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PUMPING BEHAVIOUR OF MODERN CONCRETES: CHARACTERISATION AND PREDICTION

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Abstract

Pumping of concrete plays a critical role in the modern construction industry. Pumping reduces the costs and shortens the completion time by providing a continuous casting and allowing the concrete to be supplied in difficult to access locations. Such outstanding mega tall buildings as Burj Khalifa (2010), Shanghai Tower (2015) or One World Trade Center (2014) could only be erected while smartly combining the most recent developments in the concrete technology and modern pumping techniques. Future projects are continuously throwing down challenges to the civil engineers and concrete technologists while targeting even more ambitious structures rising over 1000 m. The nature of concrete both in fresh and hardened states is perpetually changing, conditioned by new engineering and environmental requirements, e. g., within the perspective of their durability and sustainability. Analogously, the approaches for the assessment of fresh concrete workability in general and its pumpability in particular, have to be updated as well. Indeed, full-scale pumping tests cannot always be performed for any construction project to ensure the suitability of the material properties. Instead, it is desired to proceed with a series of simple experiments for example on one representative bucket of concrete from the whole batch as to reliably predict whether the concrete is pumpable or not. The primary objective of the research at hand is to assess the concrete pumpability applying existing rheological tools and validate the results in full-scale pumping experiments. The pressure-flow rate curves serve as a key pumpability indicator for the comparison between the predicted results from combined viscometer/tribometer scientific method, Sliper rheometer, numerical simulations applying computational fluid dynamics (CFD), pressure performance nomogram and the actual results from full-scale pumping. The proposed methodology shall promote the understanding of complex phenomena occurring in different types of concrete during pumping and reliably predict their behaviour with respect to pumpability.

Keywords: Pumping, modern concretes, rheology, lubricating layer, pressure loss prediction, pressure performance nomogram.