

A fire-rated ventilation duct and a method of manufacturing and/or installing such ventilation duct in a fire-rated ventilation duct structure penetration arrangement

5 The present invention relates to a ventilation duct for a fire-rated ventilation duct structure penetration arrangement, said ventilation duct (also referred to as “duct” herein) comprising one or more metal sheets forming said duct, wherein said metal sheet duct is covered on the outside by a fire protection material, and said duct includes elongated stiffening members located on the outside of the duct and attached to said metal sheets. A ventilation duct of such kind is known from EP 2 024 689 B1.

10 **Background**

Fire regulations require that a tight seal be established in the area where the section of the ventilation duct passes through a fire-rated wall and/or deck such that flames, smoke and/or toxic gases largely will not pass from one building area to the adjoining building area in case of fire in one of the areas. DIN 4102 Part 4 requires the provision of vertical internal stiffening pipes and, as the case may be, a round-going stiffening frame made up from an L-shaped profile with one leg lying flatly against the metal sheet outer surface. The mounting of the aforementioned vertical pipes inside the duct is time-consuming and also restricts the free flow of air through the ventilation/smoke exhaust duct in normal operation. Moreover, it has been found that the aforementioned stiffening L-shaped frame often applied may in fact in certain cases bring about a further loss of seal between the duct section and the wall. A metal sheet ventilation duct is known from document GB-2394541-A.

25 EP 2 024 689 B1 describes a solution wherein bar members are arranged at a distance from the ventilation duct itself, so that they are less exposed to the heat of fire if it occurs inside the ventilation duct. In the prior art cited above the L-shaped profile tends to be heated un-evenly and thereby tends to force the ventilation duct wall to bend inwardly with a risk of providing an opening through the wall and/or deck. By moving the bar members further out as in EP 2 024 689 B1, this risk is considerably reduced and it is thereby possible to maintain the structural stability of the ventilation duct during a fire.

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The arrangement described in EP 2 024 689 B1 is made on the building site after the ventilation duct is installed through a wall opening. First, fire protection material, such as stone wool slabs, is arranged around the ventilation duct and through the wall opening. Then, the stiffening bar members are mounted on the outside of the fire protection material as described above and connected to the ventilation duct by screws extending through the fire protection material. Finally, the stiffening bar members are covered by further fire protection material, which also abuts the wall and/or deck.

Another arrangement is described in WO 2021/116411 and teaches a ventilation duct suitable for location in narrow and tight areas.

Summary

A disadvantage with this arrangement is that often there is little room for installation of the stiffening bar members, in particularly if the ventilation duct is located in close proximity to a building structure, such as a ceiling and/or a wall or in case of angled ventilation duct penetrations. Angled ventilation duct penetrations, i.e. situations where the ventilation duct changes its spatial extension right next to an opening in a building structure through which it extends. Sometimes it is even impossible, and another solution must be chosen.

It is therefore an object for the present disclosure to provide a ventilation duct and a method of installing same which is suitable for installation where there is little room for installation in an opening in a building structure, such as a wall and/or a deck, floor or ceiling. Moreover, it is an object of the present invention to provide a ventilation duct for a fire-rated ventilation duct structure penetration conforming to meet different fire protection ratings, e.g. performance according to EN 1363-1:2020 with EN 1366-1:2020.

In a first aspect there is disclosed a fire-rated ventilation duct structure penetration arrangement comprising a ventilation duct and a building structure. The building structure comprises an opening extending in a longitudinally direction through the building structure, through which the ventilation duct extends. The duct is covered on the outside by a fire protection material, and the duct includes at least one elongated stiffening member attached to the outside of the duct and the stiffening member is arranged substantially within the opening of the building structure.

By locating the stiffening members substantially within the opening in the building structure between the surfaces of the building structure, an extremely compact penetration arrangement can be created. In particular, in cases where an angled structure is provided immediately adjacent the opening in the wall, it is possible to achieve a flush arrangement with the building structure. Even further, by arranging the stiffening members substantially within the opening in the building structure the building structure, such as a wall, itself also provides support to the fire-rated ventilation duct structure penetration arrangement.

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The term "substantially within" indicates that at least a majority of the stiffening member is arranged in the opening of the building structure. I.e. a part of the stiffening member may still extend beyond the opening and into the rooms on one or both sides of the building structure. As will be discussed, some advantages may be provided by having some of the stiffening member arranged within the opening such that a part of the member extends beyond the opening, however, other advantages may be obtained when the whole stiffening member is arranged within the opening as will also be discussed herein. Thus, for example 60% of the stiffening member may be arranged within the opening of the building structure, in other embodiments, 75%, 80% or 90% of the stiffening member is arranged within the building structure. In yet another embodiment 100%, or all of the stiffening member is arranged within the opening of the building structure.

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In order to ensure an even further compact solution the at least one stiffening member may in one embodiment be contained within the opening such that the at least one stiffening member does not extend beyond the longitudinal extent of the opening. For example, in embodiments where the at least one stiffening member comprises an attachment section as will be described herein the attachment section will also be contained within the opening.

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The stiffening member is typically a non-combustible member of the arrangement that will increase the stiffness of the ventilation duct structure and will increase the stability of the ventilation duct structure in case of fire. In particular, for building structure penetrations it is important that the stability of the ventilation duct is considered in case of fire. Since heating may result in deformation of the duct which further may result in

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that the fire sealing of the opening is compromised such that a fire consequently may pass from one side of the building structure to the other side of the building structure thereby resulting in a spread of the fire and smoke, respectively.

5 Thus, understanding that a stiffening member as disclosed herein is arranged substantially within the opening of the building structure the person skilled in the art will understand that a compact fire-rated ventilation duct structure penetration arrangement may be provided, but also that it may be designed to meet different fire protection ratings, e.g. performance according to EN 1363-1:2020 with EN 1366-1:2020, so that
10 the fire-rated ventilation duct structure penetration arrangement will be able to withstand unacceptable deformations for 30, 60, 90 or 120 minutes depending on the requirement of the specific arrangement.

Accordingly, in one embodiment of the fire-rated ventilation duct structure penetration
15 arrangement the at least one stiffening member has a higher stiffness than abutting elements in the arrangement. In particular, the stiffening member has a higher stiffness than the duct to which it is attached in a direction transverse to the longitudinal direction along which the ventilation duct extends through the opening. In other words, comparing the stiffening member and the duct separately then the ventilation duct will
20 deform at a lower force applied to it in the transverse direction and the stiffening member which deform at a higher force relative to the ventilation duct. Typically, the part of the ventilation duct which has a lower stiffness than the stiffening member is the metal sheet which in one embodiment forms the ventilation duct and to which the stiffening member is attached.

25 In a second aspect there is disclosed a method of manufacturing and/or installing a ventilation duct in a fire-rated ventilation duct structure penetration arrangement as disclosed herein. The method comprises a number of steps.

30 A ventilation duct section for the ventilation duct structure penetration arrangement is provided.

At least one elongated stiffening member located on the outside of the duct section is mounted on the duct section.

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The elongate stiffening member can be mounted prior or subsequent to positioning the ventilation duct section through an opening extending longitudinally through a building structure such that the stiffening member is arranged substantially within the opening of the building structure.

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The ventilation duct comprising the at least one elongated stiffening member is covered by a fire protection material. This is done after the at least one elongated stiffening member is mounted on the duct section but can be done either prior or subsequent to mounting the ventilation duct in the opening.

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With the ventilation duct arranged in the opening of the building structure with the at least one elongated stiffening member substantially arranged within the opening the gap between the outer surface of the fire protection material and the opening in the building structure is sealed.

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It should be understood that installing the ventilation duct in a fire-rated ventilation duct structure penetration arrangement as disclosed herein may further comprise assembling elements of the arrangement, such as ventilation duct sections and/or preparing parts for assembly – e.g. in the area around the installation location, such as on a floor. Installation may also comprise the act of erecting a preassembled ventilation duct, or part thereof into the opening of the building structure. Furthermore, parts may also be manufactured on site. For example, standard lengths of metal profiles and non-combustible bars may be delivered to a construction site where they are cut into correct lengths whereafter the non-combustible bars are glued to the metal profiles as discussed herein thereby manufacturing the stiffening member on site.

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By the present invention there is provided a solution wherein the stiffening members are attached to the ventilation duct itself before it is finally installed through the building opening. The stiffening bar members may comprise steel profiles combined with bars made of a non-combustible inorganic material, such as gypsum, calcium silicate, cement or other fire rated mineral materials. Hereby, the ventilation duct can be prepared for installation at a location where there is sufficient space and then taken to the location of installation and fitted in the building structure opening.

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This means that the disadvantages associated with little room for installation of the members, in particular if the ventilation duct is located close to the ceiling and/or a wall, can be eliminated.

- 5 In one embodiment the stiffening member comprises a metal profile and at least one non-combustible bar of inorganic material retained by the metal profile.

In this specification the term “inorganic materials” means a non-metallic material having a main component of a mineral material.

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In one embodiment a part of the stiffening member extends beyond the opening in the building structure. For example, an attachment section of the at least one stiffening member extends beyond the longitudinal extent of the opening.

- 15 This may for example facilitate securing the stiffening member to other parts of the penetration arrangement, e.g. the building structure. In one embodiment, the attachment section of the at least one stiffening member may be secured to the building structure by a securing member.

- 20 As discussed previously, in some embodiments not all of the stiffening member is arranged within in the opening of the building structure. This may for example be the case in the current embodiment where a part of the stiffening member, e.g. the attachment section, is secured to a securing member. In such case it may be desirable to have a part of the stiffening member extending outside the opening in order to
- 25 ensure proper securement to the securing member.

- Such a securing member may for example be used in embodiments where the ventilation duct extends vertically through an opening, e.g. in a floor/roof structure, ceiling or deck. In such cases the securing member is used to ensure that the
- 30 ventilation duct is stable and does not move up and down in the opening as such movement may compromise the fire protection of the penetration arrangement.

- In these embodiments, the part of the stiffening member extending beyond the opening, e.g. the attachment section, may have the same dimension as the securing
- 35 member, or the part of the securing member secured to the attachment section.

In one embodiment the securing member is an L-profile and the attachment section may for example have the same width as the leg of the L-profile which is secured to the attachment section.

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In the preferred embodiment, the stiffening member extends transversely to the longitudinal extension of the duct. However, it is realised that other orientations may be provided, such as at an oblique angle, if the ventilation duct extends through the deck or wall at such an oblique angle. Advantageously, the orientation of the stiffening member is parallel to the deck and/or wall.

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Furthermore, providing an embodiment where an attachment section of the at least one stiffening member extends beyond the longitudinal extent of the opening may further facilitate a method of manufacturing and/or installing a ventilation duct in a fire rated-ventilation duct structure penetration arrangement wherein the ventilation duct is already pre-installed and the stiffening member can be installed subsequently as the attachment section extending beyond the longitudinal extent of the opening allows for easy access to secure the attachment section, and thus the stiffening member, to the already installed ventilation duct. This can for example be an advantage when retrofitting ventilation ducts.

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Accordingly, in another aspect, there is disclosed herein a method of manufacturing and/or installing a ventilation duct in a fire-rated ventilation duct structure penetration arrangement, said method comprising the steps of:

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- providing a ventilation duct section extending longitudinal through an opening extending longitudinally through a building structure,
- arranging at least one elongated stiffening member on the outside of the ventilation duct section such that an attachment section of the elongated stiffening member extends beyond the longitudinal extend of the opening,
- fastening the attachment section to the ventilation duct,
- covering the ventilation duct section and the stiffening member with a fire protection material, and
- sealing the gap between the outer surface of the fire protection material and the opening in the building structure.

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In one embodiment the at least one stiffening member comprises a metal profile which retains the at least one non-combustible bar by at least partly encircling the bar.

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For example, the metal profile may completely encircle the at least one non-combustible bar thereby the metal profile fully retains the bar(s). However, in another embodiment the metal profile partly encircles the bar(s) and the duct function as a another retaining element. Thus, the bar(s) are retained by the metal profile and the duct, for example the metal sheet forming the duct.

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For example, in one embodiment the metal profile and/or the metal sheet of the duct retains the at least one non-combustible bar. I.e. the bar(s) are not retained by other elements of the fire-rated ventilation duct penetration arrangement. In other words, in one embodiment, the metal profile of the stiffening member and the metal sheet of the duct defines an enclosure wherein the at least one non-combustible bar is retained and where the enclosure fully encircles the at least one non-combustible bar.

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In a preferred embodiment of the invention, the metal profile is U-shaped with attachment sections, such as mounting flanges, so that a longitudinal groove is provided which is configured to tightly receiving the at least one non-combustible bar, preferably two non-combustible bars. In one embodiment the mounting flanges extends transverse to the legs of the U-shaped metal profile, typically in parallel to the base of the U.

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The mounting flanges may function as attachment sections via which the stiffening member can attached to the outside of the duct as discussed herein.

The ventilation duct is in one embodiment formed of one or more metal sheets. The duct can for example be square, rectangular or circular in cross section.

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The stiffening members are fastened to the metal sheet duct preferably by a plurality of rivets and/or screws. Hereby, a simple mounting of the stiffening bars may be provided which is quick to apply and inexpensive. In a preferred embodiment, the at least one non-combustible bar is glued to the metal profile. The stiffening bar is hereby easier to

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handle during mounting when the components making up the stiffening bar are secured to each other.

5 Preferably, the metal profile is a steel profile. Furthermore, the at least one non-combustible bar is preferably based on gypsum, calcium silicate or cement. Stiffening members comprising steel profiles and gypsum bars are preferred, since gypsum comprises a high amount of water that is liberated during a fire and thereby adds in cooling the structure in case of fire. As indicated above, the non-combustible bar is advantageously made of a solid material, essentially without porosity or with limited
10 porosity, which is different from the fire protection material generally surrounding the duct.

Advantageously, the fire protection material is also arranged on the outside of the stiffening members. This ensures better thermal insulation and thereby better fire
15 retarding properties, in particular if the fire protection material is mineral wool, and preferably stone wool. It should be understood that mounting the fire protection material on the outside of the stiffening member refers to mounting the fire protection material on the side of the stiffening member opposite the ventilation duct.

20 Thus, in one embodiment the fire protection material may be a thermal insulation material. For example according to European standard EN 14303:2015 "Thermal insulation products for building equipment and industrial installations - Factory made mineral wool (MW) products - Specification". It should be understood that thermal insulation materials such as mineral wool as described herein will provide a fire-
25 retardant protection of a ventilation duct. Furthermore, in addition to the fire-retardant protection, the insulating properties of such materials also prevents or limits heat transfer from e.g. a fire inside a duct to the outside surface of the fire protection material of the duct, or vice versa. Fire retardant covers and blankets do not have such thermal insulation properties but only provides a fire-retardant protection.

30 Thus, using fire-retardant and heat insulation materials, such as mineral wool and in particular stone wool together with the stiffening member as disclosed herein substantially improves the fire protection of the fire-rated ventilation duct structure penetration arrangement as disclosed herein.

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By the invention it is realised that the penetration of the ventilation duct may be through a separating building structure, which is either vertical or horizontal in orientation. For example, the ventilation duct may be essentially horizontally oriented and penetrate a vertically oriented building structure, such as a partitioning wall. Alternatively, or
5 additionally, the ventilation duct may be essentially vertically oriented and penetrate a horizontally oriented building structure, such as a deck, floor or ceiling.

When the ventilation duct is installed through an opening in the building structure, a gap will often occur between the outer surface of the fire protection material and an
10 opening in the building structure. This gap is then sealed, preferably with an intumescent material which is capable of swelling when exposed to heat.

In one embodiment as disclosed herein there is provided a fire-rated ventilation duct structure penetration arrangement and a method of manufacturing and/or installing a
15 ventilation duct in a fire-rated ventilation duct penetration arrangement where the ventilation duct section comprises a transverse section extending along a surface of the building structure, i.e. in a direction transverse to the opening in the building structure. For example, where the ventilation duct section comprises transverse
20 section extending along a surface of the building structure, for example transverse to the longitudinal direction of the opening in the building structure. The transverse section may be connected to a ventilation duct penetrating the opening in the building structure via an angled section of the ventilation duct, which provides a bend at a desired angle, for example 90 degrees.

25 It is typically a desire, when installing such transverse sections where a part of the ventilation duct extends along the surface of the structure, that they are flush (or very close) against the surface of the building structure. It should be understood that by "flush" it is meant that there is almost no gap or distance between the two elements, e.g. the surface of the building structure and the transverse section of the ventilation
30 duct including the fire protection material.

As disclosed herein, by arranging the stiffening members substantially within the opening it is not necessary to take the dimension of the stiffening members into account and thus, the distance from a surface of the building structure to the surface of
35 the fire protection material of the transverse section of the ventilation duct can be

smaller than the width of the stiffening members and thereby provide a flush or almost flush installation.

5 In the present disclosure it is understood that the term "ventilation duct" includes all kinds of duct for transferring gasses, including a smoke exhaust duct.

In the present disclosure, the term "wall penetration" is meant to mean penetration through an opening of any building structure, such as a wall, partitioning wall, a deck or a floor or ceiling.

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The ventilation duct may have any suitable shape, such as circular, flat oval, oval, square, or rectangular in cross-sectional view. For simple fabrication and mounting of the stiffening members, the ventilation duct advantageously has a square or rectangular cross-section.

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The number and location of the stiffening members affect the efficiency of the stiffening members. For example, increasing the number of stiffening members, and/or locating the stiffening members around a larger fraction of the perimeter of the duct, may further reduce the risk of bending/twisting of the duct wall during fire, and thereby reduce the risk of creating an opening around the penetrated wall, deck, floor or ceiling. It was found advantageously that the ventilation duct comprises at least one, and more preferably at least two or more stiffening members. In a further preferred embodiment, the stiffening members extend around the entire perimeter of the duct, such that for a square or rectangular cross-sectional duct, the duct comprises four stiffening members.

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Further preferably, for ducts having a rectangular cross-section, it is found advantageous that the stiffening member is located or extends along at least one of the longer rectangular sides, and preferably the duct comprises at least two stiffening members located along the two opposing longer sides of the rectangular duct.

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In a preferred embodiment, the ventilation duct is essentially vertically oriented, and the at least one stiffening member, or preferably the at least two stiffening members, are located on the upper side of the wall penetration. As such, in case of a vertically oriented duct, the penetration is likely through a deck, floor or ceiling.

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Description of drawings

In the following the invention is described in more detail with reference to the accompanying drawings, in which:

5 Fig.1a and 1b, shows a schematic cross-sectional side view of a ventilation duct and an enlarged view thereof according to prior art,

Fig.2a and 2b, shows a schematic cross-sectional side view of a first embodiment of a ventilation duct and an enlarged view thereof as disclosed herein installed in a wall
10 penetration,

Fig.3a and 3b, shows a schematic cross-sectional side view of a second embodiment of a ventilation duct and an enlarged view thereof as disclosed herein installed in a wall
15 penetration,

Fig.4a and 4b, shows a schematic cross-sectional side view of a third embodiment of a ventilation duct and an enlarged view thereof as disclosed herein installed in a wall
penetration, and

20 Fig.5a and 5b, shows a schematic cross-sectional side view of a fourth embodiment of a ventilation duct and an enlarged view thereof as disclosed herein installed in a wall penetration.

Detailed description

The different aspects will further be described below with the help of the accompanying
25 figures. Some measurements are provided in the drawings and are indicated in millimeters and are exemplary to give an example of sizes and dimensions that could be used in the embodiments disclosed. Other dimensions may be provided within the scope of the current disclosure. The exemplary measurements in the drawings are indicated by numbers in italics. A list of the reference numbers can be found at the end
30 of the detailed description section.

To illustrate some of the advantages a fire-rated ventilation duct structure penetration arrangement 100 as known in the prior art is shown in Fig.1a, where section 1B in Fig.1a is shown in enlarged view in Fig.1b.

The fire-rated ventilation duct structure penetration arrangement 100 is provided by arranging a ventilation duct 101 through a wall 102.

5 The ventilation duct 101 comprises a penetration section 101' extending longitudinally along the axis L – L through an opening 109 in the wall, an angled section 101'' which provides a 90 degrees direction change such that the ventilation duct extends along the surface of the wall in a transverse section 101''' in a direction transverse to the longitudinal direction of the penetration section 101'.

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The ventilation duct is formed of a metal sheet defining a rectangular cross section. The metal sheet (ventilation) duct is covered on the outside by a fire protection material 103 and said duct includes first and second elongated stiffening members 104 and 105 located on the outside of the duct and attached to said metal sheets on each side of
15 the wall 102.

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In order to seal the opening 109 completely a sealing fire protection layer 113 is provided within the opening between the fire protection material 103 and edge of the opening 109. The opening is further sealed by a first intumescent seal 114 and a
20 second intumescent seal 115 on opposite sides of the sealing fire protection layer 113. The intumescent seal reacts and expands when exposed to heat and thus works as an active sealing agent in case of heat development, e.g. created by a fire.

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As the first and second stiffening members 104 and 105 are arranged on opposite
25 sides of the wall 102 the compactness of the penetration arrangement 100 is largely determined by the first width w_1 of the first stiffening member 104 and the second width w_2 of the second stiffening member 105. In particular on the side of the wall where the second stiffening member is provided it can be seen that space is required on the penetration section 101' to allow attachment of the second stiffening member before
30 the angled section 101'' can be provided. This prevents the distance from the transverse section 101''' to the surface of the wall to be reduced further and thus provides a limit on the compactness of the penetration arrangement 100.

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A fire-rated ventilation duct structure penetration is shown in Fig.2a and 2b, where
35 Fig.2b shows an enlarged view of section 2B in Fig.2a. Specifically, an embodiment of

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a wall duct structure penetration 200 is shown, which is provided by arranging a ventilation duct 201 through a wall 202.

5 The ventilation duct comprises a penetration section 201' extending longitudinally along axis L – L through an opening 209 in the wall. An angled section 201'' is attached to the penetration section 201' and provides a 90 degrees direction change of the ventilation duct, such that the ventilation duct extends along the surface of the wall in a transverse section 201''' in a direction transverse to the longitudinal direction of the penetration section 201'.

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The ventilation duct is formed of a metal sheet defining a rectangular cross section. The metal sheet (ventilation) duct is covered on the outside by a fire protection material 203 and said duct includes an elongated stiffening member 204 located on the outside of the duct and attached to said metal sheets by rivets 216 punched through
15 attachment sections of the metal sheet formed as mounting flanges 205', 205'' of the stiffening member 204 and the metal sheet.

The stiffening members 204 are formed of a metal profile 205 and two non-combustible bars of inorganic material 206' and 206'' retained by the metal profile and the
20 ventilation duct. The opposing edges of the metal profile is bent around the bars and forms the mounting flanges 205' and 205'' by which the metal profile is attached to the metal sheet of the ventilation duct and thus retains the bars of inorganic material.

25 The wall is defined by a first surface 207 and a second surface 208 facing away from each other, i.e. defining the outer boundary of the wall 202. The opening 209 provided in the wall extending from the first surface and the second surface through which the ventilation duct extends.

30 The ventilation duct is arranged so the stiffening member 204 is arranged in the opening 209 within the first surface 207 and the second surface 208 of the wall. In the current embodiment the flanges 205' and 205'' extends beyond the first and second surface of the wall, which facilitates attachment of the stiffening member 204 to a ventilation duct 201 which has been previously arranged through the opening.

By arranging the stiffening member 204 in the opening the angled construction shown in the embodiment of Fig. 2a and 2b can be arranged even closer to the surface of the wall since the space between the angled/transverse part of the duct and the wall does not have to accommodate the whole stiffening member.

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By providing the stiffening member 204 within the opening of the wall it is possible to provide an arrangement where the distance w_g from the second surface 208 of the building structure to the surface of the fire protection material 203 of the transverse section 201'' of the ventilation duct including the fire protection material can be smaller than the width w_s of the stiffening member and thereby provide a flush or almost flush installation.

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In order to seal the opening 209 completely a sealing fire protection layer 213 is provided within the opening between the fire protection material 203 and edge of the opening 209. The opening is further sealed by a first intumescent seal 214 and a second intumescent seal 215 on opposite sides of the sealing fire protection layer 213. The intumescent seal reacts and expands when exposed to heat and thus works as an active sealing agent in case of heat development, e.g. created by a fire.

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An even more compact embodiment of a fire-rated ventilation duct structure penetration arrangement 300 as disclosed herein is shown in Fig.3a and 3b wherein the penetration arrangement is completely flush with the wall. Fig.3b shows an enlarged view of section 3B in Fig.3a.

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A ventilation duct 301 is arranged through a wall 302. The ventilation duct 301 comprises a penetration section 301' extending longitudinally along the axis L – L through an opening 309 in the wall. An angled section 301'' is attached to the penetration section 301' and provides a 90 degrees direction change of the ventilation duct, such that the ventilation duct including the fire protection material extends along the surface of the wall in a transverse section 301''' in a direction transverse to the longitudinal direction of the penetration section 301'.

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The ventilation duct is formed of a metal sheet defining a rectangular cross section. The metal sheet (ventilation) duct is covered on the outside by a fire protection material 303 and said duct includes an elongated stiffening members 304 located on the outside

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of the duct and attached to said metal sheets by rivets 316 punched through attachment sections of the metal sheet formed as mounting flanges 305', 305'' of the stiffening member 304 and the metal sheet.

- 5 The stiffening members 304 are formed of a metal profile 305 and two non-combustible bars of inorganic material 306' and 306'' retained by the metal profile and the ventilation duct. The opposing edges of the metal profile is bent around the bars and forms the mounting flanges 305' and 305'' by which the metal profile is attached to the metal sheet of the ventilation duct and thus retains the bars of inorganic material.

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The wall is defined by a first surface 307 and a second surface 308 facing away from each other, i.e. defining the outer boundary of the wall 302. The opening 309 provided in the wall extending from the first surface and the second surface through which the ventilation duct extends.

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The ventilation duct is arranged so the stiffening member 304 is arranged in the opening 309 within the first surface 307 and the second surface 308 of the wall. In the current embodiment the flanges 305' and 305'' extends beyond the first and second surface of the wall, which facilitates attachment of the stiffening member 304 to a ventilation duct 301 which has been previously arranged through the opening.

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Moreover, the angled section 301'' is formed with a sharp inner angle α of ninety (90) degrees.

- 25 By arranging the stiffening member 304 in the opening together with the sharp angle of the angled section 301'' shown in the embodiment of Fig. 3a and 3b the penetration arrangement can be arranged even closer to the surface of the wall. Accordingly, a completely flush penetration arrangement may be provided.

- 30 In order to seal the opening 309 completely a sealing fire protection layer 313 is provide within the opening between the fire protection material 303 and edge of the opening 309. The opening is further sealed by a first intumescent seal 314 and a second intumescent seal 315 on opposite sides of the sealing fire protection layer 313. The intumescent seal reacts and expands when exposed to heat and thus works as an active sealing agent in case of heat development, e.g. created by a fire.
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In yet another embodiment as shown in Figs.4a and 4b, a fire-rated ventilation duct structure penetration arrangement 400 is provided by arranging a ventilation duct 401 through a wall 402. Fig.4b shows an enlarged view of section 4B in Fig.4a. In other
5 embodiments the ventilation duct may be arranged through other room dividing building structures, such as ceilings or floors.

The ventilation duct 401 comprises a penetration section 401' extending longitudinally along the axis L – L through an opening 409 in the wall, an angle section 401'' which
10 provides a 90 degrees direction change such that the ventilation duct extends along the surface of the wall in a transverse section 401'''.

The ventilation duct is formed of a metal sheet defining a rectangular cross section. The metal sheet (ventilation) duct is covered on the outside by a fire protection material
15 403 and said duct includes elongated stiffening members 404 located on the outside of the duct and attached to said metal sheets.

The stiffening members 404 are formed of a metal profile 405 and two non-combustible bars of inorganic material 406' and 406'' retained by the metal profile and the
20 ventilation duct.

The wall is defined by a first surface 407 and a second surface 408 facing away from each other, i.e. defining the outer boundary of the wall 402. The opening 409 provided in the wall extending from the first surface and the second surface through which the
25 ventilation duct extends.

The ventilation duct is arranged so the stiffening member 404 is arranged in the opening 409 within the first surface 407 and the second surface 408 of the wall. I.e. the width of the stiffening member 404 is equal or smaller than the width of the opening
30 409, which allows to be fully arranged inside the boundary of the opening defined by the first and second surfaces of the wall.

By arranging the stiffening member 404 in the opening the angled construction shown in the embodiment of Fig. 1a and 1b can be arranged much closer to the surface of the

wall since the space between the angled/transverse part of the duct and the wall does not have to accommodate a stiffening member.

5 By providing the stiffening member 404 within the opening of the wall it is possible to provide an arrangement where the distance w_g from the second surface 408 of the building structure to the surface fire protection material 403 of the transverse section 401'' of the ventilation duct can be smaller than the width w_s of the stiffening member and thereby provide a flush or almost flush installation.

10 In order to provide further fire protection and ensure that the opening 409 is effectively sealed even in case of large deformations, a first outer fire protection layer 411 is arranged surrounding the opening on the first surface 407 of the wall and a second outer fire protection layer 412 is arranged surrounding the opening on the second surface 408 of the wall. The first and second outer fire protection layers provides an additional fire protection seal and extend beyond the gap w_o between the fire protection material 403 of the ventilation duct and the opening.

20 To seal the gap w_o between the fire protection material 403 of the ventilation duct and the opening a sealing fire protection layer 413 is provide within the opening. The opening is further sealed by a first intumescent seal 414 and a second intumescent seal 415 on opposite sides of the sealing fire protection layer 413. The intumescent seal reacts and expands when exposed to heat and thus works as an active sealing agent in case of heat development, e.g. created by a fire.

25 Yet another embodiment is shown in Figs.5a and 5b, where a fire-rated ventilation duct structure penetration arrangement 500 is provided by arranging a ventilation duct 501 straight through a wall 502. Fig.5b shows an enlarged view of section 5B in Fig.5a. In other embodiments the ventilation duct may be arranged through other room dividing building structures, such as ceilings or floors.

30 In the current embodiment the ventilation duct 501 extends longitudinally along the axis L – L through an opening 509 in the wall.

35 The ventilation duct is formed of a metal sheet defining a rectangular cross section. The metal sheet (ventilation) duct is covered on the outside by a first fire protection

material 503' on one side of the wall and a second fire protection material 503'' on the other side of the wall. The ventilation duct further includes elongated stiffening members 504 located on the outside of the duct and attached to said metal sheets.

- 5 The stiffening members 504 are formed of a metal profile 505 and two non-combustible bars of inorganic material 506' and 506'' retained by the metal profile and the ventilation duct. For example, by rivets as shown and discussed previously in other embodiments.
- 10 By arranging the elongated stiffening member as shown in the opening the mounting of the first and second fire protection material 503', 503'' is facilitated as mounting does not have to work around several sections of stiffening members, such as e.g. would be the case with two stiffening member sections 104 and 105 as shown in Fig. 1a and 1b.
- 15 In order to seal the opening 509 completely a sealing fire protection layer 513 is provided within the opening between the fire protection material 503 and the edge of the opening 509. The opening is further sealed by a first intumescent seal 514 and a second intumescent seal 515 on opposite sides of the sealing fire protection layer 513. The intumescent seal reacts and expands when exposed to heat and thus works as an
- 20 active sealing agent in case of heat development, e.g. created by a fire.

Although some embodiments and aspects have been described and shown in detail, the disclosure is not restricted to such details, but may also be embodied in other ways within the scope of the subject matter defined in the claims. In particular, it is to be

25 understood that other embodiments may be utilized, and structural and functional modifications may be made without departing from the scope and teachings of the present disclosure.

Reference numbers

- a fire-rated ventilation duct structure penetration arrangement 100
- 30 ventilation duct 101
wall 102
- penetration section of the ventilation duct 101'
opening 109

- angled section 101''
- transverse section 101'''
- fire protection material 103
- first elongated stiffening member 104
- 5 second elongated stiffening member 105
- a sealing fire protection layer 113
- first intumescent seal 114
- second intumescent seal 115
- 10 embodiment of a wall duct structure penetration 200
- ventilation duct 201
- wall 202
- penetration section 201'
- 15 opening 209
- angled section 201''
- transverse section 201'''
- fire protection material 203
- elongated stiffening member 204
- 20 rivets 216
- mounting flanges 205', 205''
- metal profile 205
- two non-combustible bars of inorganic material 206' and 206''
- first surface of wall 207
- 25 second surface of wall 208
- sealing fire protection layer 213
- first intumescent seal 214
- second intumescent seal 215
- 30 fire-rated ventilation duct structure penetration arrangement 300
- a ventilation duct 301
- wall 302
- penetration section 301'
- opening 309
- 35 angled section 301''

- transverse section 301'''
- fire protection material 303
- elongated stiffening members 304
- rivets 316
- 5 mounting flanges 305', 305''
- metal profile 305
- two non-combustible bars of inorganic material 306' and 306''
- first surface 307
- second surface 308
- 10 sealing fire protection layer 313
- first intumescent seal 314
- second intumescent seal 315
- fire-rated ventilation duct structure penetration arrangement 400
- 15 ventilation duct 401
- wall 402
- penetration section 401'
- opening 409
- angle section 401''
- 20 transverse section 401'''.
- fire protection material 403
- elongated stiffening members 404
- metal profile 405 two non-combustible bars of inorganic material 406' and 406''
- first surface 407
- 25 second surface 408
- first outer fire protection layer 411
- second outer fire protection layer 412
- sealing fire protection layer 413
- first intumescent seal 414
- 30 second intumescent seal 415
- fire-rated ventilation duct structure penetration arrangement 500
- ventilation duct 501
- wall 502
- 35 opening 509

first fire protection material 503'

second fire protection material 503''

elongated stiffening members 504

metal profile 505

5 two non-combustible bars of inorganic material 506' and 506''

sealing fire protection layer 513

first intumescent seal 514

second intumescent seal 515

10 **Embodiments**

The following discloses a non-exhaustive list of embodiments showing different ways of providing a fire-rated ventilation duct structure penetration arrangement or a method of manufacturing and/or installing a ventilation duct in a fire-rated ventilation duct structure penetration arrangement as discussed herein.

15

1. A fire-rated ventilation duct structure penetration arrangement comprising a ventilation duct and a building structure comprising an opening extending in a longitudinally direction through the building structure, through which the ventilation duct extends, wherein the ventilation duct is covered on the outside by a fire protection material, and the ventilation duct includes at least one elongated stiffening member attached to the outside of the ventilation duct, wherein the stiffening member is arranged substantially within the opening of the building structure.

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25 2. A fire-rated ventilation duct structure penetration arrangement according to embodiment 1, wherein the stiffening member comprises a metal profile and at least one non-combustible bar of inorganic material retained by the metal profile.

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3. A fire-rated ventilation duct penetration arrangement according to embodiment 2, wherein the metal profile retains the at least one non-combustible bar by at least partly encircling the bar.

4. A fire-rated ventilation duct structure penetration arrangement according to embodiment 2 or 3, wherein the metal profile is U-shaped with attachment sections,

such as mounting flanges, so that a longitudinal groove is provided which is configured to tightly receiving the at least one non-combustible bar, preferably two non-combustible bars.

- 5 5. A fire-rated ventilation duct structure penetration arrangement according to any one of the embodiments 2, 3 or 4, wherein the at least one non-combustible bar is glued to the metal profile.
- 10 6. A fire-rated ventilation duct structure penetration arrangement according to any one of the embodiments 2, 3, 4 or 5, wherein the metal profile is a steel profile.
- 15 7. A fire-rated ventilation duct structure penetration arrangement according to any one of the embodiments 2 – 6, wherein the at least one non-combustible bar is based on gypsum, calcium silicate or cement.
- 20 8. A fire-rated ventilation duct according to any one of the preceding embodiments, wherein the stiffening member comprises an attachment section via which the stiffening member is attached to the outside of the ventilation duct.
- 25 9. A fire-rated ventilation duct structure penetration arrangement according to embodiment 8, wherein the attachment section of the at least one stiffening member extends beyond the longitudinal extent of the opening.
- 30 10. A fire-rated ventilation duct structure penetration arrangement according to embodiment 8 or 9, wherein the attachment section of the at least one stiffening member is secured to the building structure by a securing member.
- 35 11. A fire-rated ventilation duct structure penetration arrangement according to embodiment 10, wherein the securing member is an L-profile.
12. A fire-rated ventilation duct structure penetration arrangement according to any one of the embodiments 1 – 8, wherein the at least one stiffening member is contained within the opening such that the at least one stiffening member does not extend beyond the longitudinal extent of the opening.

13. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding embodiments, wherein the at least one stiffening member has a higher stiffness than abutting elements.
- 5 14. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding embodiments, wherein the ventilation duct comprises a metal sheet to which the stiffening member is attached, and where the stiffness of the metal sheet is lower than the stiffness of the stiffening member in a direction transverse to the longitudinal direction.
- 10 15. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding embodiments, wherein the stiffening member extends transversely to the longitudinal extension of the ventilation duct.
- 15 16. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding embodiments, wherein the at least one stiffening member is fastened to the outside of the ventilation duct by a plurality of rivets and/or screws.
- 20 17. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding embodiments, wherein the fire protection material is also arranged on the outside of the stiffening member.
- 25 18. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding embodiments, wherein the fire protection material is mineral wool, preferably stone wool.
- 30 19. A fire-rated ventilation duct structure penetration arrangement according to any of the preceding embodiments, wherein the ventilation duct has a square or rectangular cross-section.
20. A fire-rated ventilation duct structure penetration arrangement according to embodiment 19, comprising two or more stiffening members, such as four stiffening members.

21. A fire-rated ventilation duct structure penetration arrangement according to embodiments 19 or 20, wherein the stiffening members are located along a longer side of the rectangular ventilation duct.
- 5 22. A fire-rated ventilation duct structure penetration arrangement according to embodiment 21, wherein the two stiffening members are located along the longer sides of the rectangular ventilation duct.
- 10 23. A method of manufacturing and/or installing a ventilation duct in a fire-rated ventilation duct structure penetration arrangement, said method comprising the steps of:
- providing a ventilation duct section,
 - mounting at least one elongated stiffening member located on the outside of
15 the ventilation duct section and attached to the ventilation duct section, and
 - positioning the ventilation duct section with stiffening member through an opening extending longitudinally through a building structure, such that the stiffening member is arranged substantially within the opening of the building structure,
 - 20 - covering the ventilation duct section and the stiffening member with a fire protection material, and
 - sealing the gap between the outer surface of the fire protection material and the opening in the building structure.
- 25 24. A method according to embodiment 23, wherein the method comprises mounting the at least one stiffening member so that it extends transversely to the longitudinal extension of the ventilation duct.
- 30 25. A method according to embodiment 23 or 24, wherein the method comprises forming the at least one stiffening member of a metal profile, which retains the at least one non-combustible bar by at least partly encircling the bar.
26. A method according to embodiment 25, wherein the method comprises shaping the metal profile in a U-shape with attachment sections, such as mounting flanges, so

that a longitudinal groove is provided which is configured to tightly receiving the at least one non-combustible bar, preferably two non-combustible bars.

5 27. A method according to any one of embodiments 26, wherein the method comprises gluing the at least one non-combustible bar to the metal profile.

28. A method according to any one of embodiments 23 to 27, wherein the method comprises fastening the at least one stiffening member to the ventilation duct by a plurality of rivets and/or screws.

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29. A method according to any one of embodiments 23 to 28, wherein the method comprises arranging at least part of the fire protection material on the outside of the stiffening member.

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30. A method according to any one of embodiments 23 to 29, wherein the fire protection material is mineral wool, preferably stone wool.

20 31. A method according to any one of embodiments 23 to 30, wherein the method comprises arranging the ventilation duct through a separating building structure, which is either vertical or horizontal in orientation.

25 32. A method according to any one of embodiments 23 to 31, wherein the method comprises sealing a gap between the outer surface of the fire protection material and an opening in a building structure, preferably with an intumescent material which is capable of swelling when exposed to heat.

33. A method according to any one of embodiments 23 to 32, wherein the method comprises mounting a transverse section on the ventilation duct, where the transverse section extends along a surface of the building structure.

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34. A method according to embodiment 33, wherein the method comprises mounting the transverse section such that the distance from the surface of the building structure to the surface of the fire protection material of the transverse section of the ventilation duct is smaller than the width of the stiffening members.

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35. A method of manufacturing and/or installing a ventilation duct in a fire-rated ventilation duct structure penetration arrangement, said method comprising the steps of:

- 5 - providing a ventilation duct section extending longitudinal through an opening extending longitudinally through a building structure,
- arranging at least one elongated stiffening member on the outside of the ventilation duct section such that an attachment section of the elongated stiffening member extends beyond the longitudinal extend of the opening,
- 10 - fastening the attachment section to the ventilation duct,
- covering the ventilation duct section and the stiffening member with a fire protection material, and
- sealing the gap between the outer surface of the fire protection material and the opening in the building structure.

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36. A method according to embodiment 35, wherein the method comprises mounting the at least one stiffening member so that it extends transversely to the longitudinal extension of the ventilation duct.

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37. A method according to embodiment 35 or 36, wherein the method comprises forming the at least one stiffening member of a metal profile, which retains the at least one non-combustible bar by at least partly encircling the bar.

38. A method according to embodiment 37, wherein the method comprises shaping the metal profile in a U-shape with attachment sections, such as mounting flanges, so
25 that a longitudinal groove is provided which is configured to tightly receiving the at least one non-combustible bar, preferably two non-combustible bars.

39. A method according to any one of embodiments 38, wherein the method comprises
30 gluing the at least one non-combustible bar to the metal profile.

40. A method according to any one of embodiments 35 to 39, wherein the method comprises fastening the at least one stiffening member to the ventilation duct by a plurality of rivets and/or screws.

35

41. A method according to any one of embodiments 35 to 40, wherein the method comprises arranging at least part of the fire protection material on the outside of the stiffening member.
- 5 42. A method according to any one of embodiments 35 to 41, wherein the fire protection material is mineral wool, preferably stone wool.
43. A method according to any one of embodiments 35 to 42, wherein the method comprises arranging the ventilation duct through a separating building structure,
10 which is either vertical or horizontal in orientation.
44. A method according to any one of embodiments 35 to 43, wherein the method comprises sealing a gap between the outer surface of the fire protection material and an opening in a building structure, preferably with an intumescent material
15 which is capable of swelling when exposed to heat.
45. A method according to any one of embodiments 35 to 44, wherein the method comprises mounting a transverse section on the ventilation duct, where the transverse section extends along a surface of the building structure.
20
46. A method according to embodiment 45, wherein the method comprises mounting the transverse section such that the distance from the surface of the building structure to the surface of the fire protection material of the transverse section of the ventilation duct is smaller than the width of the stiffening members.
25

Claims

1. A fire-rated ventilation duct structure penetration arrangement comprising a ventilation duct and a building structure comprising an opening extending in a longitudinally direction through the building structure, through which the ventilation duct extends, wherein the ventilation duct is covered on the outside by a fire protection material, and the ventilation duct includes at least one elongated stiffening member attached to the outside of the ventilation duct, wherein the stiffening member is arranged substantially within the opening of the building structure.
2. A fire-rated ventilation duct structure penetration arrangement according to claim 1, wherein the stiffening member comprises a metal profile and at least one non-combustible bar of inorganic material retained by the metal profile and where the stiffening member further comprises one or more of the following, that the at least one non-combustible bar is glued to the metal profile, that the metal profile is a steel profile and/or that the at least one non-combustible bar is based on gypsum, calcium silicate or cement.
3. A fire-rated ventilation duct penetration arrangement according to claim 2, wherein the metal profile retains the at least one non-combustible bar by at least partly encircling the bar.
4. A fire-rated ventilation duct structure penetration arrangement according to claim 2 or 3, wherein the metal profile is U-shaped with attachment sections, such as mounting flanges, so that a longitudinal groove is provided which is configured to tightly receiving the at least one non-combustible bar, preferably two non-combustible bars.
5. A fire-rated ventilation duct according to any one of the claims 1 - 4, wherein the stiffening member comprises an attachment section via which the stiffening member is attached to the outside of the ventilation duct and wherein the attachment section of the at least one stiffening member extends beyond the longitudinal extent of the opening.

- 5 6. A fire-rated ventilation duct structure penetration arrangement according to any one of the claims 1 – 5, wherein the at least one stiffening member is contained within the opening such that the at least one stiffening member does not extend beyond the longitudinal extent of the opening.
- 10 7. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding claims, wherein the ventilation duct comprises a metal sheet to which the stiffening member is attached, and where the stiffness of the metal sheet is lower than the stiffness of the stiffening member in a direction transverse to the longitudinal direction.
- 15 8. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding claims, wherein the stiffening member extends transversely to the longitudinal extension of the ventilation duct.
- 20 9. A fire-rated ventilation duct structure penetration arrangement according to any one of the preceding claims, wherein the fire protection material, such as mineral wool, preferably stone wool, is also arranged on the outside of the stiffening member.
- 25 10. A method of manufacturing and/or installing a ventilation duct in a fire-rated ventilation duct structure penetration arrangement, said method comprising the steps of:
- providing a ventilation duct section,
 - mounting at least one elongated stiffening member located on the outside of the ventilation duct section and attached to the ventilation duct section, and
 - positioning the ventilation duct section with stiffening member through an opening extending longitudinally through a building structure, such that the stiffening member is arranged substantially within the opening of the building structure,
 - covering the ventilation duct section and the stiffening member with a fire protection material, and
 - sealing the gap between the outer surface of the fire protection material and the opening in the building structure.

11. A method according to claim 10, wherein the method further comprises providing a fire-rated ventilation duct structure penetration arrangement according to any one of the claims 1 – 10.
- 5 12. A method according to claim 10 or 11, wherein the method comprises sealing a gap between the outer surface of the fire protection material and an opening in a building structure, preferably with an intumescent material which is capable of swelling when exposed to heat.
- 10 13. A method according to claim 10, 11 or 12, wherein the method comprises mounting a transverse section on the ventilation duct, where the transverse section extends along a surface of the building structure.
- 15 14. A method according to claim 13, wherein the method comprises mounting the transverse section such that the distance from the surface of the building structure to the surface of the fire protection material of the transverse section of the ventilation duct is smaller than the width of the stiffening member.