FIRE RESISTANCE OF TIMBER FRAMED FLOOR WITH ISOLATED CEILING ASSEMBLY

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ABSTRACT: Fire resistance test was performed for a floor assembly, of which stiffness was reinforced by shortening the span of floor joists by adding glulam beam in the middle of the original span, and which an additional ceiling component was installed apart from floor part. These factors are expected to show good insulation performance of timber framed floor against heavy impact sound. From full scale fire test, it is conclude that the designed and manufactured floor achieved 1 hour of fire resistance rating.

KEYWORDS: Fire resistance, Timber framed floor, Isolated ceiling, Sound insulation performance, Heavy impact sound

1 INTRODUCTION

For multi-story buildings including apartment building, fire resistance of floor assembly should be considered along with the sound insulation performance against light or heavy impact sound. In typical light timber framed building, a floor assembly shows a certain level of fire resistance by attaching adequate fire resistant gypsum boards(required for targeted fire resistance rating) beneath the basic floor structure, which are composed of floor joists and floor sheathings. Many researchers have reported that these timber joist floors showed bad insulation performance against heavy impact sound. It has been well known that major factors affecting the insulation performance of floor against heavy impact sound are stiffness of floor structure, sound absorption layer and additional ceiling assembly isolated from floor.

In this study, fire resistance of timber framed floor was evaluated in the points of reinforcement of floor stiffness and addition of isolated ceiling components.

2 MATERIALS AND METHODS

Fire resistance test was performed for floor assembly with double layers of fire resistant parts such as ceiling and floor components.

2.1 BASIC FLOOR

Basically, a floor used in this study was typical light timber framed one installed in the post and bema structure. Solid wood joists of Japanese Larch(38mm by 184mm) were placed at 400mm intervals and structural OSB(18.3mm thick) floor sheathings were attached on the joists.

Figure 1: Basic floor and stiffness reinforcement

2.2 STIFFNESS REINFORCEMENT

The span of joists was shortened by making an addition of a glulam beam at the middle of the original span for the purpose of reinforcing the stiffness of whole floor. And 12.5mm thick type-X gypsum boards were attached directly beneath the floor joists by screws.

2.3 ADDITION OF CEILING

The ceiling component was installed 30mm apart from floor part. 38mm by 89mm ceiling joists were placed perpendicular to floor joist direction at 600mm intervals.
and blocked at the same intervals. And 15mm thick type-X gypsum boards were attached directly beneath the ceiling joists by screw.

**Figure 2: Ceiling component and fire test**

### 2.4 FIRE RESISTANCE TEST

Fire resistance test for manufactured floor assembly was carried out in accordance with Korean Standard(KS F 2257-5). During the test, constant load of 48.84 kN(=3kN/m²) was applied uniformly. This load was calculated by adding the general live load(2kN/m²) for living room in a residential building and dead load increase(1kN/m²) caused by concrete topping(5mm thick) addition, which is expected to show better insulation performance against heavy impact sound. Temperatures at 4 different points(non-fire side of gypsum board attached to ceiling joist, fire and non-fire side of gypsum board, and 50mm deep in glulam placed in the middle of floor) were measured during fire tests. And the deflection of tested floor was measured at the mid-point of whole floor, which was expected to be shown maximum value.

**Figure 3: Positions for temperature measurement**

### 3 RESULTS AND DISCUSSION

#### 3.1 TEMPERATURE WITHIN FLOOR

As shown in Figure 4, temperature inside the 15mm thick type-X gypsum board increased rapidly after 20 minutes. This meant that fire resistant performance of this gypsum board was lost. The temperature inside the second gypsum board increased rapidly after about 45 minutes. From this moment, wood joists might start to be charred. Temperature within glulam increased very slightly even after 60 minutes.

**Figure 4: Temperature changes within floor structure**

#### 3.2 DEFLECTION OF FLOOR ASSEMBLY

After 60 minutes, the maximum deflection measured at the mid-point of floor was about 7mm, which was smaller than 1/360 of floor span. From this results, it is thought that there was no structural damage during fire test(1hour) and test floor satisfied 1 hour of fire resistance rating.

**Figure 5: Comparison of glulam cross-section between before and after fire test**

### 4 CONCLUSION

Timber framed floor, of which stiffness was reinforced and which additional ceiling component was installed apart from floor, showed 1 hour of fire resistance rating. This floor is expected to show good insulation performance against heavy impact sound.