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The bonding performance of desert sand self-compacting concrete overlay on normal strength concrete substrate: Macro, micro, and ultrasonic testing

Weihan Cai [a], Haifeng Liu [a,*], Wenjing Xu [a], Jialing Che [a], Shu Ing Doh [b]

[a] College of Civil and Hydraulic Engineering, Ningxia Univ., Yinchuan, Ningxia, 750021, China
[b] College of Engineering, Malaysia Pahang Univ., Gambang, Kuantan, Pahang, 26300, Malaysia

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ABSTRACT

This study investigates the performance of concrete containing desert sand (desert sand concrete and desert sand self-compacting concrete) as overlay concrete to bond with normal-strength concrete substrate, with different bonding interfaces being considered. The impermeability of the bonding interface is determined by the electrical resistance test. Static bonding strength is tested by conventional mechanical tests. The dynamic properties of bonded specimens are also studied by dynamic response tests. Non-linear parameters, low-frequency energy parameters and ultrasonic velocity are included in the bonding interface ultrasound detection. The microstructural and chemical compositional of the overlay transition zone (OTZ) are analysed to reveal the mechanisms of bonding behaviour. The results indicate that the interface electrical resistance is positively related to bonding strength. Using concrete containing desert sand as the overlay concrete improves bonding interface adhesion for 30 % at most. Bonding performance can be affected by the interface pattern and volume density in both static and dynamic conditions. The bonding strength and damping ratio with properly treated interfaces can be increased by over 300 % and 38 % than those of untreated groups, respectively. The dynamic response of the bonded specimens can effectively reflect the bonding performance. The non-linear ultrasound method and the ultrasound energy method are more accurate and sensitive than traditional way (ultrasonic velocities) in detecting the bonding interface. The incorporation of desert sand in the concrete or lowering W/B considerably contributes to a series of benefits to the microstructure of the bonding interface. The bonding gap width is reduced by 17 % and 72 % for DS incorporation and lower W/B, respectively. Characterized by Ca/Si, the OTZ width is reduced by 10 % and 31 % for DS incorporation and lower W/B, respectively. Characterized by micro-hardness, the OTZ width is reduced by 21 % and 24 % for DS incorporation and lower W/B, respectively, which provides an important reference for the engineering application of desert sand self-compacting concrete.

1. Introduction

Concrete is one of the most widely used building materials [1,2], which constitutes the backbone of many existing infrastructures and has the advantages of high plasticity, cost-effectiveness, and high compressive strength. However, concrete structure subjected to

* Corresponding author.
E-mail addresses: liuhaifeng1557@163.com, liuhaifeng@nxu.edu.cn (H. Liu).

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