FULL-SCALE FIRE TESTS OF 3-STOREY WOODEN SCHOOL BUILDING

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ABSTRACT: Outline of the Japanese national program for full-scale fire tests on 3-storey wooden school building is reported. The program includes three full-scale fire tests using buildings designed to verify fire behavior and effectiveness of firesafety countermeasures, classroom fire tests and fire resistance tests on structural assemblies.

KEYWORDS: full-scale fire test, wooden construction, school building

1 INTRODUCTION

Japan has restricted use of wooden construction to low-rise (not higher than 3-storey) and small-scale (not larger than 3000m²) buildings, and the restriction has been harder for public buildings such as school, commercial facilities and assembly buildings. However, since the introduction of the Law for the Promotion of Wooden Construction in Governmental Buildings in 2010, the Japanese Government started a 3-years national R&D project in 2011 for the relaxation of the regulation to make school buildings buildable with wooden construction not rated as Fireproof Construction. Japan has experience of 20 years with wooden Quasi-fireproof Construction, but most of them in the construction market concentrate in collective houses featuring accumulation of relative small rooms, and we lack in the experience with large wooden buildings composed of large span compartments. Because regulatory fire resistance tests can be conducted only with limited size specimens and only on limited parts of building assemblies, it arises a possibility that fire in a real building may differ from anticipations based on regulatory fire tests on assembly specimens. Considering that few large scale fire tests have been done on large scale wooden construction in the world, full-scale building fire tests are planned to verify fire behavior and effectiveness of proposed firesafety countermeasures. This paper, an interim report of the program, intends to report the outline of the project and general aspects of the full-scale fire tests on 3-storey school buildings actually designed for the project.

2 COMPONENTS OF THE PROJECT

The project includes (1) 3 full-scale building fire tests, (2) classroom fire tests conducted to clarify possibility of fire spread to upper floors, (3) fire resistance furnace tests on columns, beams, walls and floor-slabs.

2.1 FULL-SCALE BUILDING FIRE TESTS

The 3 full-scale building fire tests are designed as a) Ist test FY2011 Preliminary test: Without special firesafety countermeasures except for the use of 1 hour Quasi-fireproof Construction for loadbearing and separation assemblies, Composed of heavy-timber post & beam construction and platform construction, Construction details for joints etc based on conventional unrated wooden construction, executed on February 22, 2012
b) 2nd test FY2012 Preparatory test: Balcony or eave above each window for the prevention of the penetration of external flame into upper floors, Use of noncombustible interior lining. Construction details improved, executed on November 24, 2012

c) 3rd test FY2013: Final test: Without balcony or eave, Ceiling lined with Quasi-noncombustible material and walls lined with wood, Construction details improved, scheduled on October 20, 2013

2.2 CLASSROOM FIRE TESTS

Two series of “room-corner tests” using a classroom size room are conducted; (a) heat release measurement using a room without furniture lined with wood or noncombustible materials(indoor tests) and (b) measurement of flame projection and possibility of fire spread to upper floor through window using an outdoor room with/without eaves above window lined with wood or noncombustible linings. The indoor tests are ignited with a square porous propane burner against a corner of walls and are essentially “classroom version” of the ISO9705 Room Corner Test. They intend to verify the conditions for the occurrence of flashover due to the surface flame spread of interior linings. The outdoor tests intend to verify the effectiveness of eaves for the prevention of fire spread to upper floors due to external flame projection and possible trade-off between eaves and the combustibility of interior lining for the mitigation of the hazard of fire spread to upper floors. The indoor tests were mainly conducted between the 1st and the 2nd full-scale building fire tests to investigate into the controlling mechanism of heat release rate in a classroom fire. The outdoor tests have been conducted mainly after the 2nd full-scale building fire test in order to explore the possibility of the design to reduce the risk of fire spread by external flame projection.

2.3 FIRE RESISTANCE FURNACE TESTS

Fire resistance furnace tests are conducted on various designs of wood-based beams, columns, partition walls, floors and fire doors. These tests are conducted partly to help the analysis of the results of the full-scale building fire tests, and partly to develop Quasi-fireproof structural and fire separation assemblies suitable for school buildings. For the designs of partition walls used for the full-scale building fire tests, following two series of “special” furnace tests are conducted:

a) Both-sides heating tests.

b) Exposure to the time-temperature curve simulating the full scale building fire test record. The tests a) are conducted because most of classrooms are not fire-separated and thus partition walls between classrooms can be heated from both sides at the event of a fire. The tests b) are conducted because the temperature histories in the ignited room of the 1st and the 2nd full-scale building fire tests were very different from the ISO834 Standard Time Temperature Curve with the temperature much higher than the standard at the beginning of the fire. Some unexpected damages to the partition walls were suspected to be caused by the difference in the fire exposure.

3 SUMMARY OF FULL-SCALE BUILDING FIRE TEST RESULTS

The first full-scale building fire test resulted in extremely fast fire spread from the ignition room to the upper floors mainly due to the generation of nearly 3 story-tall fire projection from the window of the ignition room. It was also noteworthy that the collapse of the 1-hour Quasi-fireproof partition walls and the steel fire doors at the entrance to staircase was fast, within 17 - 22 minutes from ignition. The fast fire spread was attributed to the large flame projection from the ignition room. The construction details, especially of the joints, were thoroughly revisited and studied to improve integrity during fire exposure. This study was reflected to the design of the 2nd full scale test. At the 2nd full scale test, fire spread to the upper floor occurred only 89minutes from ignition and revealed effectiveness of balcony and eaves for the mitigation of fire spread due to external flame.