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(54) **Title:** RENDER COMPRISING HONEYCOMB AND CEMENTITIOUS OR CLAY OR GEOPOLYMER MATERIAL

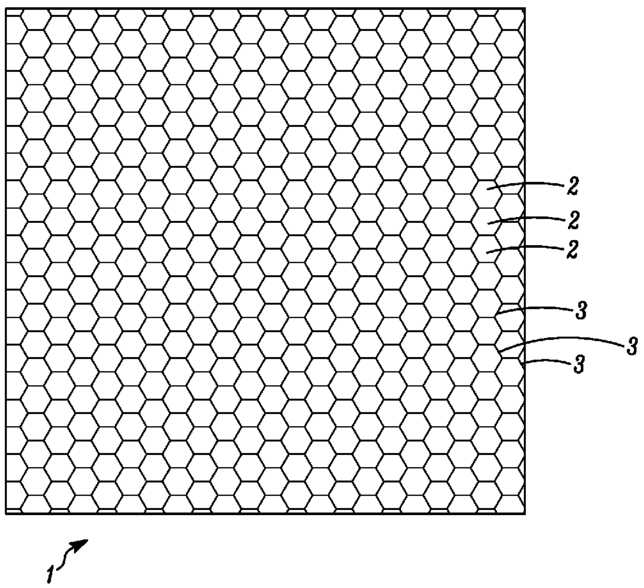

FIG. 1A

(57) **Abstract:** A render layer for a building comprises a honeycomb core of nonwoven polypropylene web, and a cementitious material fully filling the cells of the core, wherein (i) the nonwoven web has a porosity of from 5 microns to 600 microns, (ii) the core has a cell size of from 5 mm to 200 mm, (iii) the expansion and contraction across the plane of the core is greater than the expansion and contraction of the cementitious material filling the cells of the core, and (iv) the cementitious material is partly impregnated into the cell walls of the core.

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TITLE

RENDER COMPRISING HONEYCOMB AND CEMENTITIOUS OR CLAY OR GEOPOLYMER MATERIAL

BACKGROUND

1. Field of the Invention

This invention pertains to the field of building construction and, in particular, to reinforced crack-resistant render.

2. Description of Related Art

Cementitious materials are known to be fragile while under tensile load. The traditional solution to this problem is to reinforce the cement like matrix with rigid materials having high tensile strength and high modulus. In the construction field, steel bars are known to reinforce concrete matrix for structural parts. Another approach is to use a fiber glass net or grid to reinforce the render layer. A disadvantage of using such a grid is a tendency for the render to crack caused by the bad positioning of the grid. Further, resistance to shock perpendicular to the plane of the render is not optimal. There remains a need to reduce or eliminate the extent of render cracking in a building structure caused by strain in the render. This strain may be caused by contraction during curing of the render or by thermal expansion of the cured render.

Japanese publication JP11336249 discloses a thermal insulation and acoustic-proof wall panel structure for outer walls of buildings that has honeycomb panels in which mortar is filled into the cell walls of the honeycomb but not to fully fill the cell walls. The honeycomb is made from ceramic, aluminum or paper.

SUMMARY OF THE INVENTION

This invention pertains to a render layer for a building comprising

(i) a honeycomb core of nonwoven polypropylene web, and

(ii) a cementitious or clay or geopolymer material fully filling the cells of the core,

wherein

(a) the nonwoven web has a porosity of from 5 microns to 600 microns,

(b) the core has a cell size of from 5 mm to 200 mm, and

(c) the expansion and contraction across the plane of the core is greater than the expansion and contraction of the cementitious or clay or geopolymer material filling the cells of the core.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1A and 1B are representations of views of a hexagonal shaped honeycomb.

Figure 2 is a representation of another view of a hexagonal cell shaped honeycomb.

Figure 3 is an illustration of a cladding structure on a building wall.

DETAILED DESCRIPTION

Render Layer

The render layer for a building comprising a honeycomb core of nonwoven polypropylene web, and a cementitious material fully filling the cells of the core,

Honeycomb Core

Figure 1A is a plan view illustration of one honeycomb 1 of this invention and shows cells 2 formed by cell walls 3. Figure 1B is an elevation view of the honeycomb shown in Figure 1A and shows the two exterior surfaces, or faces 4 formed at both ends of the cell walls. The core also has edges 5. Figure 2 is a three-dimensional view of the honeycomb. Shown is honeycomb 1 having hexagonal cells 2 and cell walls 3. The “T” dimension or the thickness of the honeycomb is shown in Figure 2. Hexagonal cells are shown, however other geometric arrangements are possible with square, trapezoidal, over-expanded and flex-core cells being among the most common possible arrangements. Such cell types are well known in the art and reference can be made to *Honeycomb Technology* by T. Bitzer (Chapman & Hall, publishers, 1997) for additional information on possible geometric cell types.

The core has a cell size of from 5 to 200 mm, preferably from 5 to 50 mm and more preferably from 11 to 22 mm. The cell size is the diameter of an inscribed circle within the cell of the core that touches at least two cell walls.

In one embodiment, the core comprises a nonwoven polypropylene web having a porosity of from 5 microns to 600 microns. In another embodiment, the core comprises a nonwoven polypropylene web having a porosity of from 10 microns to 500 microns or even 80 to 120 microns. By porosity is meant the Apparent Opening Size (AOS) O_{95} as measured according to ASTM D4751-12. If the web porosity is less than 5 microns the cementitious material does not penetrate into the nonwoven web and thus there is no effective bond between those two materials. If the web porosity is greater than 600 microns the cementitious material can penetrate fully into the web and the cell walls lose its spring effect i. e. the ability of the cell walls to expand or contract. The core can be of any desired thickness but core thicknesses of from 5 – 12 mm are particularly useful.

It is a requirement of this invention that the expansion and contraction across the plane of the core is greater than the expansion and contraction of the cementitious material filling the cells of the core. In some embodiments the expansion and contraction across the plane of the core is at least 10% greater than the expansion and contraction of the cementitious material filling the cells of the core.

Cementitious Material

Cementitious material is a component of the render layer. Suitable cementitious materials include plaster, mortar or concrete. In other embodiments, the cementitious material may include mineral or a binder. The render may be organic or mineral in nature. In some embodiments, an organic render is preferred. Renders of clay or geopolymer concrete are also suitable materials. Typically a geopolymer concrete is characterized by long chains or networks of inorganic molecules.

The filled core structure may be produced by dispensing the wet cementitious material over the core so as to fill the cell walls followed by scraping off surplus cement or by placing the core into a wet slab of cement or by a combination of both. The cementitious material is then allowed to cure (set). In a preferred embodiment, the cementitious material fully fills the cells of the core.

Preferably the cementitious material is partly impregnated into the cell walls of the core. This partial impregnation, which is facilitated by the selected porosity of the web material, provides enhanced cohesive adhesion between the core and the cementitious material without the need for additional binding agents.

The greater expansion characteristics (dilatation capability) across the plane of the core when compared to the expansion characteristics of the cementitious material prevents micro-cracking of the render.

Cladding Structure

Figure 3 is a schematic of a composite cladding structure for a building wall, comprising in order

(i) an insulation layer,

(ii) the render layer of claim 1, and

(iii) at least one decorative layer,

wherein the insulation layer is affixed to the building wall mechanically and/or with adhesive.

In Figure 3, the building wall is shown as 31,the insulation layer as 33, the render (honeycomb core filled with cementitious material) layer as 34 and the at least one decorative layer is 35. For purposes of clarity, the figure is shown in a partly exploded view and the render is not shown inside the cells of the core.

Exemplary means of mechanically fixing the insulation layer to the building wall include bolts, nails, pins , screws, or staples. Exemplary adhesive materials for fixing the insulation layer to the building wall are liquids, films, powders or pastes. In some embodiments the ahesive may be supported by a lightweight scrim. An example of an adhesive bond is shown as 32 in Figure 3.

Examples of insulation materials are glass, aerogel or mineral fiber batts and foam such as expanded polystyrene or polyurethane foams.

Typically, the decorative layer is a thin render layer which is organic in nature, is pigmented and may optionally contain some hydrophobic agents. However, other materials may sometimes be used.

The compressive resistance of the honeycomb core helps to reduce impact damage to a cladded structure.

TEST METHODS

Experimental samples were tested according to the protocol of ETAG 004, Edition 2000, Amended February 2013 – External Thermal Insulation Composite Systems (ETICS) with Rendering. Two types of evaluation were completed (i) weathering in a climatic chamber to observe microcracking during curing and (ii) a shock or impact test with 10 Joules of energy from a 63.5 mm steel ball dropped from a height of 1.02 m (ISO 7892 issued 1998).

EXAMPLES

Shrinkage Evaluation

The render was a mineral material SM700 available from Knauf Insulation, Shelbyville, IN.

The render was poured to fully fill the cells of the core and allowed to harden. All examples were left for 30 days after pouring of the render in ambient conditions to allow shrinkage to develop. The temperatures generally ranged from 17 to 22 degrees C although temperature drops to as low as 14 degrees C occurred at weekends when the heating was turned off. Relative humidity was between 25 to 43% with one spike at 55 %. Shrinkage was evaluated in the long and short directions of the trapezoidal shaped cells.

Comparative Example A

This example comprised a 10mm thick slab of render without honeycomb core or any other reinforcement material.

Comparative Example B

This comprised a 10mm thick slab of render having a backing of fiberglass net type Gittex (mesh size 5mm) from Knauf.

Example 1

The core was made from 190 gsm Typar® polypropylene sheet available from E. I. DuPont de Nemours and Company, Wilmington, DE. The core thickness was 10mm. The cell shape approximated to a trapezoidal shape with a longest dimension of about 17 mm and a shortest dimension of about 12 mm. This gave a core that was more rigid in one direction, the long direction.

The core was filled to the top with render.

All examples showed continued shrinkage for the first three days with no further deterioration during the remaining 27 days of the evaluation. This latter level is referred to as the Steady State Shrinkage which is presented in Table 1.

Table 1

Example	Steady State Shrinkage (microns)
Comparative A	7500
Comparative B	3700
Example 1 (long direction)	3200
Example 1 (short direction)	4250

The results showed that the incorporation of a honeycomb structure into cementitious material as in Example 1 gave a product that significantly reduced the shrinkage of the render when compared to the honeycomb-free render of Example A and was comparable to that of the fabric backed render of Example B. This demonstrates the use of honeycomb having a web porosity as defined above to control shrinkage during curing of the cementitious material.

Impact Evaluation

Two series of test were carried out to evaluate impact resistance. The first series of tests were Comparative Examples C and D and inventive Examples 2-5. In all these examples the render was SM 700. All the examples were tested for impact resistance by measurement of residual deformation and a visual observation as to the extent of cracking.

All examples were prepared on a 1m x 0.5 m expanded polystyrene (EPS) plate that was 50 mm thick unless indicated otherwise. The EPS plate for Comparative Examples A-B and Examples 3-5 was placed in a metal frame representative of a window frame.

All samples were placed in a climatic chamber at 20 degrees C and 50 % relative humidity for 4 weeks to allow full curing of the cementitious material. The samples were then tested for impact resistance.

Comparative Example C

This consisted solely of a layer of a nominal 7mm thick layer of SM700 render.

Comparative Example D

This example was a 7 mm thick fiberglass net type Gittex (mesh size 5mm) from Knauf that was fully impregnated with SM700 render.

Example 2

This sample comprised a 7 mm thick core having a cell size of 11 mm made from 150 gsm Typar® polypropylene sheet. The core was filled with SM700 render.

Example 3

This was as Example 2 except that there was a 1 mm thick SM700 render layer on one outer surfaces of the core.

Example 4

This was as Example 3 except that the 1 mm thick render layer was a finishing render of SKAP 1.7 mm grain from Knauf.

Example 5

This was as Example 2 except that there was an additional 1 mm thick finishing render layer of SKAP 1.7 mm grain from Knauf on top of the 1mm thick SM700 render layer.

The results of the impact test are shown in Table 2. All samples cracked after impact.

Table 2

Sample	Residual Deformation (mm)
Comparative C	4.8
Comparative D	3.4
Example 2	3.6
Example 3	4.4
Example 4	5.0
Example 5	3.4

All the deformation values showed a relatively deep ball penetration and were considered to be statistically similar showing that the honeycomb containing examples performed no worse than the comparative examples.

The second series of tests were inventive Examples 6-16. All of these examples had core made from 190 gsm Typar® polypropylene sheet. The core thickness was either 7 mm or 10 mm and the cell size was 11 mm. The renders filling the core cells were both organic renders either type ZF-SIL 3585 from Brillux GmbH, Muenster, Germany or Plastol P394 from Knauf. In some examples there was also a 3 mm thick fiberglass net on top of the render filled core. In some other examples there was also a decorative layer as an outer surface. The decorative material was either Rausan KR K# 3517 from Brillux or SKA P311 from Knauf.

The results are summarized in Table 3.

Table 3

Example	Core Thickness (mm)	EPS Thickness (mm)	Render	Glass Layer	Deco Layer	Total thickness (mm)	Residual Deformation (mm)
6	10	10	Brillux	Yes	Rausan	14	2.2
7	10	10	Brillux	Yes	Rausan	14	2.4
8	10	10	Brillux	Yes	Rausan	14	2.1
9	10	50	Brillux	Yes	Rausan	14	2.0
10	10	50	Brillux	Yes	Rausan	14	3.0
11	7	50	Brillux	No	Rausan	8	2.8
12	7	50	Brillux	No	Rausan	8	2.2
13	10	50	Pastol	No	Skap	11	3.0
14	10	50	Pastol	No	Skap	11	2.7
15	7	50	Pastol	No	Skap	8	1.7
16	7	50	Pastol	No	Skap	8	2.6

The residual deformation of all Examples 6-16 was lower than those reported in Table 2. Further, none of the samples had cracks as a result of the impact.

CLAIMS

What is claimed is:

1. A render layer for a building comprising

(i) a honeycomb core of nonwoven polypropylene web, and

(ii) a cementitious or clay or geopolymer material fully filling the cells of the core,

wherein

(a) the nonwoven web has a porosity of from 5 microns to 600 microns,

(b) the core has a cell size of from 5 mm to 200 mm, and

(c) the expansion and contraction across the plane of the core is greater than the expansion and contraction of the cementitious or clay or geopolymer material filling the cells of the core

2. The render layer of claim 1 wherein the honeycomb core has a cell size of from 5 mm to 50mm.

3. The render layer of claim 1 wherein the cementitious material comprises plaster, mortar, concrete, mineral or organic binder.

4. The render layer of claim 1 wherein the nonwoven web has a porosity of from 80 microns to 120 microns.

5. The render layer of claim 1 wherein the expansion and contraction across the plane of the core is at least 10% greater than the expansion and contraction of the cementitious material filling the cells of the core.

6. The render layer of claim 1 wherein the cementitious or clay or geopolymer material is partly impregnated into the cell walls of the core.

7. The render layer of claim 2 wherein the honeycomb core has a cell size of from 11 mm to 22 mm.

8. A composite cladding structure for a building wall, comprising in

order

(i) an insulation layer,

(ii) the render layer of claim 1, and

(iii) at least one decorative layer,

wherein the insulation layer is affixed to the building wall mechanically and/or with adhesive.

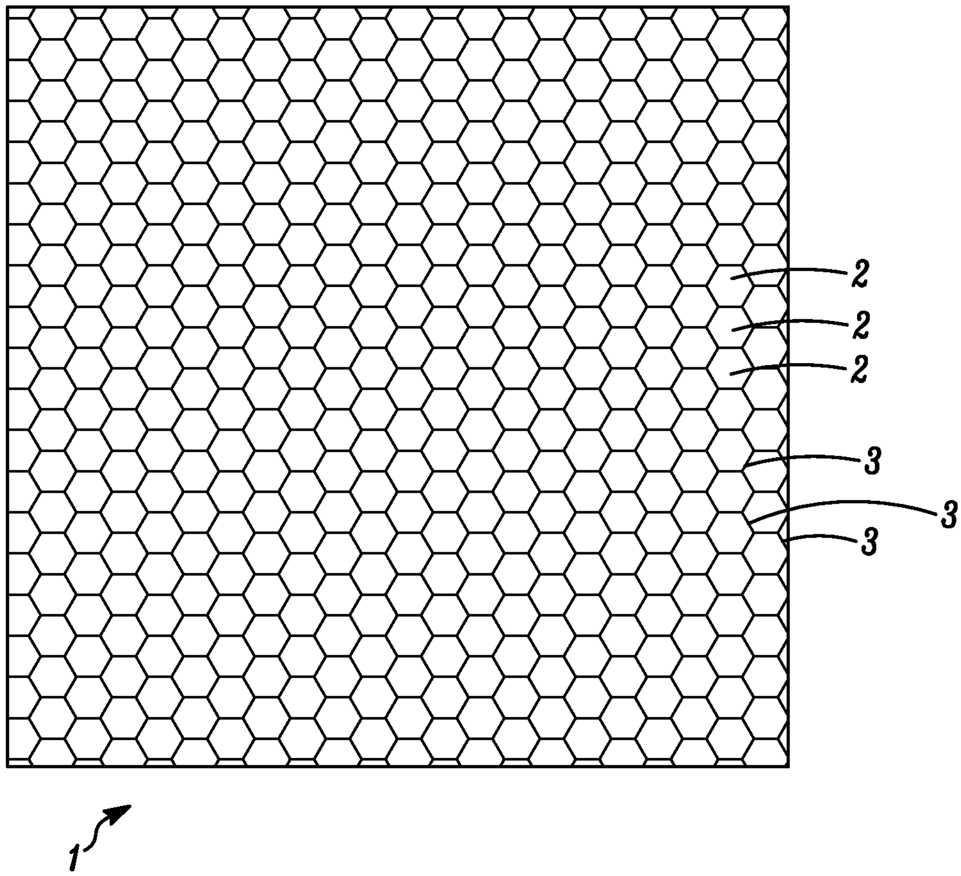

FIG. 1A

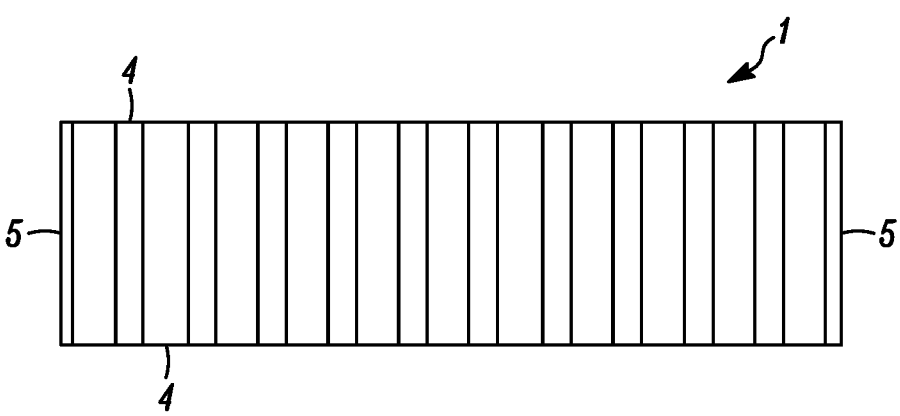

FIG. 1B

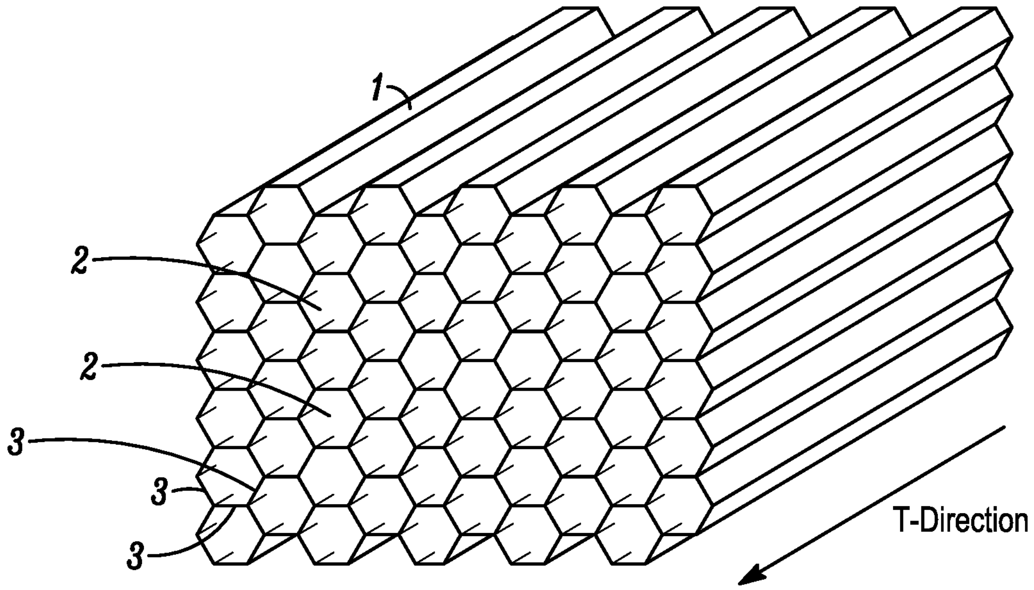

FIG. 2

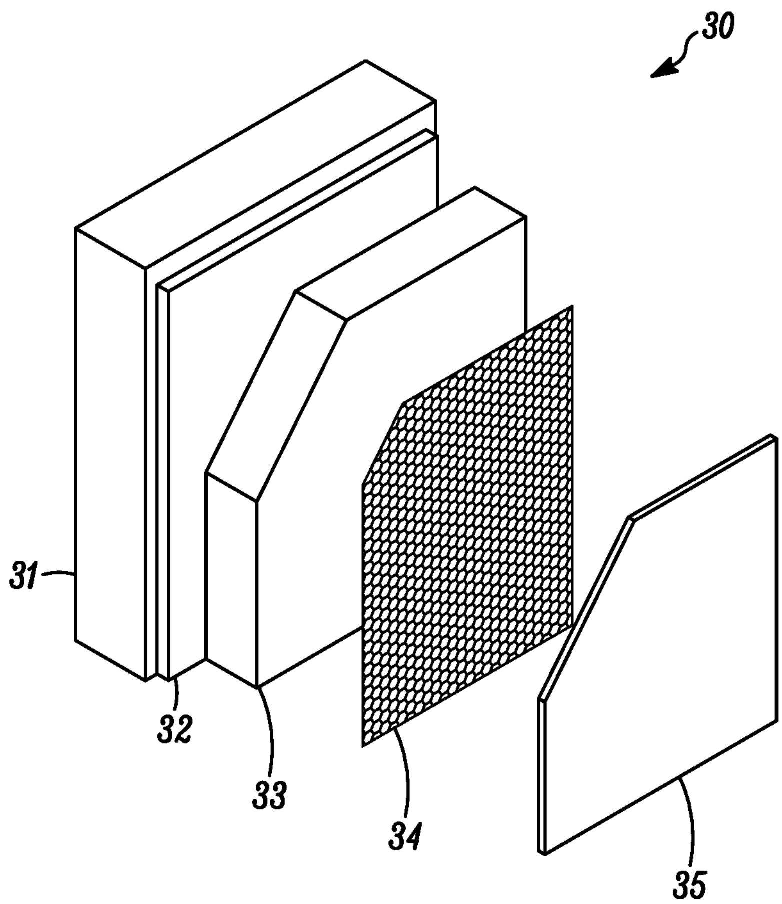

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/034377

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04C5/07 E04C2/06
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)
E04C

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	WO 2005/118275 A2 (PETRITECH INC [US]; MEIROWITZ RANDY E [US]; DYLAN TYLER M [US]) 15 December 2005 (2005-12-15)	1-8
Y	figures 1,9 paragraph [00112] paragraph [00129] paragraph [0051] paragraph [0047] paragraph [00111] paragraph [00276] paragraph [0086] paragraph [00169] -----	1-8

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[X] Further documents are listed in the continuation of Box C.

[X] 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

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"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
4 August 2017	11/08/2017

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 02/25034 A1 (JAMES HARDIE RES PTY LTD [AU]; NAJI BASIL [AU]) 28 March 2002 (2002-03-28) figures 1,2,3 page 4, line 4 - line 6 page 7, line 3 - line 7 page 9, line 5 - line 6 -----	1-8
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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