Fire-safe Use of Traffic Areas in Residential Buildings

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INTRODUCTION

According to the Dutch Building Code, a building of any size must contain at least two escape routes, which give access from any fire compartment in the building to the public road. In order to keep the escape routes usable in the event of a fire, they are located outside the fire compartments, they are 'extra protected escape routes' in terms of the Building Code. A fire compartment is a part of the building designated as a maximum extension area of fire. There are no restrictions to the fire load in a compartment.

Logically, the idea is that fire is not taken into account in an extra protected escape route, and that therefore the escape route must be kept free from fire loads. A fire load is a combustible object or a collection of combustible objects, such as a chair, couch, standing lamp, bicycle, wheelchair, mobility scooter, etc. Are they really prohibited in an escape route? That is not realistic in practice. But if we do allow them in the escape route, what is the risk for fire safety?

The restrictions on fire loads in escape routes have been determined by a simulation study. The reason for this was the fire in the entrance of an apartment building on the Gelderseplein in Arnhem on New Year's Eve 2019 (Figure 1). In the entrance, part of the extra protected escape route, two benches were lit by fireworks. The escape route and the elevator shaft quickly became covered in smoke. This has cost the lives of two people in the elevator. The conditions in the apartments in the building remained safe.

WHETHER OR NOT TO EVACUATE IN CASE OF FIRE?

The Building Code is based on an evacuation concept in case of a fire emergency. This means that in case of fire the building will be evacuated. It is assumed that the majority of building users are self-reliant. They can therefore independently use the escape routes and staircases in a building. Objects in that escape route must not impede escape. So there must be enough free space left.

However, evacuation is not an option in case of fire in the escape route. In case of a fire in the escape route, the risk of casualties is considerably greater when building users evacuate than when they remain in their relatively safe fire compartment. The fire compartment must of course remain sufficiently safe during the fire in the escape route. At all costs, fire spread in the escape route needs to be prevented: the object on fire should not lead to ignition of any other objects by flashover. In addition, the conditions in the escape route must not become a threat to the adjacent fire compartments.

In short, fire load in the escape route can be allowed but with restrictions to ensure that the fire load does not impose a threat to the fire compartments designated on that escape route.

ASSUMPTIONS AND BOUNDARY CONDITIONS FOR SIMULATION

The fire load that can be permitted in the escape route depends not only on the object, but also on the traffic zone through which the escape route leads. In large traffic zones, the conditions become less threatening to the adjacent compartments than in small traffic zones. The following classification of traffic zones was used in the simulation study:

- Small traffic zone (volume < 150 m³)
- Large traffic zone (volume between 150 and 500 m³)
- Atrium (traffic zone with void over two or more floors with a volume > 500 m³)

In addition, the source of ignition is of importance. The probability of ignition increases with an ignition source. Taking this into account, the fire load is divided into the following categories:

- Category A. Fire load without ignition source
- Category A1. Small fire load (< 500 MJ)
- Category A2. Large fire load (< 1000 MJ)
- Category B. Fire load with ignition source
- Category B1. Small fire load (< 500 MJ)
- Category B2. Large fire load, including charging option (< 1000 MJ)

Figure 1: Entrance residential building Gelderseplein in Arnhem after the fire

- Category C. Very large fire load with ignition source, including charging option (< 3000 MJ)

A fire load of 500 MJ contains circa 25 kg combustible material, 1000 MJ contains 50 kg and 3000 MJ contains 150 kg combustible material.

Below are some examples of objects that can be classified in the aforementioned fire load categories:

- Category A1: table, chair, seat, closet, bicycle
- Category A2: couch, sofa, mattress, or various objects from A1 together (Figure 2)
- Category B1: lamp, monitor, TV, electric clock, printer
- Category B2: electric wheelchair, electric bicycle or scooter, electric tools with charging option (Figure 3)
- Category C: mobility scooter with charging option

Whether fire load can be permitted in the escape route depends on the quality of the separation construction between fire compartments and the escape route. The floor area and height of the escape route also play a role. After all, no flashover or fire spread to other objects may occur in the escape route. In addition, in a compartment adjacent to that escape route, the conditions for a safe stay must be guaranteed throughout the entire fire scenario.

The following assessment criteria were used:
In the escape route:
- Gas temperature < 300 °C

In an adjacent fire compartment:
- Gas temperature < 45 °C
- Radiation flux < 1 kW/m²
- Visibility > 30 m

Table 1. Combinations of traffic zones and fire load categories, with minimum distance between separate local fire loads in the traffic zone

Traffic zone (escape route)	Fire load Category	Acceptable Y/N (min. distance)
Small (< 150 m³)	A1	**Y (> 3 m)**
	A2	**N**
	B1	**Y (> 3 m)**
	B2	**N**
	C	**N**
Large (150 - 500 m³)	A1	**Y (> 3 m)**
	A2	**Y (> 4 m)**
	B1	**Y (> 3 m)**
	B2	**Y (> 4 m)**
	C	**N**
Atrium (> 500 m³)	A1	**Y (> 3 m)**
	A2	**Y (> 4 m)**
	B1	**Y (> 3 m)**
	B2	**Y (> 4 m)**
	C	**Y (> 5 m)**

ACCEPTABLE FIRE LOAD IN THE ESCAPE ROUTE

When the internal separation constructions between the fire compartments and the escape route are airtight and fire-resistant for at least 20 minutes (from the escape route to the fire compartments), combinations of traffic zone and fire load categories according to Table 1 are possible. This table also indicates the needed mutual distance between several separate local fire loads in the escape route, in order to prevent fire spread.

Under certain conditions, fire load in the traffic zone of a residential building is acceptable. The clear passage width in the traffic zone needs to be 0.50 m (minimum) to 0.85 m (when using aids such as a walking frame or a walker), in order to keep the escape route available in case of fire in a compartment.

When a fire load category is used in a traffic zone that is not suitable for this according to Table 1, measures must be taken. Measures can vary from removing the fire load, reducing the ignition probability, to reducing the fire scenario.

The fire load can be removed by moving it to a fire compartment. A specific separate compartment can be created for mobility scooters.

It is possible to reduce the ignition probability by isolating the ignition source. Especially during charging of batteries there is a high ignition probability. It is best to only allow charging of batteries in charging facilities designed for this purpose, located outside the traffic zone. This considerably reduces the fire risk in the escape route.

Reducing the fire scenario is possible by a fire-resistant hood or screen over the fire load. However, actively controlling the fire scenario by a built-in extinguishing system is also an option. In a sprinklered building, where the escape routes are also sprinklered, a fire load with an electrical source and charging option is possible without additional measures. ■

Figure 2: Examples of Category A2

Figure 3: Electric wheelchair (left, category B2) and Mobility scooter (right, category C)