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(54) Title: FIBER REINFORCED CEMENT (FRC) COMPOSITION, A PROCESS FOR PREPARING THE SAME AND AN FRC
ARTICLE

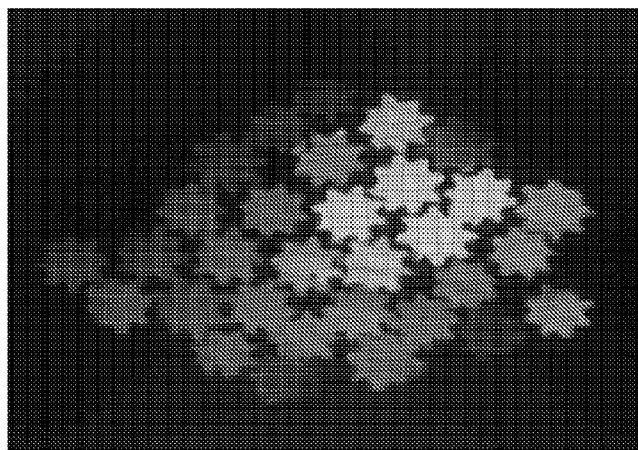


Figure 3

(57) Abstract: The present disclosure relates to the field of fiber reinforced cement (FRC) composition for preparing articles. The FRC composition of the present disclosure comprises: i. polyester fibers having gear shaped cross section in an amount in the range of 0.05 to 5%; ii. cement in an amount in the range of 30 to 60%; iii. asbestos fiber in an amount less than 14%; iv. pulp in an amount in the range of 0.5 to 5%; and v. at least one filler in an amount in the range of 30 to 50%. The FRC composition of the present disclosure employs reduced amount of asbestos fibers and the articles prepared from the FRC composition of the present disclosure have improved mechanical properties.



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).

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FIBER REINFORCED CEMENT (FRC) COMPOSITION, A PROCESS FOR PREPARING THE SAME AND AN FRC ARTICLE

FIELD

The present disclosure relates to a Fiber Reinforced Cement (FRC) composition, a process for preparing the same and articles prepared from that Fiber Reinforced Cement (FRC) composition.

DEFINITIONS

As used in the present disclosure, the following terms are generally intended to have the meaning as set forth below, except to the extent that the context in which they are used indicate otherwise.

Denier: Denier is a unit for the measurement of linear mass density of fibers. It is defined as the mass in grams per 9000 meters.

Tenacity: Tenacity is the customary measure of strength of a fiber or yarn. It is expressed as grams per denier (gpd).

Fiber Elongation: Fiber elongation is specified as the percentage of increase in length as compared to the initial length.

Uster value: Uster value is the measurement of evenness, thick places, and thin places in a fiber.

Quenching: It is a method used for rapid cooling of melt to obtain fibers.

Draw Ratio: expressed as the ratio of cross sectional area of undrawn material to that of the drawn material.

MR_A: MR_A refers to the modulus of rupture adjusted to the dry density of the cement specimen. MR_A is directly proportional to the flexural strength of the cement specimen.

BACKGROUND

Fibers are widely used as reinforcement material for Fiber Reinforced Cement (FRC) composites. Asbestos fibers are most commonly used as a reinforcement fiber in FRC. However, due to the carcinogenic effect of asbestos, the use of synthetic fibers as

reinforcement material in FRC is progressively increasing, with an approach to minimize the use of asbestos fibers.

The bonding efficiency of fibers with the cement matrix is a prerequisite for selecting the fibers for such use. If the bonding of fibers with the cement matrix is poor, the FRC will have
5 a low modulus of rupture, resulting in lower flexural strength of the FRC. Parameters affecting the bonding of fibers with cement include the cross section of the fiber, the length of the fiber and the surface of the fiber. Fibers known in the art, have a circular cross section. An FRC made from fibers having circular cross section, has inferior interaction between the fibers and the cement matrix and therefore shows inferior flexural strength, due to the lower
10 area of contact between the fibers and the cement matrix.

There is, therefore, felt a need for an FRC composition having improved strength and environment friendly properties, and that can be used in various applications.

OBJECTS

Some of the objects of the present disclosure, which at least one embodiment herein satisfies,
15 are as follows:

It is an object of the present disclosure to ameliorate one or more problems of the prior art or to at least provide a useful alternative.

An object of the present disclosure is to provide a fiber reinforced cement composition, which can be used for preparing articles having enhanced flexural strength.

20 Another object of the present disclosure is to provide a process for preparing a fiber reinforced cement composition.

Other objects and advantages of the present disclosure will be more apparent from the following description, which is not intended to limit the scope of the present disclosure.

SUMMARY

25 The present disclosure provides a fiber reinforced cement composition. The fiber reinforced cement composition of the present disclosure comprises polyester fibers having gear shaped cross section in an amount in the range of 0.05 to 5% with respect to the total mass of the composition. Further, the fiber reinforced cement composition comprises cement in an

amount in the range of 30 to 60% with respect to the total mass of the composition. The amount of asbestos fibers used in the fiber reinforced cement composition, is less than 14% with respect to the total mass of the composition. Pulp, typically cellulosic pulp is used in an amount in the range of 0.5 to 5% with respect to the total mass of the composition. The fiber reinforced cement composition further comprises at least one filler in an amount in the range of 30 to 50% with respect to the total mass of the composition.

The polyester fiber having gear shaped cross section, used in the fiber reinforced cement composition of the present disclosure, is characterized by:

- linear mass density in the range of 0.6 to 10 denier per filament;
- tenacity in the range of 2.0 to 10.0 grams per denier (gpd);
- fiber elongation in the range of 5 to 50%; and
- uster value in the range of 2 to 12%.

Further, a process of preparing the fiber reinforced cement composition of the present disclosure is disclosed. The method of preparing the fiber reinforced cement composition of the present disclosure comprises the following steps:

- a. dispersing polyester fibers having gear shaped cross section, in water to obtain a dispersion;
- b. mixing pulp and water to obtain a slurry;
- c. mixing the dispersion and the slurry to obtain a mixture; and
- d. gradually adding to the mixture cement containing asbestos fibers and at least one filler with continuous stirring to obtain the fiber reinforced cement composition, wherein the asbestos fiber is present in an amount of less than 14% with respect to the total mass of the composition.

The polyester, of the polyester fiber used in the fiber reinforced cement composition of the present disclosure, can be at least one selected from the group consisting of polyethylene terephthalate (PET), polytrimethylene isophthalate (PTI), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polytrimethylene naphthalate (PTN), polybutylene naphthalate (PBN), polyethylene naphthalate (PEN) and vectran. The filler used in the fiber reinforced cement composition of the present disclosure can be at least one selected from the group consisting of fly ash, hard ground waste and a mixture of fly ash and hard ground waste.

Further, the fiber reinforced cement composition of the present disclosure can be used to make various articles. The article can be made by molding the fiber reinforced cement composition in a mold under pressure to obtain a molded mass followed by air curing the molded mass to form the article. The articles made from the fiber reinforced cement composition of the present disclosure have density in the range of 1.25 to 1.40 gm/cm³ and an MR_A in the range of 170 to 190 kg/cm².

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWING

The present disclosure will now be described with the help of the accompanying drawing, in which:

10 **Figure 1** illustrates a block diagram of the process for manufacturing filaments having gear shaped cross section;

Figure 2 illustrates a block diagram of the process for manufacturing staple fibers having gear shaped cross section; and

15 **Figure 3** illustrates the gear shaped cross section of the fibers obtained from the process as shown in **Figure 2** of the present disclosure.

DETAILED DESCRIPTION

Fiber reinforced cement (FRC) composites known in the art, teach the use of fibers having lower surface area which reduces the bonding of fibers with the cement matrix. Thus, the fiber reinforced cement (FRC) composite shows inferior flexural strength. Further, these fiber reinforced cement (FRC) composites contain asbestos fibers, which is carcinogenic to humans. Thus, there has been a lack of FRC composites having improved strength and environment friendly properties.

25 In accordance with one aspect of the present disclosure, there is provided fiber reinforced cement composition for preparing articles. The fiber reinforced cement composition of the present disclosure comprises polyester fibers having gear shaped cross section. The amount of polyester fibers used in the fiber reinforced cement composition of the present disclosure is in the range of 0.05 to 5% with respect to the total mass of the fiber reinforced cement composition.

30 The fiber reinforced cement composition of the present disclosure comprises cement in an amount in the range of 30 to 60% with respect to the total mass of the fiber reinforced cement

composition. The cement used in the fiber reinforced cement composition of the present disclosure can be selected from the group consisting of Ordinary Portland Cement (OPC) and Pozzolanic Portland Cement (PPC).

5 In accordance with the present disclosure, the fiber reinforced cement composition comprises asbestos fibers in an amount less than 14% with respect to the total mass of the FRC composition.

10 The fiber reinforced cement composition of the present disclosure comprises pulp in an amount in the range of 0.5 to 5% with respect to the total mass of the fiber reinforced cement composition. The pulp used in the fiber reinforced cement composition of the present disclosure is at least one selected from the group consisting of cellulosic pulp and textile fiber waste.

15 In accordance with the present disclosure, the fiber reinforced cement composition comprises at least one filler in an amount in the range of 30 to 50% with respect to the total mass of the composition. The filler used in the fiber reinforced cement composition of the present disclosure is at least one selected from the group consisting of fly ash, hard ground waste and a mixture thereof.

The polyester fiber used in the fiber reinforced cement composition of the present disclosure is characterized by:

- linear mass density in the range of 0.6 to 10 denier per filament;
- 20 • tenacity in the range of 2.0 to 10.0 grams per denier (gpd);
- fiber elongation in the range of 5 to 50%; and
- uster value in the range of 2 to 12%.

25 In accordance with the present disclosure, there is provided a process for the preparation of polyester fibers having gear shaped cross section as shown in **Figure 1** and **2**. **Figure 1** depicts the process steps for the manufacturing of filaments having gear shaped cross section.

As shown in **Figure 1**, the polymer material is melted in an extruder (1) at a temperature in the range of 220 to 300 °C to obtain a molten mass. The molten mass is passed through a spinneret (2) having multiple gear shaped holes, to obtain a plurality of filaments having gear shaped cross section. The filaments coming out of the spinneret having gear shaped cross section, are quenched in a quench air (3), at a temperature in the range of 20 to 25 °C. The air

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flow rate used for quenching, is in the range of 0.4 to 0.7 m/s, preferably 0.6 m/s. At this air flow rate and temperature, the filaments coming out of the spinneret holes freeze instantly resulting in the filaments having uniform and similar cross section as that of the spinneret holes. These filaments then passed through a finish oil applicator (4) followed by pig tail guide (5) and kiss roller (6). The filaments thus obtained are passed through a series of godet rollers, godet roller-1 (7 and 8) and godet roller-2 (9 and 10) for drawing. After passing through the series of godet rollers, the filaments are wound on a spinning package at a speed in the range of 3500 to 4200 m/minute. A draw ratio in the range of 2 to 5 is used for drawing the filament. Further, these filaments are cut into required length and used in FRC composition.

Figure 2 depicts the process steps for manufacturing staple fibers having gear shaped cross section. As shown in **Figure 2**, spinneret (11) is used to produce single tow of as-spun fiber. After passing through a series of rollers (12 and 13), the tow is collected in a can (14) followed by drawing the tow in drawing zone (15 and 16) for post spinning operation. After post spinning, the tow is passed through an annealer zone (17). The thus obtained tow is passed through a finish oil applicator where, a layer of oil is sprayed on the tow. The tow is then passed through a crimper (19) to obtain crimped fibers. Crimping is done to impart bulkiness to the fibers. These crimped fibers are then passed through a cutter (20) to obtain staple fibers having gear shaped cross section as shown in **Figure 3**, which can be used in the preparation of articles. A draw ratio in the range of 3 to 4 and a speed in the range of 150 to 180 m/minute are used for the staple fiber rout.

In accordance with another aspect of the present disclosure, there is provided a process for preparing a fiber reinforced cement composition. The process comprises the following steps:

Polyester fibers having gear shaped cross section are dispersed in water to obtain a dispersion of the polyester fibers in water. A slurry, comprising pulp and water is prepared. The slurry is then mixed with the dispersion to obtain a mixture. To this mixture, cement containing asbestos fibers and at least one filler are added gradually with continuous stirring to obtain the fiber reinforced cement composition.

In accordance with the present disclosure, the polyester, of the polyester fibers having gear shaped cross section, is at least one selected from the group consisting of polyethylene terephthalate (PET), polytrimethylene isophthalate (PTI), polybutylene terephthalate (PBT),

polytrimethylene terephthalate (PTT), polytrimethylene naphthalate (PTN), polybutylene naphthalate (PBN), polyethylene naphthalate (PEN) and vectran.

In accordance with yet another aspect of the present disclosure, there is provided a process of preparing an article from the fiber reinforced cement composition. The article prepared from the fiber reinforced cement composition of the present disclosure includes sheets, columns,
5 panels, slabs, shafts, boards, plinths, planks and tiles.

In accordance with the present disclosure, the article thus prepared comprises:

- polyester fibers having gear shaped cross section in an amount in the range of 0.05 to 5% by weight;
- 10 • cement in an amount in the range of 30 to 60% by weight;
- asbestos fibers in an amount less than 14% by weight;
- pulp in an amount in the range of 0.5 to 5% by weight; and
- at least one filler in an amount in the range of 30 to 50% by weight.

In accordance with one exemplary embodiment of the present disclosure, the article prepared from the fiber reinforced cement composition of the present disclosure is an FRC sheet. The
15 process of preparing the FRC sheets comprises the following steps:

The fiber reinforced cement composition is introduced in a mold and pressed using a hydraulic press at a predetermined pressure to remove the moisture present in the composition. The same pressure is maintained for 1 minute and then the press is slowly
20 removed. The sheets thus obtained, are placed in 90% humidity for 24 hours followed by water curing the sheets by keeping the sheets in water for a predetermined time and then the sheets are air cured to obtain the ready to use FRC sheets.

The above process for the manufacturing of FRC sheets is based on laboratory scale. On industrial scale, the the FRC sheets are manufactured by Hatscheck process. The fiber
25 reinforced cement composition is used for the manufacturing of FRC sheets. The process employs the use of a specific number of vats or containers and endless felt to form the layers of FRC sheets. Solids from the FRC composition get transfer from the vats to the felt to form the FRC sheets of specific thickness.

In accordance with the present disclosure, the FRC sheet made from the fiber reinforced cement composition of the present disclosure has density in the range of 1.25 to 1.4 gm/cm³ and an MR_A in the range of 170 to 190 kg/cm².

5 The present disclosure is further described in light of the following Laboratory experiments which are set forth for illustration purpose only and not to be construed for limiting the scope of the disclosure. The following experiments can be scaled up to industrial/commercial scale and the results obtained can be extrapolated to industrial scale.

Experiment 1: Preparation of Fiber Reinforced cement (FRC) composition

(1a) – preparation of polyester fibers having gear shaped cross section

10 Polyethylene terephthalate (PET) was melted at a temperature of 270 °C in an extruder to obtain a molten mass. The molten mass thus obtained, was passed through a spinneret having multiple gear shaped holes, wherefrom a plurality of filaments having gear shaped cross section were drawn.

15 The filaments coming out of the spinneret holes and having gear shaped cross section, were quenched using air. A quench air duct was maintained at a distance of 5 to 20 cm below the spinneret. Air at a flow rate of 0.6 m/s was blown and a temperature of 20 °C was maintained for quenching the filaments having gear shaped cross section. At this air flow rate and temperature, the filaments freeze and filaments of uniform gear shaped cross section as that of the spinneret holes, were obtained. These filaments were then passed through a finish oil
20 applicator followed by pig tail and a kiss roller. The filaments thus obtained were passed through a series of goddet rollers and wound on a spinning package at a speed of 3700 m/minute. A draw ratio of 2.3 was used for drawing the filaments.

The filaments from the spinning package were taken and passed through an annealer where the filaments were moderately heated. Further, the filaments were passed through a finish oil
25 applicator to provide lubrication to the filaments. The lubricated filaments were passed through a crimper to obtain crimped filaments. A cutter was used to cut the crimped filaments and to obtain staple fibers having gear shaped cross section. A draw ratio of 3 and a speed in the range of 160 m/minute was used for the staple fiber rout.

(1b) – Preparation of the Fiber Reinforced cement composition

The materials and their respective amounts used for preparing the fiber reinforced cement composition, are given below in Table 1.

S.no.	Material(s)		Amount (gm)
1.	gear shaped cross section fibers	polyethylene terephthalate (PET) fibers	0.7
2.	cement	ordinary portland cement (OPC)	79.6
3.	asbestos fibers		9.8
4.	pulp	cellulosic pulp	2
5.	filler(s)	fly ash	53
		Total solids	145

0.7 gm of polyethylene terephthalate fibers obtained from Experiment (1a), were dispersed in water to obtain a dispersion of polyethylene terephthalate fibers in water. 2 gm of pulp was added into the water to obtain a slurry. This slurry was added to the dispersion of polyethylene terephthalate fibers in water followed by mixing to obtain a mixture comprising polyethylene terephthalate fibers, pulp and water. 53 gm of fly ash was added to the mixture containing polyethylene terephthalate fibers, pulp and water, and the resultant mixture was stirred to obtain a stirred mixture. Finally, a mixture containing 79.6 gm of ordinary portland cement and 9.8 gm of asbestos fibers, was added to the stirred mixture followed by further stirring the mixture to obtain the fiber reinforced cement composition to be used for the preparation of articles.

Experiment 2: Preparation of FRC sheets from the Fiber Reinforced cement composition

The fiber reinforced cement composition obtained from Experiment 1 was used to make the FRC sheets. The fiber reinforced cement composition was introduced in a mold and pressed till a pressure of 550 bar was reached, using a hydraulic press to remove the moisture present in the composition. The pressure of 550 bar was maintained for 1 minute and then the press

was slowly removed. The sheets thus obtained, were placed at 90% humidity for 24 hours followed by keeping the sheets in water for 14 days for water curing and thereafter, the FRC sheets were air cured for 24 hours.

The density of the FRC sheet thus obtained was 135 gm/cm³.

5 Experiment 3: Evaluation of the Mechanical properties of the FRC sheet

The FRC sheet made from the fiber reinforced cement composition of the present disclosure as given in Experiment 2, was compared with the FRC sheet containing conventional circular cross section PET fibers. The amount of materials used in the preparation of FRC sheet from the fiber reinforced cement composition of the present disclosure and the FRC sheet made from the composition comprising conventional circular cross section PET fibers is shown here in Table 2 below.

Table 2:

S.no.	Material(s)	Amount used (gm)	
		FRC sheet containing gear shaped cross section PET fibers	FRC sheet containing conventional circular cross section PET fibers
1.	PET fibers (having gear shaped cross section)	0.7	---
2.	PET fibers (having circular cross section)	---	0.7
3.	ordinary portland cement (OPC)	79.6	79.6
4.	asbestos fibers	9.8	9.8
5.	pulp	2	2
6.	fly ash	53	53
	Total solids	145	145

The mechanical properties of the FRC sheet made from the fiber reinforced cement composition of the present disclosure as given in Experiment 2 were compared with the mechanical properties of the FRC sheet made from the composition containing conventional circular cross section PET fibers. The data thus obtained is tabulated in Table 3.

5 **Table 3:**

S.no.	Mechanical property	FRC sheet containing gear shaped cross section PET fibers	FRC sheet containing conventional circular cross section PET fibers
1.	MR_A (kg/cm ²)	171	145

As shown in Table 3, the MR_A of the FRC sheet made from the fiber reinforced cement composition of the present disclosure was 171 kg/cm² whereas the MR_A of the FRC sheet made from the composition containing conventional circular cross section PET fibers was 145 kg/cm². Thus, the FRC sheet comprising gear shaped PET fibers has an improvement of
10 18% in MR_A over the FRC sheet containing conventional circular cross section PET fibers. This is because the FRC composition of the present disclosure comprises gear shaped PET fibers which have high surface area as compared to the circular cross section PET fibers, which results in improved bonding between the gear shaped PET fibers and the cement matrix and also higher friction between the fibers and the cement matrix. Thus, the FRC sheet
15 comprising gear shaped PET fibers has an improved MR_A over the FRC sheet containing conventional circular cross section PET fibers.

TECHNICAL ADVANCEMENTS

The present disclosure described herein above has several technical advantages including, but not limited to, the realization of:

- 20
- FRC composition with reduced amount of asbestos fibers; and
 - articles made from the fiber reinforced cement composition of the present disclosure have improved mechanical properties.

Throughout this specification the word “comprise”, or variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated element, integer or step,

or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

The use of the expression “at least” or “at least one” suggests the use of one or more elements or ingredients or quantities, as the use may be in the embodiment of the invention to achieve one or more of the desired objects or results. While certain embodiments of the inventions have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Variations or modifications to the formulation of this invention, within the scope of the invention, may occur to those skilled in the art upon reviewing the disclosure herein. Such variations or modifications are well within the spirit of this invention.

The numerical values given for various physical parameters, dimensions and quantities are only approximate values and it is envisaged that the values higher than the numerical value assigned to the physical parameters, dimensions and quantities fall within the scope of the invention unless there is a statement in the specification to the contrary.

While considerable emphasis has been placed herein on the specific features of the preferred embodiment, it will be appreciated that many additional features can be added and that many changes can be made in the preferred embodiment without departing from the principles of the disclosure. These and other changes in the preferred embodiment of the disclosure will be apparent to those skilled in the art from the disclosure herein, whereby it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the disclosure and not as a limitation.

CLAIMS:

1. A fiber reinforced cement composition comprising:
 - i. polyester fibers having gear shaped cross section in an amount in the range of 0.05 to 5% with respect to the total mass of the composition;
 - ii. cement in an amount in the range of 30 to 60% with respect to the total mass of the composition;
 - iii. asbestos fibers in an amount less than 14% with respect to the total mass of the composition;
 - iv. pulp in an amount in the range of 0.5 to 5% with respect to the total mass of the composition; and
 - v. at least one filler in an amount in the range of 30 to 50% with respect to the total mass of the composition.
2. The fiber reinforced cement composition as claimed in claim 1, wherein said polyester fiber is characterized by:
 - linear mass density in the range of 0.6 to 10 denier per filament;
 - tenacity in the range of 2.0 to 10.0 grams per denier (gpd);
 - fiber elongation in the range of 5 to 50%; and
 - uster value in the range of 2 to 12%.
3. The fiber reinforced cement composition as claimed in claim 1, wherein the polyester, of said polyester fiber, is at least one selected from the group consisting of polyethylene terephthalate (PET), polytrimethylene isophthalate (PTI), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polytrimethylene naphthalate (PTN), polybutylene naphthalate (PBN), polyethylene naphthalate (PEN) and vectran.
4. The fiber reinforced cement composition as claimed in claim 1, wherein said filler is at least one selected from the group consisting of fly ash and hard ground waste.
5. A process for preparing fiber reinforced cement composition, said process comprising the following steps:

- a. dispersing polyester fibers having gear shaped cross section, in water to obtain a dispersion;
 - b. mixing pulp and water to obtain a slurry;
 - c. mixing said dispersion and said slurry to obtain a mixture; and
 - d. gradually adding to said mixture cement containing asbestos fibers and at least one filler with continuous stirring to obtain said fiber reinforced cement composition, wherein said asbestos fiber is present in an amount less than 14% with respect to the total mass of the composition.
6. A process for preparing an article using the fiber reinforced cement composition of claim 1, wherein said process comprises the following steps:
 - i. molding said fiber reinforced cement composition in a mold under pressure to obtain a molded mass; and
 - ii. air curing said molded mass to form said article.
7. An article manufactured by the process as claimed in claim 6, wherein said article comprises:
 - a. polyester fibers having gear shaped cross section in an amount in the range of 0.05 to 5% by weight;
 - b. cement in an amount in the range of 30 to 60% by weight;
 - c. asbestos fibers in an amount less than 14% by weight;
 - d. pulp in an amount in the range of 0.5 to 5% by weight; and
 - e. at least one filler in an amount in the range of 30 to 50% by weight.
8. The article as claimed in claim 7, wherein said article is characterized by:
 - i. density in the range of 1.25 to 1.4 gm/cm³; and
 - ii. MR_A in the range of 170 to 190 kg/cm².

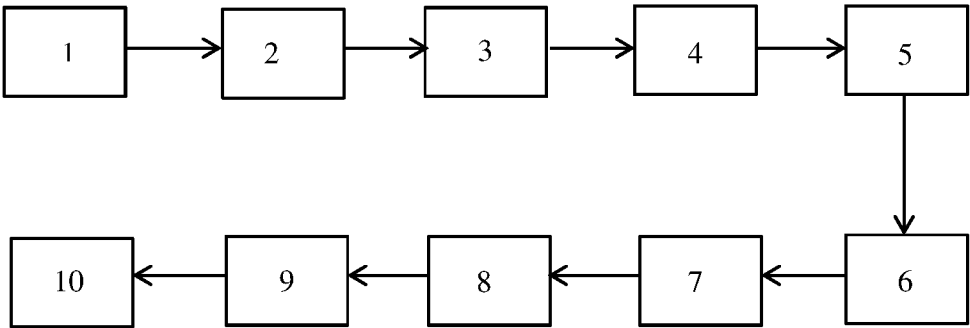


Figure 1

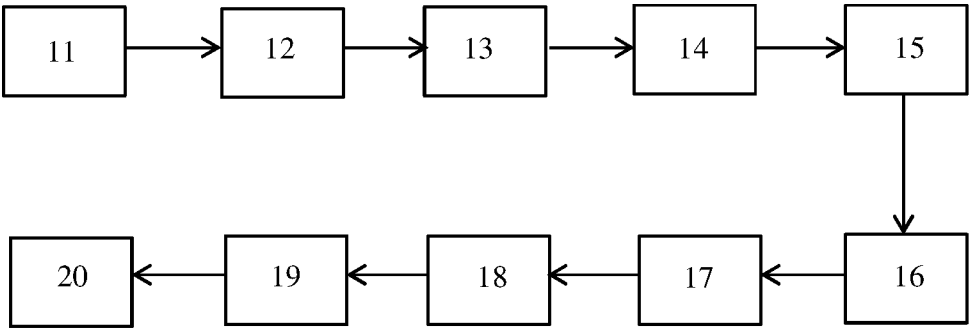


Figure 2

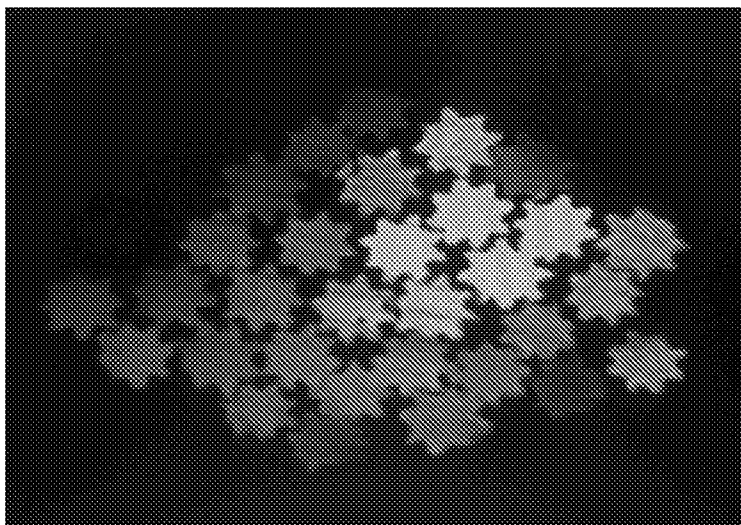


Figure 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2016/054003

A. CLASSIFICATION OF SUBJECT MATTER

E04C5/20, C04B28/00, C04B16/00, B28B1/00 Version=2016.01

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)

E04C5/20, C04B28/00, C04B16/00, B28B1/00

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)

Patseer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US6753081B1 (FORTA CORPORATION) (PUBLICATION DATE 22 JUNE 2004) Page 2 Lines 38-45, 59-63; Page 7 Lines 6-8	1-4, 7-8
Y	GB2042607A (AMIANUS) (PUBLICATION DATE 24 SEPTEMBER 1980) Page 2 Lines 56-63; Page 3 Lines 23-41	1, 4-8
Y	US20100147194A1 (CONCRETOS TRANSLUCIDOS, S. DE R.L. DE C.V.) (PUBLICATION DATE 17 JUNE 2010) Page 1 Para 5 Lines 2-6; Page 1 Para 17 Lines 3-13	1-7

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search

05-12-2016

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2016/054003

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