

Description

Title of Invention: Fire Protection Structure for Building Element, Frame Unit, and Frame Element

Technical Field

- [0001] The present disclosure relates to a fire protection structure for protecting an element in a building, and in particular to a structure having a composite fire-resistance panel, and a frame unit and a frame element for assembling the fire protection structure.

Background

- [0002] For fire protection of an element in a building, for example, fire protection of a pipe in a building, the pipe is surrounded by a metal frame conventionally, and mineral wool or rock wool boards or blocks are provided outside the frame or to fill the metal frame. Further, an outer panel is provided outside mineral wool or rock wool to cover the same. The outer panel may be a rock board or a calcium silicate board.
- [0003] However, during handling or mounting, mineral wool or rock wool materials may incur human discomfort, such as itchy skin, or a respiratory problem. In addition, filling a metal frame with rock wool or mineral wool results in a relatively long time spent in mounting.

Summary

- [0004] An objective of the present disclosure is to provide a novel solution for fire protection of an element in a building without the use of rock wool or mineral wool materials, thereby avoiding potential harm to the human body, improving mounting convenience, and reducing a mounting time.
- [0005] To this end, according to an aspect of the present disclosure, provided is a fire protection structure for a building element, comprising a frame and a fire-resistance panel fixed to the frame, wherein the fire-resistance panel is comprised of at least one layer of calcium silicate board and at least one layer of gypsum plaster board.
- [0006] The calcium silicate board and the gypsum plaster board are fixed to the frame, respectively.
- [0007] The fire-resistance panel is comprised of an inner layer and an outer layer, the inner layer is formed with at least one gypsum plaster board, and the outer layer is formed with at least one calcium silicate board. Alternatively, the fire-resistance panel is comprised of an inner layer and an outer layer, the inner layer is formed with at least one calcium silicate board, and the outer layer is formed with at least one gypsum plaster board.
- [0008] The fire-resistance panel is comprised of more than one layers of calcium silicate board and at least one layer of gypsum plaster board, or of at least one layer of calcium

silicate board and more than one layers of gypsum plaster board, the layers of calcium silicate board and gypsum plaster board are stacked as alternating with each other.

- [0009] The gypsum plaster board has a thickness ranging from 9 mm to 26 mm. The calcium silicate board has a thickness ranging from 9 mm to 15 mm. Particularly, the thickness of the gypsum plaster board ranges from 13 to 17 mm, and the thickness of the calcium silicate board ranges from 10 to 14 mm.
- [0010] The fire protection structure retains integrity for 240 minutes and insulation for 180 minutes, according to the standard BS476: Part 20: 1987.
- [0011] The fire protection structure retains insulation for not less than 28 minutes when exposed to fire, according to the standard BS476: Part 20: 1987.
- [0012] The frame is assembled with at least one frame unit, and the frame unit is pre-fabricated as an entire unit or as separate components.
- [0013] The frame unit comprises at least one collar frame element, and at least one longitudinal frame element fixed to the collar frame element. The collar frame element and the longitudinal frame element are made of a steel sheet with a thickness of at least 0.6 mm.
- [0014] According to another aspect of the present disclosure, provided is a frame unit for assembling the aforementioned fire protection structure.
- [0015] According to still another aspect of the present disclosure, provided is a frame element for assembling the aforementioned fire protection structure.
- [0016] In the fire protection structure provided in the present disclosure, a combination of different panels provides sufficient fire protection for different building elements. In addition, the fire protection structure of the present disclosure is easily mounted, facilitates improvement of on-site construction speed, and avoids harm to constructors caused by exposure to rock wool or mineral wool materials.

Brief Description of the Drawings

- [0017] [Fig.1] is an overall perspective view of a fire protection structure according to an embodiment of the present disclosure.
- [0018] [Fig.2] is a schematic view of an internal structure of the fire protection structure shown in [Fig.1].
- [0019] [Fig.3] is a schematic view of a test furnace used.

Detailed Description

- [0020] Specific embodiments of the present disclosure will be described below with reference to the accompanying drawings. Those skilled in the art can understand that the details provided herein are for description, but are not for limiting the present disclosure.
- [0021] Provided in the present disclosure is a fire protection structure for protecting an

element in a building. The fire protection structure includes a frame and a fire-resistance panel fixed to the frame. The fire-resistance panel is comprised of at least one layer of calcium silicate board and at least one layer of gypsum plaster board.

- [0022] There is not any intermediate layer, such as a bonding material layer, between the boards. That is, the adjacent calcium silicate boards, the adjacent gypsum plaster boards, or the calcium silicate board and the gypsum plaster board that are adjacent to each other contact each other directly, thereby avoiding the possible adverse effect of the intermediate layer on the fire protection performance. To this end, the calcium silicate board and the gypsum plaster board are fixed to the frame, respectively, for example, in a detachable or undetachable manner by means of screws, rivets, etc.
- [0023] In an embodiment, the fire-resistance panel may be comprised of an inner layer and an outer layer. The inner layer may be formed with at least one gypsum plaster board, and the outer layer may be formed with at least one calcium silicate board. Alternatively, in another embodiment, the fire-resistance panel may also be comprised of an inner layer and an outer layer, where the inner layer is formed with at least one calcium silicate board, and the outer layer is formed with at least one gypsum plaster board. Herein, the inner layer refers to a layer that is relatively close to the frame, and the outer layer is a layer relatively distant from the frame.
- [0024] In other embodiments, the fire-resistance panel is comprised of more than one layers of calcium silicate board and at least one layer of gypsum plaster board, or of more than one layers of gypsum plaster board and at least one layer of calcium silicate board. In this case, the layers of calcium silicate board and gypsum plaster board are stacked as alternating with each other. For example, at least one layer of calcium silicate board may be provided between two layers of gypsum plaster board, or at least one layer of gypsum plaster board may be provided between two layers of calcium silicate board, or more than one layers of gypsum plaster board and more than one layers of calcium silicate board alternate sequentially.
- [0025] Further, depending on requirements on a particular application, the gypsum plaster board may have a thickness ranging from 9 mm to 26 mm, and the calcium silicate board may have a thickness ranging from 9 mm to 15 mm.
- [0026] Those skilled in the art can understand that in some embodiments, depending on requirements on a particular application, two or more layers of gypsum plaster board may be provided, and similarly, two or more layers of calcium silicate board may be provided. In this case, on the basis of requirements on a particular application, e.g., mounting space, etc., the two or more layers of gypsum plaster board may have same or different thicknesses, and two or more layers of calcium silicate board may also have same or different thicknesses.
- [0027] Due to the good integrity properties of the calcium silicate board and the excellent in-

sulation properties of the gypsum plaster board, the fire-resistance panel integrating the two boards can provide a building element with sufficient passive fire protection performance, and has a good consumption ratio. The gypsum plaster board and the calcium silicate board employed in the present disclosure can be acquired commercially.

[0028] The frame may be any structure capable of providing mounting and fixation, such as a ceiling frame, a partition wall frame, or a hollow frame surrounding a building element, as long as the frame can provide fixation and supporting. Hence, the fire protection structure of the present invention can be adapted to protect a variety of building elements.

[0029] Table 1 provides a plurality of examples of the present disclosure, which were used to perform insulation tests. These examples include a plurality of thickness combinations. Four different types of gypsum plaster board products were used in examples 1-14, were sold with the trademarks BaseLine (BL), FireLine (FL), Duraline (DL), and Topline (TL), respectively, and can all be acquired commercially. The fire-resistance panel in examples 1-14 was comprised of one layer of calcium silicate board and one layer of gypsum plaster board. Those skilled in the art can understand that a fire-resistance panel comprised of more layers of gypsum plaster board and/or more layers of calcium silicate board has higher insulation.

[0030] [Table 1]

Examples	Fire-resistance Panel		Frame	Insulation (minutes)
	Calcium silicate board thickness	Gypsum plaster board thickness		
1	9 mm	9 mm TL	ceiling frame	28
2	9 mm	12.5 mm BL	ceiling frame	35
3	9 mm	15 mm BL	ceiling frame	45
4	9 mm	15 mm FL	ceiling frame	50
5	9 mm	19 mm DL	ceiling frame	63
6	12 mm	12.5 mm BL	ceiling frame	42
7	9 mm	26 mm BL	ceiling frame	72
8	9 mm	9 mm TL	partition wall frame	78
9	9 mm	12.5 mm BL	partition wall frame	95
10	9 mm	15 mm BL	partition wall frame	130
11	9 mm	15 mm FL	partition wall frame	140
12	9 mm	19 mm DL	partition wall frame	186
13	12 mm	12.5 mm BL	partition wall frame	100
14	9 mm	26 mm BL	partition wall frame	195

[0031] The insulation tests were based on the standard BS476: Part 20: 1987. Specifically, the test sample was placed in a chamber of a test furnace shown in [Fig.3], and fire was incurred in the chamber, so that a portion of or all of the sample was exposed to the fire. A test result was acquired by measuring a signal of a sensor provided on the sample or in a particular position.

[0032] As shown in Table 1, the frame in examples 1-7 was configured to be a ceiling frame. In the test, the fire protection structure was placed at the top of the chamber of the test furnace, so that a fire-resistance panel was horizontal, and was exposed to the

fire. A plurality of sensors, such as thermocouples, were mounted on a side of the fire protection structure not exposed to the fire. When the greatest value of temperature measured by any sensor was 180 degrees greater than an initial temperature, or the average value of temperatures measured by the sensors was 140 degrees greater than the initial temperature, whichever came first, the time interval from the start of the test to the time when the above temperature was measured was determined as the insulation performance indicator in the unit of minutes.

- [0033] Also as shown in Table 1, the frame in examples 8-14 was configured to be a partition wall frame, and the fire-resistance panel was fixed to each of two sides of the partition wall frame. In the test, the fire-resistance panel located on one side of the fire protection structure faced the interior of the chamber of the test furnace so as to be exposed to the fire, and the fire-resistance panel on the other side faced the outside of the chamber of the test furnace. The sensor was mounted on a side of a partition wall that was not exposed to the fire. Similarly, when the greatest value of temperature measured by any sensor was 180 degrees greater than an initial temperature, or which the average value of temperatures measured by the sensors was 140 degrees greater than the initial temperature, whichever came first, the time interval from the start of the test to the time when the above temperature was measured was determined as the insulation performance indicator in the unit of minutes.
- [0034] [Fig.1] and [Fig.2] are schematic views of another embodiment of the present disclosure. In this embodiment, a fire protection structure 100 of the present disclosure is used to provide fire protection for a pipe 400 in a building.
- [0035] Referring to [Fig.1] and [Fig.2], a frame 200 includes a plurality of collar frame elements 210 and a plurality of longitudinal frame elements 220. The longitudinal frame elements 220 are connected to the collar frame elements 210, respectively. In particular, the plurality of collar frame elements 210 are aligned longitudinally, and are connected by means of the longitudinal frame elements 220, thereby forming the frame 200. A cross section of the collar or longitudinal frame element may be L-shaped or U-shaped. The “longitudinal” refers to the lengthwise direction of the fire protection structure, and the “collar” herein refers to the widthwise direction of the fire protection structure. In this embodiment, the collar frame element 210 and the longitudinal frame element 220 are made of a steel sheet with a thickness of at least 0.6 mm.
- [0036] Referring to [Fig.1], the collar frame element 210 is configured to be rectangular. For example, in a specific example, two L-shaped elements may be connected, for example by screws, and fixed at ends to form the collar frame element 210. However, the collar frame element may also be formed with any other suitable elements. In this example, the longitudinal frame elements 220 are fixed to four corners of the collar frame element 210, respectively.

- [0037] Those skilled in the art can recognize that in other embodiments, depending on a particular application environment, the collar frame element 210 can be configured to be of any suitable shape, so that a cross section of the frame 200 can be of any suitable shape, such as a circle or a triangle, as long as a hollow inner cavity can be provided.
- [0038] As shown in [Fig.1], a fire-resistance panel 300 is fixed to the frame 200, so that the fire protection structure 100 is configured to be a hollow pipe of which a cross section is rectangular. Depending on a particular application environment, a longitudinal end portion of the fire protection structure 100 may be open or closed. Additionally, the fire-resistance panels may be fixed to four side walls of the fire protection structure 100, as shown in [Fig.1]. Alternatively, in other embodiments, according to a particular application environment, the fire-resistance panels may be fixed to only two or three side surfaces of the fire protection structure 100. The end portion refers to a portion at or close to an end in the lengthwise direction of the fire protection structure. The side surface refers to a surface to which the fire-resistance panel can be fixed.
- [0039] In this embodiment, the fire-resistance panel 300 is a stacked structure comprised of an outer layer formed with at least one calcium silicate board 310 and an inner layer formed with at least one gypsum plaster board 320. The gypsum plaster board 320 and the calcium silicate board 310 are fixed to the frame, respectively, for example by screws. Specifically, the calcium silicate board 310 and the gypsum plaster board 320 are directly fixed to the longitudinal frame elements 220, respectively. In this way, the fire-resistance panel can be easily fixed to the frame 200, so that mounting and construction are fast and easy.
- [0040] In the embodiment shown in [Fig.1], the thickness of the gypsum plaster board ranges from 13 to 17 mm, and is preferably 15 mm, and the thickness of the calcium silicate board ranges from 10 to 14 mm, and is preferably 12 mm.
- [0041] Similarly, samples of the embodiment of [Fig.1] and [Fig.2] were tested according to the standard BS476: Part 20: 1987.
- [0042] Specific test steps are as follows: placing a portion of the test sample in a chamber of a test furnace, the portion being exposed to fire during the test, and being referred to as an exposed portion; the remaining portion of the sample being located outside the chamber of the test furnace, this portion being not exposed to fire during the test, and being referred to as a non-exposed portion; in the test, providing a plurality of temperature sensors, such as thermocouples, on a fire-resistance panel of the non-exposed portion; providing a plurality of temperature sensors, such as thermocouples, on a pipe 400 protected by the exposed portion in the chamber of the test furnace; and introducing fire into the chamber of the test furnace, heating being performed according to “Building Element Fire-resistance Test Method – General Rules” stipulated in chapter 20 of the test standard BS 476, for a period of time.

- [0043] For the exposed portion, when the sensor provided on the pipe 400 reached 75 degrees Celsius, an elapsed test time was used as an insulation indicator of the exposed portion in the unit of minutes.
- [0044] For the non-exposed portion, when the greatest value of temperature measured by any sensor was 180 degrees greater than an initial temperature, or the average value of temperatures measured by the sensors was 140 degrees greater than the initial temperature, whichever came first, the time interval from the start of the test to the time when the above temperature was measured was determined as the insulation indicator in the unit of minutes. Additionally, a time for which the fire protection structure of the non-exposed portion had retained integrity was measured in the unit of minutes.
- [0045] In the above sample test for the embodiment of [Fig.1], the exposed portion of the fire protection structure can retain insulation for no less than 37 minutes, and the non-exposed portion can retain integrity for 240 minutes and insulation for 180 minutes.
- [0046] According to the above plurality of embodiments, the fire protection structure of the present disclosure can be used to provide sufficient fire protection for a variety of building elements.
- [0047] Further, in other embodiments, the frame may be assembled with at least one frame unit. The frame unit may be prefabricated as an entire unit, and a plurality of frame units are fixedly connected to each other to form a complete frame. Alternatively, the frame unit may be prefabricated as separate components, and these components may be assembled into a complete frame.
- [0048] Thus, according to another embodiment of the present disclosure, a frame unit for assembling a fire protection structure may be prefabricated as an entire unit or as a plurality of separate components. In this way, a plurality of frame units or components may be fixedly connected to each other easily in a construction site to form a complete frame.
- [0049] Further, according to another embodiment of the present disclosure, a frame element for assembling the fire protection structure shown in FIGs. 1 and 2 may be a collar frame element. Alternatively, according to another embodiment of the present disclosure, a frame element for assembling the fire protection structure shown in FIGs. 1 and 2 may be a longitudinal frame element.
- [0050] In the above description, the details of the technical solution of the present invention are set forth. However, those skilled in the art can appreciate that the present invention is not limited to the specific details set forth in the above embodiments, but rather can vary within the scope defined by the claims.

Claims

- [Claim 1] A fire protection structure (100) for a building element, comprising a frame (200) and a fire-resistance panel (300) fixed to the frame, wherein the fire-resistance panel (300) is comprised of at least one layer of calcium silicate board (310) and at last one layer of gypsum plaster board (320).
- [Claim 2] The fire protection structure (100) for a building element of claim 1, wherein the calcium silicate board (320) and the gypsum plaster board (310) are fixed to the frame (200), respectively.
- [Claim 3] The fire protection structure (100) for a building element of claim 1 or 2, wherein the fire-resistance panel (300) is comprised of an inner layer and an outer layer, said inner layer is formed with at least one gypsum plaster board (320), and said outer layer is formed with at least one calcium silicate board (310).
- [Claim 4] The fire protection structure (100) for a building element of claim 1 or 2, wherein the fire-resistance panel (300) is comprised of an inner layer and an outer layer, said inner layer is formed with at least one calcium silicate board, and said outer layer is formed with at least one gypsum plaster board.
- [Claim 5] The fire protection structure (100) for a building element of any one of claims 1-4, wherein the fire-resistance panel (300) is comprised of more than one layers of calcium silicate board and at least one layer of gypsum plaster board, or of at least one layer of calcium silicate board and more than one layers of gypsum plaster board, the layers of calcium silicate board and gypsum plaster board are stacked as alternating with each other.
- [Claim 6] The fire protection structure (100) for a building element of any one of claims 1-5, wherein the gypsum plaster board has a thickness ranging from 9 mm to 26 mm.
- [Claim 7] The fire protection structure (100) for a building element of any one of claims 1-6, wherein the calcium silicate board has a thickness ranging from 9 mm to 15 mm.
- [Claim 8] The fire protection structure (100) for a building element of any one of claims 1-7, wherein the thickness of the gypsum plaster board ranges from 13 to 17 mm, and the thickness of the calcium silicate board ranges from 10 to 14 mm.
- [Claim 9] The fire protection structure (100) for a building element of claim 8,

wherein the fire protection structure retains integrity for 240 minutes and insulation for 180 minutes, according to the standard BS476: Part 20: 1987.

- [Claim 10] The fire protection structure (100) for a building element of claim 1, wherein, the fire protection structure retains insulation for not less than 28 minutes when exposed to fire, according to the standard BS476: Part 20: 1987.
- [Claim 11] The fire protection structure (100) for a building element of any one of claims 1 to 10, wherein the frame (200) is assembled with at least one frame unit, and said frame unit is prefabricated as an entire unit or as separate components.
- [Claim 12] The fire protection structure (100) for a building element of claim 11, wherein the frame unit (200) comprises at least one collar frame element (210), and at least one longitudinal frame element (220) fixed to the collar frame element (210).
- [Claim 13] The fire protection structure (100) for a building element of claim 12, wherein, said collar frame element (210) and said longitudinal frame element (220) are made of a steel sheet with a thickness of at least 0.6 mm.
- [Claim 14] A frame unit for assembling the fire protection structure according to claim 11.
- [Claim 15] A frame element for assembling the fire protection structure according to claim 12 or 13.