

FIRE RESISTANCE TESTING OF FIRE DOORS

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Abstract: Fire-resistant doors are widely used as part of passive fire protection systems, preventing the spread of fire and smoke beyond the fire compartment. Fire resistance is usually determined through standard fire tests in accredited laboratories, such as the *Laboratory for thermal technique and fire protection in Institute IMS*, Serbia. Current regulations in Serbia allow testing of fire doors according to two standards: Serbian national SRPS U.J1.160 [1] and European SRPS EN 1634-1 [2].

In the past five years, 236 samples of different fire doors were tested. Most of them were single-leaf, steel doors. Although almost one third (31%) of all samples (tested on 15, 20, 30, 45, 60, 90, 120, 180, 240 and 380 minutes) provided fire resistance of 120 minutes, which should be sufficient for the safe evacuation of people, as well as the protection of expensive equipment (hospitals, rooms with electrical devices, etc.). Samples usually fail the test when sustained flaming occurs on the unexposed side in the upper corner of the specimen (lock side), or when the temperature measured by thermocouples exceeds the limitation given in the standard, usually at the top corner (lock side). In this paper, both currently valid standard testing procedures are analysed and compared.

Key words: fire-resistant door, fire resistance, standards, testing, single-leaf steel door

1. INTRODUCTION

Fire safety in buildings depends on fire barriers, so fire-resistant doors play a major role in preventing fire and smoke spreading between fire compartments. For that reason, it is necessary to test the fire-resistant door and establish a specific fire resistance for each door type. Whether standard U.J1.160 from 1988, or EN 1634-1 from 2018 will be used, depends on the needs of the ordering party.

EN 1634-1 describes, in much more detail, the processes of a sample installation, installation of measuring equipment, testing process, as well as giving the final value for fire resistance of tested sample compared to U.J1.160.

This research focuses on processes and procedures defined by these standards, aiming to determine the time one specimen can withstand without loss of criteria for thermal insulation and/or integrity. The integrity shall be evaluated throughout the test by cotton wool pads, gap gauges and monitoring the test specimen for evidence of sustained flaming. Insulation is the criteria for which the door continues to maintain its separating function during the test without crossing the limit temperatures given in the standard.

2. METHOD

Although Serbian national rules [3] suggest the use of test standard U.J1.160, they also allow, at the same time, European standard EN 1634-1 to be used, providing testing methodology according to EU's market demands. The parallel use of both standards will remain until the new rulebook is adopted, in which only the European standards will remain valid.

Comparison of the two valid standards in terms of furnace conditions, installation methods, measuring equipment, and required fire resistance for doors are given in Table 1.

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Table 1 –Comparative analysis between Serbian and European fire resistance standard

	SRPS U.J1.160	EN 1634-1
Year of publication	1988	2018
Furnace conditions	SRPS U.J1.070/SRPS ISO 834-1*	EN 1363-1*
Sample size	Maximum dimensions: 2 m x 2.5 m (width x height)	As far as dimensions of the test furnace allow
Sample construction	Identical like in real use	Identical like in real use
Test wall	Identical like in real use	Identical like in real use
Wall thickness	<2h – 100 mm >2h – 200 mm	Not specified
Number of test specimens	two	two
Conditioning	If the sample contains hygroscopic materials	Not specified
Verification	Not specified	The client submits the technical documentation before the test
Test procedure	Insulation and integrity	Insulation, integrity and others
Gaps measurements	Not specified	Three measurements between door leaf and frame on each side
Closing force measurements	Not specified	Before testing
Unexposed face thermocouples	A smaller number of thermocouples are used: average temperatures – 140°C + ambient temperature Maximum temperature – 180 °C + ambient temperature	A large number of thermocouples are used and the temperatures on the frame are measured. The limit values depend on the desired class (I1 or I2).**
Deformation measurements	Not specified	Measurements during the test
Ignition of a cotton pad	A conditioned cotton pad is brought to the sample in case of an opening during the test.	A conditioned cotton pad is brought to the sample in case of an opening during the test.
Sustained flaming on the unexposed side	Longer than 10 s – integrity loss.	Longer than 10 s – integrity loss.
Fire resistance (min)	15, 30, 60, 90, 120, 180, 240, 380	15, 20, 30, 45, 60, 90, 120, 180, 240, 360
Report	Report + Certification	Report + Classification report

*Note 1: While both standards provide the same temperature-time evolution inside furnace, the group of standards EN 1363 also prescribe alternative and additional procedures, as well as procedures regarding the verification of furnace performance.

**Note 2: Difference between I1 and I2 is in limited temperatures that are measured on the sample frame. For I1 the limit is 180 °C, and for the I2 the limit is 360 °C.

The most obvious difference between two standards is in the pre-test measurements (verification, closing force measurement) and deformation measurements during test, which are not required by the Serbian standard. In addition to temperature measurements on the unexposed side of the door leaf, EN 1634-1 demands the installation of additional thermocouples for measuring maximum temperatures. U.J1.160 measures the frame temperatures only informative, not to be part of the report. When preparing final reports, U.J1.160 requires a Certification of Conformity to be issued, while EN 1634-1 requires Classification report written according to standard EN 13501-2, based on the report made according to EN 1634-1.

3. RESULTS OF THE CONDUCTED TESTS

Among the 236 specimens tested in the last 5 years, the division was made according to:

- leaf type (single-leaf door, double-leaf door, sliding door, and shutter assemblies);
- material (timber, steel, steel doors with wooden panels);
- type (glazed doors, doors with grills).

Figure 1 shows fire resistance for the most tested door type, single-leaf, steel, solid doors tested in the past five years.

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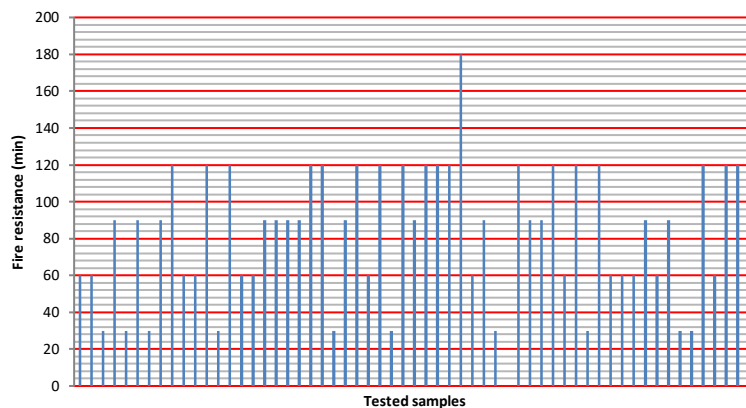


Figure 1 – Fire resistance of single-leaf, steel doors tested in the past five years

The most tested door type was the single-leaf door (107). Within this group, steel, solid doors were the most frequent with 59 tested samples, which accounts for 25% of all tested specimens. The most represented fire resistance was 120 minutes with 31% of specimens exceeding the compliance threshold. Very few tests are conducted until specimen failure, since in most cases; the test is stopped on the ordering party request, once the desired fire resistance is reached.

25 single-leaf, steel solid doors failed either by loss of insulation or integrity criteria. The tests have shown that the temperature is usually exceeded at thermocouple in the upper corner on the opposite side of the hinges.

In terms of integrity, the most common breach of continuous flames was in the upper corner of the sample on the side of the door opening. Figure 2 shows the thermocouples setup on the unexposed side of the specimen according to two considered standards. Unlike the Serbian standard, which requires only measuring the temperature on the door leaf, the European standard, pays attention to the temperatures on the frame, requiring larger number of thermocouples to be installed.

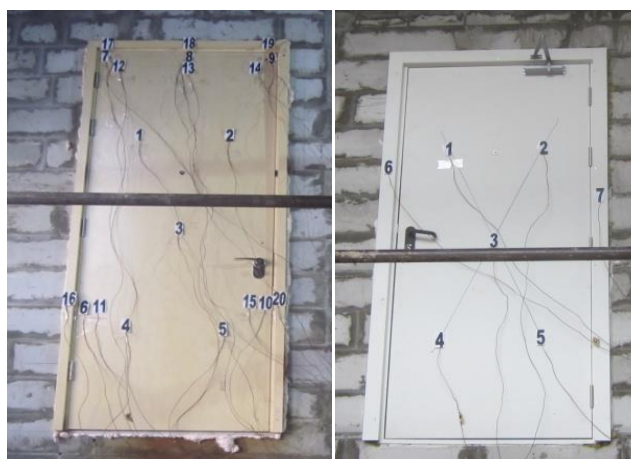


Figure 2 – Installation of thermocouples on the unexposed side of the door sample according to: European standard (left) and Serbian standard (right)

4. CONCLUSION

The comparative analysis concluded that the European standard is much more detailed in the part that determines pre-test conditions. The essence of the testing process is the same, but SRPS EN 1634-1 pays more attention to frame temperatures and deformations than SRPS U.J1.160. When testing according to Serbian standard, Certificate of Conformity is issued, and in case of European standard, Classification report. The difference between these two documents is in different form and period of validity.

Single-leaf doors make 45% of all tested samples in the past five years in Serbia. Almost 55% of them were steel, solid doors. 31% of these doors reached fire resistance of 120 minutes, and 58% of the samples passed the test for the required fire resistance.

ACKNOWLEDGEMENT

This research has been supported by the Ministry of Education, Science and Technological Development through project no. 451-03-68/2022-14/200156.

This paper has been supported by the Ministry of Education, Science and Technological Development through project no. 451-03-68/2022-14/ 200156“Innovative scientific and artistic research from the FTS (activity) domain”.

5. LITERATURE

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- [2] Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware –Part 1: Fire resistance test for door and shutter assemblies and openable windows, EN 1634-1-1(2018).
- [3] Rulebook on mandatory certification of elements of type building structures for fire resistance and conditions which must be fulfilled by associated labor organizations authorized to certify these products (Official Gazzete of SFRJ, no. 24/90), (1990).