Fire-resistant barriers: background on requirements and determination method.

Reading guide for test reports.

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1 Introduction

Especially in situations with movable partition walls, the wall continues up to the overlying concrete floor in the ceiling plenum, e.g. due to considerations of required sound insulation between the two rooms separated by the partition wall. To this purpose, barriers are often fitted in a metal bandraster and then clamped to the overlying (concrete) floor.
Partition walls may also have a fire-resistant function. If such cases, a fire-resistant barrier must also be present in the plenum unless the ceiling is fire-resistant. Using a barrier with acoustic and fire-resistant qualities will satisfy both requirements.

Whether a barrier can function as an acoustic or fire-resistant barrier is determined in laboratory tests where the construction is investigated in a standardised manner. The assessment of the fire resistance of a barrier and the field of application are not always clear in practice. In this regard, this report first discusses in general terms the requirements related to fire resistance and the manner of testing. This is the basis for describing the relationship between implementation of the test and the field of application for the investigated product.

Subsequently, a description is given on how a particular fire resistance is derived from a test report for the situation with barriers and in which situations the attained results are valid.

2 Fire resistance

2.1 Background

Fire compartments must often be present in a building. The fire compartments are intended to make it possible to escape safely or to limit the extent of any fire. Whether, and where, the fire compartments are needed follows from the building regulations. The required quality of the fire barriers, needed as a separation between fire compartments is also specified by the building regulations, whereby the requirement is dependent on various factors. For example, the construction height may be a determinant factor in answering the question of whether a fire partition must be fire resistant for 30 or 60 minutes.
The Dutch Building Code refers to the Dutch standard NEN 6069 for a "translation" of the requirements in the Building Code into the new European classification system. To this end, NEN 6069 describes based on the position of the fire barrier which criteria the fire barrier must satisfy: integrity, radiation and/or thermal insulation. These criteria are detailed in Section 2.2. Section 2.3 explains how the fire resistance of a construction is determined. Section 2.4 indicates in which situations the attained results are valid.

2.2 Fire resistance criteria

In the Europian standards, four criteria are differentiated based on how the fire resistance can be determined. The results of a fire resistance investigation are translated to these criteria:

- loadbearing capacity: this criterion is applicable to loadbearing constructions where the construction must be able to bear more load than its own weight;
- integrity: this looks at gaps and cracks that arise in the construction during a fire test (determined with gauges that can be stuck into the furnace), whether hot gasses arise from the construction (glowing or ignition of the cotton pad), and whether flaming arises on the non-heated side during the fire test;
- thermal insulation: for this criterion, the average surface temperature on the non-heated side (thus the "safe" side) may not rise more than 140 degrees during a fire test. Locally, a rise up to 180 degrees is permitted;
- radiation: the radiation that arises during the fire test may not exceed 15 kW/m^2 measured at a 1 m distance in front of the specimen.

One or more criteria can be set as requirements depending on the situation. Table 2 in NEN 6069 indicates (for the Dutch situation) which criteria must be satisfied. In all cases, integrity is important. The loadbearing criterion is not relevant with respect to non-loadbearing constructions. Thus, this criterion is not relevant for movable partition walls, doors, etc. For the constructions specified in the table either the criterion radiation or the criterion temperature is always applicable, always in combination with integrity. Thus, constructions must not only be "stop flaming", but may also not become too hot.

This combination leads to the classifications EW and EI. The rule of thumb to use is that in situations where no inflammable materials are expected in the direct proximity of the fire partition, then an assessment on radiation will be sufficient and when there are flammable materials in the direct proximity then an assessment for the temperature will be required. An example of the first situation is a door that must be capable of opening. An example of the second situation is a partition wall where a cabinet can be placed against it.

Table 2 of NEN 6069 also specifies “partitions”. This refers to the part of a partition construction (including penetrations) underneath a raised floor or above a lowered ceiling. This latter situation also relates to a fire-resistant barrier.

A requirement specified for fire barriers is that these must satisfy the integrity and temperature criteria (EI). The temperature requirement is also set because in due course dust will accumulate above a lowered ceiling or under a raised floor. To prevent ignition (or a dust explosion), the surface temperature of the non-heated side may not rise too high therefore. Depending on the situation, the requirement specified by the Dutch Building Code on a barrier will lead to a necessary classification of EI 30 or EI 60.

2.3 Determination method

The fire resistance of a construction is determined with a fire resistance investigation, hereinafter called “fire test”. In this regard, NEN 6069 refers to the various European standards. These standards that are obligatory and binding for European member states describe in detail how a construction must be tested and how and at which positions temperatures and radiation must be measured. Descriptions are also provided on which requirements the test arrangement (the furnace) must satisfy, the level of accuracy in which the measurements must be taken, etc. Finally, the situations for which the attained results are valid are also specified. This is called the “direct field of application” (see also Section 2.4). Based on other European standards, the field of application can often be extended. This is indicated with “extended field of application”. As the entire process (required equipment, installation, testing, interpretation of results and report) is specified in detail, the attained results are not (no longer) dependent on the testing institute or the interpretation by the institute, but on the quality of the product.

During a fire test, the construction (the “test specimen”) is heated on one side in accordance with the standard heating curve. The temperature on the heated side reaches about 850 °C after half an hour and about 950 °C after one hour. An over pressure in the furnace of approximately 20 Pa is maintained during the test. If the investigated product is not symmetric, the result will generally only be valid in the direction under consideration. In this case, it may be necessary to test the product in both directions.

During the test, a number of observations are made for the non-heated side, both visually (integrity: gauges, cotton pad, and flaming) and electronically (temperature and radiation).

The test report details the investigated construction and lists the attained results. However, no conclusion is drawn with respect to the fire resistance. For this purpose, the European system requires a separate classification report to be drawn up where the attained results are translated into the fire resistance classification (e.g. EI 60). Both the test report and classification report must describe the direct field of application, possibly by also referring to the relevant test standard.

2.4 Field of application

The test standards always indicate the situations in which the result is valid, namely, the direct field of application. The field of application is dependent on the type of construction, but often also on the test method. Thus, the manner of installation can have a significant impact: a fire test on a door that is installed in a rigid (stony) construction can lead to a different result than for the same door installed in a flexible (non-rigid) metal stud wall. It is therefore advisable before the test to mutually agree on which situation(s) the results must be usable for.

The test standards all contain a description of the direct field of application. Sometimes, this may be limited to the investigated situation, but often there is a broader field of application with the proviso that additional conditions are met. For example, walls may be wider than that tested when the wall was tested with a width of at least 3 m and was installed with a so-called free edge, i.e. one of the vertical sides may not be attached. A wall that was tested with a height of 3 m (again, the minimum dimension specified in the European standards) may be used with a height up to 4 m if the lateral deflection of the wall during the test was limited to a maximum of 100 mm.

Finally, further extensions to the field of application may also be specified for many constructions. Such an "extended field of application" must be specified according to a European standard, where the previously determined fire resistance classification will be valid for the direct and extended field of application.

If a product does not (yet) have a CE mark, the field of application can be extended based on national expert judgements ("assessments"). In the Netherlands, such declarations are generally specified within the scope of NEN 6069, Appendix A. Such a declaration cannot lead to a European classification because the classification standard (EN 13501-2) bases the classification only on the European standards.

An official classification must be accepted in all European member states. An expert judgement is usually only valid in the country where it was specified. Expert judgements may not be used for products where the fire resistance classification also falls under the CE mark.

3 Case: fire resistant barriers

3.1 Determination method

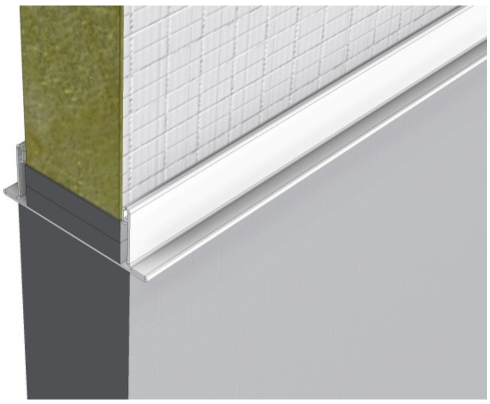
For most constructions, the NEN 6069 standard indicates under which European standard the fire resistance must be determined. However, no European standard is available for barriers. Given the position where barriers are used (above a non-loadbearing partition wall), the composition of the partitions and the function these are used for, it can be stated that these are a component of the partition wall design and should also be assessed as such. In this case, the fire resistance is determined according to (NEN-)EN 1364-1.

3.1.1 Installation details

A construction that must be investigated ideally must be installed as much as possible as it will actually be installed. In particular, this relates to the wall connections and the manner of mounting as well as the wall that will be under a barrier. Concretely, this means that the height of the barrier to be investigated must be (at least) equal to the maximum size used in practice. The mounting of the bandraster must also match what will occur in practice.

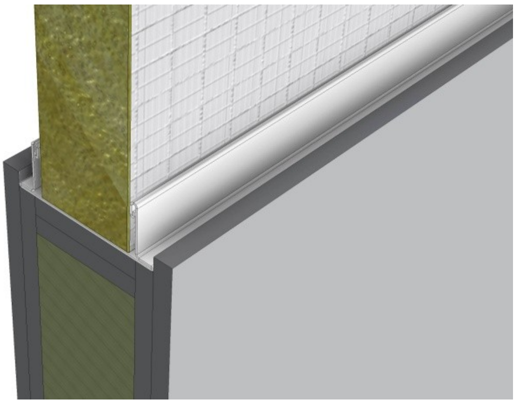
It is also important that the connections of the barriers with the surrounding constructions match the situation in practice. This also applies to the details underneath that are usually realised with a bandraster. Given that the bandraster can also determine the outcome of the investigation, the same type of bandraster must be used with the barrier during the fire test as the one that is actually used in practice. If during the fire test, gypsum panels or similar are used in the bandraster to limit the temperature, these must also be used in practice.
The use of the bandraster during the test must match how it will be used in practice. In practice, the partition wall is usually underneath the bandraster. See Figure 3.1 below.

f3.13.1 *Barrier with bandraster above partition wall.*



In this situation, the side of the bandraster is exposed to the heat of the fire, which is what happens in practice when the ceiling falls away. The thermal load of the construction is thus greater than when during the test parts of the bandraster are screened off, e.g. by protruding panels above the bandraster from the wall underneath. See Figure 3.2.

f3.2 Bandraster screened off



If the test is performed with continuous panels as shown in Figure 3.2 then the result is only valid for that situation. The result of a test for a design shown in Figure 3.1 is valid for both situations because the test is performed under more severe conditions.

3.1.2 Supporting construction

The barrier can not fill the entire height of the furnace (3 m). The space under the barrier must be closed off during the test with a suitable wall, namely, the "supporting construction". This may be a "standard" flexible or rigid or a specific wall, e.g. a movable system wall. The preference here is to test with a supporting construction such that test results provide the broadest possible use. For each case, it can be derived from the test standards which type of supporting construction is preferred.

In practice, a movable system wall or light partition wall is usually underneath the bandraster. If the investigation is performed with a certain type of "standard wall" underneath the bandraster, then the result is also applicable for other walls of the same type (and same fire resistance). In addition, a wall (described in detail) consisting of metal panel wall with plasterboard panels on both sides counts as a standard wall for light, flexible walls. In other words, if a similar wall is used during the fire test then the result is also valid if the barrier is used above another flexible wall at some later time. This may also be a system wall.
The reverse does not apply for a system wall as a standard wall. If the barrier is tested in combination with a system wall, then the result is only valid in combination with that specific system wall.

Rigid walls used in a fire test are often cellular concrete blocks. The result is then usually also valid for thicker and/or heavier stony walls. A stony wall does not deform or hardly deforms during the heating (in any case, notably less than a flexible partition wall) and will also cool the bandraster. The result of a fire test with a barrier above a rigid wall is not valid for the same barrier above a flexible wall therefore. Given that a barrier generally is not used above a rigid partition wall, such a test is less useful.

Summary: If tested above a "standard" metal stud construction as described in the European test standards, then the result is also valid for use in combination with other flexible partition walls, with the proviso that these have at least the same fire resistance. A result attained in this manner may therefore also be valid in combination with a movable system wall. The reverse is not the case. If a barrier is tested above a specific type of movable system wall, the test result is only valid for that situation.

For instance, a test in combination with a rigid supporting construction (cellular concrete, limey sandstone, etc.) is only valid in combination with such a wall. The result for a barrier tested above a cellular concrete is thus not valid above a flexible partition wall such as for example, a metal stud wall. This is because the different materials behave differently. A rigid wall does not deform or hardly deforms during heating, but a flexible partition wall usually deforms substantially.

3.1.3 Dimensions

In general, if a partition wall is installed with a width of at least 3 m and with a vertical "free edge" is installed, the partition can be (unrestrictedly) made wider. For the height of a partition wall (with or without a barrier), a 3 m tall tested wall may be extended to a height of maximally 4 m, with the proviso that the deformation of the wall during the test was less than 10 cm.

3.1.4 Heating direction

If the barrier is symmetric in construction, a test in one direction is sufficient. The attained result is then also valid for the other direction. If the barrier is not symmetric in construction, then generally two tests are required, each heating one side of the wall. If it is known from previous investigations what heating direction is normative, a test in the normative direction is sufficient.

3.1.5 Interpretation of measurement results

The surface temperature of the barrier is measured during the test. If during the first 30 or 60 minutes, the maximum temperature rise does not exceed 180 °C and the average temperature rise does not exceed 140 °C, the barrier satisfies the temperature criterion for a fire resistance of 30 or 60 minutes.

In addition, no gaps or cracks may arise such that a steel bar ("gauge") can be poked into the furnace. The cotton pad may not glow or burn as a consequence of hot gases passing through openings in the barrier or the connection to the surrounding constructions. Finally, no sustained flaming may be visible from the non-heated side that continues to burn for more than 10 seconds.

3.1.6 Field of application

For a successful test, the result is in any case valid for the situations that match that in the investigated situation with respect to construction, materials and dimensions. For instance, other glue may not be used, nor a different bandraster, and the manner of installation must match the tested situation. See also Sections 3.1.1 and 3.1.2 for some examples of the possible restriction of the field of application for a deviating installation.

Depending on inter alia the fire test implementation and the results, the field of application can be broader than the "exact" implementation investigated. Assuming a successful fire test for a construction of at least 3 m width and 3 m high, the results is also valid for the following situations and combinations thereof:

- if the construction is designed symmetrically, the result is valid for both directions;
- for testing above a standard flexible supporting construction, the result is also valid for using the barrier above other flexible (non-rigid) partition walls;
- the width may be smaller than that tested;
- if the barrier and the support were installed with a free edge, the width may be unrestrictedly widened;
- the height of the barrier may be smaller than that tested;
- if during the test the lateral deformation of the wall (measured in the middle and along the free edge) was less than 10 cm, the wall may be increased in height to 4 m. The extra height must be proportionately distributed across the barrier and the wall underneath;
- no layers may be added or excluded. The barrier may in practice not be thinner than that tested, but may be thicker. This means that in practice one or more layers may be thicker than those tested;
- the density of the materials used may not be less than that tested, but the material density may be higher.

3.1.7 Expert judgement

The specified possibilities in Section 3.1.6 follow from the direct field of application as described in the test standards. A farther-reaching extension of the field of application can often be attained by combining results attained for different tests. Therefore, it is not always necessary to perform a complete fire test for each variant.

For example, several design variants can be tested in one fire test where it is investigated which variant is the weakest and is thus the normative variant. If subsequently an official fire test is performed (successfully) for that one variant, it is realistic to assume that the other specimens investigated will at least attain the same fire resistance.

Setting up such an investigation requires a thorough knowledge of the determination methods and the construction behaviour and thus must be performed in collaboration with a laboratory that has experience with these tests.

Mook,

This report contains 11 pages