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Short Communication

An Investigative Technique on the LBS Principals between Reinforcements and UHPC Containing Nano-Silica

Ahad Amini Pishro* and Xiong Feng

Department of Civil Engineering, Sichuan University, China

***Corresponding author:** Western China Earthquake and Hazards Mitigation Research Center, Civil Engineering Department, Sichuan University, China.

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Short Communication

Nowadays, Ultra-High-Performance Concrete (UHPC) is being widely applied although there is a vital need to meet the design requirements. The bond stress between Ultra-High-Performance Concrete and reinforcing steel bars is a major issue which should be considered while designing the UHPC structures. In fact, there are some parameters such as UHPC strength, additive materials like Nano-silica content, concrete cover, development length and reinforcing steel bar size, which are the most effective factors on the bond stress between UHPC and reinforcing steel bars, therefore, the accurate design equations are required to consider the effects of all mentioned parameters on the bond stress. A comprehensive study on this topic showed that there's not any exact equations to calculate the bond stress between UHPC and reinforcing steel bars, so in the present research, we conducted a series of experiments to modify the most accurate equation which includes the effects of mentioned important parameters on the bond stress. This thesis aimed to study the effects of concrete cover, development length, reinforcing steel bar size, and Nano-silica content on the bond force, bond stress, and normalized bond stress, as well as specimen failure modes.

A comprehensive experimental test including 144 specimens based on RILEM standards was conducted by using Pullout test method to analyze the bond stress between UHPC containing Nano-silica and reinforcing steel bars. These 144 specimens included the main effective parameters on bond stress, for instance, different steel reinforcing bars of No. 16 and No. 18, increasing Nano-silica contents from 0% to 6.5% by weight of cement, conventional and thermal curing methods, the bond lengths and concrete covers of d_b, $2d_b$ and $3d_b$ in which d_b presents the reinforcing steel bar diameter. By pullout test, the specimens' failure modes were investigated. Observations showed that specimens' failures can be divided into three main modes of pull-out, split, and bar-yielding. Afterwards, the results were compared with the previously existed equations. The comparison showed that those former equations were not accurate enough to calculate the bond stress, since there were considerable differences between experimental and theoretical results. Therefore, a new series of bond stress equations for UHPC and steel reinforcing bars No. 16 and No. 18 were proposed. The results obtained from the new equations were in good agreement with tests results.

Given that experimental study and analysis of more parameters in order to determine local bond stress between UHPC and reinforcing steel bars are expensive and time-consuming, in the following we conducted numerical and parametric studies and analyzed these parameters using ABAQUS finite element software to verify the proposed bond stress equations and failure modes. In order to complete the research, 16 experimentally tested and 39 non-tested specimens were modeled using ABAQUS finite element software by taking into account additional parameters (e.g. development length and concrete cover of , and bar diameters of 12, 14, and 20 mm) which were not considered in experimental tests. The results obtained from numerical analysis were in good agreement with experimental tests results. Also, both experimental

and numerical results showed that bond stress decreased with increasing development length and diameter of reinforcing bar. However, bond stress increased with increasing concrete cover and Nano-silica content. Considering all the mentioned outstanding parameters and also experimental and numerical results, we finally proposed a comprehensive Local Bond Stress (LBS) equation to calculate the local bond stress between reinforcing steel bars and UHPC containing Nano-silica which was the main target of this research. A fair comparison between the results, confirmed that the local bond stress values obtained from the proposed LBS equation were logically in good agreement with the experimental results.

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Conflict of Interest

No conflict of interest.