EXPERIMENTAL STUDY ON FULL SCALE COMPOSITE FLOOR SLABS UNDER FIRE CONDITION

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BACKGROUND

Cardington test and real fire disaster show that, the performance of concrete floor slabs composited with unprotected steel decks and beams in fire condition was much better than the prediction without considering membrane action. The observation and analyses show that, during a fire, with the strength and stiffness decrease of the steel decks, the reinforcement and the concrete, the load capacity of the slab offered by traditional bending mechanism will not be enough to bear the applied load. Instead of bending mechanism, membrane action will contribute to keep the stability of the slab by

ABSTRACT

4 full-scaled slab tests were performed at Tongji University in China. The test specimens were 5.232m*3.72m of composite floor slabs with steel decks unprotected. Two of them have an unprotected secondary beam supporting the slabs in the middle, while the others do not have. The slabs were loaded by 24 loading points to stimulate uniform load with the constant load ratio of 0.60~0.65 over the load-bearing capacity of the slabs at the room temperature. The temperature-time curve of the furnace used for the tests followed ISO834 standard fire. The displacement of slabs, the temperature at the surface and bottom of the slabs, the temperature and strain of the

OBJECTIVE

- Observe the development of membrane action
- Analyze the membrane mechanism
- Verify the existed theories considering the membrane

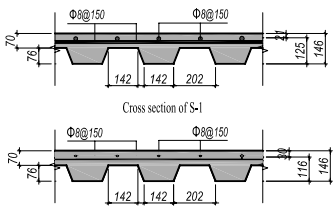
TEST

The tests were performed under ISO834 standard fire with uniform load which was applied on the slabs in 10 steps. After all the load was applied at ambient temperature, no crack and other failure phenomena were found on the slabs. Tests began until load and deflection were stable at room temperature. The test load and duration for the 4 tests were shown in *Table 4*.

***Table 4*. Test load and duration for 4 tests**

No.	Ultimate bearing capacity of design value (kN/m²)	Test load (kN/m²)	Load ratio (%)	Duration (min)
S-1	30.64	18.38	60	75
S-2	29.51	17.71	60	90
S-3	14.57	8.75	60	100
S-4	14.57	9.47	65	100

* Terminated without fail.



TEST RESULTS

❖ Test phenomena


Cracks along the long edge


Cracks along the short side face

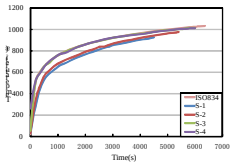

The yield line at the corner


The deformation of the slab after the test

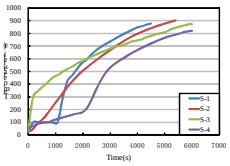

The cracks on the S-2 after the test


The deformation at the bottom of S-2 after the test

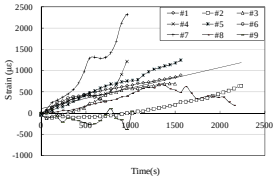
❖ Temperature



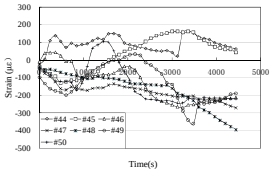
Furnace temperature curve



Bottom temperature in the middle of the slabs

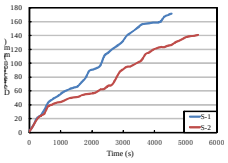


The strains of the reinforcement along short edge in S-1

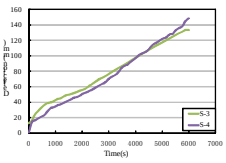


The strains of the concrete at the boundary of S-4

❖ Deflection



The deflection of S-1 and S-2



The deflection of S-3 and S-4

CONCLUSION

- Membrane action will occur to carry the applied load instead of bending mechanism due to large deflection, when the composite floor slabs are subjected to fire. This membrane action can help to keep the load capacity of the slabs and maintain the stability of the floor system under fire condition.
- Based on the data measured in the tests, the reinforcement in the slabs will be under tensile force and form an elliptical paraboloid tensile mesh which can bear the load on the slabs. A concrete compressive ring will be formed at the boundary of the slabs to provide anchorage for the reinforcement.
- Due to the membrane action, the existence of secondary

ACKNOWLEDGEMENT

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