TITLE OF INVENTION: HOLCIM STRUCTURAL LIGHTCRETE

SPECIFICATIONS / DESCRIPTION

In today's situation when there is a scarcity of land and people look forward to additional floors for old buildings where foundation are not being able to withstand the higher dead weight of normal concrete. The answer is Holcim Structural Lightcrete – the light weight concrete but the problem till date was achieving higher strength as required for structural needs. The normal light weight concrete compressive strength in the range of 10 to 20 MPa in place of expected minimum Grade 35 to 40 MPa concrete as per the specification requirement of structural concrete. In view of the above, Holcim Structural Lightcrete was developed which is innovative and has many specialties as describe below:

1. This Structural Lightcrete is a lightweight concrete with compressive strength in the range of 35 to 40 MPa.
2. This unique product has been produced by judicious combination of light weight high strength aggregates, creating controlled annular air space, special mineral additives and producing the concrete by a specially designed process & equipment.
3. The density of concrete is in the range of 1600 to 1800 kg/m^3 against the normal concrete density of 2400kg/m^3. That means it has lower dead weight around 67 to 75% of the normal weight concrete and thus permitting additional floors or structural amendments on the old buildings where the foundation has limitation to take additional weight of normal weight concrete. Further, it can be used for the buildings / projects under design stage which will enable the Designer to have lesser load on foundation making it environment friendly and creating a possibility of constructive structures where there are problems of weak sub-soil conditions.
4. When use for structural light weight concrete walls, in addition to lower dead weights, it also provides improved insulation and acoustic properties of wall elements.
5. This product provides higher fire rated concrete structure as compared to normal concrete.
6. This permits alternation and additions of the structural member with minimal possible dead weight load.

CLAIMS

1. This unique product Holcim Structural Lightcrete concrete is characterized by the description and abstract indicated shall be having exclusive intelligent property rights for the inventor and anyone trying to utilize this combination directly or indirectly and copying the same would be breaching the patent rights filed for this product by the inventor and the said party would be liable for legal actions.

TITLE OF THE INVENTION

STRUCTURAL LIGHTWEIGHT CONCRETE AND THE METHOD OF FABRICATION THEREOF

FIELD OF THE INVENTION

The present invention relates generally to concrete and more specifically to structural lightweight concrete material and a method for making a structural lightweight concrete for buildings.

BACKGROUND OF THE INVENTION

Concrete is versatile building material comprising cement, aggregate, and water and it is prepared in aqueous slurry and is then allowed to cure in a mold of desired shape and size. After dehydration process, cement binds the aggregate in a hardened matrix having considerable compressive strength.

There are many building applications where relatively low density concrete or lightweight concrete is a suitable material. Lightweight concrete has the advantage and favourable insulation properties, although the full strength of normal concrete is insufficient.

Traditionally, there are two ways to achieve a low density concrete, that is by way of a low density aggregate such as pumice or other lightweight rock or by making low density concrete by the addition of foam to the concrete mix. However, the use of lightweight aggregate material is not always feasible, since it is generally unavailable in many locations where lightweight concrete may be required.

And for the second method, foam introduces small air bubbles into the slurry so that when the concrete cures, the air bubbles remain trapped therein, thus providing a so-called "cellular concrete" having a decreased overall density.

US Patent No. 7,794,825 discloses a lightweight, prefabricated modular concrete structure having a hollow configuration in the shape of a column; said concrete structure comprising a first exterior layer consisting of short length glass fiber reinforced concrete forming a smooth outer surface supported by a second interior layer consisting of long length glass fiber reinforced concrete; wherein said first layer of short length glass fibers produces a fine surface finish and replicates intricate design features on the external surface of said concrete structure; and wherein said column further comprises prefabricated end caps.

US Patent No. 6,402,830 discloses lightweight, durable concrete composition comprising: 55-65 weight percent cement, 1-4 weight percent expanded perlite, 35-45 weight percent pumice, and enough water to make smooth slurry of the cement, perlite, pumice and water composition.

US Patent No. 4,235,640 discloses method of treating scoria aggregate to reduce its absorption rate to make the scoria aggregate more suited as an aggregate for lightweight concrete, said method comprising: providing a slow or medium-setting asphalt emulsion; diluting the slow or medium-setting asphalt emulsion with water to provide a dilute asphalt emulsion; mixing aggregate consisting essentially of scoria aggregate with the dilute asphalt emulsion to impregnate the individual particles of the scoria aggregate with the dilute asphalt emulsion; and drying the scoria aggregate.

US Patent No. 4,351,670 discloses a method of making lightweight, substantially non-shrinking concrete comprising the steps of: (a) providing a body of cured cellular concrete material, said cellular concrete material being of a type whose curing is accompanied by substantial shrinkage; (b) breaking said body of cured cellular concrete material into fragments; (c) coating said fragments with a first cementitious material and allowing said cementitious material to cure; and (d) mixing said fragments, thus coated, with a second cementitious material for ultimate curing as a finished product, said second cementitious material being of a type whose curing is accompanied by minimal shrinkage.

U.S. Pat. No. 5,580,378 discloses a lightweight cementitious product made up of an aqueous cementitious mixture that can include fly ash, Portland cement, sand, lime and, as a weight saving component, micronized polystyrene particles having particle sizes in the range of 50 to 2000 μm and a density of about 1 lb./ft^3. The mixture can be poured into molded products such as foundation walls, roof tiles, bricks and the like. The product can also be used as a mason's mortar, a plaster, stucco or a texture.

JP 9 071 449 discloses a lightweight concrete that includes Portland cement and a lightweight aggregate such as foamed polystyrene, perlite or vermiculite as a part or all parts of the aggregate. The foamed polystyrene has a granule diameter of 0.1-10 mm and a specific gravity of 0.01-0.08.

US. Pat. Nos. 5,580,378, 5,622,556, and 5,725,652 disclose lightweight cementitious products made up of an aqueous cementitious mixture that includes cement and expanded shale, clay, slate, fly ash, and/or lime, and a weight saving component, which is micronized polystyrene particles having particle sizes in the range of 50 to 2000 μm, and characterized by having water contents in the range of from about 0.5% to 50% v/v.

U.S. Pat. No. 4,265,964 discloses lightweight compositions for structural units such as wallboard panels and the like, which contain low density expandable thermoplastic granules; a cementitious base material, such as, gypsum; a surfactant; an additive which acts as a frothing agent to incorporate an appropriate amount of air into the mixture; a film forming component; and a starch. The expandable thermoplastic granules are expanded as fully as possible.

US Patent No. 4351670 discloses a method of making lightweight, substantially non-shrinking concrete comprising the steps of: (a) providing a body of cured cellular concrete material, said cellular concrete material being of a type whose curing is accompanied by substantial shrinkage; (b) breaking said body of cured cellular concrete material into fragments; (c) coating said fragments with a first cementitious material and allowing said cementitious material to cure; and (d) mixing said fragments, thus coated, with a second cementitious material for ultimate curing as a finished product, said second cementitious material being of a type whose curing is accompanied by minimal shrinkage. The lightweight, non-shrinking concrete material comprises: cementitious slurry of a type whose curing is accompanied by minimal shrinkage; and fabricated aggregate, each of the individual particles of which comprises a core of cured cellular concrete of a type whose curing is accompanied by substantial shrinkage and a coating of cured cement.

US Patent No. 4235640 discloses a method of treating scoria aggregate to reduce its absorption rate to make the scoria aggregate more suited as an aggregate for lightweight concrete, said method comprising: providing a slow or medium-setting asphalt emulsion; diluting the slow or medium-

setting asphalt emulsion with water to provide a dilute asphalt emulsion; mixing aggregate consisting essentially of scoria aggregate with the dilute asphalt emulsion to impregnate the individual particles of the scoria aggregate with the dilute asphalt emulsion; and drying the scoria aggregate.

US Patent No. 4398958 discloses a method of making lightweight concrete comprising the steps of coating expanded polystyrene beads with an aqueous surfactant solution containing both a substantive cationic surfactant and a non-ionic surfactant, coating the wet beads with dry cement, and then mixing the cement-coated beads with a further supply of cement, water and sand or aggregate to complete the concrete mix.

US Patent No. 6488762 discloses a cellular concrete mixture comprising, by weight percent: (a) about 3% to 70% cement; (b) about 3% to 70% ground glass as a first cement substitute, wherein the ground glass is selected from the group consisting of mixed waste glass, flat glass, window glass, and mixtures thereof; (c) 0 to 60% of a second cement substitute; (d) a lime-containing material; (e) a gas-forming agent or foaming agent; and (f) at least 20% water.

US Patent No. 6616752 discloses a light weight aggregate for a casting compound that is bonded with a binder, comprising: a plurality of foam glass lumps of crushed foam glass, the foam glass lumps exhibiting a screen-analysis curve that is graded between 0 and a largest grain size with at least 3 fractions.

US Patent No. 6,676862 discloses a method of forming a lightweight concrete building unit, comprising: providing a first mold having a plurality of side walls defining at least one mold cavity; forming a batch of cementitious slurry by mixing at least one dry cementitious ingredient, water and a temperature sensitive foaming agent for producing air cells in the cementitious slurry, wherein the foaming agent has a critical temperature at which the foaming agent destabilizes, wherein the cementitious slurry is formed at a temperature below the critical temperature; heating the sidewalls of the first mold to at least the critical temperature; dispensing said batch of cementitious slurry into said at least one mold cavity; and compressing said cementitious slurry from a first position to a substantially precise second position within said first mold, wherein the heat from the mold enables the slurry to form into a building unit and the heat causes air cells in the building unit to collapse to yield a closed cell surface and a dense outer layer around a less dense, lightweight inner core, wherein compressing said cementitious slurry assists in further collapsing air cells to increase the density of the outer layer.

The present invention relates to structural lightweight concrete being made by using expanded shale/clay coarse aggregate which is advantageous as compared to conventional type of material and method, the concrete thus fabricated having substantially uniform dimensions and relatively consistent densities. The structural lightweight concrete material of the present invention enables the reduction in foundation loads, that is, smaller footings, fewer piles, smaller piles caps and less reinforcement steel. Dead loads are also reduced, that is, smaller support members (decks, beams, girders) and reduced inertial seismic loads. The product of the present invention facilitates rehabilitation work: New member / topping of existing floors, addition of member to old buildings without structural / foundation modification. The concrete material is of lower form pressure. The lightweight concrete material if used in wall elements, the insulation and acoustics thereof are improved.

SUMMARY OF THE INVENTION

A main object of the present invention is to provide a structural lightweight concrete material comprising:(a) expanded shale / clay coarse aggregate which is 5 – 15 mm in size, or 10 – 23 mm in size, and 1.30 SG or 0.6 SG; (b) a small quantity of washed copper slag (WCS); (c) a cementitious material conforming to CEM I (conforming to 52.5 N Grade and BS EN 197-1:2000) varying between 500 – 650 kg/m3 and undensified silica fume varying between 50 and 60 kg/m3; (d) a SNF based superplasticizer to achieve the desired consistency; (e) an air entraining agent being added to achieve an air content of 8 – 10%.

Yet another object of the present invention is to provide a structural lightweight composition , wherein the AIV of the aggregate varies from 16 – 37% depending up on the physical condition of the aggregate (SSD/oven dry).

Still a further object of the present invention is to provide a structural lightweight concrete material, wherein the aggregates have cellular segmented pore structure with solid volume varying between 40 and 70%.

Another yet object of the present invention is to provide a structural lightweight concrete material, wherein the amount of coarse aggregate in the mix varies from 250 to 350 kg per cubic meter of concrete.

Further object of the present invention is to provide a structural lightweight concrete material, further comprising natural sand (2.6 SG, FM 2.6 to 2.9) varying between 650 and 700 kg/m3.

Yet a further object of the present invention is to provide a structural lightweight concrete material, wherein the compressive strength of the concrete increases with the decreases air content in the mix.

Another main object of the present invention is to provide a method of making a structural lightweight concrete comprising the steps of (a) pre-wetting lightweight coarse aggregates by sprinkling water onto the aggregates; (b) bringing the wetted aggregates to SSD condition in a batching process; (c) introducing coarse aggregates, sand and silica fume into a mixer; (d) adding Portland cement and water to the mixture obtained in (c); (e) mixing the admixtures to the mix through the last portion of the mix water.

A further object of the present invention is to provide a method of making a structural lightweight concrete, wherein the total mixing time varies between 40 to 60 seconds.

Still a further object of the present invention is to provide a method of making a structural lightweight concrete, further comprising the step of adding a superplasticizer to the mix to adjust the slump to a required level.

It is an object of the invention to provide a structural lightweight concrete which has sufficient compressive strength in the range of 30-45 MPa (Characteristic Strength).

It is another object of the invention to provide a structural lightweight concrete which is produced by judicious combination of light weight high strength aggregates and mineral additives.

It is still another object of the invention to provide a structural lightweight concrete, wherein the density of the concrete is in the range of 1600 to 1800 kg/m3 against the normal concrete density of 2400 kg/m3.

Another object of the present invention is to provide a structural lightweight concrete, wherein the concrete is applicable in non-construction based application, such as in marine vessels, wherein the top up layer on the floors with minimum reduction in draft for the improvement in shallow shipping channels. In floating docks/platforms, for laying floor as the lightweight concrete do not affect the reserve buoyancy of the floating structure. For floating concrete, for urban greenery projects, backwater, beach, estuary) or for installation of solar panels on water bodies.

For a further understanding of the nature and advantages of the present invention, reference should be made to the remaining portions of the specification and drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram showing the main operations involved in making structural lightweight concrete according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The structural lightweight concrete material in accordance with the present invention is made by using expanded shale / clay coarse aggregate, which is 5 – 15 mm size, or 10 – 23 mm size, 1.30 SG or 0.6 specific gravity (SG). The average impact value (AIV) of the aggregate varies from 16 – 37% depending up on the physical condition of the aggregate (Saturated Surface Dry Condition (SSD)/oven dry). The aggregates in accordance with the present invention have cellular segmented pore structure with solid volume varying between 40 and 70%. The amount of coarse aggregate in the mix varies from 250 to 350 kg per cubic meter of concrete with balance consisting of natural sand with Specific Gravity of 2.6 and Fineness Modulus (FM) of 2.6 to 2.9) varying between 650 and 700 kg/m3. Addition of small quantity of washed copper slag (WCS) as a replacement to sand to the mix will decrease the thermal conductivity (k) but increase the unit weight / oven day density of the concrete. The cementitious materials in the preferred embodiment of the present invention are Portland cement conforming to CEM I (Portland Cement conforming to BS EN 197-1:2000 having 5% additional constituents and balance Portland Cement) (conforming to 52.5 N Grade) varying between 500 – 650 kg/m^3 and undensified silica fume varying between 50 and 60 kg/m^3. The water / cement ratio is maintained around 0.30 to 0.40 to achieve an initial slump of 100 +/-20 mm. A Sulphonated Napthalim Formaldelyde (SNF) based superplasticizer is added (1200 – 1400 ml / 100 kg cementitious material) to achieve the desired consistency. An air entraining agent is also added (300 ml / 100 kg cementitious materials) to achieve an air content of 8 – 10%. The compressive strength increases with decreases air content in the mix.

In accordance with the present invention, the lightweight coarse aggregates are pre-wetted before batching by sprinkling water and are brought to SSD condition at the time of batching. The coarse aggregates, sand and silica fume are first discharged into the mixer and mixed followed by Portland cement and water. The admixtures are added to the mix through the last portion of the mix water. The total mixing time varies between 40 to 60 seconds. A sample of concrete discharged from the

truck mixer (second discharge) is collected in a wheel barrow and tested for consistency through slump cone test. Superplasticizer is added to the mix to adjust the slump to the required level.

At site over vibration is avoided to ensure cohesiveness of the mix. In short, the steps of fabrication of the structural lightweight concrete are as follows: (a) pre-wetting lightweight coarse aggregates by sprinkling water onto the aggregates; (b) bringing the wetted aggregates to SSD condition in a batching process; (c) introducing coarse aggregates, sand and silica fume into a mixer; (d) adding Portland cement and water to the mixture obtained in (c); (e) mixing the admixture to the mix through the last portion of the mix water. In the present method, wherein the total mixing time varies between 40 to 60 seconds. The fabrication method further includes the step of adding a superplasticizer to the mix to adjust the slump to a required level.

FIG. 1 is a block diagram showing the fabrication process to obtain lightweight concrete in accordance with the present invention. Block 110 shows the pre-wetting step of structural lightweight coarse aggregates; sprinkling water is used and are brought to saturated surface dry condition (SSD) condition at the time of batching to obtain pre-wetted coarse aggregates (step 120) Next, as shown in step 130, the coarse aggregates, sand and silica fume are first discharged into a mixer so as to obtain a mixed composition. In step 140, the mixed composition then is mixed with Portland cement and water, and the admixtures are added to the mix through the last portion of the mix water, as shown in step 140. The admixtures are then proceeded to mixing step for 40-60 second, shown in block 150. The product shown in block 150 is proceeded to a consistency step by adding superplasticizer to the admixtures, shown in block 160. Then, the entire admixtures are proceeded to a hydration step, shown in block 170 .

The structural lightweight concrete is a light concrete having 28-day mean cube strengths between 38 and 53 MPa. The characteristic strengths with a margin of 8 MPa are 30 MPa to 45 MPa. The unit weight of the concrete is $\leq$ 2000 kg/m^3. On drying the cube in the oven the density will drop by 4 – 8% from the wet density. The thermal conductivity (k) of the concrete in accordance with the present invention is between 0.4 and 1.2 W/m°K. The thermal conductivity increases with increasing evaporable water in the concrete. The coefficient of the thermal expansion (α) varies from 7 – 11 x 10^{-6} mm/mm/°C. The Static Modulus of Elasticity varies from 18 to 25 GPa depending on the 28-day mean cube strengths. The 28-day drying shrinkage is less than 200 microstrains.

In accordance with the present invention, the concrete because of cellular pore structure undergoes Internal Moist Curing and has lower drying shrinkage as water in the aggregate eases drying shrinkage of the concrete. Due to good elastic compatibility between aggregate and the matrix there are less chances of micro cracking in the ITZ and thereby leading to lower permeability and enhanced durability when exposed to aggressive environment. The aggregate also makes the ITZ stronger due to Pozzolanic action provided by silica rich lightweight aggregates.

In summary the present invention provides an improved structural lightweight concrete product and a method of fabricating the concrete.

While the above provides a full and complete disclosure of the preferred embodiment of the invention, various modifications, alternate constructions, and equivalents may be employed without departing from the true spirit and scope of the invention. For example, the proportions of materials disclosed are representative, but particular applications may require departure therefrom. Moreover,

while all the material at each stage of the process (except for by-product) is shown as being used in subsequent stages, it should be understood that various amounts of material of different sizes could be diverted for fill and other uses rather than as part of the low density concrete mix. Therefore, the above description and illustrations should not be construed as limiting the scope of the invention, which is defined by the appended claims.

We claim:

1. A structural lightweight concrete comprising:(a) expanded shale / clay coarse aggregate which is 5 – 15 mm in size, or 10 – 23 mm in size, and 1.30 SG or 0.6 SG; (b) a small quantity of washed copper slag (WCS); (c) a cementitious material varying between 500 – 650 kg/m3 and undensified silica fume varying between 50 and 60 kg/m3; (d) a Sulphonated Naphthalene Formaldehyde (SNF) based superplasticizer to achieve the desired consistency of concrete; and (e) an air entraining agent being added to achieve an air content of 8 – 10%.
2. The structural lightweight concrete as set forth in Claim 1, wherein the Aggregate Impact Value (AIV) of the aggregate varies from 16 – 37% depending up on the physical condition of the aggregate (Saturated surface dry (SSD)/oven dry).
3. The structural lightweight concrete as set forth in Claim 1, wherein the aggregates have cellular segmented pore structure with solid volume varying between 40 and 70%.
4. The structural lightweight concrete as set forth in Claim 1 or 2, wherein the amount of coarse aggregate in the mix varies from 250 to 350 kg per cubic meter of concrete.
5. The structural lightweight concrete as set forth in Claim 1, further comprising natural sand (2.6 SG, FM 2.6 to 2.9) varying between 650 and 700 kg/m^3.
6. The structural lightweight concrete as set forth in Claim 1, wherein the compressive strength of the concrete increases with the decreases air content in the mix.
7. The structural lightweight concrete as set forth in Claim 1, wherein the cementitious material is Portland cement.
8. The structural lightweight concrete of Claim 1, wherein the water / cement ratio is maintained around 0.30 to 0.40 to achieve an initial slump of 100+/-20 mm.
9. The structural lightweight concrete of Claim 1, wherein the SNF based superplasticizer added is in an amount 1200 – 1400 ml / 100 kg cementitious material.
10. The structural lightweight concrete of Claim 1, wherein air entraining agent added is in an amount 300 ml / 100 kg cementitious material.
11. The structural lightweight concrete of Claim 1, wherein the addition of small quantity of washed copper slag to the mix decreases the thermal conductivity (k) but increases the unit weight / oven day density of the concrete method of making lightweight concrete.
12. The lightweight concrete of Claim 1, wherein the Portland cement has undensified silica fume ranging between 50 and 60 kg/m^3
13. A method of making a structural lightweight concrete comprising the steps of (a) pre-wetting lightweight coarse aggregates by sprinkling water onto the aggregates; (b) bringing the wetted aggregates to SSD condition in a batching process; (c) introducing coarse aggregates, sand and silica fume into a mixer; (d) adding Portland cement and water to the mixture obtained in (c); and (e) mixing the admixture to the mix through the last portion of the mix water.
14. The method of making a structural lightweight concrete as set forth in Claim 13, further comprising the step of adding a superplasticizer to the admixtures to obtain consistency concrete.
15. The method of making a structural lightweight concrete as set forth in Claim 13, further comprising the step of hydrating of the concrete.
16. The method of making a structural lightweight concrete as set forth in Claim 13, wherein the total mixing time varies between 40 to 60 seconds.