CSETD AGM Talk on "Ultra-High Performance Fiber Reinforced Concrete (UHPFRC): Technology for the Present and Future"

by Dr Sudharshan N. Raman

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The Civil and Structural Engineering Technical Division (CSETD) organized a technical talk on the "Ultra-High Performance Fiber Reinforced Concrete (UHPFRC): Technology for the Present and Future" on 14th July 2018. The talk which was organized as a precursor to the 32nd AGM of the CSETD, was held at the Tan Sri Prof. Chin Fung Kee Auditorium at Wisma IEM, Petaling Jaya, Selangor. It attracted a good 150 participants, which included engineers from engineering consultants, contracting firms, government agencies and local authorities, as well as faculty members from local higher learning institutions. The speakers for the event was Ir. Adjunct A/Prof Dr. Yen-Lei Voo, the CEO and Founder, and Mr. Jasson Jhen-Shen Tan, the Associate Director (Bridge) of the internationally renowned Malaysian UHPFRC builder, Dura Technology Sdn. Bhd. Dr. Sudharshan N. Raman acted as the Session Chair for the Talk.

Ir. Dr. Yen-Lei Voo obtained his Bachelor of Engineering (Hons) and PhD from the University of New South Wales (UNSW), Sydney, Australia in 2000 and 2004, respectively. Dr. Voo is also an Adjunct Associate Professor at the UNSW Australia. He founded Dura Technology Sdn. Bhd. in 2006 based on his interest and knowledge in UHPFRC, and his passion to create a more sustainable and environment friendly development. Meanwhile, Mr. Jasson Tan obtained his Bachelor of Engineering and Master of Science in Civil Engineering from UTHM and UPM, respectively. In the last 13 years, Dura has supplied or constructed over 100 UHPFRC bridges in Malaysia, and has also transferred this technology to the international market, particularly to China, India and Canada. Dura was also awarded the 2016 PCI Design Award for the Best International Transportation Structure by the USA Precast/Prestressed Concrete Institution for the Construction of the 100 m Single Span Batu 6 UHPFRC Bridge; and the 2017 Best Project Award - Infrastructure Projects (Small Category) in the Malaysian Construction Industry Excellence Award 2017 by the Construction Industry Development Board (CIDB) of Malaysia.

Ir. Dr. Voo commenced his talk by elaborating on the constituent materials in UHPFRC, the evolution of concrete technology over the decades and how UHPFRC compares with conventional reinforced concrete. Subsequently, he discussed on the load-displacement and stress-strains behaviors of conventional concrete and steel, how the load-displacement and stress-strains behaviors of UHPFRC compares with these two conventional construction materials. Ir. Dr. Voo then presented on the flexural behavior of conventional concrete, a typical steel fiber reinforced concrete (SFRC) and Dura's UHPFRC mix, as shown in Figure 1, to emphasize his point. It can observed from this figure that the designed UHPFRC mix exhibited superior ductility and toughness characteristics compared to even SFRC, which exemplifies its exceptional properties and enables it to be utilized for specialized and advanced structural engineering applications.

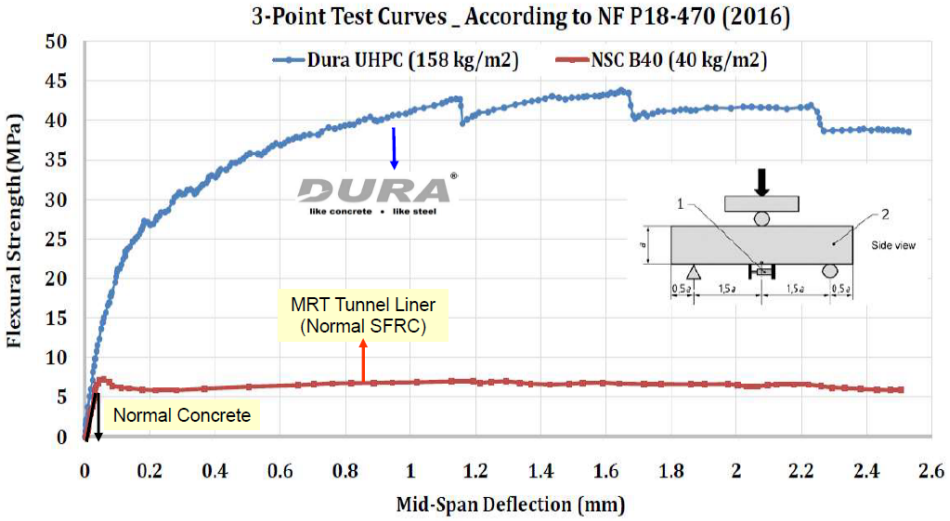

Figure 1: The flexural behavior of conventional concrete, a typical steel fiber reinforced concrete (SFRC) and Dura's UHPFRC mix

Subsequently, Ir. Dr. Voo discussed on the mixing and batching procedures of UHPFRC which requires more specialized treatment when compared to conventional concrete. The findings of various durability tests of the UHPFRC composite, such as water absorption, depth of water penetration under pressure and rapid chloride penetration test (RCPT) were presented next, which revealed the superior durability characteristics of the composite compared to any other concrete variations. The performance criteria of the main characteristics of UHPFRC in comparison to French Materials Standard of NF P 18-470 (2016), Structural Standards of NF P 18-710 (2016), which is an addition to Eurocode 2, and the Design Life Requirement, NF P18-410 (2016) were presented comprehensively.

In the next section, Ir. Dr. Voo elaborated on the engineering applications of UHPFRC, mainly in bridge construction, where it should be noted that at present, Malaysia has the most number of UHPC bridges in the world, where the number stood at 132 in 2018. Almost 50% of these bridges were commissioned by the Public Works Department (JKR) of Malaysia. Some of the notable bridges that were discussed include the Batu 6 Bridge in Gerik, Perak which was awarded the 2016 PCI Design Award for the Best International Transportation Structure; the Section 49 Viaduct at Laluan 4 (KM 157 Gerik - Kota Bahru), Ecological Corridor at Central Forest Spine (CFS), Gerik, Perak; and the Kg Baharu to Kg. Teluk Bridge in Manjung, Perak (Figure 2), which at 13.7 m wide x 420 m long, is to date, the longest UHPC composite bridge in Malaysia.

For the next segment, Ir. Dr. Voo invited Mr. Jasson Jhen-Shen Tan, the lead design engineer of Dura's recent flagship bridges to present on two recent projects by Dura, namely:

- Projek Membina Jambatan Menyeberangi Sungai Perak di antara Kampung Seberang Manong Ke Pekan Manong, Kuala Kangsar, Perak
- Projek Membina Kuala Terengganu Bypass – Bridge ST3

Mr. Tan discussed in detail on various aspect on the design and construction of the bridges which included the typical cross-sections of the girders, beam's sectional properties, loading configuration of the bridges, details of the design approaches and design codes, the computation of main design parameters and design checks.

Figure 2: The 13.7 m wide x 420 m long Kg Baharu to Kg. Teluk Bridge in Manjung, Perak.

In concluding the lecture, Ir. Dr. Voo directed the participants to the state-of-the-art architectural applications and solutions of UHPFRC. These included the application of UHPC drymix for construction, the innovative UHPFRC precast bathroom units and volumetric precast bathroom units, precast UHPFRC staircase construction, and examples of modern façade construction and interior architecture using UHPFRC applications. This was then followed by a lively question and answer session, during which the participants took the opportunity to raise their queries and doubts, and was involved in active discussion with the speakers. In concluding the event, the Session Chair, Dr. Sudharshan N. Raman thanked both Ir. Dr. Voo and Mr. Jasson Tan for delivering the informative and cutting edge lecture on the application of the UHPFRC technology, and invited the (then) Chairman of the CSETD, Ir. Dr. Ng Soon Ching to present a token of appreciation to both speakers.