論文の内容の要旨
Abstract of Dissertation

EFFECTS OF EXPANSIVE AGENT / LIGHT-WEIGHT AGGREGATE COMBINATION AND SELF-HEALING TECHNOLOGY ON FATIGUE BEHAVIOR OF RC MEMBER
（膨張材と軽量骨材の併用と自己治癒技術が鉄筋コンクリート部材の疲労挙動に及ぼす影響 ）

TRUONG VIET PHUONG
トゥロン　ビエット　プオン

Lightweight concrete (LWC), has several desirable and beneficial characteristics such as lower modulus of elasticity, improved microstructure, provided internal curing, and reduced dead load. Furthermore, when lightweight concrete is used for bridges, several potential benefits emerge including increased width or number of traffic lanes, increased load capacity, balanced cantilever construction, reduction in seismic inertia forces, increased cover with equal weight, improved deck geometry, and longer spans saving pier costs. However, heavy damages were found in some lightweight bridge deck. Main reasons include insufficient thickness of slab and lightweight slab tends to be sensitive to cracks. Expansive agent (EA) can reduce the crack sensitivity of cement paste, mortar and concrete by generating an expansion. EA, under restrained conditions, generates a compressive stress, which counteracts tensile stresses induced due to shrinkage.

The combination between lightweight concrete and expansive agent can compensate autogenous and thermal shrinkage of concrete member. High content of EA can supply chemical pre-stress for structure. LWC+ standard content of EA slabs show good performance when they are replaced to damaged LWC slabs. A wheel load test conducted

as a project of Metropolitan Expressway Company indicated that lightweight expansive concrete slab has remarkably longer fatigue life than that of normal concrete if sufficient chemical pre-stress is induced. Even though that experiment indicates the promising results of overall behavior of LWC+EA combination, it is also necessary to study the shear transfer behavior of LWC+EA concrete member subjected to shear in more severe condition such as in wet condition or considering the existence of crack. Recently, initial imperfections between round shaped coarse aggregate and matrix are found due to arch action while using high content of EA. This is also one of the important reasons why shear transfer behavior of LWC+EA member needs to be examined after a crack penetrates through the section. Furthermore, the crack surface of LWC is smooth compared to normal concrete. Therefore, shear transfer fatigue behavior of LWC+EA subjected to one side fatigue and reversed cyclic loading is investigated. Damage at interface of LWC is larger than that of normal concrete in early loading cycles but become stable in later stage for both of concrete under dry condition. Even though shear transfer fatigue behavior of LWC+EA is not good in comparison with Normal concrete in water, but still LWC+EA shows much better performance than normal LWC. Therefore, EA is recommended to adopt when using Lightweight concrete to enhance the shear transfer resistance of LWC. Furthermore, to improve the overall structural behavior of LWC+EA, including shear transfer fatigue, current self-healing technology is one of potential alternatives.

A kind of self-healing agent (SHA) and its products can fill the crack due to the swelling effect, expansion effect and re-crystallization actions and it strengthens surrounding crack surface area by adhesive healing mechanisms. Self-healing concrete (SHC) containing SHA may be able to heal itself from cracks and other minor imperfections and thus to prolong the life of the materials and structures. Water leakage test is conducted with several types of SHC where it is confirmed that SHC can effectively reduce the water leakage from crack. In plain and reinforced concrete structures, fatigue is one of the major causes of material failure. Recently, granulation technology is applied to manufacture a new type self-healing additive (SHA) in order to prolong its effectiveness in long time range. When a crack forms, the release of effective components from the granulated self-healing additive may be promoted. Opening and closing of cracks and repeated reverse movement under cyclic loading may accelerate the release of effective components from SHA. Further, new types of self-healing additives effectively using Low heat Portland cement (LC) are also recently proposed. The structural tests of SHC under low cycle tensile, low cycle compressive and shear are conducted. Contributions of some types of SHA to structural performance are confirmed. The recovery of shear stiffness and the longer flexural fatigue endurance are found in Low heat Portland cement based self-healing concrete. The application of upgrade Low heat Portland cement based Self-healing technology into lightweight expansive concrete is examining. Lightweight aggregate cooperated well with self-healing additives during manufacture. Extremely longer flexural fatigue endurance was found in LWC+EA+SHA compared to LWC due to the effect of chemical pre-stress. Recovery of shear stiffness was also observed in case of LWC+EA+SHA in comparison with LWC+EA. The recovery of shear stiffness and longer fatigue endurance of self-healing concrete may indicate the existence and contributions of self-healing products after curing into shear transfer fatigue and flexural fatigue of cracked concrete members.