



(51) International Patent Classification:

D03D 1/00 (2006.01) **B32B 5/02** (2006.01)
D03D 15/00 (2006.01) **B32B 37/12** (2006.01)
D03D 15/12 (2006.01)

(21) International Application Number:

PCT/US2014/067963

(22) International Filing Date:

1 December 2014 (01.12.2014)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

10-2013-0148811 2 December 2013 (02.12.2013) KR

(71) Applicant: **3M INNOVATIVE PROPERTIES COMPANY** [US/US]; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

(72) Inventor: **PARK, Dae-Soon**; 19th Floor, Hana Daetoo Securities Building, 27-3 Yeouido-dong, Yeongdeungpo-gu, Seoul 150-600 (KR).

(74) Agents: **GEISE, C. Michael** et al.; 3M Center Office of Intellectual Property Counsel, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: **WOVEN HYBRID REINFORCING MESH FOR INTUMESCENT PASSIVE FIRE PROTECTION PAINT**

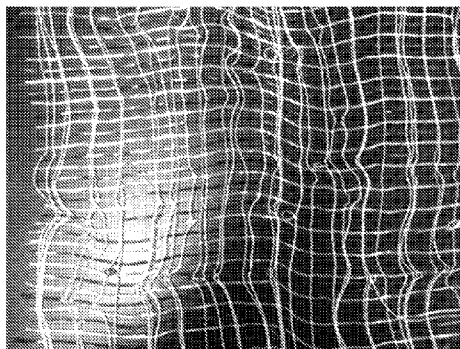


Fig. 1

(57) Abstract: Provided is a woven hybrid reinforcing mesh for an intumescent passive fire protection paint.



WOVEN HYBRID REINFORCING MESH FOR INTUMESCENT PASSIVE FIRE PROTECTION PAINT

Technical Field

The present description relates to a novel woven hybrid ceramic reinforcing mesh that can be used in a reinforcing system for a passive fire protection paint (PFPP).

Background

Fires in confined spaces, such as tall buildings, etc., are serious dangers and may threaten our lives. In order to resolve the problem, there is a growing need for fire protection paint. A passive fire protection paint (PFPP), which is a type of special paints, is used to prevent a hydrocarbon fire from being propagated into the inner part of the metal substrate in case of a fire. Further, the PFPP expands by it is exposed to fire to protect a structure from the fire for a certain time and to prevent a poisonous gas that is generated when the structure burns so that people can gain evacuation time. Accordingly, the PFPP is widely used in the fields of offshore, skyscrapers, chemical plants and refineries.

For example, a reinforcing system using the PFPP is configured such that a primer is applied on a metal substrate; an intumescent epoxy layer is formed and a mesh is disposed as a mid coat; and an intumescent epoxy layer is applied thereon again. The objective of such a reinforcing system is to prevent the creep of an intumescent epoxy coating layer, the generation of a fissure or the propagation of a crack in case of a fire. At this time, the mesh performs a role of a matrix of a passive fire protective paint coating.

Meanwhile, for a reinforcing layer mesh for the PFPP, a conventional glass fiber or a combination of a carbon fiber and a glass fiber was used. However, the glass fiber could not provide a proper reinforcing effect in flames because it has a low melting point. Moreover, when the manufactured mesh was conveyed or cut, the mesh did not maintain its shape, which resulted in dewinding, i.e., handling problems, such as transferring and cutting (see Fig. 1).

Summary

In some embodiments, reinforcing meshes of the present description resolve the aforesaid problems, the present description provides a novel woven hybrid reinforcing mesh, wherein a hybrid mesh is woven by using a ceramic fiber having high operating temperature and breaking load and high intensity in combination with a glass fiber having flexibility, and a small amount of a certain adhesive is sprayed on a surface of the mesh to increase mechanical property and solidity and to enhance ease of handling, such as storing, transferring and cutting, in comparison to the conventional hybrid mesh.

The present description provides a woven hybrid reinforcing mesh comprising a woven hybrid mesh having a surface and comprising a plurality of ceramic fibers and a plurality of glass fibers; and an

adhesive layer on at least a portion of the surface of the woven hybrid mesh. It is preferable that the woven hybrid reinforcing mesh is used in a reinforcing layer for an intumescent fire protection paint.

According to an embodiment of the present description, the hybrid mesh may be leno weave fabric with cells having a shape selected from square and rectangular. More preferably, a plurality of major cells and a plurality of minor cells are included in the hybrid mesh. The major cells are sectored by a major weft and a major warp intersecting with each other, wherein the major weft and major warp are comprised of the ceramic fiber. The minor cells may be formed by a minor weft and a minor warp intersecting with the major cell, wherein the minor weft and minor warp are comprised of the glass fiber.

A dimension of the major cell 5 and the minor cell may be in the range of 22 mm x 22 mm and 9mm x 9mm. The cell size ratio of the major cell to the minor cell may be from 1.5:1 to 2.5:1, preferably 2 : 1.

According to another embodiment of the present description, it is preferable that an use temperature of the ceramic fiber may range between 1100°C and 1300°C.

According to another embodiment of the present description, it is preferable that the ceramic fiber has a composition comprising at least 60% of Al_2O_3 . Further, it is preferable that the glass fiber comprises at least two types of glass fibers having different thicknesses, which are used as weft and warp, respectively.

According to another embodiment of the present description, it is preferable that the woven hybrid mesh further comprises a fiber selected from the group consisting of a cotton fiber, a polyester fiber and a nylon fiber.

According to another embodiment of the present description, it is preferable that the adhesive layer is made of an adhesive selected from the group consisting of urethane-based adhesive, polyvinyl alcohol (PVA)-based adhesive, acryl-based adhesive and epoxy-based adhesive. Further, the amount of the adhesive may range between 20 g/m² and 40 g/m².

The present description can provide a woven hybrid reinforcing mesh having superior mechanical property and solidity by using a hybrid mesh woven by using a ceramic fiber having high operating temperature and breaking load and high intensity in combination with a glass fiber having flexibility and low modulus.

Further, ease of handling, such as storing, transferring and cutting of the mesh, can be remarkably enhanced by spraying a small amount of adhesive on the hybrid mesh surface.

Brief Description of the Drawings

Fig.1 is a photograph illustrating a conventional hybrid mesh.

Fig. 2 is a cross-sectional view of a woven hybrid reinforcing mesh.

Fig. 3 is a cross-sectional view of a magnified hybrid reinforcing.

Fig. 4 is a cross-sectional view of a woven hybrid reinforcing mesh.

Fig. 5 is a photograph illustrating a woven hybrid reinforcing mesh.

Detailed Description

The present description provides a woven hybrid ceramic reinforcing mesh that can be used in a reinforcing system for a passive fire protection paint (PFPP).

To this end, the present description is characterized by weaving a hybrid mesh using a ceramic fiber and a glass fiber; and spraying a small amount of adhesive on the surface of the woven mesh.

With high operating temperature and breaking load and high intensity, the ceramic fiber can increase the mechanical property and solidity to enhance physical and structural reinforcement of the hybrid mesh. Further, with high flexibility and low modulus, the glass fiber can increase weaving-ability and processibility of the hybrid mesh.

Additionally, the adhesive layer formed on the hybrid mesh can remarkably improve handling of the mesh, such as storing, transferring and cutting.

Woven hybrid reinforcing mesh

The woven hybrid reinforcing mesh of the present description comprises a woven hybrid mesh having a surface and comprising a plurality of ceramic fibers and a plurality of glass fibers; and an adhesive layer on at least portion of the surface of the woven hybrid mesh.

Herein, the woven hybrid mesh is used as a reinforcing layer for an intumescent fire protection paint, and thus, promotes reinforcement of the structure of the PFPP reinforcing system and prevents the creep in an intumescent epoxy coating layer and the propagation of a crack when the temperature rises by fires.

Provided below is a detailed description of the woven hybrid reinforcing mesh in accordance with an embodiment of the present description by referring to the attached drawings.

Referring to Fig. 2, it is preferable that the hybrid mesh is leno weave fabric with cells having a shape selected from square and rectangular.

More specifically, referring to Fig. 3, it is preferable that the hybrid mesh comprises a plurality of major cells (M_1) and a plurality of minor cells (M_2), wherein the major cells (M_1) are sectored by a major weft and a major warp intersecting with each other, in which the major weft and major warp are comprised of the ceramic fiber; and the minor cells (M_2) may be formed by a minor weft and a minor warp intersecting with the major cell (M_1), in which the minor weft and minor warp are comprised of a glass fiber.

In the present description, the dimensions of the major cell (M_1) and the minor cell (M_2) are not specifically limited, but may be in the range of 22 mm x 22 mm and 9mm x 9mm. Specifically, the dimensions of the major cell M_1 and the minor cell (M_2) may range respectively in approximately $20 \pm 2 \times 20 \pm 2 \text{ mm}^2$ and $10 \pm 1 \times 10 \pm 1 \text{ mm}^2$, preferably, $20 \times 20 \text{ mm}^2$ and $10 \times 10 \text{ mm}^2$. Further, the cell size ratio of the major cell (M_1) to the minor cell (M_2) may be 1.5 - 2.5 : 1, preferably 2 : 1.

The size of the major cell (M_1) comprised of the ceramic fiber is preferably $20 \pm 2 \times 20 \pm 2 \text{ mm}^2$. When the size of the major cell is larger than the afore-mentioned range, it would be difficult to predict a proper fire resistant effect due to an excessive expansion of the epoxy layer and the generation of a crack in case of a fire. When the size of the major cell is smaller than the afore-mentioned range, the major cell

would be closely formed per unit area, which may result in the raise in unit cost and the lowered impregnation for an epoxy layer. Further, the size of the minor cell (M_2) is defined as $10 \pm 1 \times 10 \pm 1 \text{ mm}^2$ in order to avoid difficulties in handling and constructing, which may occur due to the excessively wide space of the major cell (M_1).

One of the components of the woven hybrid mesh may be a conventional ceramic fiber known in the art.

In order that the leno weave cells constituting the hybrid mesh are stably maintained at a very high temperature, it is important to use a high temperature heat resistant ceramic fiber of which heat resistance can be maintained up to about 1200°C . Actually, a ceramic fiber has an use temperature higher than a conventional glass fiber or a carbon fiber, and thus, can faithfully perform a role of a matrix of the PFPP reinforcing system by continuously maintaining the structure stability of the leno weave cells even in case of a fire.

In the present description, the use temperature of the ceramic fiber may range between 1100 and 1300°C , preferably, 1150 and 1250°C . Herein, the term “use temperature” refers to a temperature range in which the ceramic fiber can be used while stably maintaining its intrinsic property without change or decomposition of the material.

Further, it is preferable that the ceramic fiber has a composition comprising at least 60% of Al_2O_3 . More specifically, it is preferable that the composition ratio comprises 60-65% of alumina (Al_2O_3), 20-28% of silica (SiO_2) and 10-15% of boria (B_2O_3), but the ceramic fiber is not defined only by the aforesaid composition ratio.

In order to secure excellent wetting property in the PFPP reinforcing system, it is preferable that the woven hybrid reinforcing mesh has a thickness as thin as possible. Since roving is in the fiber form of not being twisted, it can contribute to a thinner structure as compared to other fabric styles. Accordingly, it is preferable that the ceramic fiber is roving yarn. Herein, the term “roving” is defined as a slack assembly of fibers in a single strand without twist.

In the present description, the ceramic fiber comprises two types of ceramic fibers having the same thickness, which are preferably used as weft and warp, respectively. For example, the ceramic fiber may have a thickness of 900 denier, wherein denier may be defined as grams per 900 meter.

Based on the aforesaid description, it is preferable to use 3M Nextel™ 312 as the ceramic fiber. For example, a specific composition of 3M Nextel™ 312 comprises 62.5% of alumina (Al_2O_3), 24.58% of silica (SiO_2) and 13.0% of boria (B_2O_3), and the continuous operating temperature is $1,204^\circ\text{C}$, which is sufficiently higher than the usual temperature in case of a fire. Further, commercially available Nextel™ 312-style fibers have the same operating temperature, and thus, it is more preferable for the denier to have a lower grade, which results in sufficiently securing breaking load. In consideration of price and performance, it is preferable to use 900 Denier 312 Roving (see Table 1 below).

Meanwhile, another component of the hybrid mesh may be a conventional glass fiber known in the art.

Since a ceramic fiber has a high modulus, it is difficult to constitute a hybrid mesh in a leno weave shape solely with a ceramic fiber. Accordingly, when a ceramic fiber is used in combination with a glass fiber having high flexibility and low modulus tension, an excellent processibility in weaving and knitting can be provided to constitute the hybrid mesh. Herein, the modulus is generally used to mean an elastic constant for tension.

For available glass fibers, conventional glass fibers known in the art may be used without restriction. Non-limiting examples of the glass fibers that may be used in the present description include E-glass fiber, A-glass fiber, C-glass fiber, D-glass fiber, r-glass fiber, S-glass fiber, E-glass fiber derivatives, or a mixture of at least one thereof. They may be used alone or in combination of two or more.

In the present description, the glass fiber comprises at least two types of glass fibers having different thicknesses, which are preferably used as weft and warp, respectively. In consideration of the mechanical property, price and weaving-ability, it is preferable to use 2700 Denier weft glass fiber in combination of 1200 Denier warp glass fiber. Generally, the density of weft is lower than the density of warp in most cases. Thus, it is preferable to use a yarn having a thick thickness as weft.

Further, it is preferable that the glass fiber uses roving yarn to secure superior wetting property in the PFPP reinforcing system by making the thickness of the woven hybrid reinforcing mesh to be thin.

The thickness of the hybrid mesh may range between 0.8 mm and 2.0 mm, preferably, between 1.0 mm and 1.5 mm.

In addition to the aforesaid ceramic fiber and glass fiber, the hybrid mesh may further comprise a cotton fiber (D), as shown in Figs. 3 and 4, in order to increase weaving-ability. Such cotton fiber can be used as warp in order to improve integrity of the hybrid mesh structure.

In addition to the aforesaid cotton fiber, the hybrid mesh can further comprise a polyester fiber and a nylon fiber. These fibers are additionally included in order to enhance weaving-ability, because the glass fiber does not combine well with the ceramic fiber. However, the additional fibers are not limited to the aforesaid fibers. Although sufficient weaving-ability of the mesh can be obtained solely with the ceramic fiber and the glass fiber, the weaving-ability can be more enhanced by using the ceramic fiber and the glass fiber in combination with the aforesaid organic fibers.

Meanwhile, upon comparison with the conventional mesh comprised of the carbon fiber and the glass fiber, the woven hybrid reinforcing mesh comprised of the ceramic fiber and the glass fiber may have a problem in maintaining a superior cell structure. For example, there may be handling difficulties when dewinding, storing, transferring or cutting the fiber. In the present description, each of handling the woven hybrid reinforcing mesh can be improved by forming a small amount of adhesive layer on the surface of the hybrid mesh.

For the adhesive comprised of the adhesive according to the present description, a conventional component known in the art can be used without restriction, particularly a fast curable adhesive is preferable.

Non-limiting examples of the adhesive that may be used include urethane-based adhesive, acrylic-based adhesive, polyvinyl alcohol (PVA)-based adhesive, epoxy-based adhesive or a mixture of at least one thereof.

There is no particular limitation in a method for forming the adhesive layer, as long as an adhesive has to be formed on the woven hybrid mesh. Such method includes a spray-coating method, a painting method and a dipping method. Among them, the spray method is preferable, because it is possible to apply an adhesive in a uniform and proper amount. For example, an adhesive layer can be formed by spraying an adhesive on the hybrid mesh immediately after weaving. As a result, the mesh can maintain its lattice form and can be fixed. Accordingly, the woven hybrid reinforcing mesh is easy in transferring or cutting.

The spray amount of the adhesive is not specifically limited, but may range between 20 g/m² and 40 g/m², preferably, between 25 g/m² and 35 g/m². Further, the amount of the adhesive applied on the hybrid reinforced mesh surface due to spraying may range between 5 and 15 g/m², preferably, between 8 g/m² and 12 g/m².

Meanwhile, the woven hybrid reinforcing mesh can satisfy various physical properties required in the PFPP reinforcing system by variously changing the constitution of the fibers constituting the aforementioned mesh and the composition ratio thereof.

The woven hybrid reinforcing mesh may largely have two embodiments. However, the present description is not limited to the embodiments presented below, but various modifications and applications are possible based on need.

Fig. 2 is a cross-sectional view illustrating the first embodiment of the hybrid reinforcement mesh.

Herein, the woven hybrid reinforcing mesh is woven by comprising a plurality of ceramic fibers(A) and a plurality of glass fibers (B), and comprises an adhesive layer (not shown) formed on the woven hybrid mesh.

Fig. 4 is a cross-sectional view illustrating the second embodiment of the woven hybrid reinforcing mesh.

Herein, the woven hybrid reinforcing mesh is woven by comprising a plurality of ceramic fibers (A), a plurality of glass fibers (B, C) and a cotton fiber (D), and comprises an adhesive layer (not shown) formed on the woven hybrid mesh.

Meanwhile, the woven hybrid reinforcing mesh may be prepared by various methods for preparing a mesh known in the art. For example, a hybrid mesh is woven by any proper type of weaving method using a plurality of ceramic fibers; a plurality of glass fibers; and selectively a cotton fiber, a polyester fiber or a nylon fiber as needed, and then, an adhesive is sprayed on the mesh surface and dried, thereby preparing a woven hybrid reinforcing mesh.

Reinforcing System for Passive Fire Protection Paint (PFPP)

The present description provides a reinforcing system for a passive fire protection paint (PFPP) comprising the aforesaid woven hybrid reinforcing mesh.

According to a preferable example, the reinforcing system for the passive fire protection paint (PFPP) comprises: (a) a metal substrate; (b) an intumescent fire protection paint resin layer (e.g., first epoxy resin layer) formed on the metal substrate; (c) a woven hybrid reinforcing mesh disposed on the first epoxy resin layer in a matrix form; and (d) an intumescent fire protection paint resin layer (e.g., second epoxy resin layer) formed on the hybrid mesh.

Herein, the component and amount of the intumescent fire protection paint are not specifically limited. A conventional intumescent fire protection paint known in the art can be properly used within a conventional range.

The reinforcing system for PFPP is used to protect a structure from the flame, e.g., in the fields of construction, plant and vessel, more particularly, in the fields of interior and exterior materials of tall buildings, chemical plants and hydrocarbon processing facilities, hydrocarbon storage facilities and refineries, such as gas platforms.

For example, when the woven hybrid reinforcing mesh is applied to the field of construction or plant, weaving-ability can be increased by adding a cotton fiber. When the woven hybrid reinforcing mesh is applied to the field of vessel, since cotton may absorb seawater, it is preferable to use the hybrid mesh woven by comprising a ceramic fiber and a glass fiber, wherein an adhesive layer 5 is formed on the woven hybrid mesh.

The below examples and experimental examples merely present an embodiment, and the scope of the claims is not limited by the examples and experimental examples below.

Materials and Physical Properties

The physical properties of the ceramic fiber and the glass fiber used are shown in Table 1 and Table 2 below.

Table 1

3M™ Nextel™ Roving 312 – Typical Properties				Color: White	
Roving	Nominal Filament Count	Yield ± 10%		Breaking Load*	
		yds/lb	m/kg	lbs	kg
600 denier (67 tex)	400	7420	14950	6	2.7
900 denier (100 tex)	400	4950	9970	7	3.2
1200 denier (133 tex)	750	3720	7490	12	5.4
1800 denier (200 tex)	750	2480	4960	14	6.4
3600 denier (400 tex)	1375	1240	2500	24	10.9

Table 2

DESCRIPTION	TEX (g/9m)	TENSILE STRENGTH (N/cm ²)	FLAMENT DIA. (μm)	RECOMMENDED RESINS	USE
ER 270 FW	270	MIN. 0.245	13	POLYESTER/EPON	WEAV./RL.FW.
ER 330 FW	330	MIN. 0.245	16	POLYESTER/EPON	WEAV./RL.FW.
ER 660 FW	660	MIN. 0.245	14	POLYESTER/EPON	WEAV./RL.FW.
ER 660 FW	660	MIN. 0.245	15	POLYESTER/EPON	WEAV./RL.FW.
ER 900 FW	900	MIN. 0.245	17	POLYESTER/EPON	WEAV./RL.FW.
ER 1200 FW	1200	MIN. 0.245	17	POLYESTER/EPON	WEAV./RL.FW.
ER 2000 FW	2000	MIN. 0.245	22	POLYESTER/EPON	WEAV./RL.FW.
ER 3400 FW	3400	MIN. 0.245	25	POLYESTER/EPON	WEAV./RL.FW.
ER 4400 FW	4400	MIN. 0.245	24	POLYESTER/EPON	PW./RL.FW.
ERS 816 FW	816	MIN. 0.245	13	POLYESTER/EPON	PW./RL.FW.
ERS 2400 FW	2400	MIN. 0.245	11	POLYESTER/EPON	PW./RL.FW.

Example 1. Preparation of Woven hybrid reinforcing mesh

As a ceramic fiber, 900 Denier Nextel™ 312 Roving was used. Further, in terms of price-competitive mesh structure, commercially available glass fibers manufactured from Corning Co. or Hankook Fiber Co. were selected. In consideration of mechanical properties, price and weaving-ability, 2700 denier weft glass roving and 1200 denier warp glass roving were used.

A normal weaving machine only for medical thread is unavailable. In order to weave a ceramic fiber having high modulus, a specifically manufactured DORNIER weaving machine must be used. The maximum weaving size of the DORNIER weaving machine is 210 cm in width, the weaving speed is 160-180 rpm, and the maximum number of bobbins is 800. In order to manufacture the woven hybrid reinforcing mesh, a total of 728 bobbins was used on the basis of the maximum width of 2 m, including 182 bobbins for Nextel 312, 182 bobbins for glass fiber, and 364 bobbins for cotton thread.

After leno weaving by using the aforesaid ceramic fiber, glass fiber and cotton fiber (20 cotton yarn number), 30 g/m² of PVA adhesive [Hanil Chemical Ltd Co. Ltd., CAS No. 9002-89-5] was sprayed on the woven mesh of 1 lube per unit area (1m x 1m), and then the adhesive passed through a continuous oven having a length of 3m at 30 °C. A woven hybrid reinforcing mesh was prepared through drying by air from the end portion of the oven.

The present description performed passing through a continuous oven at 150 °C by considering the length of the continuous oven, fast curing of an adhesive and the resulting improvement of workability, but is not limited specifically thereto. It is also possible to cure the adhesive at room temperature or at temperatures ranging from 50° to 60°. The photograph of the finally manufactured hybrid mesh is shown in Fig. 5.

Experimental Example 1. Evaluation of Physical Property of the Woven hybrid reinforcing mesh

Fire Resistance was tested by using the steel beam and steel column of the structure manufactured using the woven hybrid reinforcing mesh prepared in Example 1.

The following is an official test report from the Korea Institute of Construction Technology in order to prove the fire resistance of the woven hybrid reinforcing mesh. The woven hybrid reinforcing mesh is superior in the testing items.

No. 2013-209

Public Announcement

It is publicly announced that pursuant to Article 3(viii) of the Regulations of the Standards for the Egress and the Fire Protection of Buildings and the Recognition and Management Standards of the Fire Protection Structure (Notification No. 2012-625 of the Ministry of Land, Infrastructure, and Transport), the fire protection structure is recognized as set forth below.

April 15, 2013

President of the Korea Institute of Construction Technology

Recognition of Fire Protection Structure

1. Recognized Content

Recognition No.	Product Name	Name of Fire Protection Structure	Fire Protection Performance	Thickness of Application	Part for Use
BP13-0415-1	FIREMASK	FIREMASK 3000 (Beam)	3 hours	At least 16.90	Steel beam of building
CP13-0415-2	FIREMASK	FIREMASK 3000 (Beam)	3 hours	At least 17.40	Steel column of building

2. Recognized Company: KCC Corporation (President: Mong-Ik Chung)

3. Factory Location: #1234, Bangeo-dong, Dong-gu, Ulsan
(Bangeojin Ring Road 30, Dong-gu, Ulsan)

4. Expiry Date: April 4, 2016

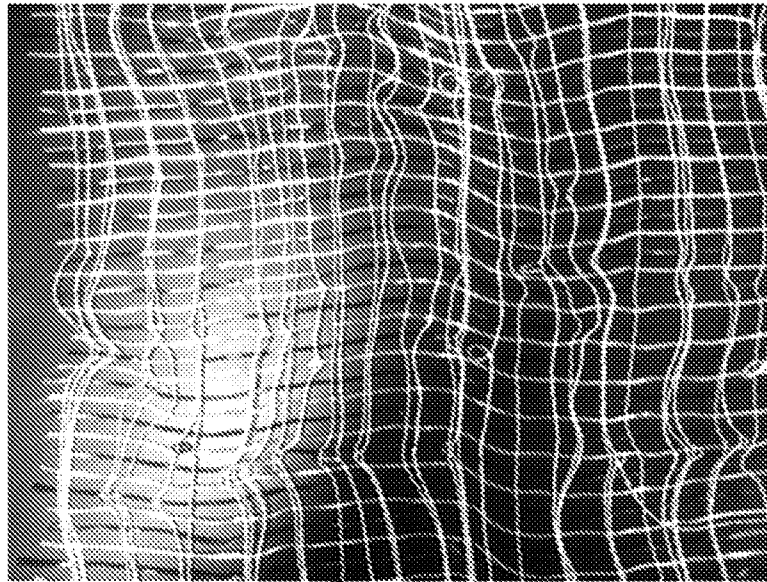
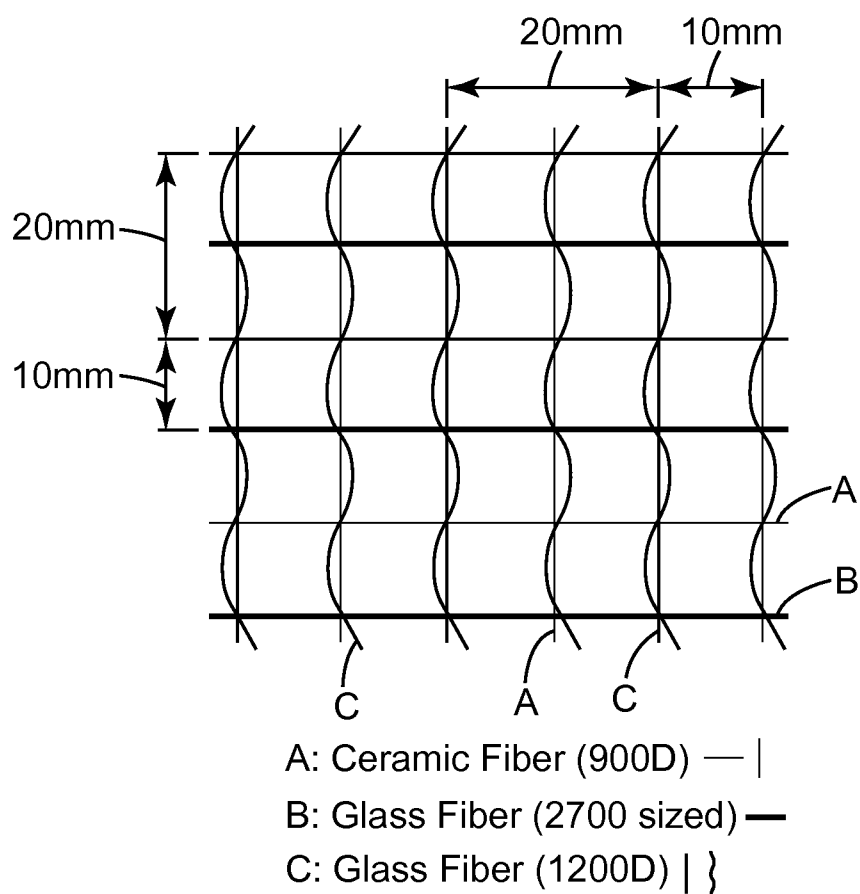
5. Detailed Recognized Content: See the book attached to the Written Recognition.

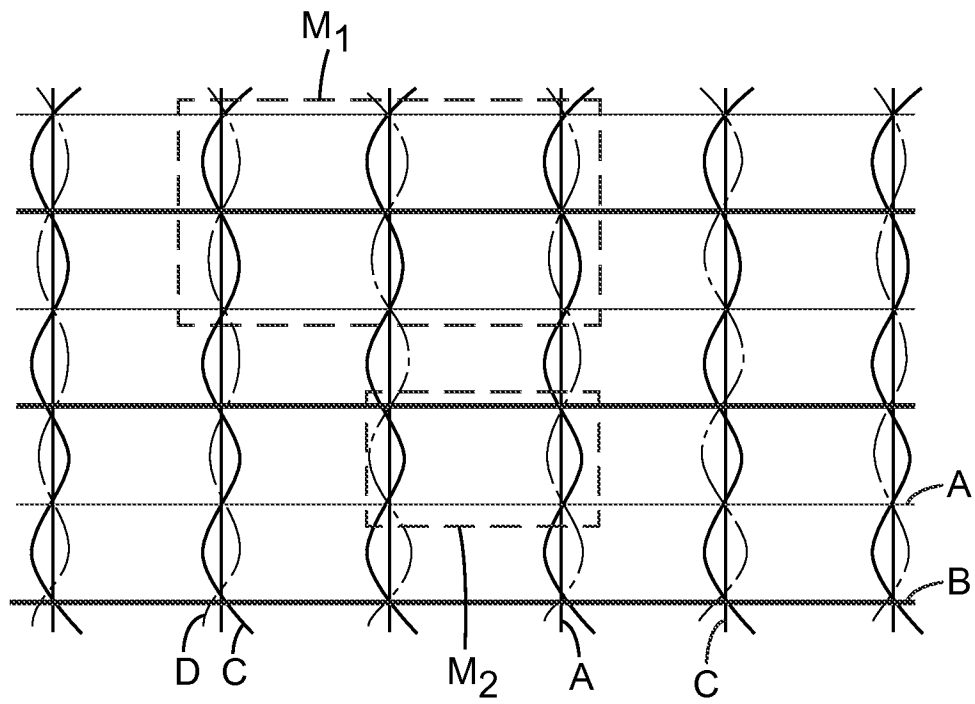
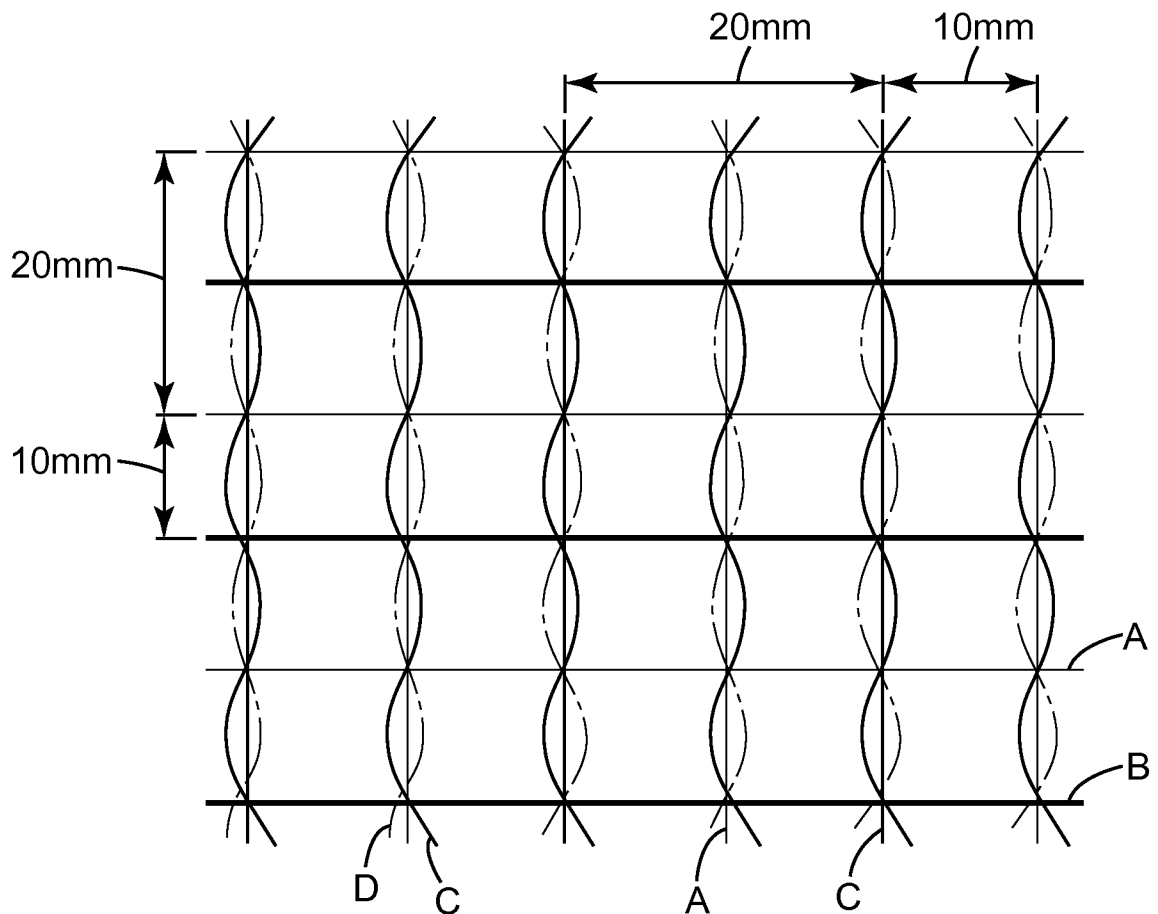
13-42.43

What is claimed is:

1. A woven hybrid reinforcing mesh for an intumescent passive fire protection paint, comprising:
a woven hybrid mesh having a surface and comprising a plurality of ceramic fibers and a plurality of glass fibers; and
an adhesive layer on at least a portion of the surface of the woven hybrid mesh.
2. The woven hybrid reinforcing mesh according to Claim 1, wherein the woven hybrid mesh is a leno weave fabric with cells having a shape selected from square and rectangular.
3. The woven hybrid reinforcing mesh according to Claim 1, wherein the woven hybrid mesh comprises a plurality of major cells and a plurality of minor cells;
in which the major cells are sectored by a major weft and a major warp intersecting with each other, wherein the major weft and major warp are comprised of the ceramic fiber; and
the minor cells are formed by a minor weft and a minor warp intersecting with the major cell, in which the minor weft and minor warp are comprised of the glass fiber.
4. The woven hybrid reinforcing mesh according to Claim 3, wherein the dimensions of the major cell and the minor cell are in the range of 22mm x 22mm and 9mm x 9mm.
5. The woven hybrid reinforcing mesh according to Claim 3, wherein the cell size ratio of the major cell to the minor cell is from 1.5:1 to 2.5:1.
6. The woven hybrid reinforcing mesh according to Claim 1, wherein the ceramic fibers is a roving yarn.
7. The woven hybrid reinforcing mesh according to Claim 1, wherein an use temperature of the ceramic fiber ranges between 1100 °C and 1300 °C.
8. The woven hybrid reinforcing mesh according to Claim 1, wherein the ceramic fiber has a composition comprising at least 60% of Al_2O_3 .
9. The woven hybrid reinforcing mesh according to Claim 1, wherein the glass fiber comprises at least two types of glass fibers having different thicknesses.
10. The woven hybrid reinforcing mesh according to Claim 1, wherein the woven hybrid mesh further comprises a fiber selected from the group consisting of a cotton fiber, a polyester fiber and a nylon fiber.

11. The woven hybrid reinforcing mesh according to Claim 1, wherein the woven hybrid mesh has a thickness of from 0.8 mm to 2.0 mm.
12. The woven hybrid reinforcing mesh according to Claim 1, wherein the adhesive layer comprises an adhesive selected from the group consisting of a urethane-based adhesive, a polyvinyl alcohol (PVA)-based adhesive, an acryl-based adhesive and an epoxy-based adhesive.
13. The woven hybrid reinforcing mesh according to Claim 1, wherein the amount of the adhesive ranges between 20 g/m² and 40 g/m².

***Fig. 1******Fig. 2***

**Fig. 3**

A: Ceramic Fiber (900D) — | C: Glass Fiber (1200D) | }
 B: Glass Fiber (2700 sized) — | D: Glass Fiber (1200D) | }

Fig. 4

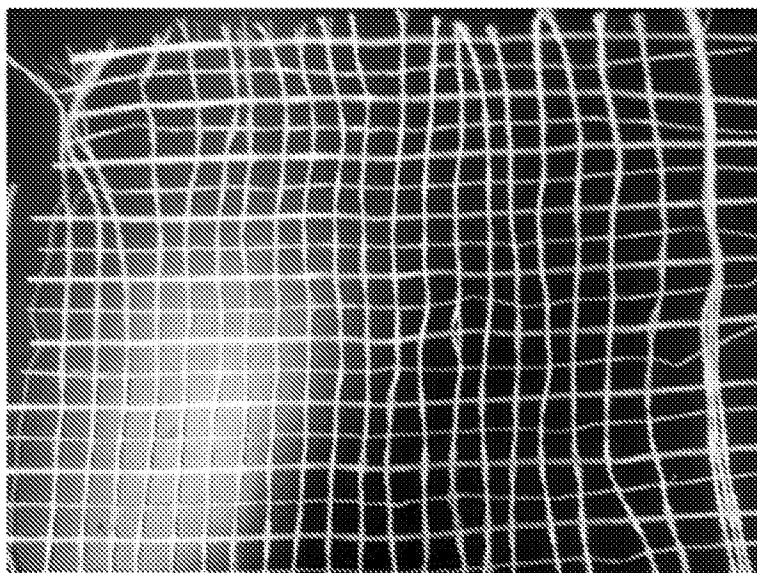


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/067963

A. CLASSIFICATION OF SUBJECT MATTER INV. D03D1/00 D03D15/00 D03D15/12 B32B5/02 B32B37/12 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) D03D B32B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/142618 A1 (PORTER JOHN FREDERICK [CA]) 22 July 2004 (2004-07-22) paragraphs [0055], [0011]; claims 10,1; figure 9	1
Y	----- US 5 433 991 A (BOYD JR GEORGE P [US] ET AL) 18 July 1995 (1995-07-18) column 2, line 40 - column 5, line 11; claims 1,3,5	1-13
Y	----- US 6 503 856 B1 (BROADWAY ANDREW [US] ET AL) 7 January 2003 (2003-01-07) column 2, lines 22-24; claims 1,14; figure 1b	1-13
A	----- WO 90/06847 A1 (ORCON CORP [US]) 28 June 1990 (1990-06-28) the whole document -----	1-13
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 25 February 2015		Date of mailing of the international search report 06/03/2015
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Iamandi, Daniela

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/067963

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004142618	A1	22-07-2004	
		AU 2004207774 A1	12-08-2004
		CA 2513508 A1	12-08-2004
		CN 1754015 A	29-03-2006
		EP 1595012 A2	16-11-2005
		ES 2349370 T3	30-12-2010
		JP 5019481 B2	05-09-2012
		JP 5019482 B2	05-09-2012
		JP 5019486 B2	05-09-2012
		JP 2006517268 A	20-07-2006
		JP 2009149510 A	09-07-2009
		JP 2009174310 A	06-08-2009
		JP 2010156196 A	15-07-2010
		MX PA05007692 A	25-05-2006
		NZ 541275 A	24-12-2008
		US 2004142618 A1	22-07-2004
		US 2006065342 A1	30-03-2006
		US 2006105653 A1	18-05-2006
		WO 2004067271 A2	12-08-2004

US 5433991	A	18-07-1995	
		AU 703721 B2	01-04-1999
		AU 706226 B2	10-06-1999
		AU 5072593 A	16-06-1994
		BR 9304597 A	14-06-1994
		DE 600651 T1	20-04-1995
		DE 69321200 D1	29-10-1998
		DE 69321200 T2	02-06-1999
		DK 0600651 T3	14-06-1999
		EP 0600651 A1	08-06-1994
		ES 2123623 T3	16-01-1999
		JP 3657629 B2	08-06-2005
		JP H06220741 A	09-08-1994
		NO 934341 A	02-06-1994
		US 5433991 A	18-07-1995

US 6503856	B1	07-01-2003	NONE

WO 9006847	A1	28-06-1990	NONE
