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# Flexural Behavior of Discretely Connected Precast Concrete Floor and Shallow Silo Roof with Innovative Slab Joint Connections

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## Extended Abstract

Untopped discretely connected precast concrete floor (DCPCF) represents a hight-quality, cost-effective, low-carbon, and environmentally friendly solution compared with traditional solutions used for building floors. The author's research team has developed a paired connector and applied it to untopped precast floors, called the DCPCF systems, which would be bi-axial bending under vertical loads in a similar way as cast-in-situ floor system. The main researches are as follows:

1) The initially paired connectors were composed of hairpin connectors (HPCs) and cover plate connectors (CPCs). Experimental and numerical studies were conducted to reveal the force transmission mechanism of DCPCF in the orthogonal slab laying direction (OSLD) under vertical static loading. It was verified that increasing the number of anchor bars and increasing the diameter of diagonal anchor bars can effectively enhance the anchoring measures of slab joint connectors. That can make the perforated steel plates yielded and failed before the anchor bars of CPC, thereby achieving the design goal of replaceability.

2) The vertical mechanical properties of DCPCF with four sides simply supported was investigated by vertical static loading test program consisting of two DCPCF specimens and one cast-in-situ slab specimen. The test results indicated that DCPCFs have the characteristics of a typical two-way slab floor. In the early stages of loading, the deflection of DCPCF was mainly caused by the opening deformation of the slab joint and the rotational deformation of the precast units, with the bond slip occurred between the CPCs and the concrete slab at the late loading stage. A simplified equation for the DCPCF's equivalent flexural stiffness in the OSLD was subsequently given employing the conjugate beam method. The theoretically calculated values were in good agreement with the test values.

3) To further improve the connection between precast units, the improved configuration is mainly characterized by a) the innovative paired cover-plate and cover-plate connector; b) more rational shape of slab joints; and c) precast sandwich slabs units. An experimental program consisting of five the improved DCPCF specimens and two cast-in-situ sandwich specimens was conducted to evaluate the flexural behavior of the improved DCPCF in the OSLD. The results showed that the flexural capacity of DCPCF could be significantly increased with these improved configurations and was greater than corresponding to the cast-in-place specimens. Considering the effect of concentrated stress of discrete connectors on precast units, a vertical deflection calculation method for DCPCF in the elastic stage and concrete cracking stage was proposed. The error between the calculated value and the experimental value did not exceed 10%.

4) On the basis of the above, the improved DCPCF was applied to the precast silo roof of squat silo structure with granular grain, called prefabricated silo roof. The vertical flexural behavior of the prefabricated silo roof in the OSLD and 1:2 scale model of the squat silo structure with prefabricated silo roof have been investigated experimentally, numerically and theoretically. The results of the test and numerical simulation showed that the deflection deformation, crack distribution, force transmission path and damage pattern of prefabricated silo roof were similar to that of the cast-in-situ silo roof. The beam-slab connection and slab-slab connection showed good force transfer performance during the test process. In addition, the feasibility of the finite element simulation method for prefabricated silo roofs based on multi-layer shell elements was also verified. Finally, based on the membrane theory and bending theory of conical shell, the design method of vertical bearing capacity of prefabricated silo roof structure was proposed and the calculated values agreed well with the test values.