



A Summary of Methods for Fire Tests of Roof Coverings

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Abstract

The testing method about the fire performance of roof covering and materials has not been put into operation in China. This article focuses on two main international testing about fire performance of roof covering and materials, comparing the difference between the two test methods.

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1. Introduction

With the development of society, the roof covering material showing the diversity of inorganic materials, metal plates, wood or plywood, waterproof membrane and coatings, insulation materials and so on. Roof is an important part of the building, the fireproof performance and waterproof property of the roof covering material has relationship with the construction safety. Therefore, the study of the fire performance of roof covering materials and the scientific, mature, operability and compliance with domestic objective reality standards for roof covering fire protection is essential.

So far, the fire prevention norms relevant about roof covering project has not formally implemented in China, flame retardant properties has not been required in the roof covering materials standard, burning test method of roof covering systems and materials is absence. Currently, the EN13501-5-Fire classification of construction products and building elements-Part 5 Classification using data from external fire exposure to roofs test^[1] is adopted in the European, this standard adopted ENV 1187-test methods for external fire exposure to roofs-test method^[2] and which is the fire performance requirements of all European countries roof covering materials. The UL 790-Standard Test Methods for Fire Tests of Roof Coverings^[3] are adopted in North America in which the roof coverings are divided into three fire class. The fire regulations of United States and Canada require follow by this standard. The test method in ISO 12468-1-External exposure of roofs to fire -Part 1: Test method^[4] is similar to ENV 1187.

It can be concluded that there are mainly two systems of Standard for Safety for Standard Test Methods for Fire Tests of Roof Coverings: the ENV1187 as well as ISO standards and American-Standard. The test methods used by the two standard systems are similar in principle, the impact of the flame of roof on coverings materials with a wind of certain speed is considered. The main types of European standards are ENV 1187:2002 and ISO 12468-1:2003, American standard mainly has UL 790-2004, ASTM E108-04^[5] and NFPA 256-2003^[6]. Taking UL 790 and ENV 1187 for example the differences of two standard systems are analyzed.

2. The similarities between the two test methods.

First, brand and gas were used as the source of fire in the roof coverings materials testing; second, the case of the roof coverings materials in the practical application has been considered and certain slope has been set in the test; third, the

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impact of external wind speed on the test is considered, the wind is applied to the sample by the air supply system in the test and the wind speed has been set strict demands on; fourth, the standard of judgment is similar, the test temperature do not need real-time acquisition, the length of the flame and whether the burning material falling from the roof surface need recorded.

3. The difference between the two test methods

3.1. Brand fire source

Both ISO 12468-1 and UL790 use brand fire source. Three types of brand fire source are in UL790, and only two types in ISO 12468-1. The brand fire source parameters in these two standard systems are compared in table 1 and table 2.

Table 1 The brand parameters in UL790 and ISO 12468-1

| | Weight(g) | Type | Dimension |
|-------------|-----------|-------------|---|
| UL790 | A | 2000 ± 150 | Douglas fir lumber The brand is to be made of 36 strips of lumber each 19.1 by 19.1 mm square by 300 mm long, placed in three layers of 12 strips each, the overall dimension of brand is 300 × 300 × 57 mm |
| | B | 500 ± 50 | Douglas fir lumber The brand is to be made of 18 strips of lumber each 19.1 by 19.1 mm square by 150 mm long, placed in three layers of 6 strips each, the overall dimension of brand is 150 × 150 × 57 mm |
| | C | 9.25 ± 1.25 | Douglas fir lumber The brand is to measure 38.1 × 38.1 × 19.8mm and a saw kerf 3.2 mm wide is to be cut across the center of both the top and bottom faces to a depth of one-half the thickness of the brand, and at right angles to each other. |
| ISO 12468-1 | A | 550 ± 50 | Beech The brand is to be made of 18 strips of lumber each 19 by 19 mm square by 150 mm long, placed in three layers of 6 strips each, the overall dimension of brand is 150 × 150 × 57 mm |
| | B | 33 ± 5 | Beech The brand is to measure 40 × 40 × 40mm, and a saw kerf 3.2 mm wide is to be cut across the center of both the top and bottom faces. |

As can be seen from Table 1, the Class B and Class C brand in UL790 is similar with Class A and Class B in ISO 12468-1. Two methods both simulate the burning state of roof coverings materials in the fire while the burning pieces of wood falling on the roof, and test the roof coverings materials to resist brand fire, but there are some differences in the brand simulation. Relatively speaking, the requirement of U.S. standards is more security. The Grade A brand size in U.S. standards is 100mm × 300mm × 57mm, weight is 2000 ± 150g which is more destructive than wood shavings in ISO 12468-1.

3.2. Ignition method

Ignition method of two standard systems also has different. Class A: ISO 12468-1: brand ignition for 240s ± 10s, each surface of 150mm × 150mm ignition for 30s; each surface of 57mm × 150mm ignition for 30s; each surface of 150mm × 150mm re-ignition for 30s, ignited flame above the burner 60mm ± 5mm and the temperature is 900°C ± 50°C. UL790: 305 × 305mm surface for 30s, each 57.2 × 57.2mm surface for 45s, a total of 300s, the flame ignited 58.7mm above the burner and the temperature is 888°C ± 28°C.

Class B: ISO 12468-1: ignition timing is 120s ± 10s, each slotted surface ignition for 60s and the flame located above the burner 60mm ± 5mm, the temperature is 900°C ± 50°C. UL790: Brand ignition for 240s ± 10s, each surface of 152 × 152mm ignition for 30s, each surface of 57.2 × 152mm ignition for 45s, each surface of 152 × 152mm repeat fire for 30s, the flame ignited 58.7mm above the burner and the temperature is 888°C ± 28°C.

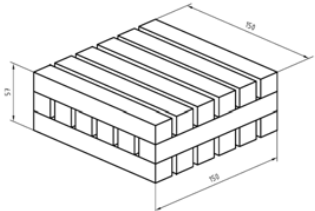
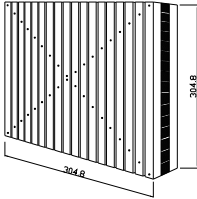
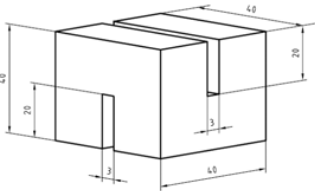
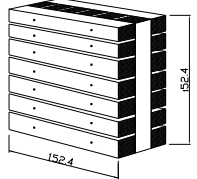
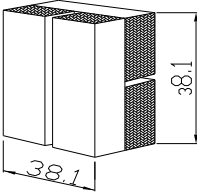
Class C: UL 790: ignition time is 120s, each slotted surface ignition for 60s and the flame located above the burner 58.7mm, the temperature is 888°C ± 28°C. There are only two classes in ISO 12468-1 for roof coverings.

3.3. Gas fire source and heat radiation source

UL790 using gas fire source applied the fire on the roof covering materials, while the ISO 12468-1 using the gas heat

radiation source radiated the roof covering materials. The specially designed gas burner is used in the experiments of UL790 which is composed by the inner tube and the outer tube, 1.12m length, with 60.3mm diameter and a 12.7mm width 0.91m length slit. Under the certain wind speed, flame temperature should be reached $(760\pm 28)^\circ\text{C}$ or $(704\pm 28)^\circ\text{C}$, and the flame is roughly triangular shape. The fire application time is different in different levels. The fire application time in the class A and class B is 10min while that in class C is 4min.

Table 2 Figures of the brand in UL790 and ISO 12468-1 (unit: mm)

| Class | ISO 12468-1 | UL790 |
|-------|---|---|
| A |  |  |
| B |  |  |
| C | --- |  |

Heat radiation rather than fire is adopted by the ISO 12468-1, the size of the radiation plate is $(600\pm 10) \times (600\pm 10)$ mm. In the test, the radiation plate parallel to the sample surface and the vertical distance to the sample is $500\text{mm} \pm 10\text{mm}$. The mixed gas of methane and air is using as gas; the radiation flux of the center of the radiation plate in the test should reach $12.5 \text{ kW/m}^2 \pm 0.5 \text{ kW/m}^2$.

By comparison, flame is used in the UL790 while the thermal radiation is used in the ISO 12468-1. The ability to resist the flame is simulated in UL790 when the roof under the flames, while in ISO 12468-1 is burning brand e and around thermal radiation of the combustible.

3.4. Plus wind

The fireproof performance of the roof coverings materials under addition wind speed is simulated in these two standards while there is a definite difference in the wind speed. In accordance with the provisions of UL 790, the wind speed of 1.3 meters from the duct export is $(5.3\pm 0.2) \text{ m/s}$, and the flame temperature reached $(760\pm 28)^\circ\text{C}$ or $(704\pm 28)^\circ\text{C}$ under the action of this wind speed. The flame shape is roughly triangular and the duct size is 760mm high, 2130mm wide. In accordance with the provisions of ISO 12468-1, the wind speed of certain distance from the duct export is $(3.0\pm 0.2) \text{ m/s}$ and the smallest size of the duct is 250mm high, 1000mm wide, 1200mm long.

3.5. Others

The requirements about the regulation of the sample and the environment are different. In UL 790, the distance between sample and ground should be 147mm, the test environment temperature should be $10^\circ\text{C}\sim 32^\circ\text{C}$, condition

temperature should be 16°C to 32°C; In ISO 12468-1, the distance between sample and ground should be 750mm±250 mm, the test environment temperature should be 5°C~35°C, condition temperature should be 23°C, the humidity is 50%.

3.6. Concluding remarks

Reinforcing the research of fire performance of the roof covering materials, based on foreign experience and domestic situation, working out of the test method conforms to the real condition of China with particular significance.

Acknowledgements

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References

- [1] EN13501-5:2007, Fire classification of construction products and building elements-Part 5 Classification using data from external fire exposure to roofs test[s].
- [2] ENV 1187:2002, Test Methods for External Fire Exposure[s].
- [3] UL790-2004, Standard Test Methods for Fire Tests of Roof Coverings[s].
- [4] ISO12468-1:2003, External exposure of roofs to fire -Part 1:Test method[s].
- [5] ASTM E108-2004, Spread of Flame & Burning Brand Tester[s].
- [6] NFPA 256-2003, Standard Methods of Fire Tests of Roof Coverings[s].