   A pilot test was carried in which the low-cost lightweight wall panels were produced and erected on site at the Centre for the Arts at National University of Singapore
Figure 2  The Adiabatic Temperature Rise (ATR) Chamber that was invented during the project. An International Patent Application (PCT) has been submitted for the invention.

Contact Details

Name         : Assoc Prof Wee Tiong Huan
Organisation : National University of Singapore
Department   : Department of Building
Tel          : (65) 68742551
Fax          : (65) 67791635
Email        : cveweeth@nus.edu.sg