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(54) Title: AN ADDITIVE FOR INCREASING THE SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT IN CE-  
 MENT, MORTAR AND CONCRETE

(57) Abstract: The present invention relates to an additive for increasing the loading of supplementary cementitious materials like fly ash and granulated blast furnace slag in cement, mortar, concrete or precast concrete products. The additive according to the present invention generally comprises at least one of an alkali metal sulfate having a pH greater than 9, an alkali metal thiosulfate or an alkanolamine, where preferably the alkali metal is sodium and the alkanolamine is Triethanol amine. The additive may further include alkali metal nitrate, alkali metal carbonate, alkali metal hydroxide, Polyhydroxyalkylamine or combinations thereof. The additive significantly reduces the delay in setting time and increases early strength gain of concrete or cement containing a high proportion of pozzolanic substitute material for hydraulic or Portland type cement and often eliminates that delay.



AN ADDITIVE FOR INCREASING THE SUPPLEMENTARY CEMENTITIOUS MATERIALS  
CONTENT IN CEMENT, MORTAR AND CONCRETE

FIELD OF INVENTION

The present invention relates to an additive for increasing the loading of  
5 supplementary cementitious materials such as fly ash and slag in cement, mortar,  
concrete or precast concrete products. The additive manufactured according to the  
present invention may be used along with cement, mortar or concrete as an  
accelerating composition for increasing the compressive strength or for increasing  
the percentage loading of Granulated blast furnace slag (GGBFS) or fly ash etc.  
10 without affecting the initial strength gain. The additive according to the present  
invention generally comprises an alkali metal sulfate having a pH greater or equal to  
9, a first alkaline component and or alkali metal thiosulfates and or alkali metal  
carbonate and or alkanol amine. The composition may further comprise fly ash, a  
waste by product from a coal burning power plant.

15 BACKGROUND OF INVENTION

Construction related materials such as mortars, blocks, pavers, concretes and  
plasters are typically formed by combining an aggregate material, such as sand and  
gravel, with a cementitious binder (cement). The most common binder used in the  
world today is Ordinary Portland cement (OPC). OPC is a finely-ground material  
20 containing binding phases based on calcium, aluminum, silica and Iron. When a  
mixture of OPC and an aggregate is further combined with water, a hydration  
reaction occurs, and the mixture solidifies.

OPC has many benefits as a binder in concretes and related materials.  
Concretes produced using OPC are reasonably quick to set and cure to a high  
25 compressive strength. The raw materials for the manufacture of OPC are readily  
available and the cement itself is relatively cheap. Other cementitious materials, such  
as pozzolan or blast furnace slags, may produce structures with increased final

strength or durability, but the setting and curing of such materials tends to be inferior in comparison with OPC based materials. Thus, conventional cement compositions comprise a proportion of OPC even if other cementitious materials are also used.

In recent years, the environmental impact of various industrial processes has become a great global concern. These industrial processes produce substantial amount of waste materials having self or supplementary cementing properties (like slag and fly ash) which can be used beneficially in cement and concrete. The use of cementitious materials as partial substitutes for Portland cement in concrete has become an increasingly attractive alternative to using Portland cement alone. The desire to increase the use of fly ash, blast furnace slag and pozzolanic cement in concrete mixtures can be attributed to several factors. The production of OPC is a highly energy intensive process that involves various raw materials being heated in a kiln to temperatures greater than 1500° C., cooled, and then ground to a fine powder. It is estimated that about one tonne of carbon dioxide is released, as a result of chemical reactions that occur during heating and due to the combustion of fuels (1.6GJ/tonne), for every tonne of OPC produced. Other advantages of using such supplementary cementing materials along with cement and concrete include economic advantages, lower heat of hydration and improved permeability.

Even though the increased use of the supplementary cementitious materials such as fly ash or slag along with cement and concrete had numerous advantages, there is practically a limit to the maximum amount that can be used along with Portland cement. Using these materials at elevated levels can delay the setting time of the concrete and decrease the early strength gain. This imposes an unacceptable cost and time burden on end users.

There are commercial set time accelerators available in the market to decrease the setting time of concrete and such accelerators are not effective when the proportion of supplementary cementitious materials (like fly ash and slag) is increased. There remains a need to have an additive that will increase the percentage

loading of supplementary cementitious materials like fly ash or slag without affecting the initial setting time and strength gain.

The present invention discloses an additive having a pH greater than 9, that can be used to increase the percentage use of GGBFS or fly ash along with cement, mortars or concrete of any grade without affecting the initial strength gain or other properties.

#### PRIOR ART

1) Patent Application Number: CN104773973A

Title: Cement grinding aid and preparation method thereof

10 The invention describes a cement grinding aid comprising sodium sulfate, amine, glycol and polyol. The use of sodium thiosulfate or high pH sodium sulfate is not disclosed.

2) Patent Application Number: CN104909600A

Title: Composite cement grinding aid

15 A composite cement grinding aid is described, primarily a composition comprising Sodium thiosulfate, amine etc. The invention does not include high pH sodium sulfate.

3) Patent Application Number: WO2014118052A1

Title: Accelerator for mineral binding agents

20 The invention relates to the use of a thiosulfate as a setting accelerator for a mineral binder composition, in particular, a cement-containing binder composition comprising different types of thiosulfates. The use of high pH sodium sulfate is not disclosed.

## 4) Patent Application Number: WO2018122091

Title: Strength enhancing admixture for cementitious compositions

5 A strength enhancing admixture for cementitious and/or pozzolanic compositions is described comprising different types of sulfates, amines, carboxylate ethers etc., however, not including high pH sodium sulfate or thiosulfates.

## 5) Patent Application Number: WO2016207429

Title: Additive for hydraulically setting compositions

10 The invention relates to an additive for hydraulically setting compositions which is suitable more particularly as a slump retainer. It provides a colloidal composition comprising different inorganic salts of sulfates, phosphates, carbonates etc. The use of high pH sodium sulfate or thiosulfates is not taught by WO2016207429.

## 6) Patent Application Number: JP2010132547

15 Title: Cementitious mixture containing high pozzolan cement replacement and compatabilizing admixture therefor

20 A composition for cementitious mixtures containing the pozzolanic cement replacement is described, comprising different inorganic salts of thiosulfates, hydroxides, nitrates, thiocyanates, amines etc. JP2010132547 doesn't teach the use of high pH sodium sulfate.

## 7) Patent Application Number: US4256500

Title: Pozzolan Cement Compositions

25 The invention is a cement composition comprising cement, a pozzolan material, fine aggregate, air, water, at least one alkali metal constituent which includes sodium and at least one iron complexing anionic constituent. The

cement composition may further consist of at least one additional anion which may include thiosulfate, sulfate and nitrate. The pH for the alkali metal sulfate and a source of amine are not disclosed.

#### OBJECTS OF THE INVENTION

5           It is an object of the invention to provide a composition for increasing the percentage loading of supplementary cementitious materials in cement, concrete or precast concrete products.

          It is a further object of the invention to reduce the content of Ordinary Portland cement in cement/mortar/ concrete.

10           It is another object of the invention to increase the percentage loading of Granulated blast furnace slag (GGBFS) or fly ash etc. in the composition without affecting the initial strength gain.

          It is yet another object of the invention to provide an accelerating composition for increasing the compressive strength of the concrete

15           It is another object of the invention to beneficially use waste industrial material like slag and fly ash in the production of cement/mortar/ concrete.

          It is an object of the invention to reduce the cost of cement products.

          It is a further object of the invention to lower the heat of hydration and improve permeability of the cement.

20           It is another object of the invention to provide a composition that obviates the problem of using supplementary cementitious materials at elevated levels, namely, delayed setting time of concrete and decrease in early strength gain.

#### SUMMARY OF THE INVENTION

25           The present invention relates to an additive for increasing the loading of supplementary cementitious materials like fly ash and granulated blast furnace slag in cement, mortar, concrete or precast concrete products. The additive according to the present invention generally comprises at least one of an alkali metal sulfate having a pH greater than 9, an alkali metal thiosulfate or an alkanolamine, where

preferably the alkali metal is sodium and the alkanolamine is Triethanol amine. The additive may further include alkali metal nitrate, alkali metal carbonate, alkali metal hydroxide, Polyhydroxyalkylamine or combinations thereof. The additive significantly reduces the delay in setting time and increases early strength gain of concrete or cement containing a high proportion of pozzolanic substitute material for hydraulic or Portland type cement and often eliminates that delay.

#### DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a novel additive which enables a high percentage substitution of pozzolanic material in cementitious compositions comprising Portland cement and pozzolan. The present invention significantly reduces the delay in setting time and increases early strength gain of concrete or cement containing a high proportion of pozzolanic substitute material for hydraulic or Portland type cement and often eliminates that delay.

Pozzolanic cement substitute materials for hydraulic or Portland type cement which can be used in high proportions according to the invention include both Class C and Class F fly ash, blast furnace slag and natural pozzolanic materials or combinations thereof. These substitution materials can be used in proportions greater than 10% by weight, preferably greater than 15% by weight, and most preferably greater than 20% by weight of the hydraulic cement and cement substitute. However, it is most preferred that the cementitious mix comprises at least 50% by weight of Portland cement of the total weight of the combination of Portland cement and pozzolanic cement substitute material.

More specifically the invention relates to a composition comprising sodium sulfate having a pH greater than 9, a source of thiosulfate and a source of amine, to increase the loading of supplementary cementitious materials in cement, concrete and precast products.

Supplementary cementitious materials according to the present invention include fly ash (both Class C fly ash and Class F fly ash), blast furnace slag and natural pozzolanic material.

Preferably, the composition has components selected from the following:

- 5     a)     Alkali metal sulfate having a pH greater than 9
- b)     Alkali metal thiosulfate
- c)     Alkali metal nitrate
- d)     Alkali metal carbonate
- e)     Alkali metal hydroxide
- 10    f)     Polyhydroxyalkylamine

Preferable weight proportion of components of the composition:

- a)     Alkali metal sulfate having a pH greater than 9. (0.5-95%)
- b)     Alkali metal thiosulfate (0.5-60%)
- c)     Triethanol amine (0.2-20%)
- 15    d)     Water (0.1-80%)

An additive composition is provided consisting essentially of a source of alkali metal sulfate having a pH greater than 9, a source of alkali thiosulfate and a source of alkanolamine.

The additive of this invention can be added in powder form to a cement composition in weight percentage of 0.1-4% based on the total weight of the additive with clinker, supplementary cementitious material and gypsum. Further, the additive of this invention can be added to a cement, mortar or concrete composition, in the form of an aqueous solution where the weight percentage of the water in said aqueous solution is 0.1-80%, the weight percentage of the alkali metal sulfate is 0.5-95%, the weight percentage of the alkali metal thiosulfate is 0.5-60% and the weight percentage of the Triethanol amine is 0.2-20%. The additive of this invention when added to a cement composition in the form of an aqueous solution, the additive is

present in weight percentage of 0.1-5% based on the total weight of clinker, supplementary cementitious material and gypsum. The additive of this invention when added to a concrete composition in the form of an aqueous solution, the additive is present in weight percentage of 0.1-5% based on the total weight of  
5 cement and supplementary cementitious material.

The addition of the additive of this invention to a cement, mortar or concrete composition, increases the supplementary cementitious materials content to up to 70% of the total weight of said composition, without compromising on the compressive strength.

## 10 EXAMPLES

For the purpose of the examples/experimental data which follow, the following terms are defined:

Admixture - the composition normally used in concrete for the purpose of retaining the workability of concrete for a longer period.

15 Additive -the composition of the current invention, added to increase the supplementary cementitious loading (in this case slag or fly ash).

IST - Initial Setting time

FST - Final Setting time

Mpa - Megapascal

20 NC - Normal consistency

R-45 - Residue on 45 microns

CRF - Crushed rock fines

CEMENT TRIALS

Example 1: Cement trials using sodium sulfate (SS) having two different pH as additive.

| Parameters                        | With Sodium Sulfate (SS) pH of 10 | With SS pH of 7 |
|-----------------------------------|-----------------------------------|-----------------|
| % NC                              | 29.0                              | 29.5            |
| IST                               | 135                               | 130             |
| FST                               | 225                               | 215             |
| <b>Compressive Strength (Mpa)</b> |                                   |                 |
| 1 Day                             | 12.1                              | 10.9            |
| 3 Days                            | 28.1                              | 24.2            |
| 7 Days                            | 35.0                              | 29.4            |
| 28 Days                           | 45.0                              | 41.0            |
| Clinker (%)                       | 45                                | 45              |
| Slag (%)                          | 49                                | 49              |
| Gypsum (%)                        | 5                                 | 5               |
| Sodium Sulfate (%)                | 1                                 | 1               |

Sodium sulfate used in both the trials were in powder form. No other chemicals other than sodium sulfate was used.

Observation: It is noted that sodium sulfate with increased pH shows enhanced efficacy when compared to the sodium sulfate of low pH. This can be concluded by comparing the compressive strength results of Day 1, 3, 7 and 28.

Example 2: Cement trials with Sodium sulfate having a pH of 10 with increased slag percentage. Sodium sulfate used in both the trials were in powder form. No other chemicals other than sodium sulfate was used.

| Parameters                        | With No SS | With SS pH of 10 | With SS pH of 10 |
|-----------------------------------|------------|------------------|------------------|
| % NC                              | 26.5       | 26.8             | 26.5             |
| IST                               | 120        | 95               | 90               |
| FST                               | 205        | 160              | 175              |
| <b>Compressive Strength (Mpa)</b> |            |                  |                  |
| 1 Day                             | 17.4       | 18.8             | 18.9             |
| 3 Days                            | 34.0       | 41.7             | 42.2             |
| 7 Days                            | 50.2       | 52.2             | 55.4             |
| 28 Days                           | 63.8       | 67.8             | 69.5             |
| Clinker (%)                       | 50.0       | 49.0             | 45.0             |
| Slag (%)                          | 45.0       | 45.0             | 49.0             |
| Gypsum(%)                         | 5.0        | 5.0              | 5.0              |
| Sodium Sulfate (%)                | 0.0        | 1.0              | 1.0              |

Sodium sulfate used in both the trials were in powder form. No other chemicals other than sodium sulfate was used.

Observation: It is seen that upon adding sodium sulfate having a pH of 10, the slag percentage increases from 45 to 49 without compromising on the compressive strength. It is a known fact that whenever the supplementary cementitious loading is increased in cement, the strength decreases. Therefore, the efficacy of sodium sulfate with pH over 9 in aiding increase in loading of supplementary cementitious material without decreasing the cement strength is demonstrated.

10

Example 3: Cement trials with additive containing sodium thiosulfate and triethanolamine solution (35.7 % water, 53.6% Sodium Thiosulfate, 3.6% sodium sulfate having a pH 10, 7.1% Triethanol amine) with increased slag percentage.

| Parameters                                                | With No additive | With 0.25% of additive |
|-----------------------------------------------------------|------------------|------------------------|
| R-45                                                      | 20.6             | 16.4                   |
| IST                                                       | 120              | 115                    |
| FST                                                       | 200              | 200                    |
| <b>Compressive Strength (Mpa)</b>                         |                  |                        |
| 1 Day                                                     | 15.4             | 18.0                   |
| 3 Days                                                    | 32.4             | 29.7                   |
| 7 Days                                                    | 47.9             | 50.7                   |
| 28 Days                                                   | 63.1             | 68.7                   |
| Clinker (%)                                               | 49.0             | 45.0                   |
| Slag (%)                                                  | 46.0             | 50.0                   |
| Gypsum (%)                                                | 5.0              | 5.0                    |
| Additive (%)<br>(By weight of<br>Clinker+Slag+<br>Gypsum) | 0.0              | 0.25                   |

Observation: From this trial, it is seen that on using additive formed by combining sodium sulfate having a pH of 10 with sodium thiosulfate and triethanolamine, the slag percentage increased from 46 to 50 percentage without compromising on the compressive strength.

Example 4: Cement trials with additive containing sodium thiosulfate and triethanolamine solution (50% water, 45% Sodium Thiosulfate, 5% Triethanol amine) with increased fly ash percentage

| Parameters                                               | With No additive | With 0.5% of additive |
|----------------------------------------------------------|------------------|-----------------------|
| R-45                                                     | 20.0             | 14.0                  |
| IST                                                      | 180              | 140                   |
| FST                                                      | 250              | 225                   |
| <b>Compressive Strength (Mpa)</b>                        |                  |                       |
| 1 Day                                                    | 10.0             | 11.6                  |
| 3 Days                                                   | 25.5             | 24.3                  |
| 7 Days                                                   | 33.5             | 36.1                  |
| 28 Days                                                  | 50.3             | 62.8                  |
| Clinker (%)                                              | 70.0             | 65.0                  |
| Fly ash (%)                                              | 25.0             | 30.0                  |
| Gypsum (%)                                               | 5.0              | 5.0                   |
| Additive(%)<br>(By weight of<br>Clinker+Slag+<br>Gypsum) | 0.0              | 0.5                   |

Observation: From the above example it is seen that by combining sodium thiosulfate and triethanolamine, it is possible to increase the fly ash percentage from 25 to 30 percentage without compromising on the compressive strength

5

#### CONCRETE TRIALS

##### Example 5: Grade of Concrete -M-30

Additive Composition: 66.7% water, 26.6 % Sodium Sulfate with a pH of 10 and 6.7% Triethanol amine.

10

|                                                                | A     | B     | C     | D     | E     | F     | G     |
|----------------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| Cement (Kg/m <sup>3</sup> )                                    | 230   | 185   | 230   | 185   | 230   | 185   | 185   |
| GGBS (Slag) (Kg/m <sup>3</sup> )                               | 140   | 185   | 140   | 185   | 140   | 185   | 185   |
| % Slag Loading                                                 | 37.8  | 50    | 37.8  | 50    | 37.8  | 50    | 50    |
| Additive (In Litres) (0.5% by weight of Cementitious material) | 0     | 1.85  | 0     | 1.85  | 0     | 1.85  | 0     |
| CRF (Kg/m <sup>3</sup> )                                       | 803   | 803   | 803   | 803   | 803   | 803   | 803   |
| 10 mm (Kg/m <sup>3</sup> )                                     | 470   | 470   | 470   | 470   | 470   | 470   | 470   |
| 20 mm (Kg/m <sup>3</sup> )                                     | 725   | 725   | 725   | 725   | 725   | 725   | 725   |
| Water (Litres)                                                 | 160   | 160   | 160   | 160   | 160   | 160   | 160   |
| Admixture (Litres)                                             | 0.50  | 0.50  | 0.50  | 0.50  | 0.50  | 0.50  | 0.5   |
| <b>Compressive Strength (Mpa)</b>                              |       |       |       |       |       |       |       |
| 3 Days                                                         | 28.51 | 27.82 | 21.74 | 21.54 | 29.93 | 27.23 | 18.84 |
| 7 Days                                                         | 33.98 | 34.40 | 33.78 | 30.69 | 35.51 | 34.78 | 27.98 |
| 28 Days                                                        | 46.77 | 49.48 | 41.29 | 45.38 | 50.67 | 49.87 | 37.25 |

Observation: From the above trial, it is noted that by using a combination of sodium sulfate having a pH of 10 and triethanolamine, the slag percentage in concrete can be increased from 37.8 to 50 percentage without compromising on the compressive strength. The effect of additive can be seen from by comparing the results of Row B and Row G. Both the trials of Row B and G has a slag percentage of 50% but with use of the additive the compressive strength results are greatly enhanced.

Example 6: Grade of concrete - M 30

Additive Composition: 66.7 % water, 26.6 % Sodium Sulfate with a pH of 10 and 6.7% Triethanol amine.

|                                                              | A     | B     | C     | D     | E     | F     |
|--------------------------------------------------------------|-------|-------|-------|-------|-------|-------|
| Cement (Kg/m <sup>3</sup> )                                  | 300   | 260   | 300   | 260   | 300   | 260   |
| Fly ash (Kg/m <sup>3</sup> )                                 | 100   | 140   | 100   | 140   | 100   | 140   |
| % Fly ash Loading (%)                                        | 25    | 35    | 25    | 35    | 25    | 35    |
| Additive (1% by weight of Cementitious material) (In Litres) | 0     | 4.0   | 0     | 4.0   | 0     | 4.0   |
| CRF                                                          | 754   | 754   | 754   | 754   | 754   | 754   |
| 10 mm                                                        | 460   | 460   | 460   | 460   | 460   | 460   |
| 20 mm                                                        | 728   | 728   | 728   | 728   | 728   | 728   |
| Water (In Litres)                                            | 160   | 160   | 160   | 754   | 754   | 160   |
| Admixture (In Litres) (By weight of Cementitious material)   | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  | 0.40  |
| <b>Compressive Strength (Mpa)</b>                            |       |       |       |       |       |       |
| 3 Days                                                       | 18.68 | 19.09 | 24.8  | 20.16 | 23.38 | 25.31 |
| 7 Days                                                       | 29.63 | 25.13 | 28.36 | 27.20 | 28.60 | 32.31 |
| 28 Days                                                      | 42.21 | 41.62 | 47.20 | 47.75 | 39.50 | 40.97 |

Observation: From the above example it is demonstrated that by combining sodium sulfate having a pH of 10 and triethanolamine, the fly ash percentage in concrete is increased from 25 to 35 percent without compromising on the compressive strength.

5 Example 7: Grade of concrete - M 30

|                                           | A   | B   | C   |
|-------------------------------------------|-----|-----|-----|
| Portland Slag Cement (Kg/m <sup>3</sup> ) | 380 | 380 | 380 |

|                                                               |       |                           |                          |
|---------------------------------------------------------------|-------|---------------------------|--------------------------|
| Microfine Slag (Kg/m <sup>3</sup> )                           | 20    | 19                        | 19                       |
| Additive (Kg/m <sup>3</sup> )                                 | 0     | 1 Sodium Sulfate of pH 10 | 1 Sodium Sulfate of pH 7 |
| CRF (Kg/m <sup>3</sup> )                                      | 1008  | 1008                      | 1008                     |
| 10 mm (Kg/m <sup>3</sup> )                                    | 584   | 584                       | 584                      |
| 20 mm (Kg/m <sup>3</sup> )                                    | 392   | 392                       | 392                      |
| Water (In Liters)                                             | 0.37  | 0.37                      | 0.38                     |
| Admixture (In Liters)<br>(By weight of Cementitious material) | 0.45  | 0.45                      | 0.45                     |
| <b>Compressive Strength (Mpa)</b>                             |       |                           |                          |
| 3 Days                                                        | 19.17 | 20.26                     | 17.8                     |
| 7 Days                                                        | 31.53 | 33.36                     | 30.96                    |
| 28 Days                                                       | 48.69 | 49.82                     | 43.13                    |

Observation: From the compressive strength results it can be inferred that sodium sulfate having a pH of 10 provides enhanced results as compared to sodium sulfate having a pH of 7.

5 Example 8: Grade of Concrete - M 50

Additive Composition: 66.7 % water, 26.6 % Sodium Sulfate with a pH of 10 and 6.7% Triethanol amine.

|                             | <b>A</b> | <b>B</b> |
|-----------------------------|----------|----------|
| Cement (Kg/m <sup>3</sup> ) | 250      | 225      |
| Slag (Kg/m <sup>3</sup> )   | 200      | 225      |

|                                                                           |       |       |
|---------------------------------------------------------------------------|-------|-------|
| % Slag Loading                                                            | 44.4  | 50    |
| Additive<br>(1% by weight<br>Of Cementitious<br>Materials)<br>(In Liters) | 0     | 4.5   |
| CRF                                                                       | 754   | 747   |
| 10 mm                                                                     | 460   | 460   |
| 20 mm                                                                     | 728   | 722   |
| Water                                                                     | 144   | 144   |
| Admixture                                                                 | 0.50  | 0.50  |
| 3 Days                                                                    | ----- | 35.83 |
| 7 Days                                                                    | 38.38 | 42.56 |
| 28 Days                                                                   | 50.67 | 57.05 |

Observation: From the above example it is seen that by combining sodium sulfate having a pH of 10 and triethanolamine, the slag percentage in high grade concrete is increased from 44.5 to 50 percent without compromising on the compressive strength.

This invention is not necessarily restricted to the particular embodiments presented herein but the scope of the invention is to be defined by the terms of the following claims as given meaning by the preceding description.

## CLAIMS:

1. An additive for increasing the supplementary cementitious materials content in cement, mortar and concrete comprising at least one of: a) an alkali metal sulfate having a pH greater than 9; b) an alkali metal thiosulfate; and c) an alkanolamine.  
5
2. The additive as claimed in claim 1 which includes one or more of an alkali metal nitrate, an alkali metal carbonate, an alkali metal hydroxide and a Polyhydroxyalkylamine.
3. The additive as claimed in claim 1 wherein the alkali metal sulfate is sodium sulfate, the alkali metal thiosulfate is sodium thiosulfate and the  
10 alkanolamine is Triethanol amine.
4. The additive as claimed in claim 1 wherein the supplementary cementitious material is selected from the group comprising of fly ash, blast furnace slag and natural pozzolanic material or combinations thereof.
- 15 5. A cement composition wherein when the additive of claim 1 is added in powder form, said additive is present in weight percentage of 0.1-4% based on the total weight of the additive with clinker, supplementary cementitious material and gypsum.
6. A cement, mortar or concrete composition wherein when the additive of  
20 claim 1 is added in an aqueous solution, the weight percentage of the water in said aqueous solution is 0.1-80%, the weight percentage of the alkali metal sulfate is 0.5-95%, the weight percentage of the alkali metal thiosulfate is 0.5-60% and the weight percentage of the Triethanol amine is 0.2-20%.
- 25 7. A cement composition wherein when the additive of claim 1 is added in an aqueous solution, the additive is present in weight percentage of 0.1-5% based on the total weight of clinker, supplementary cementitious material and gypsum.

8. A concrete composition wherein when the additive of claim 1 is added in an aqueous solution, the additive is present in weight percentage of 0.1-5% based on the total weight of cement and supplementary cementitious material.
- 5 9. A cement, mortar or concrete composition wherein addition of the additive of claim 1 increases the supplementary cementitious materials content to up to 70% of the total weight of said composition, without compromising on the compressive strength.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IN2020/050098

| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>C04B7/04, C04B7/06, C04B7/12, C04B7/153, C04B22/06, C04B22/10, C04B22/14, C04B24/06, C04B24/12, C04B28/04, C04B28/08, C04B28/22 Version=2020.01<br>According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                    |                                                                   |           |                                                                                    |                       |   |                                                                               |     |   |                                                                               |     |   |                                                                      |     |   |                                                                  |     |   |                                                                  |     |
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| <b>B. FIELDS SEARCHED</b><br>Minimum documentation searched (classification system followed by classification symbols)<br>C04B<br>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched<br>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)<br>TotalPatent One, IPO Internal Database                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                    |                                                                   |           |                                                                                    |                       |   |                                                                               |     |   |                                                                               |     |   |                                                                      |     |   |                                                                  |     |   |                                                                  |     |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>WO2017085565A2 (EKO TECH4TRANS PVT. LTD [IN]); 26 May 2017 The whole document</td> <td>1-9</td> </tr> <tr> <td>A</td> <td>CA2853143A1 (CEMBLEND SYSTEMS INC. [CA]); 05 December 2014 The whole document</td> <td>1-9</td> </tr> <tr> <td>A</td> <td>US10000414B2 (US CONCRETE INC [US]); 19 June 2018 The whole document</td> <td>1-9</td> </tr> <tr> <td>A</td> <td>WO2013150145A1 (CHRYSO [FR]); 10 October 2013 The whole document</td> <td>1-9</td> </tr> <tr> <td>A</td> <td>AU6326790A (GRACE W R &amp; CO); 04 November 1991 The whole document</td> <td>1-9</td> </tr> </tbody> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                    |                                                                   | Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. | A | WO2017085565A2 (EKO TECH4TRANS PVT. LTD [IN]); 26 May 2017 The whole document | 1-9 | A | CA2853143A1 (CEMBLEND SYSTEMS INC. [CA]); 05 December 2014 The whole document | 1-9 | A | US10000414B2 (US CONCRETE INC [US]); 19 June 2018 The whole document | 1-9 | A | WO2013150145A1 (CHRYSO [FR]); 10 October 2013 The whole document | 1-9 | A | AU6326790A (GRACE W R & CO); 04 November 1991 The whole document | 1-9 |
| Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No.                                             |           |                                                                                    |                       |   |                                                                               |     |   |                                                                               |     |   |                                                                      |     |   |                                                                  |     |   |                                                                  |     |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | WO2017085565A2 (EKO TECH4TRANS PVT. LTD [IN]); 26 May 2017 The whole document      | 1-9                                                               |           |                                                                                    |                       |   |                                                                               |     |   |                                                                               |     |   |                                                                      |     |   |                                                                  |     |   |                                                                  |     |
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| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | AU6326790A (GRACE W R & CO); 04 November 1991 The whole document                   | 1-9                                                               |           |                                                                                    |                       |   |                                                                               |     |   |                                                                               |     |   |                                                                      |     |   |                                                                  |     |   |                                                                  |     |
| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                    |                                                                   |           |                                                                                    |                       |   |                                                                               |     |   |                                                                               |     |   |                                                                      |     |   |                                                                  |     |   |                                                                  |     |
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| Date of the actual completion of the international search<br>24-06-2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                    | Date of mailing of the international search report<br>24-06-2020  |           |                                                                                    |                       |   |                                                                               |     |   |                                                                               |     |   |                                                                      |     |   |                                                                  |     |   |                                                                  |     |
| Name and mailing address of the ISA/<br>Indian Patent Office<br>Plot No.32, Sector 14, Dwarka, New Delhi-110075<br>Facsimile No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                    | Authorized officer<br>Manoj Kumar<br>Telephone No. +91-1125300200 |           |                                                                                    |                       |   |                                                                               |     |   |                                                                               |     |   |                                                                      |     |   |                                                                  |     |   |                                                                  |     |

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

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