KLOKNER INSTITUTE CTU IN PRAGUE

Abstract

Steel reinforced concrete is the most important composite material used in civil engineering. The combination of ultra high compressive strength of UHPC and high tensile strength of a steel reinforcement created new possibilities. A rather new developed composite is textile reinforced concrete (TRC) where a fabric reinforcement instead of steel one is used in combination with very fine grained concrete, often even with UHPC concrete characterised by a compressive strength higher than 150 MPa. UHPTRC enables very thin-walled concrete elements that possess very high strength in compression as well as in tension. The most common used technical textiles are made of alkali resistant glass, carbon or aramid. UHPTRC enables the full potential of fibers to be materialized because the manufacturing technique is fully controlled so all the fibers can be positioned at any required direction. These textiles can provide a higher effectiveness than formerly used composites with randomly distributed short fibres without any control. Another significant advantage of TRC is its formability allowing to produce elements with complex shapes and geometries. Moreover in the non-metalic UHPTRC it is not necessary to have a significant concrete cover to protect the reinforcement against corrosion so UHPTRC elements are very economical. From the point of sustainability, UHPTRC enables to use less material thanks to thinner structures as well as a longer service life without any deterioration even under higher loads. So the structures from UHPTRC are signifacantly lighter and consume less materials. The second criterion can be an emmision of CO2 where it reaches the same values as conventional concrete but these values are smaller than that for any other construction material. UHPTRC possess strain-hardening cement composite characteristics so they may involve a large energy absorption in thin sections, high strain capacity, fatigue, impact resistance, or seismic resistance where high ductility is required. UHPTRC as train-hardening material is used in industrial structures, highways, bridges, as well as earthquakes, hurricanes, and high–wind load conditions where a multiple cracking under tensile stresses and a postcrack response that exceeds the firstcrack stress over a large strain range is required as well as a bridging mechanism is working, unlike conventional fibre-reinforced concrete where a fracture localization occurs immediately after the first crack is formed. Thanks to its significant strength and ductility improvement, UHPTRC is used for cement boards including architectural cladding panels, exterior siding, roofing and flooring tiles, sandwich membranes subjected to flexure; structural components; and strengthening, repairing, and retrofitting of structural concrete elements exposed to static as well as severe loading conditions. In some of these applications, they are expected to provide a protection, especially, isolate the structure from the environment by preventing penetration of fluids and deleterious materials. UHPTRC is an innovative material and necessary detailed information is still missing and furthermore, more experiments should

be performed. The properties of this material enables very thin structures that are durable enough and at the same time they are still impermeable thanks to the very-fine grained concrete with a very low water-cement ratio creating a very dense microstructure. This dissertation is mainly focused on permeability of UHPC/UHPTRC and its diffusion properties that are not examined almost at all. This composite is supposed to be nearly impermeable for all fluids as well as gases or water vapours. The summary of these properties sounds very good, but it is necessary to take into consideration one more aspect. As it was mentioned above, UHPTRC is used for example for cladding facade pannels where moisture problems can occure if the structure will be impermeable. That is a very strong reason for thinking about this idea to use UHPTRC for this purpose. Of course, it is not problem in case of forced inner ventilation that can be very efficient nowadays. But it has to be designed very reasonably and permanently controlled operation should be ensured. Tests of permeability as well as additional tests of other properties of UHPC and UHPTRC have been performed within this dissertation work to prove the impermeability of this material and to highlight this potential problem of its application.