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Numerical Analysis of Concrete Interfaces with Different Connector Arrangements

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Extended Abstract

Layered concrete structures are prevalent in contemporary construction, encompassing filigree slabs [1], bridge girders with concrete decks [2], old concrete structures with strengthening concrete toppings during renovations [3] and more. The performance of these structures depends on the bond between the layers. A sufficiently stiff bond allows for analysis similar to typical flexural concrete members, whereas a partially stiff bond reduces the overall flexural capacity and stiffness, and the partial interface stiffness has to be considered [4].

This study examines the interface behavior between concrete layers through the testing of six experimental push-off specimens designed to simulate the shear resistance of the concrete interface. Three specimen types were investigated: those with interface connectors normal direction to the interface (N), and two types with interface connectors in the form of lattice girders (G1 and G2). For all experimental specimens the initial adhesive failure occurred at small slippage, followed by a slight decrease and subsequent increase in interface shear stress, indicating the engagement of the interface connectors. After reaching peak shear stress, the first connector failed leading to a drop in shear stress. At the adhesive interface behavior stage, the experimental lattice girder specimens exhibited the highest interface shear resistances. Notably, G2 lattice girder specimen demonstrated the highest overall shear resistance, which was during the dowel action stage. A numerical analysis was carried out to better understand the behaviour of the interface and the differences between the specimens. The numerically obtained shear stress-layer slippage curves closely matched the experimental results. The analysis confirmed that the behavior of the interface is significantly influenced by the arrangement of connectors. The interface connectors of G2 started yielding at the highest interface shear stress value, but at the same time, at the lowest slip value (compared to other specimens). N and G1 specimens showed similar yielding behavior. These yielding points, as well as the points at which the connectors failed completely, can be explained by the stress/strain state of the connectors in each specimen type. All specimens exhibited dowel action, characterized by simultaneous connector bending and shearing. However, the N specimen primarily failed due to bending, whereas the G1 specimen showed a more pronounced shear component, and the G2 specimens experienced the highest degree of shear. Furthermore, the study presents the contributions of various shear mechanisms at different stages of interface behavior. For the N specimen, the highest interface shear resistance resulted from an almost equal contribution of shear friction and dowel action. In contrast, G1 specimen achieved the highest shear resistance through interface friction, and for specimen G2 dowel action dominated the interface shear transfer. This analysis highlights the critical role of connector arrangement in layered concrete members, offering insights into the advantages and disadvantages of specific configurations.

References

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