(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 265 832 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
25.10.2023 Bulletin 2023/43

(21) Application number: **22779630.7**

(22) Date of filing: **18.02.2022**

(51) International Patent Classification (IPC):
D03D 15/242 *(2021.01)* ***B32B 17/04*** *(2006.01)*
E04H 15/54 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B32B 17/04; B32B 27/12; D03D 15/242; D03D 15/267; E04H 15/54

(86) International application number:
PCT/JP2022/006537

(87) International publication number:
WO 2022/209403 (06.10.2022 Gazette 2022/40)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **01.04.2021 JP 2021062614**

(71) Applicant: **Nitto Boseki Co., Ltd.**
Fukushima-shi
Fukushima 960-8161 (JP)

(72) Inventors:
- **HAKOISHI Yusaku**
Fukushima-shi, Fukushima 960-8161 (JP)
- **ADACHI Tetsuya**
Fukushima-shi, Fukushima 960-8161 (JP)
- **HIKINO Shunichi**
Fukushima-shi, Fukushima 960-8161 (JP)

(74) Representative: **Schön, Christoph**
Dr. Schön, Neymeyr & Partner mbB
Bavariaring 26
80336 München (DE)

(54) **INORGANIC-FIBER WOVEN FABRIC FOR CONSTRUCTION FILM MATERIAL, AND CONSTRUCTION FILM MATERIAL**

(57) Provided are an inorganic-fiber fabric for a construction membrane material and construction membrane material having excellent resistance to heat damage, great ease of weaving, and high applicability for use in a construction membrane material. An average Al_2O_3 content of a warp, At, and an average Al_2O_3 content of a weft, Ay, are 17.5 mass% or more; a mass per unit length of the warp, Tt, and a mass per unit length of the weft, Ty, are within a range of 100 to 600 g / 1000 m; a weave density of the warp, Wt, and a weave density of the weft, Wy, are within a range of 10.0 to 55.0 filaments / 25 mm; a ratio of Tt to Ty, Tt/Ty, is within a range of 0.66 to 1.50; and At, Ay, Tt, Ty, Wt, and Wy satisfy the following formula (1-1). $316.5 \leq Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100) \leq 550.0$ ...(1-1)

Processed by Luminess, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention relates to an inorganic-fiber fabric for a construction film (membrane) material, and a construction film (membrane) material.

Background Art

[0002] Conventionally known as a membrane material for construction or structure (hereinafter, referred to as a construction membrane material) is a noninflammable sheet including a glass-fiber fabric and a coating resin applied to both of the front and back surfaces of the glass-fiber fabric (for example, see Patent Literature 1).

[0003] Conventional noninflammable sheets may be certified as noninflammable in terms of the amount of heat generation, but the glass-fiber fabric in the noninflammable sheet may be damaged when heated at a high temperature for a long time. Thus, particularly when the noninflammable sheet is used as a ceiling material, the damage of the glass-fiber fabric may cause a fall of the noninflammable sheet in a case of a fire, and such a glass-fiber fabric cannot necessarily be said to have sufficient fire resistance.

[0004] A fire-resistant material including an alumina-fiber fabric is also known (for example, see Patent Literature 2).

Citation List

Patent Literature

[0005]

Patent Literature 1: Japanese Patent Laid-Open No. 2018-84097
Patent Literature 2: Japanese Patent Laid-Open No. 2000-331546

Summary of Invention

Technical Problem

[0006] Accordingly, it is considered that a construction membrane material having sufficient fire resistance can be obtained by using the alumina-fiber fabric instead of the conventional glass-fiber fabric of the noninflammable sheet.

[0007] However, the alumina-fiber fabric has poor ease of weaving compared with the glass-fiber fabric, and in addition, a sheet material including the alumina-fiber fabric and the coating resin applied to both of the front and back surfaces of the alumina-fiber fabric does not have sufficient strength as a construction membrane material disadvantageously.

[0008] An object of the present invention is to provide: an inorganic-fiber fabric for a construction membrane material, the fabric solving the above disadvantage and thus having excellent resistance to heat damage, great ease of weaving, and high applicability for use in a construction membrane material; and a construction membrane material including the inorganic-fiber fabric for a construction membrane material.

Solution to Problem

[0009] To achieve the above object, the present invention is an inorganic-fiber fabric for a construction membrane material; wherein an average Al_2O_3 content of a warp constituting the inorganic-fiber fabric, At, and an average Al_2O_3 content of a weft constituting the inorganic-fiber fabric, Ay, are each within a range of 17.5 mass% or more; a mass per unit length of the warp constituting the inorganic-fiber fabric, Tt, and a mass per unit length of the weft constituting the inorganic-fiber fabric, Ty, are each within a range of 100 to 600 g / 1000 m; a weave density of the warp constituting the inorganic-fiber fabric, Wt, and a weave density of the weft constituting the inorganic-fiber fabric, Wy, are each within a range of 10.0 to 55.0 filaments / 25 mm; a ratio of the Tt to the Ty, Tt/Ty, is within a range of 0.66 to 1.50; and the At, Ay, Tt, Ty, Wt, and Wy satisfy the following formula (1-1).

$$316.5 \leq Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100) \leq 550.0 \quad ...(1\text{-}1)$$

[0010] The inorganic-fiber fabric for a construction membrane material of the present invention, in which the At, Ay, Tt, Ty, Wt, and Wy are within the above ranges and satisfy the formula (1-1), can have excellent resistance to heat damage, great ease of weaving, and high applicability for a construction membrane material.

[0011] Here, the inorganic-fiber fabric for a construction membrane material having the excellent resistance to heat damage refers to no damage in a sample when the sample on which a weight with 100 mm in diameter and 10 kg is placed is set in a muffle furnace, heated to 800°C so that the temperature in the furnace is increased in accordance with a standard time/temperature curve in ISO 834, and cooled over a triple time of the time for heating. The inorganic-fiber fabric for a construction membrane material having the great ease of weaving refers to absence of slack, fluff, or cutting of the yarn when warping or weft-weaving is performed. The inorganic-fiber fabric for a construction membrane material having high applicability for a construction membrane material refers to one having a tensile strength of 2000 N / 25 mm or more, in both of the longitudinal and lateral directions, as determined by a tensile test in accordance with JIS L 1096:2010 on a specimen produced by cutting to 25 mm in width and 150 mm in length.

[0012] In the inorganic-fiber fabric for a construction membrane material of the present invention, the At, Ay, Tt, Ty, Wt, and Wy preferably satisfy the following formula (1-2).

$$346.0 \leq Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100) \leq 464.0 \quad ...(1\text{-}2)$$

[0013] The inorganic-fiber fabric for a construction membrane material of the present invention can have further excellent resistance to heat damage, great ease of weaving, and further higher applicability for a construction membrane material when the At, Ay, Tt, Ty, Wt, and Wy satisfy the formula (1-2).

[0014] Here, the inorganic-fiber fabric for a construction membrane material having the further excellent resistance to heat damage means that when a sample on which a weight with 100 mm in diameter and 10 kg is placed is set in a muffle furnace, heated to 800°C so that the temperature in the furnace is increased in accordance with a standard time/temperature curve in ISO 834, and cooled over a triple time of the time for heating, the sample has no damage and also having a tensile strength of 450 N / 25 mm or more, in both of longitudinal and lateral directions, as measured by a tensile test in accordance with JIS L 1096:2010 on a specimen produced by cutting to 25 mm in width and 150 mm in length. The inorganic-fiber fabric for a construction membrane material having further higher applicability for a construction membrane material refers to one having a tensile strength of 3000 N / 25 mm or more, in both of longitudinal and lateral directions, as determined by a tensile test in accordance with JIS L 1096:2010 on a specimen produced by cutting to 25 mm in width and 150 mm in length.

[0015] In the inorganic-fiber fabric for a construction membrane material of the present invention, the At, Ay, Tt, Ty, Wt, and Wy more preferably satisfy the following formula (2-1).

$$316.5 \leq (Tt/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\} \leq 550.0 \quad ...(2\text{-}1)$$

[0016] The inorganic-fiber fabric for a construction membrane material of the present invention can have excellent resistance to heat damage, great ease of weaving, and high applicability for a construction membrane material when the At, Ay, Tt, Ty, Wt, and Wy satisfy the formula (2-1).

[0017] In the inorganic-fiber fabric for a construction membrane material of the present invention, the At, Ay, Tt, Ty, Wt, and Wy further preferably satisfy the following formula (2-2).

$$346.0 \leq (Tt/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\} \leq 464.0 \quad ...(2\text{-}2)$$

[0018] The inorganic-fiber fabric for a construction membrane material of the present invention can have further excellent resistance to heat damage, great ease of weaving, and further higher applicability for a construction membrane material when the At, Ay, Tt, Ty, Wt, and Wy satisfy the formula (2-2).

[0019] A construction membrane material of the present invention comprises: any of the above inorganic-fiber fabrics for a construction membrane material; and a coating resin applied to both of front and back surfaces of the inorganic-fiber fabric for a construction membrane material.

Description of Embodiments

[0020] Next, embodiments of the present invention will be described in more detail.

[0021] In an inorganic-fiber fabric for a construction membrane material of the present embodiment, the average Al_2O_3 content of a warp constituting the inorganic-fiber fabric, At, and the average Al_2O_3 content of a weft constituting the inorganic-fiber fabric, Ay, are each within a range of 17.5 mass% or more; the mass per unit length of the warp constituting the inorganic-fiber fabric, Tt, and the mass per unit length of the weft constituting the inorganic-fiber fabric, Ty, are each within a range of 100 to 600 g / 1000 m; the weave density of the warp constituting the inorganic-fiber fabric, Wt, and the weave density of the weft constituting the inorganic-fiber fabric, Wy, are each within a range of 10.0 to 55.0 filaments / 25 mm; the ratio of the Tt to the Ty (Tt/Ty) is within a range of 0.66 to 1.50; and the At, Ay, Tt, Ty, Wt, and Wy satisfy the following formula (1-1).

$$316.5 \leq Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100) \leq 550.0 \quad ...(1\text{-}1)$$

[0022] The average Al_2O_3 content of the warp constituting the inorganic-fiber fabric, At, and the average Al_2O_3 content of the weft constituting the inorganic-fiber fabric, Ay, can be obtained in the following manner. For example, when the warp is constituted by integrated or intertwined "n" types of inorganic-fiber yarns having different Al_2O_3 contents, the average Al_2O_3 content of the warp can be determined by At = $\Sigma Ati \times Tti / \Sigma Tti$, where Ati represents the Al_2O_3 content (mass%) of the "i"-th inorganic-fiber yarn and Tti represents the mass per unit length thereof (g / 1000 m), "i" and "n" represent an integer of 1 or more, and $i \leq n$.

[0023] The At and Ay are preferably within a range of 17.5 to 35.0 mass%, more preferably within a range of 20.5 to 30.0 mass%, and further preferably within a range of 23.5 to 28.0 mass%, relative to the total amount of the inorganic fiber yarns.

[0024] In addition to Al_2O_3, the inorganic fiber yarn may contain, for example, SiO_2 within a range of 40.0 to 80.0 mass%, preferably within a range of 50.0 to 75.0 mass%, more preferably within a range of 60.0 to 70.0 mass%, further preferably within a range of 61.0 to 69.0 mass%, and particularly preferably within a range of 63.5 to 66.5 mass%, relative to the total amount of the inorganic fiber yarns. The inorganic fiber yarn may contain CaO and MgO at a total amount within a range of 5.0 to 20.0 mass%, preferably within a range of 7.5 to 15.0 mass%, and more preferably within a range of 8.5 to 11.5 mass%.

[0025] The content of each component contained in the inorganic fiber yarn can be measured by using a wavelength-dispersive X-ray fluorescent spectrometer.

[0026] As the measuring method, the following method can be used. First, the inorganic fiber yarn is put into a platinum crucible. When an organic matter adheres to a surface of the inorganic fiber yarn or when the inorganic fiber yarn is contained in a resin, the inorganic fiber yarn can be, for example, heated, before use, in a muffle furnace at 300 to 650°C for approximately 0.5 to 24 hours to remove the organic matter. Then, the inorganic fiber yarn in the platinum crucible is melted in an electric furnace by stirring and holding a temperature at 1650°C for 6 hours to obtain a homogeneous melted product. Then, the obtained melted product is poured onto a carbon plate to produce a cullet, and then the cullet is crushed and powdered to obtain a powder for measurement. This powder for measurement is molded into a disk shape using a pressing machine, and then quantitatively analyzed using the wavelength-dispersive X-ray fluorescent spectrometer. Specifically, in the quantitative analysis using the wavelength-dispersive X-ray fluorescent spectrometer, a specimen for calibration is produced based on a result of measurement by a fundamental parameter method, and analysis can be performed by a calibration method. The content of each component in the specimen for calibration can be quantitatively analyzed by an ICP atomic emission spectrometer. These results of the quantitative analysis are converted into the amount of oxides to calculate the content of each component and the total amount, and the content of each of the aforementioned components can be determined from these values.

[0027] The mass per unit length of the warp constituting the inorganic-fiber fabric, Tt, and the mass per unit length of the weft constituting the inorganic-fiber fabric, Ty, are preferably within a range of 136 to 540 g / 1000 m, more preferably within a range of 180 to 450 g / 1000 m, further preferably within a range of 226 to 425 g / 1000 m, particularly preferably within a range of 250 to 420 g / 1000 m, and most preferably within a range of 256 to 350 g / 1000 m.

[0028] The Tt or Ty can be measured in accordance with JIS R 3420:2013. When an organic matter adheres to the inorganic-fiber fabric or when the inorganic-fiber fabric is contained in the construction membrane material, the inorganic-fiber fabric can be, for example, heated in a muffle furnace at 300 to 650°C for approximately 0.5 to 24 hours to remove the organic matter, and then the resulting inorganic-fiber fabric can be used to measure the Tt or Ty. When the inorganic-fiber fabric is a glass-fiber fabric contained in the construction membrane material, the masses of the warp and weft can be calculated based on: the fiber diameter of the glass filament constituting the warp and the weft; the number of bundled glass filaments, which are measured by methods described later; and the specific gravity of the glass constituting the warp and the weft. The specific gravity of the glass constituting the warp and the weft can be determined by analyzing the composition of the glass constituting the glass-fiber fabric by the aforementioned method, preparing a glass batch so as to have the same composition, melting and cooling the glass batch to produce a glass bulk, and measuring the specific gravity of the glass bulk.

[0029] The specific gravity of the glass can be measured by the following method, for example. First, the construction membrane material containing the glass-fiber fabric is heated, for example, in a muffle furnace at 300 to 650°C for approximately 0.5 to 24 hours to decompose the organic matter. Then, the remained glass fiber is put into a platinum crucible, and melted in an electric furnace by stirring and holding a temperature at 1650°C for 6 hours to obtain a homogeneous melted glass. Then, the platinum crucible containing the melted glass is taken out from the electric furnace to cool the melted glass. Thereafter, the melted glass is hit to be taken out from the platinum crucible, then heated at a distortion-removing temperature (660 to 780°C) for 2 hours to remove distortion of the glass, and cooled to a room temperature (20 to 25°C) over 8 hours to obtain a glass lump.

[0030] The weight of the glass lump in air (a density ρ_1), A, and the weight thereof in ion-exchanged water as a substitution liquid (a density ρ_0), B, are measured with a hydrometer, and the density of the glass fiber can be measured by calculating a specific gravity (ρ) from the following formula (α).

$$\rho = \rho_1 + A(\rho_0 - \rho_1) / (A - B) \quad ...(\alpha)$$

[0031] The weave density of the warp constituting the inorganic-fiber fabric, Wt, is preferably within a range of 12.0 to 36.0 filaments / 25 mm, more preferably within a range of 15.0 to 30.0 filaments / 25 mm, further preferably within a range of 17.0 to 25.0 filaments / 25 mm, and particularly preferably within a range of 18.3 to 24.7 filaments / 25 mm. The weave density of the weft constituting the inorganic-fiber fabric, Wy, is preferably within a range of 12.0 to 36.0 filaments / 25 mm, more preferably within a range of 15.0 to 30.0 filaments / 25 mm, further preferably within a range of 17.0 to 25.0 filaments / 25 mm, particularly preferably within a range of 18.3 to 24.7 filaments / 25 mm, and most preferably within a range of 18.4 to 19.9 filaments / 25 mm.

[0032] Here, the Wt or Wy can be determined, in accordance with JIS R 3420:2013, by counting a number of the warps and wefts per 25 mm in width of the inorganic-fiber fabric using a loupe for fabric. When an organic matter adheres to the surface of the inorganic-fiber fabric or when the inorganic-fiber fabric is contained in a construction membrane material, the inorganic-fiber fabric can be, for example, heated in a muffle furnace at 300 to 650°C for approximately 0.5 to 24 hours to remove the organic matter, and the resulting inorganic-fiber fabric can be used to measure the Wt or Wy.

[0033] The ratio of the Tt to the Ty, Tt/Ty, is preferably within a range of 0.75 to 1.34, more preferably within a range of 0.80 to 1.25, and further preferably within a range of 0.90 to 1.12.

[0034] A larger value of the Wt or Wy in the formula (1-1) improves the resistance to heat damage of the inorganic-fiber fabric for a construction membrane material, but tends to reduce the ease of weaving of the inorganic-fiber fabric for a construction membrane material. A larger value of the Tt or Ty improves the resistance to heat damage, but tends to reduce the ease of weaving. A smaller value of At or Ay improves the ease of weaving. It is surmised that the formula (1-1) integrates these tendencies to express a balance between the resistance to heat damage and ease of weaving of the inorganic-fiber fabric for a construction membrane material.

[0035] The inorganic fibric yarn constituting the inorganic-fiber fabric for a construction membrane material of the present embodiment is preferably a twisted yarn formed by twisting 2 to 120 same inorganic fibric yarns, more preferably a twisted yarn formed by twisting 5 to 90 same inorganic fibric yarns, further preferably a twisted yarn formed by twisting 8 to 50 same inorganic fibric yarns, and particularly preferably a twisted yarn formed by twisting 10 to 20 same inorganic fibric yarns.

[0036] The inorganic fibric yarn constituting the inorganic-fiber fabric is preferably not bulky-processed.

[0037] Examples of the inorganic fibric yarn constituting the inorganic-fiber fabric for a construction membrane material of the present embodiment include: a glass-fiber yarn; a glass-fiber twisted yarn (a twisted yarn formed by twisting same glass-fiber yarns); a ceramic-fiber yarn; a ceramic-fiber twisted yarn; a twisted yarn of a plurality types of glass-fiber yarns; a twisted yarn of a plurality types of ceramic-fiber yarns; a twisted yarn of a glass-fiber yarn and a ceramic-fiber yarn; a twisted yarn of a glass-fiber yarn and an alumina-fiber yarn; and a twisted yarn of a ceramic-fiber yarn and an alumina-fiber yarn. The inorganic fibric yarn is preferably a glass-fiber yarn or a glass-fiber twisted yarn because it exhibits great ease of weaving, and more preferably a glass-fiber twisted yarn because it has excellent tensile strength and high applicability for use in the construction membrane material.

[0038] When the inorganic fibric yarn constituting the inorganic-fiber fabric is the glass-fiber yarn or the glass-fiber twisted yarn, a filament diameter of the glass filament constituting the glass-fiber yarn or the glass-fiber twisted yarn is, for example, within a range of 2.5 to 21.0 μm, preferably within a range of 3. 0 to 13.0 μm, and more preferably within a range of 3.0 to 9.0 μm.

[0039] When the inorganic fibric yarn constituting the inorganic-fiber fabric is the glass-fiber yarn or the glass-fiber twisted yarn, the number of filaments of the glass filaments constituting the glass-fiber yarn or the glass-fiber twisted yarn is, for example, within a range of 150 to 20000, preferably within a range of 600 to 18000, more preferably within a range of 1000 to 15000, further preferably within a range of 1500 to 10000, particularly preferably within a range of 1800 to 9000, still further preferably within a range of 2000 to 8000, and most preferably within a range of 2200 to 7500.

[0040] The fiber diameter of the glass filament can be determined by, for example, polishing a cross section of the construction membrane material containing the inorganic-fiber fabric, then observing the cross section of the construction membrane material by using an electron microscope, and measuring lengths of diameters of 100 or more glass filaments exposed to the cross section to calculate an average value thereof. The number of the bundled glass filament can be determined by counting a number of filaments constituting the warp and the weft that are exposed to the above cross section.

[0041] The mass per unit area of the inorganic-fiber fabric for a construction membrane material of the present embodiment is, for example, within a range of 310 to 750 g/m^2, preferably within a range of 410 to 650 g/m^2, further preferably within a range of 420 to 550 g/m^2, and particularly preferably within a range of 425 to 490 g/m^2.

[0042] Here, the mass per unit area of the inorganic-fiber fabric can be determined by measuring the mass of the inorganic-fiber fabric cut to a size of 200 mm × 200 mm with a scale in accordance with JIS R 3420:2013, making the measurement in triplicate, and converting these results into a mass per m^2 to average these values. When an organic matter adheres to the surface of the inorganic-fiber fabric or when the inorganic-fiber fabric is contained in the construction membrane material, the inorganic-fiber fabric can be, for example, heated in a muffle furnace at 300 to 650°C for approximately 0.5 to 24 hours to remove the organic matter, and the resulting inorganic-fiber fabric can be used to measure the mass per unit area.

[0043] Examples of weave of the inorganic-fiber fabric include plain weave, twill weave, satin weave, basket weave, and rib weave.

[0044] In the inorganic-fiber fabric for a construction membrane material of the present embodiment, the At, Ay, Tt, Ty, Wt, and Wy preferably satisfy the following formula (1-2), and more preferably satisfy the following formula (1-3).

$$346.0 \leq Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100) \leq 464.0 \quad ...(1\text{-}2)$$

$$358.0 \leq Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100) \leq 418.0 \quad ...(1\text{-}3)$$

[0045] In the inorganic-fiber fabric for a construction membrane material of the present embodiment, the At, Ay, Tt, Ty, Wt, and Wy further preferably satisfy the following formula (2-1), particularly preferably satisfy the following formula (2-2), and most preferably satisfy the following formula (2-3).

$$316.5 \leq (Tt/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\} \leq 550.0 \quad ...(2\text{-}1)$$

$$346.0 \leq (Tt/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\} \leq 464.0 \quad ...(2\text{-}2)$$

$$358.0 \leq (Tt/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\} \leq 418.0 \quad ...(2\text{-}3)$$

[0046] Tt/Ty, in the formula (2-1), closer to 1.00 tends to have higher applicability for the construction membrane material of the inorganic-fiber fabric for a construction membrane material. It is surmised that the formula (2-1) integrates the aforementioned tendencies exhibited by the Tt, Ty, Wt, Wy, At, and Ay, and this tendency exhibited by Tt/Ty to express a balance between the resistance to heat damage, ease of weaving, and the applicability for a construction membrane material, of the inorganic-fiber fabric for a construction membrane material.

[0047] To a surface of the inorganic-fiber fabric for a construction membrane material of the present embodiment, a surface-treating agent of a silane-coupling agent, a starch, and a lubricant may adhere in an amount of 0.3 to 2.5 mass% relative to the mass of the inorganic-fiber fabric for a construction membrane material of the present embodiment containing the surface-treating agent.

[0048] Examples of the silane-coupling agent include an aminosilane, a chlorosilane, an epoxysilane, a mercaptosilane, a vinylsilane, an acrylsilane, and a cationic silane.

[0049] Examples of the aminosilane include γ-aminopropyltnethoxysilane, N-β-(aminoethyl)-γ-aminopropyltrimethoxysilane, N-β-(aminoethyl)-N'-β-(aminoethyl)-γ-aminopropyltrimethoxysilane, and γ-anilinopropyltrimethoxysilane.

[0050] Examples of the chlorosilane include γ-chloropropyltrimethoxysilane.

[0051] Examples of the epoxysilane include γ-glycidoxypropyltnmethoxysilane and β-(3,4-epoxycyclohexyl)ethyltrimethoxysilane.

[0052] Examples of the mercaptosilane include γ-mercaptotnmethoxysilane.

[0053] Examples of the vinylsilane include vinyltrimethoxysilane and N-β-(N-vinylbenzylaminoethyl)-γ-aminopropyltrimethoxysilane.

[0054] Examples of the acrylsilane include γ-methacryloxypropyltrimethoxysilane.

[0055] Examples of the cationic silane include a hydrochloride salt of N-(vinylbenzyl)-2-aminoethyl-3-aminopropyltrimethoxysilane and a hydrochloride salt of N-phenyl-3-aminopropyltrimethoxysilane.

[0056] As the silane-coupling agent, these compounds can be used singly, or can be used in combination of two or more thereof.

[0057] Examples of the starch include corn starch, potato starch, rice starch, tapioca starch, wheat starch, sweet potato starch, high-amylose corn starch, sago starch, and modified starches obtained by, for example, etherizing, esterifying, grafting, or crosslinking any of these starches. As the starch, these compounds can be used singly, or can be used in combination of two or more thereof.

[0058] Examples of the lubricant include a modified silicone oil, an animal oil and a hydrogenated product thereof, a plant oil and a hydrogenated product thereof, an animal wax, a plant wax, a mineral wax, a condensed product between a higher saturated fatty acid and a higher saturated alcohol, a polyethyleneimine, a polyalkylpolyamine alkylamide derivative, a fatty acid amide, and a quaternary ammonium salt.

[0059] Examples of the animal oil include beef tallow.

[0060] Examples of the plant oil include soybean oil, coconut oil, rapeseed oil, palm oil, and castor oil.

[0061] Examples of the animal wax include beeswax and lanolin.

[0062] Examples of the plant wax include candelilla wax and carnauba wax.

[0063] Examples of the mineral wax include paraffin wax and montan wax.

[0064] Examples of the condensed product between a higher saturated fatty acid and a higher saturated alcohol include stearate esters such as lauryl stearate.

[0065] Examples of the fatty acid amide include a dehydrative condensed product between: a polyethylenepolyamine such as diethylenetriamine, triethylenetetramine, and tetraethylenepentamine; and a fatty acid such as lauric acid, myristic acid, palmitic acid, and stearic acid.

[0066] Examples of the quaternary ammonium salt include alkyltrimethylammonium salts such as lauryltrimethylammonium chloride.

[0067] As the lubricant, these materials can be used singly, or can be used in combination of two or more thereof.

[0068] The construction membrane material of the present embodiment comprises: any of the above inorganic-fiber fabrics for a construction membrane material; and a coating resin applied to both of front and back surfaces of the inorganic-fiber fabric for a construction membrane material.

[0069] Examples of the coating resin include a fluororesin or a silicone resin. Examples of the fluororesin include polytetrafluoroethylene (PTFE), perfluoroalkoxyalkane (PFA), tetrafluoroethylene-hexafluoropropylene copolymer (FEP), tetrafluoroethylene-ethylene copolymer (ETFE), polyvinylidene fluoride (PVDF), polychlorotrifluoroethylene (PCTFE), tetrafluoroethylene-perfluorodioxol copolymer (TFE/PDD), and polyvinyl fluoride (PVF).

[0070] The coating resin may be a resin composition containing an additive such as a coating agent in addition to the resin. A part of the coating resin may penetrate the inorganic-fiber fabric.

[0071] Examples of use of the construction membrane material of the present embodiment include a membrane ceiling, a tent warehouse, and a roof of a fire-resistant construction.

[0072] Next, Examples and Comparative Examples of the present invention will be described.

Example

[Example 1]

[0073] A glass-fiber twisted yarn having a mass of 270 g / 1000 m and composed of 2400 glass filaments having an Al_2O_3 content of 25.0 mass%, a SiO_2 content of 65.0 mass%, and a total content of MgO and CaO of 10.0 mass% and having a diameter of 7.4 μm was used as warps and wefts. The twisted yarn was plain-weaved at a warp weave density of 24.6 filaments / 25 mm and a weft weave density of 19.7 filaments / 25 mm to produce an inorganic-fiber fabric of Example 1.

[Example 2]

[0074] A glass-fiber twisted yarn having a mass of 405 g / 1000 m and composed of 3600 glass filaments having an Al_2O_3 content of 25.0 mass%, a SiO_2 content of 65.0 mass%, and a total content of MgO and CaO of 10.0 mass% and having a diameter of 7.4 μm was used as warps and wefts. The twisted yarn was plain-weaved at a warp weave density of 18.5 filaments / 25 mm and a weft weave density of 19.0 filaments / 25 mm to produce an inorganic-fiber fabric of Example 2.

[Example 3]

[0075] A glass-fiber twisted yarn having a mass of 202 g / 1000 m and composed of 1800 glass filaments having an Al_2O_3 content of 25.0 mass%, a SiO_2 content of 65.0 mass%, and a total content of MgO and CaO of 10.0 mass% and having a diameter of 7.4 μm was used as warps and wefts. The twisted yarn was plain-weaved at a warp weave density of 24.5 filaments / 25 mm and a weft weave density of 21.0 filaments / 25 mm to produce an inorganic-fiber fabric of Example 3.

[Example 4]

[0076] A twisted yarn of the first glass-fiber twisted yarn and the second glass-fiber twisted yarn was used as warps and wefts. The first glass-fiber twisted yarn had a mass of 270 g / 1000 m, and was composed of 2400 glass filaments having an Al_2O_3 content of 25.0 mass%, a SiO_2 content of 65.0 mass%, and a total content of MgO and CaO of 10.0 mass% and having a diameter of 7.4 μm. The second glass-fiber twisted yarn had a mass of 135 g / 1000 m, and was composed of 1200 glass filaments having an Al_2O_3 content of 14.0 mass%, a SiO_2 content of 54.5 mass%, a total content of MgO and CaO of 23.5 mass%, and a total content of other components of 8.0 mass% and having a diameter of 7.4 μm. The twisted yarn of the first glass-fiber twisted yarn and the second glass-fiber twisted yarn was plain-weaved at a warp weave density of 18.5 filaments / 25 mm and a weft weave density of 19.0 filaments / 25 mm to produce an inorganic-fiber fabric of Example 4.

[Comparative Example 1]

[0077] An alumina-fiber yarn having a mass of 100 g / 1000 m and having an Al_2O_3 content of 72.0 mass% and a SiO_2 content of 28.0 mass% was used as warps and wefts. The alumina-fiber yarn was plain-weaved at a warp weave density of 19.8 filaments / 25 mm and a weft weave density of 16.8 filaments / 25 mm to produce an inorganic-fiber fabric of Comparative Example 1.

[Comparative Example 2]

[0078] An alumina-fiber yarn having a mass of 100 g / 1000 m and having an Al_2O_3 content of 62.5 mass%, a SiO_2 content of 24.5 mass%, and a total content of other components of 13.0 mass% was used as warps and wefts. The alumina fiber yarn was plain-weaved at a warp weave density of 19.8 filaments / 25 mm and a weft weave density of 16.8 filaments / 25 mm to produce an inorganic-fiber fabric of Comparative Example 2.

[Comparative Example 3]

[0079] A twisted yarn of an alumina-fiber twisted yarn and a glass-fiber twisted yarn was used as warps and wefts. The alumina-fiber twisted yarn had an Al_2O_3 content of 72.0 mass% and a SiO_2 content of 28.0 mass%, and had a mass of 300 g / 1000 m; and the glass-fiber twisted yarn had a mass of 135 g / 1000 m, and was composed of 1200 glass filaments of a glass composition having an Al_2O_3 content of 14.0 mass%, a SiO_2 content of 54.5 mass%, a total content of MgO and CaO of 23.5 mass%, and a total content of other components of 8.0 mass% and having a diameter of 7.4 μm. The twisted yarn of the alumina-fiber twisted yarn and the glass-fiber twisted yarn was plain-weaved at a warp weave density of 17.5 filaments / 25 mm and a weft weave density of 16.5 filaments / 25 mm to produce an inorganic-fiber fabric of Comparative Example 3.

[Comparative Example 4]

[0080] A twisted yarn of an alumina-fiber twisted yarn and a glass-fiber twisted yarn was used as warps and wefts. The alumina-fiber twisted yarn had an Al_2O_3 content of 62.5 mass%, a SiO_2 content of 24.5 mass%, and a total content of other components of 13.0 mass%, and had a mass of 300 g / 1000 m. The glass-fiber twisted yarn had a mass of 135 g / 1000 m, and was composed of 1200 glass filaments of a glass composition having an Al_2O_3 content of 14.0 mass%, a SiO_2 content of 54.5 mass%, a total content of MgO and CaO of 23.5 mass%, and a total content of other components of 8.0 mass% and having a diameter of 7.4 μm. The twisted yarn of the alumina-fiber twisted yarn and the glass-fiber twisted yarn was plain-weaved at a warp weave density of 17.5 filaments / 25 mm and a weft weave density of 16.5 filaments / 25 mm to produce an inorganic-fiber fabric of Comparative Example 4.

[Comparative Example 5]

[0081] A twisted yarn of the first glass-fiber twisted yarn and the second glass-fiber twisted yarn was used as warps and wefts. The first glass-fiber twisted yarn had a mass of 135 g / 1000 m and was composed of 1200 glass filaments having an Al_2O_3 content of 25.0 mass%, a SiO_2 content of 65.0 mass%, and a total content of MgO and CaO of 10.0 mass% and having a diameter of 7.4 μm. The second glass-fiber twisted yarn had a mass of 270 g / 1000 m and was composed of 2400 glass filaments having an Al_2O_3 content of 14.0 mass%, a SiO_2 content of 54.5 mass%, a total content of MgO and CaO of 23.5 mass%, and a total content of other components of 8.0 mass% and having a diameter of 7.4 μm. The twisted yarn of the first glass-fiber twisted yarn and the second glass-fiber twisted yarn was plain-weaved at a warp weave density of 18.5 filaments / 25 mm and a weft weave density of 19.0 filaments / 25 mm to produce an inorganic-fiber fabric of Comparative Example 5.

[Comparative Example 6]

[0082] A glass-twisted yarn having a mass of 135 g / 1000 m and composed of 1200 glass filaments having an Al_2O_3 content of 25.0 mass%, a SiO_2 content of 65.0 mass%, and a total content of MgO and CaO of 10.0 mass% and having a diameter of 7.4 μm was used as warps and wefts. The twisted yarn was plain-weaved at a warp weave density of 19.0 filaments / 25 mm and a weft weave density of 18.5 filaments / 25 mm to produce an inorganic-fiber fabric of Comparative Example 6.

[Comparative Example 7]

[0083] A glass-twisted yarn having a mass of 135 g / 1000 m and composed of 1200 glass filaments having an Al_2O_3 content of 25.0 mass%, a SiO_2 content of 65.0 mass%, and a total content of MgO and CaO of 10.0 mass% and having a diameter of 7.4 μm was used as warps. A glass-twisted yarn having a mass of 405 g / 1000 m and composed of 3600 glass filaments having an Al_2O_3 content of 25.0 mass%, a SiO_2 content of 65.0 mass%, and a total content of MgO and CaO of 10.0 mass% and having a diameter of 7.4 μm was used as wefts. The twisted yarns were plain-weaved at a warp weave density of 49.2 filaments / 25 mm and a weft weave density of 19.7 filaments / 25 mm to produce an inorganic-fiber fabric of Comparative Example 7.

[Comparative Example 8]

[0084] A glass-fiber twisted yarn having a mass of 200 g / 1000 m and composed of 1780 glass filaments having an Al_2O_3 content of 14.0 mass%, a SiO_2 content of 54.5 mass%, a total content of MgO and CaO of 23.5 mass%, and a total content of other components of 8.0 mass% and having a diameter of 7.4 μm was used as warps and wefts. The twisted yarn was plain-weaved at a warp weave density of 19.8 filaments / 25 mm and a weft weave density of 19.7 filaments / 25 mm to produce an inorganic-fiber fabric of Comparative Example 8.

[0085] Table 1 shows the mass per unit area, value of $Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)$, and value of $(Tt/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\}$ of the inorganic-fiber fabric of each Example and each Comparative Example.

[0086] The resistance to heat damage, applicability for a construction membrane material, and ease of weaving of the inorganic-fiber fabric of each Example and Comparative Example were evaluated in the following manner. Table 1 shows the results of Examples 1 to 4, Table 2 shows the results of Comparative Example 1 to Comparative Example 4, and Table 3 shows the results of Comparative Examples 5 to 8.

[Resistance to Heat Damage]

[0087] A sample on which a weight with 100 mm in diameter and 10 kg is placed is set in a muffle furnace, heated to 800°C so that the temperature in the furnace is increased in accordance with a standard time/temperature curve in ISO 834, and cooled over a triple time of the time for heating. Then the sample is taken out and observed in terms of presence/absence of damage. Then, for both of longitudinal and lateral directions, a specimen cut to 25 mm in width and 150 mm in length is prepared and evaluated in a tensile test in accordance with JIS L 1096:2010. When having no damage and having a tensile strength of 450 N / 25 mm or more, the inorganic-fiber fabric is rated as "A". When having no damage and having a tensile strength of less than 450 N / 25 mm, the inorganic-fiber fabric is rated as "B". When having damage, the inorganic-fiber fabric is rated as "C".

[Applicability for Construction Membrane Material]

[0088] For both of longitudinal and lateral directions, a specimen cut to 25 mm in width and 150 mm in length is prepared and evaluated in a tensile test in accordance with JIS L 1096:2010. When having a tensile strength of 3000 N / 25 mm or more, the inorganic-fiber fabric is rated as "A". When having a tensile strength of 2000 N / 25 mm or more and less than 3000 N / 25 mm, the inorganic-fiber fabric is rated as "B". When having a tensile strength of less than 2000 N / 25 mm, the inorganic-fiber fabric is rated as "C".

[Ease of weaving]

[0089] When no slack, fluff, nor cutting of the yarn occurs during warping or weft-weaving, the inorganic-fiber fabric is rated as "OK". When slack, fluff, or cutting of the yarn occurs during warping or weft-weaving, the inorganic-fiber fabric is rated as "NG".

[Table 1]

			Example 1	Example 2	Example 3	Example 4
Warp	Yarn type 1	Al_2O_3 content (mass%)	25.0	25.0	25.0	25.0
		Mass per unit length (q / 1000 m)	270	405	202	270
	Yarn type 2	Al_2O_3 content (mass%)	-	-	-	14.0
		Mass per unit length (g/1000m)	-	-	-	135
	Average Al_2O_3 content At (mass%)		25.0	25.0	25.0	21.3
	Mass per unit length Tt (g/1000m)		270	405	202	405
Weft	Yarn type 1	Al_2O_3 content (mass%)	25.0	25.0	25.0	25.0
		Mass per unit length (g/1000m)	270	405	202	270
	Yarn type 2	Al_2O_3 content (mass%)	-	-		14.0
		Mass per unit length (g/1000m)	-	-	-	135
	Average Al_2O_3 content Ay (mass%)		25.0	25.0	25.0	21.3
	Mass per unit length Ty(g/1000m)		270	405	202	405
Tt/Ty			1.00	1.00	1.00	1.00
Warp weave density Wt (filaments / 25 mm)			24.6	18.5	24.5	18.5
Weft weave density Wy (filaments / 25 mm)			19.7	19.0	21.0	19.0
Mass per unit area (g/m^2)			478.0	606.0	367.6	607.5
$Wt^{1/3}\times Tt^{1/2}/(At/100)+Wy^{1/3}\times Ty^{1/2}/(Ay/100)$			368.7	427.7	322.0	501.2
$(Tr/Ty)\{Wt^{1/3}\times Tt^{1/2}/(At/100)+Wy^{1/3}\times Ty^{1/2}(Ay/100)\}$			368.7	427.7	322.0	501.2
Resistance to heat damage			A	A	B	B
Applicability for construction membrane material			A	A	A	A
Ease of weaving			OK	OK	OK	OK

[Table 2]

			Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Warp	Yarn type 1	Al_2O_3 content (mass%)	72.0	62.5	72.0	62.5
		Mass per unit length (g/ 1000m)	100	100	300	300
	Yarn type 2	Al_2O_3 content (mass%)	-	-	14.0	14.0
		Mass per unit length (g/ 1000m)	-	-	270	270
	Average Al_2O_3 content At (mass%)		72.0	62.5	44.5	39.5
	Mass per unit length Tt (g/1000m)		100	100	570	570
Weft	Yarn type 1	Al_2O_3 content (mass%)	72.0	62.5	72.0	62.5
		Mass per unit length (g/ 1000m)	100	100	300	300
	Yarn type 2	Al_2O_3 content (mass%)	-	-	14.0	14.0
		Mass per unit length (g/ 1000m)	-	-	270	270
	Average Al_2O_3 content Ay(mass%)		72.0	62.5	44.5	39.5
	Mass per unit length Ty (g/1000m)		100	100	570	570
Tt/Ty			1.00	1.00	1.00	1.00
Warp weave density Wt (filaments / 25 mm)			19.8	19.8	17.5	17.5
Weft weave density Wy (filaments / 25 mm)			16.8	16.8	16.5	16.5
Mass per unit area (g/m^2)			309	309	775.2	775.2
$Wt^{1/3}\times Tt^{1/2}/(At/100) + Wy^{1/3}\times Ty^{1/2}/(Ay/100)$			73.1	84.3	275.7	310.6
$(Tr/Ty)\{Wt^{1/3}\times Tt^{1/2}/(At/100) + Wy^{1/3}\times Ty^{1/2}/(Ay/100)\}$			73.1	84.3	275.7	310.6
Resistance to heat damage			A	A	A	A
Applicability for construction membrane material			C	C	A	A

(continued)

	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Ease of weaving	NG	NG	NG	NG

[Table 3]

			Comparative Example 5	Comparative Example 6	Comparative Example 7	Comparative Example 8
Warp	Yarn type 1	Al_2O_3 content (mass%)	25.0	25.0	25.0	14.0
		Mass per unit length (g/1000m)	135	135	135	200
	Yarn type 2	Al_2O_3 content (mass%)	14.0	-	-	-
		Mass per unit length (g/1000m)	270	-	-	-
	Average Al_2O_3 content At (mass%)		17.7	25.0	25.0	14.0
	Mass per unit length Tt (g/1000m)		405	135	135	200
Weft	Yarn type 1	Al_2O_3 content (mass%)	25.0	25.0	25.0	14.0
		Mass per unit length (g/1000m)	135	135	405	200
	Yarn type 2	Al_2O_3 content (mass%)	14.0	-	-	-
		Mass per unit length (g/1000m)	270	-	-	-
	Average Al_2O_3 content Ay(mass%)		17.7	25.0	25.0	14.0
	Mass per unit length Ty (g/1000m)		405	135	405	200
Tt/Ty			1.00	1.00	0.33	1.00
Warp weave density Wt (filaments / 25 mm)			18.5	19.0	49.2	19.8
Weft weave density Wy (filaments / 25 mm)			19.0	18.5	19.7	19.7
Mass per unit area (g/m^2)			607.5	202.5	680.4	496.0

(continued)

	Comparative Example 5	Comparative Example 6	Comparative Example 7	Comparative Example 8
$Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)$	605.2	246.9	387.7	546.1
$(Tr/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\}$	605.2	246.9	129.2	546.1
Resistance to heat damage	C	C	A	C
Applicability for construction membrane material	A	C	A	A
Ease of weaving	OK	OK	NG	OK

[0090] It is obvious from Table 1 that the inorganic-fiber fabrics of Examples 1 to 4 have excellent resistance to heat damage, great ease of weaving, and high applicability for the construction membrane material.

[0091] It is obvious from Table 2 that the inorganic-fiber fabrics of Comparative Examples 1 and 2, which have a higher average Al_2O_3 content of the warp constituting the inorganic-fiber fabric, At, and a higher average Al_2O_3 content of the weft constituting the inorganic-fiber fabric, Ay, than Examples 1 to 4, and have the value of $Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)$ of less than 316.5, have low applicability for the construction membrane material and poor ease of weaving.

[0092] It is obvious that the inorganic-fiber fabrics of Comparative Examples 3 and 4, which have a lower average Al_2O_3 content of the warp constituting the inorganic-fiber fabric, At, and a lower average Al_2O_3 content of the weft constituting the inorganic-fiber fabric, Ay, than Comparative Examples 1 and 2, but have the value of $Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)$ of less than 316.5, have poor ease of weaving.

[0093] It is obvious from Table 3 that the inorganic-fiber fabric of Comparative Example 5, which has the value of $Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)$ of more than 550.0, has lower resistance to heat damage. It is obvious that the inorganic-fiber fabric of Comparative Example 6, which has the value of $Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)$ of less than 316.5 and is lower than that of the inorganic-fiber fabric of Comparative Examples 3 and 4, has low resistance to heat damage and low applicability for the construction membrane material.

[0094] Furthermore, it is obvious that the inorganic-fiber fabric of Comparative Example 7, which has the ratio of the Tt to the Ty (Tt/Ty) of less than 0.66, has poor ease of weaving. It is obvious that the inorganic-fiber fabric of Comparative Example 8, which has an average Al_2O_3 content of the warp constituting the inorganic-fiber fabric, At, and an average Al_2O_3 content of the weft constituting the inorganic-fiber fabric, Ay, of less than 17.0 mass%, has low resistance to heat damage.

Claims

1. An inorganic-fiber fabric for a construction membrane material, wherein

   an average Al_2O_3 content of a warp constituting the inorganic-fiber fabric, At, and an average of Al_2O_3 content of a weft constituting the inorganic-fiber fabric, Ay, are each within a range of 17.5 mass% or more,
   a mass per unit length of the warp constituting the inorganic-fiber fabric, Tt, and a mass per unit length of the weft constituting the inorganic-fiber fabric, Ty, are each within a range of 100 to 600 g / 1000 m,
   a weave density of the warp constituting the inorganic-fiber fabric, Wt, and a weave density of the weft constituting the inorganic-fiber fabric, Wy, are each within a range of 10.0 to 55.0 filaments / 25 mm,
   a ratio of the Tt to the Ty, Tt/Ty, is within a range of 0.66 to 1.50, and
   the At, Ay, Tt, Ty, Wt, and Wy satisfy the following formula (1-1):

$$316.5 \leq Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100) \leq 550.0 \quad ...(1\text{-}1).$$

2. The inorganic-fiber fabric for a construction membrane material according to Claim 1, wherein the At, Ay, Tt, Ty, Wt, and Wy satisfy the following formula (1-2):

$$346.0 \leq Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100) \leq 464.0 \quad ...(1\text{-}2).$$

3. The inorganic-fiber fabric for a construction membrane material according to Claim 1 or 2, wherein the At, Ay, Tt, Ty, Wt, and Wy satisfy the following formula (2-1):

$$316.5 \leq (Tt/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\} \leq 550.0 \quad ...(2\text{-}1).$$

4. The inorganic-fiber fabric for a construction membrane material according to any one of Claims 1 to 3, wherein the At, Ay, Tt, Ty, Wt, and Wy satisfy the following formula (2-2):

$$346.0 \leq (Tt/Ty)\{Wt^{1/3} \times Tt^{1/2}/(At/100) + Wy^{1/3} \times Ty^{1/2}/(Ay/100)\} \leq 464.0 \quad ...(2\text{-}2).$$

5. A construction membrane material comprising:

the inorganic-fiber fabric for a construction membrane material according to any one of Claims 1 to 4; and
a coating resin applied to both of front and back surfaces of the inorganic-fiber fabric for a construction membrane material.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/006537

A. CLASSIFICATION OF SUBJECT MATTER

D03D 15/242(2021.01)i; ***B32B 17/04***(2006.01)i; ***E04H 15/54***(2006.01)i
FI: D03D15/242; B32B17/04 Z; E04H15/54

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)

D03D1/00-27/18; B32B1/00-43/00; E04H15/00-15/64

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2017-159483 A (HIRAOKA & CO., LTD.) 14 September 2017 (2017-09-14) examples 3, 4, paragraphs [0001], [0015]	1-5
A	WO 2013/084897 A1 (NITTO BOSEKI CO., LTD.) 13 June 2013 (2013-06-13) claims, paragraphs [0054], [0103]	1-5

☐ 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	Date of mailing of the international search report
25 March 2022	**05 April 2022**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/006537

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2017-159483 A	14 September 2017	(Family: none)	
WO 2013/084897 A1	13 June 2013	EP 2789592 A1 claims, paragraphs [0054], [0103] US 2014/0357143 A1 CN 103974916 A KR 10-2014-0102273 A HK 1199010 A TW 201336799 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2018084097 A **[0005]**
- JP 2000331546 A **[0005]**