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論 文 要 旨

Summary of Dissertation

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専　攻 Department	Department of Civil Engineering
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論文題目 Title	Mechanics of Dowel Action Causing Bond Deterioration and Splitting Failure under Service Shear Load
和訳または英訳 Translation (J->E, or E->J)	繰返しせん断荷重下における接合部の割裂破壊および付着低下とダウエル効果のメカニズム

Shear loading is one of the critical loading conditions for joints. Joints subjected to combinations of loading at interfaces. Depending on the interfacial behavior and loading condition the behavior of joints vary. Different design codes and research present simplified models to incorporate the interaction of the loads and interfacial behavior. These models are the backbone of reinforced concrete structures, precast structures, concrete pavements, and offshore structures. The interaction of reinforcement bars and concrete mainly lies in the adhesive force between the two materials, and bond stresses. These stresses have a great contribution to the overall performance of RC structures under elastic and nonlinear loading conditions.

Shear transfer in a reinforced concrete interface is made up on two mechanisms along the two directions. The normal stress is perpendicular to the joint interface and the shearing stress is parallel to the interface. Perpendicular to the joint interface the aggregate interlocking resistance to the displacement caused by shear loading will result in bar pullout and crack opening. The confining pressure due to the dowel will result in crack closure. Parallel to the interface the shear resistance is due to the dowel bars (kinking of bars) and the concrete resistance. The dowel capacity is set to be a function of concrete strength and the strength of the reinforcement bar.

In this dissertation, the mechanics of shear transfer considering the contribution of dowel action (very smooth interfaces) are investigated. Experimental investigation for different specimens with different bar types, bond types, bar arrangements, cross-section sizes, load levels, spiral confinements, and coarse aggregate distribution is analyzed. Cyclic shear loading less than the expected dowel capacity is applied to the jointed specimens. The mechanism of shear transfer under loading less than the design dowel load capacity is scrutinized.

The deterioration of concrete observed for unconfined sections is splitting at top and bottom surfaces of the reinforced concrete specimens. This splitting failure originated from the bar and progressed to the top and bottom faces of the concrete specimen. These types of failures are identified as bond failures and have been reported for sections loaded above the dowel capacity. The confined section showed concrete deterioration near the joint interface. The load deflection diagram of all the specimens an initiation stage and crack propagation stage has been observed. In the crack initiation stage, the permanent damage after each cycle of loading has shown to be small but progressive. In the crack propagation the permanent damage increases, and the behavior varies depending on the specimen's distinct property.

The Bond loss existing under varied bar sizes, bond types, bar types, cross sections, load levels, bar arrangements, and spiral confinement is confirmed to be the cause for the surface deterioration of concrete. The bond loss facilitated curvature formation and led to splitting failure or concrete deterioration near the joints. The rate of curvature formation has also shown to depend on the type of bond condition. To investigate this RC specimens embedded with plain bars, deformed bars, and bars lapped with rubber (no bond specimens) are tested.

The contribution of aggregate interlocking to the rate of crack propagation on the top and bottom surfaces of the specimen is also investigated. It has shown that aggregate packed within the RC sections delays the propagation of cracks. On the other hand, sections made with mortar mix only have shown to deteriorate fast. Even though this specimen possesses higher strength due to the removal of coarse aggregate the deterioration of concrete has shown to be rampant.

The design of RC joints is based on design assumptions and theories like; perfect bond between bar and concrete, elastic subgrade stiffness, beam theory, material homogeneity, and linear stress-strain profiles within the section. These properties directly or indirectly are affected by the condition of the bond between the bar and concrete. Under fatigue loading conditions these concepts have shown to greatly vary from the theoretical values.

A new model considering bond degradation rate due to cyclic loading is proposed to estimate the accurate remaining life of structures. Thus, a performance-based design approach is recommended to determine the structural health and monitor the safety of structures.

4,000 字以内

Must not exceed 4,000 Japanese characters or 1,600 words.