Full-scale fire tests of wooden 3-story school building

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1.Background 1

Act for Promotion of Use of Wood in Public Buildings

- During the 174th regular session of the Japanese Diet, the "Act for Promotion of Use of Wood in Public Buildings“ (2010, Law No. 36) was passed, and it went into effect on October 1st 2010.
- For the survival and stable growth of forests and the sustainable use of woods, from the standpoint of environmental protection, the new Law obligates the national and local governments to utilize wood materials for public buildings that have 3-story (for limited use) or less.

Basic Policies for Promotion of Use of Wood in Public Buildings 2/3

- Based on Article 7 of the "Act for Promotion of Use of Wood in Public Buildings", the Minister of Agriculture, Forestry and Fisheries and the Minister of Land, Infrastructure, Transport and Tourism shall establish the basic policies for the promotion of the use of wood in public buildings.
- These basic policies establish the essential points to be covered in promoting the use of wood in public buildings and the objectives of this promotion in public buildings which are developed and maintained by the national government; for example, one objective for the national government is to - as a rule - employ fully timber construction in those low-rise public buildings that fall within the scope of nation-controlled public buildings that are candidates for active timber construction promotion.

1.Background 2

Cabinet decision on policy related to addressing regulatory reform (June 18th 2010)

- Requirement for fire-resistive construction by total floor area and number of stories of special building, especially for school, by Building Standard Law of Japan shall be reexamined depending on research results of fire performance of wood and wooden building.

2.Purpose of research project 1/3

Requirements by BSL (except for those by zoning)

- 3-story school buildings (Article 27. item1) or
- Wooden buildings exceeding 3,000 m^2 in total floor area(Article21. item2)

Fire-resistive building
(Principal building parts : Fire-resistive construction)

Putting the merit of wood to school buildings,

1) we are reconfirming requirements for 3-story school buildings,

2) we are gathering knowledge of fire performance of wood and timber for structural member and interior material.

We are checking by fire tests whether the school building constructed by quasi-fire-resistive buildings can satisfy the requirements or not, relating to safe egress, support of fire fighting activity, and so on.

2.Purpose of research project 2/3

Fire-resistive building

- Principal building parts are of fire-resistive construction.
- Fire doors in exterior walls liable to catch fire.

Quasi fire-resistive building

- Principal building parts are of quasi fire-resistive construction.
- Fire doors in exterior walls liable to catch fire.

Fire-resistive construction

Performance is required during and after fire exposure.

Quasi-fire-resistive construction

Performance is required during 30, 45, or 60 minutes fire exposure.

2.Purpose of research project 3/3

Full-scale fire test of wooden 3-story school building

[Purpose]

By specifying fire safety requirements of wooden 3-story school building about

1) safe egress,

2) prevention of fire harm to neighbor (collapse, heat transfer, fire brands) and

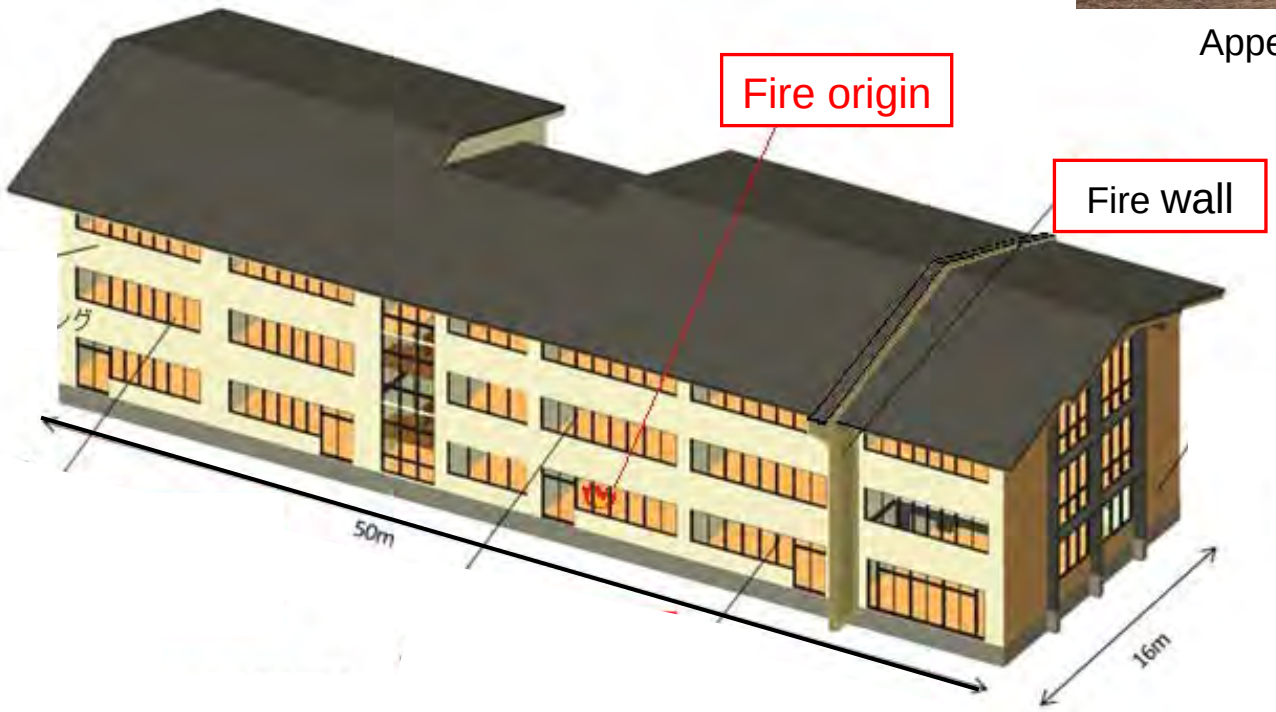
3) support of fire fighting activity, and so on.

We establish the technical standards of wooden 3-story school building by 3 full-scale fire tests.

3.Outline of full scale fire test (Preliminary test) 1/5

Site : NILIM(Tsukuba)
Structure : Wooden 3-story construction(1hr quasi-fire resistive construction)
Area : 830m^2 (50mx16m, 15mHeight)
: 2,260m^2
Date : February 22nd 2012 9:00a.m. start
Weather : Fine 6～8℃ Humidity about 50%
wind speed 4m/s (East)

Appearance before test

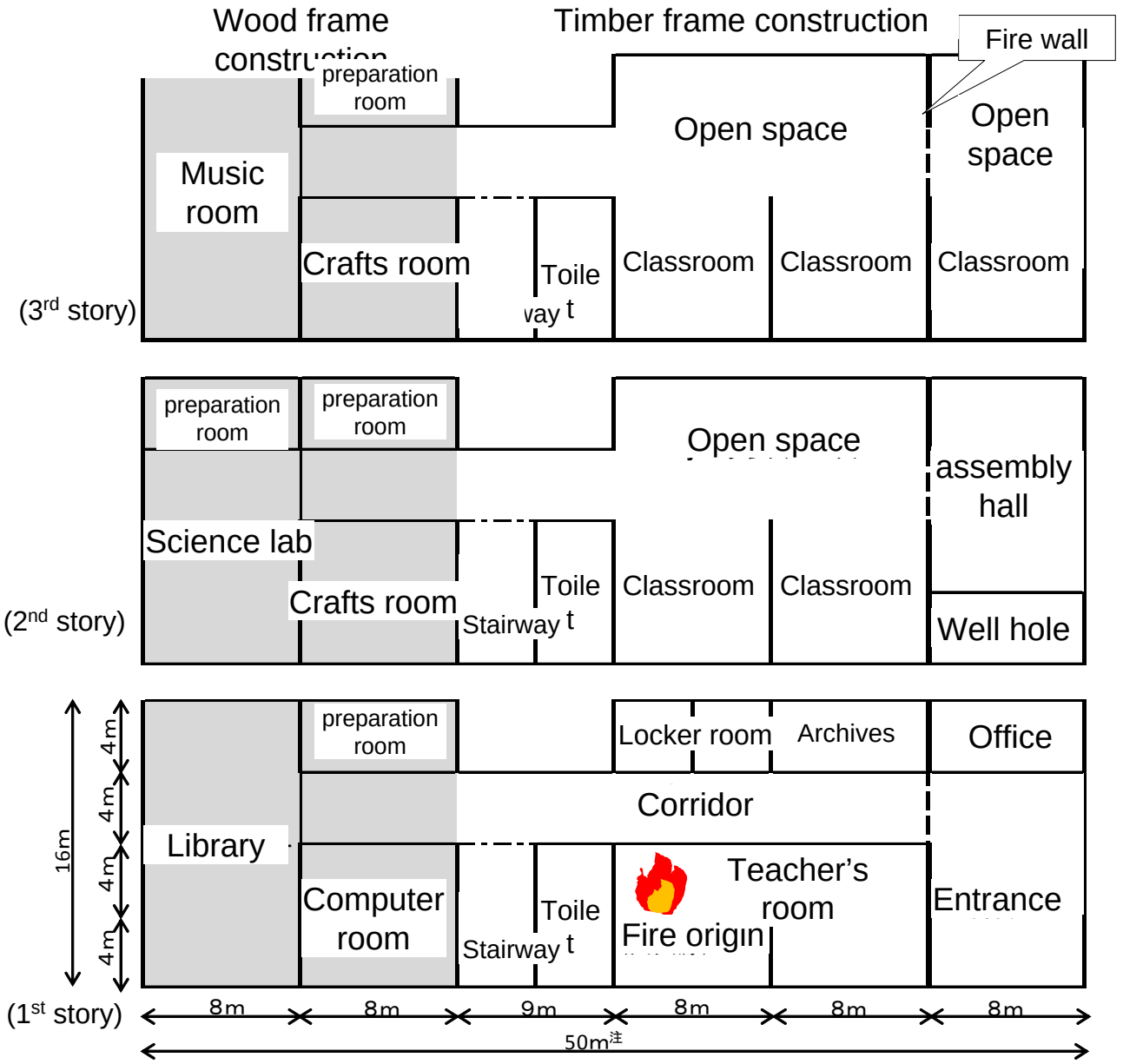


Axonometric projection

3.Outline of full scale fire test (Preliminary test) 2/5

Floor area
830m²

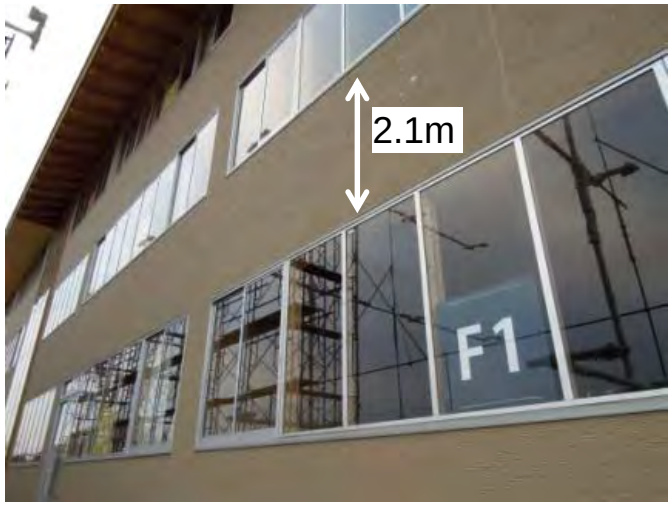
Plan



3.Outline of full scale fire test (Preliminary test) 3/5

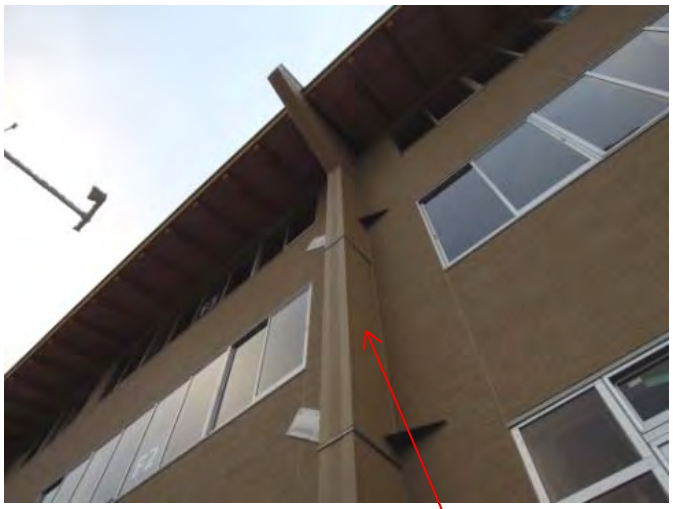
Appearance

Interior finish



Exterior Wall

Fiber reinforced cement siding



Fire Wall

It is jointed with other part to support horizontal force

3.Outline of full scale fire test (Preliminary test) 4/5

0min. Ignition

2min. Flashover

4min. Glass of 2nd story classroom broke

6min. Fire spread to classroom of 2nd story

8min. Fire spread to classroom of 3rd story

17min. Flame spread to opening of east side beyond fire wall

22min. Fire spread to wall frame construction part

South Side

27min. Fire spread to east side beyond fire wall (whole building)

36min. Floor of 3rd story fell down

76min. Collapse of timber frame construction part

95min. Collapse of wood frame construction part

96min. Collapse of fire wall

123min. Collapse of whole building

■Summary of result

・In early stage, fire spread all over the building.

・Fire spread through fire wall.

・ Fire wall collapsed. and so on

4.Outline of full scale fire test (Preparatory test) 1/5

- From preliminary test, we found

・Early fire spread to upper stories through the external openings (about 4 minutes to the 2nd story and about 6 minutes to the 3rd story for flame spreading)

・Early fire spread through fire wall (about 18 minutes)

・Fire wall collapsed without freestanding (96 minutes).

In order to address these issues, we did preparatory test

・to make interior materials except columns, beams and floors resistant to fire,

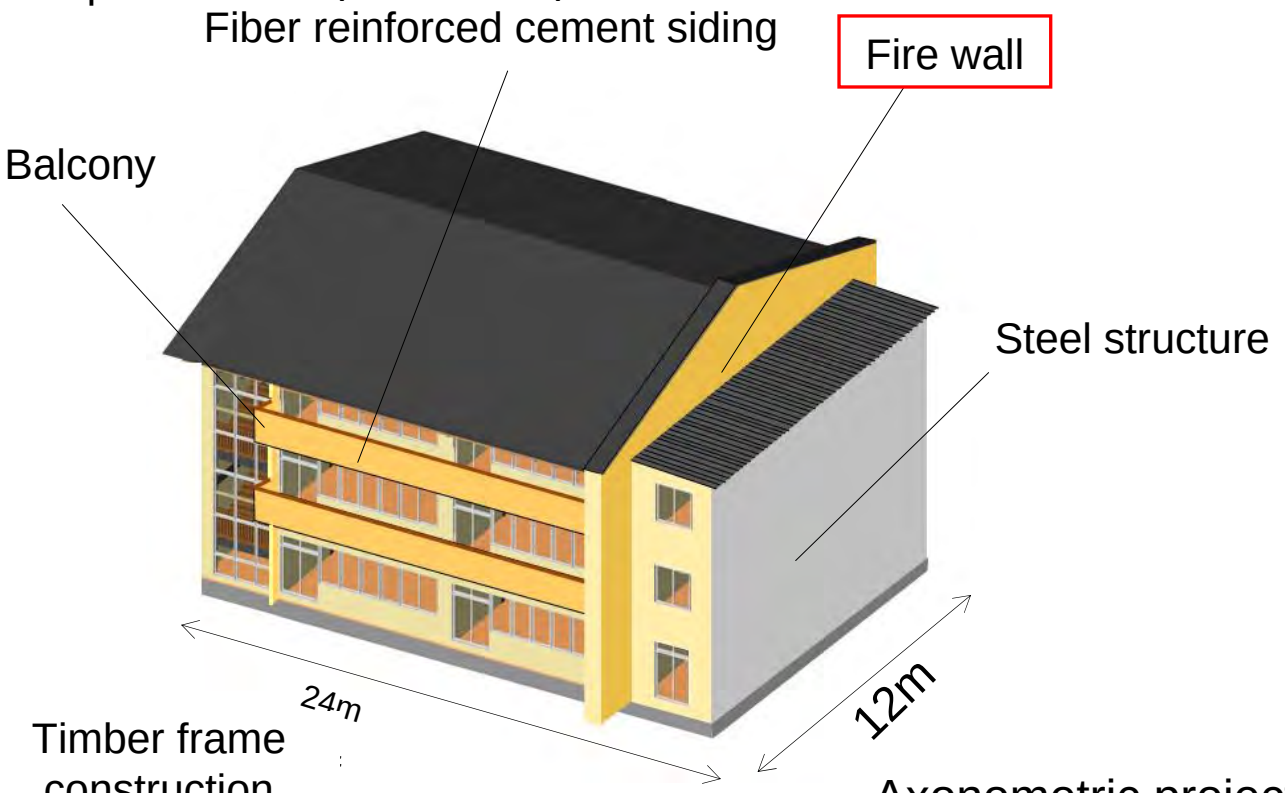
・to place balconies and eaves to upper part of openings of exterior wall and

・to separate fire wall structurally and change fire doors

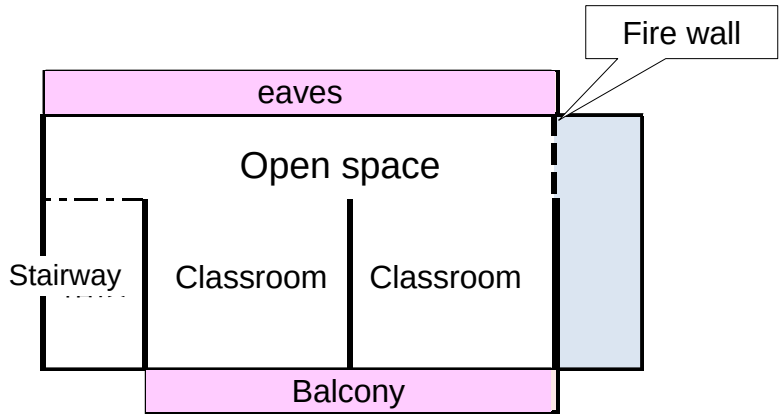
worked out as countermeasures.

4.Outline of full scale fire test (Preparatory test) 2/5

Site : Gero city, Gifu prefecture
Structure : Wooden 3-story construction(1hr quasi-
Area : 310m^2(24mx12m, 15mHeight)
: 850m^2
Date : November 25th 2012 8:00a.m. start
Weather : Fine -2～4℃ Humidity 52～77%
wind speed 0.4m/s (south west)



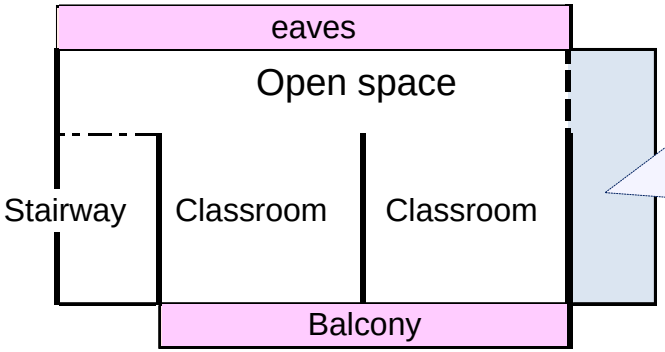
4.Outline of full scale fire test (Preparatory test) 3/5



(3rd story)

Floor area
310m2

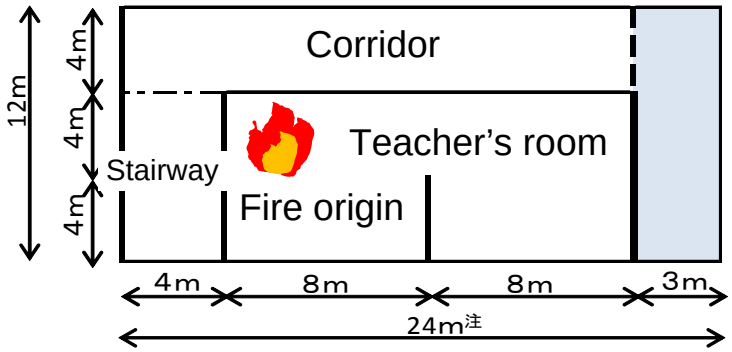
About 40% area
of preliminary test



(2nd story)

※This is the part to check fire spread over fire wall.

Simple steel structure



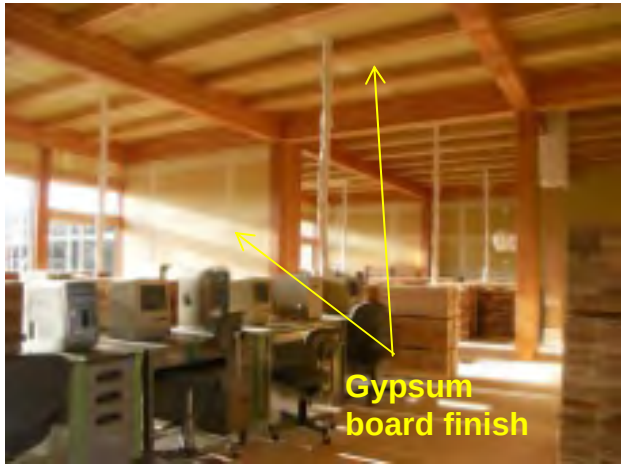
Plan

(1st story)

4.Outline of full scale fire test (Preparatory test) 4/5

To prevent fire spread

Appearance



Interior finish

Partly non-combustible material

※column, beam and floor are wood finish

Exterior Wall　Balcony and eaves

To prevent upward fire spread

Fire Wall

※improved installation of fire door to wall

Independent on building structurally

4.Outline of full scale fire test (Preparatory test) 5/5

0min. Ignition

7min. Smoke from the south opening of ignited room

21min. Smoke from the north opening of ignited room

37min Smoke filled ignited room

50min. Reignition by torch

61min. Glass of 2nd story classroom broke

90min. Flashover

113min. Flame from the north opening of ignited room

129min. Fire spread to classroom of 2nd story through the floor

Sorth side

North side

131min. Flame from the opening of 2nd story

139min. Fire spread to classroom of 3rd story

142min. Extinguishing fire by safety reason

420min. No collapse after test

■Summary of result

- Prevented early fire spreads
- Prevented fire spread through fire wall.
- Prevented fire wall collapse

5. Conclusions 1/1

- The full-scale fire test will be carried out based on specifications which hypothesize standardization in the fiscal 2013, with specifications and test method adjusted based on these results.
- The results of the three full-scale fire tests will be used for revision of BSL which ensure the fire safety that will be required of a wooden 3-story school building.

Thank you

http://www.nilim.go.jp/lab/bbg/kasai/h23/top.htm (in Japanese)

These tests were carried out based on a joint research among
Waseda Univ.,
Akita Prefectural Univ.,
Mitsui Home Ltd,
Sumitomo Forestry,
Gendai Keikaku Kenkyujo, Architects and Associates,
Building Research Institute
and NILIM.