Experimental Study of Mechanical Behavior of Fabricated Slabs of H-type Thin-walled Steel Beams and Lightweight Concrete

Sunyang Zhou and Xintang Wang

ABSTRACT

Through the static loading test of 3 fabricated slabs consisting of H-type thin-walled steel beams and lightweight aggregate concrete, the mechanical property and deformation behavior of the slabs was studied. The results showed that the composite slabs had better entirety and deformation ability. It was shown that strengthening the restraint at the ends of the main beam can improve the bearing capacity of the slabs in a little degree. Increasing the height of the secondary beam can increase the ultimate bearing capacity of the slabs, but it has little influence on the integral stiffness of the composite slabs presented here.¹

INTRODUCTION

Lots of research have been completed to promote the application of composite slabs. The bearing capacity of profiled steel sheet-lightweight aggregate concrete floor slabs is experimentally studied to compare with the ordinary concrete composite slabs[1]. Through experimental research, the mechanical property of light steel truss-profiled sheet lightweight concrete composite slabs is studied, and the combined action of light steel trusses and the lightweight aggregate concrete is analyzed[2]. The composite slabs consisting of different materials are presented and studied[3-4]. It can be seen that the research on lightweight prefabricated composite floor needs to be further studied. Hence, a new type of lightweight composite slab consisting of the H-type thin-walled steel beams and the lightweight concrete is put forward, and its mechanical properties are experimentally studied.

¹Sunyang Zhou, Xintang Wang, Faculty of Architectural, Civil Engineering and Environment, Ningbo University, Ningbo 315211, China.
CONSTRUCTION OF SPECIMENS

The construction of specimens is shown in Figure 1. It is indicated that the composite slab consists of the thin-walled steel skeleton which contains a set of H-type main steel beams and steel secondary beams, the lightweight aggregate concrete precast panels and the post-pouring concrete layer.

As is shown in the Figure 1, the main beams and the secondary beams of specimens are supported at the support beam. The specimens are noted as LB1, LB2 and LB3, of which the constraint condition and the height of secondary beam are different. Particularly, two ends of main steel beam of specimen LB1 and LB3 are all fixed supported, while the ends of main beam of specimen LB2 are simply supported. The Figure 2 shows that the height of secondary beams of specimen LB1 is 20mm, which is only half of those in specimen LB2 and LB3. All the other parameters of three specimens are the same.
It is noted that the thickness of steel plate of the main steel beams and the secondary beams is 0.6mm, the height of the precast panels is 40mm, and the depth of the post-pouring concrete layer is 20mm.

The material mechanical properties are listed below, the yield strength and elastic modulus of steel are $f_y=147\text{MPa}$, $E_s=1.06\times10^5\text{MPa}$, respectively, and the cube strength standard value and elastic modulus of the lightweight concrete are $\sigma_c=41.2\text{MPa}$ and $E_c=2.17\times10^4\text{MPa}$, respectively.

**EXPERIMENTAL RESULTS AND DISCUSSIONS**

**Test Scheme**

As is shown in Figure 3, the loading point is located at the center of the specimen and the measuring point of deflection is set to measuring the mid-span deflection of the slabs. The measuring points of strain of steel main beam are distributed on the flange and web of the H-type thin-walled steel beam.

**Test Phenomena**

The results indicated that the composite slabs had better deformation ability and entirety, there was only local failure and no overall collapse whereas the deflection at mid-span was up to $L/100$. There is noise during loading test, which is caused by the slippage of steel beam and concrete. There are obvious local buckling of steel main beam and crack on the upper surface of slabs.

![Figure 3. Distribution of measuring points.](image_url)
Displacements And Strains of Specimens

The comparison of equivalent uniform load-deflection curves of three slabs are shown in Figure 4. It is seen that the relation of load and the mid-span deflection is nearly linear when the equivalent uniform load is less than 6kN·m² for all slabs, which means that the specimens are elastic. It is shown in TABLE I that strengthening the restraint at the ends of the main beam or increasing the height of the secondary beam can both improve the bearing capacity of the slabs but fail to delay the yield of composite slabs.

![Load-Deflection Curves](image1)

**Figure 4.** Comparison of load-deflection curves of specimens.

| Specimen | Crack load /kN·m⁻² | Yield load /kN·m⁻² | Ultimate load /kN·m⁻² |
|----------|---------------------|--------------------|-----------------------|
| LB1      | 10.25               | 8.00               | 12.50                 |
| LB2      | 11.00               | 6.00               | 12.75                 |
| LB3      | 10.05               | 7.25               | 16.50                 |

**TABLE I. MECHANICAL PARAMETERS OF TEST SPECIMEN.**

![Load-Steel Strain Curves](image2)

(a) Specimen LB1
(b) Specimen LB3

**Figure 5.** Curves of load-steel strain of specimens.
The curves of equivalent uniform load-steel strain of specimen LB1 and LB3 are shown in the Figure 5. It is seen that the strain of measuring points which are located in the lower flange is much greater than ones in the upper flange. Compared to the specimen LB1, the disparity between the measured strain values of upper and lower flange points of specimen LB3 is more obvious. It is seen that increase of the height of the secondary beam can strengthen the bonding effect between the concrete and the upper flange of steel main beam.

CONCLUSIONS

Based on the results above, the conclusions are obtained as below:

(1) It is shown that all the composite slabs have better deformation ability and entirety, there was no overall collapse during the loading test.

(2) Strengthening the restraint at the ends of the main beam can improve the bearing capacity of the slabs in a little degree.

(3) Increasing the height of the secondary beam can strengthen the bonding effect between the concrete and the upper flange of steel main beam.

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