Nano Technology in Concrete Future (KandCrete)

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ABSTRACT: We all aim to reach concrete structures (low to medium-rise) that resist external environmental factors (hot climates- humidity- coastal environment- earthquake-prone areas - frost areas - high-noise environment - the environment surrounding industrial areas- the weather fluctuation environment- storm areas- ... etc.) characterized by high fire resistance (externally and internally), at the same time it achieves higher structural balance rates, achieves higher sustainability rates and higher durability with a longer life than its counterparts. All this is achieved by using lightweight structural concrete with totally environmentally friendly materials that do not involve any harmful substances, that concrete we called (Kandcrete) is the concrete of the future because with all these features we do not use any (unconventional) materials, as they are composed of gravel (coarse aggregates) and sand (fine aggregate) and cement (ordinary or resistive) have the same composition proportions as any conventional concrete, but with the addition of some Micro & Nano components to get all of these advantages, Without a significant increase in cost.

Keywords: Cellular concrete , abrasion , ASTM , fire &heat resistance, permeability, physical properties , PH, strength , sulfate & chloride content.

INTRODUCTION

There are different types of Structural Lightweight Concrete (ACI 211.2-98): light concrete with a structural nature, and ongoing research is carried out to improve the physical and structural properties of it, by using aggregates with specific properties or by adding improved materials to the mixture - But what differs in our topic is that we have used the same components for any constructional concrete anywhere in the world and almost the same proportions, but with making it distinguished by the characteristics and advantages of light concrete - meaning that we have reached concrete with a density less than that of conventional concrete (1600 to 1850 kg/m³), so we have reduced weight by 25 % to 35% by weight of conventional concrete, while retaining all required structural characteristics, but with higher engineering rates than others - and we added new features to it which are all the above mentioned properties for cellular concrete. In order to take advantage of all of these wonderful properties, practical thinking must be used by using a structural system that efficiently achieves these advantages on the ground. The structural system is: the use of that concrete as an external and internal load bearing walls, by making a form for the whole house walls with the synthesis of all openings, installing all service supplies (plumbing - electricity - air conditioning …etc.) and then installing a single-layer mesh of rebar (or sufficiency) by placing steel reinforcement in the corners and intersections, and using the fiberglass as an add-on for concrete); then pouring the ceiling with the same intensity (or with prefabricated slabs of the same concrete) ; work is repeated in the case of repeated floors with the placement of (vertical dowels) in the lower walls to connect the upper walls to it; thus structurally, we obtain fully structural system integral components and members, where there is no any joints or links, no welds, no (thermal bridges) – we get one body that works as a one structural unit with a full distribution of loads in various loading states, without any opportunity for differential settlement or great settlement or defects in other members (cracking – deflection – deformation - weak connections - buckling – torsion..etc.), (Kandcrete) concrete is characterized by being easy to operate (handling - casting - forming) as it is self-compacting & self-leveling, so the percentage of appearance of casting defects (nesting..etc) is lacking, especially around openings, in corners, vertical edges andintersections, so we get completely sound structure - intact structurally & outwardly and free from the disadvantages of traditional concrete, in addition to the stability of the structure thermally because the coefficient of thermal expansion of the concrete body used, is much lower than the other traditional structures.

This system is used up to ten (+) floors high, completely safe. The structural system with (Kandcrete) concrete: is easily and quickly implemented - the union of all structural elements, does not need structural or appearance maintenance, often for a long time - retains its luster and appearance for many years, as it does not show symptoms of weakness or weariness over time - maintains a high structural efficiency which It makes its economic value alwayshigh - the default longevity of its counterparts to a large degree - it achieves the highest levels of comfort in terms of isolating the residential area from all harmful external factors, annoying or damaging, and it achieves safety from wind, humidity,heat, frost, weather fluctuation, and Reduces energy consumption to the extreme, this alone is high economic value at the individual level and the international level.

General View

When lightweight concrete is used structurally, its load-bearing function is normally the priority and its thermal benefits are considered beside other benefits such as fire resistance. Therefore, this project aims to produce foamed concrete with a satisfactory strength suitable for structural purposes reaches HSC strength, with good insulation and durability properties. Furthermore, knowing about the fundamentals of how this concrete will behave and how to develop this material to make it capable of withstanding the mechanical, thermal, and permeation loadings is essential to improve its long-term durability. In other words, based on a fundamental understanding of the material behavior, its performance in service can be assessed. Therefore, in addition to the mechanical and thermal properties, the pore structure, permeation properties, and damage behavior of foamed concrete will also be of interest.

SUSTAINABILITY CONSIDERATIONS for "KANDCRETE"

Sustainability and green buildings: are currently hot topics in the construction industry, but durability and longevity have always been major reasons for selecting reinforced concrete as the construction material for buildings and other civil-infrastructure systems. Both initial and life-cycle economic considerations, as well as the thermal properties of concrete, also play major roles in the selection of reinforced concrete for buildings and other construction projects.

Sustainable/green construction: is not easily defined, In general, green buildings will be viewed somewhat differently by the owner, designer, and general public, but sustainable design is generally accepted as a compromise between economic considerations, social values, and environmental impacts.

Economic impact: is one of the three primary components of sustainable construction. Economic considerations include both the initial and life-cycle costs of either a building or component of the civil-infrastructure system. Whether cast-in-place or precast, reinforced concrete is normally produced using local materials and labor, and thus, helps to stimulate the local economy while reducing transportation costs and energy consumption. Efficient structural designs can reduce the total quantity of concrete and reinforcing steel required for different building components and innovative mix designs can include recycled industrial by-products to reduce the consumption of new materials and the amount of cement required per cubic yard of concrete. Concrete’s thermal mass and reflective properties can also reduce life-cycle energy consumption, and thus the operating costs for a building.

Aesthetics and occupant comfort:are major factors in evaluating the sustainability of a building. A well-designed and aesthetically pleasing building will have a low environmental impact and can be a source of pride for the local community. Concrete’s ability to be molded into nearly any form can make it particularly suitable for innovative and aesthetically pleasing architecture. A sustainable building should also provide a comfortable living and working environment for its occupants. Through its thermal mass properties, concrete can play a role in modulating interior temperatures, it can reduce natural lighting requirements because of its reflectance and ability to adapt to various methods of utilizing natural lighting, and it can reduce the use of potentially hazardous interior finishes because it can be used as a finished interior or exterior surface.

Durability of a structure:is an integral part of reducing the long-term costs and use of natural resources in a sustainable building. Many buildings change usage and owners over their service life and the longer a building can perform its required functions without undergoing major renovations, the more it benefits the overall society. Concrete has a long history of providing durable and robust structures, and while a fifty-year service life is typically discussed for most new construction, modern concrete structures are likely to have a service life that exceeds one hundred years.

Reducing the carbon footprint: is a major concern for all new construction and is often discussed in terms of CO2 emissions both during construction and over the life span of a building. Many items that reduce the energy consumption, and thus CO2 emissions, over the service life of a concrete structure have been noted in the previous paragraphs. One of the commonly noted concerns regarding concrete construction is the emission of green-house gases during the manufacture of cement. The three primary sources of CO2 emissions in cement production and distribution are: (1) the energy consumed to heat the kilns during cement production, (2) the release of CO2 from the limestone during the physical/chemical process that converts limestone, shale, clay, and other raw materials into calcium silicates, and (3) the transportation of cement from the point of manufacture to concrete production facilities. The cement industry is actively working to reduce CO2 emissions in all three areas through the use of alternate fuels to fire the kilns, plant modifications to improve energy efficiency, carbon capture and storage systems, and more fuel-efficient cement handling and distribution systems. As noted previously, the carbon footprint per cubic yard of concrete can also be reduced through the use of supplemental cementitious materials, such as fly ash, slag cement, and silica fume, to replace a portion of the cement in a typical mix design.

Sustainability considerations: are not typically incorporated into national building codes like the widely used International Building Code. The American Concrete Institute's Building Code Requirements for StructuralConcrete is the recognized standard for the design of concrete structures and is adopted by reference into the International Building Code. The ACI has recently established a sustainability committee (ACI Committee 130) that is tasked to work with other ACI technical committees, including the building code committee, to include sustainability issues in the design requirements for concrete structures. Many ACI documents and standards refer to materials standards developed by the American Society for Testing and Materials (ASTM) and ASTM has also developed a sustainability committee to work with its technical committees to include sustainability considerations in the development and revision of ASTM standards.

(KandCrete) AS STRUCTURAL LIGHTWEIGHT CONCRETE

Structural lightweight concrete is concrete having a density between 1450 to 1920 kg/m³ and containing naturally occurring lightweight aggregates such as pumice; artificial aggregates made from shales, slates, or clays that have been expanded by heating; or sintered blast-furnace slag or cinders. Such concrete is used when saving in dead load is important. Lightweight concrete costs about 20% more than normal concrete. The terms “all-lightweight concrete” and “sand-lightweight concrete” refer to mixes having either lightweight fine aggregates or natural sand, respectively. The modulus of elasticity of lightweight concrete is less than that of normal concrete and can be computed from Eq. The stress-strain curve of lightweight concrete is affected by the lower modulus of elasticity and relative strength of the aggregates and the cement paste.

If the aggregate is the weaker of the two, failure tends to occur suddenly in the aggregate, and the descending branch of the stress-strain curve is very short or nonexistent, The fracture surface of those lightweight concretes tends to be smoother than for normal concrete. On the other hand, if the aggregate does not fail, the stress-strain curve will have a well-defined descending branch, as shown by the curved lower solid line in this figure. As a result of the lower modulus of elasticity of lightweight concrete, the strain at which the maximum compressive stress is reached is higher than for normal-weight concrete. The tensile strength of all-lightweight concrete is 70 to 100 percent of that of normal-weight concrete. Sand-lightweight concrete has tensile strengths in the range of 80 to 100 percent of those of normal-weight concrete.

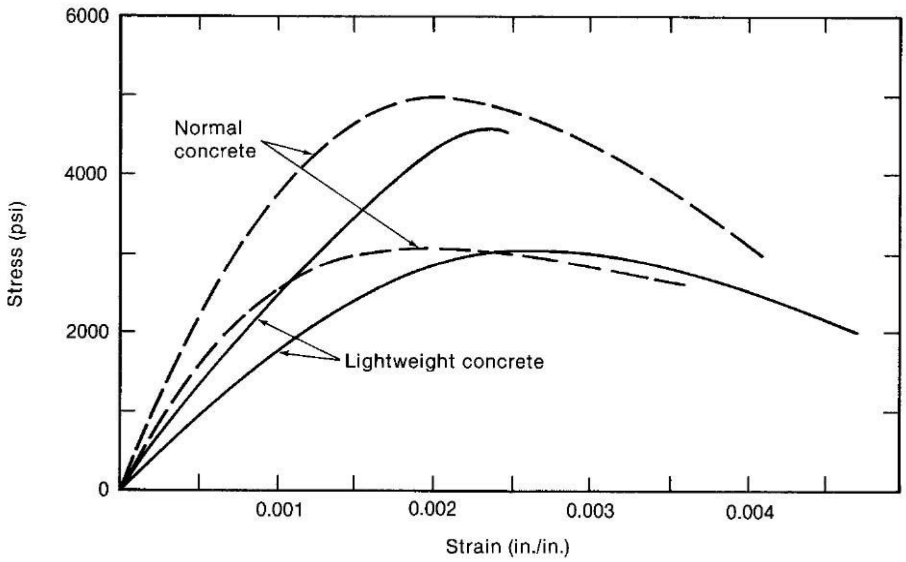


Fig. 1–Compressive stress–strain curves for normal-weight & lightweight concretes, fc=210 & 350 kg/cm²

FIBER-REINFORCED CONCRETE

Research on structural applications of fiber reinforced concrete has primarily focused on their use as shear reinforcement in beams and flat plates, and as shear/confinement reinforcement in elements subjected to high shear reversals, such as beam-column connections, structural walls, and coupling beams of earthquake-resistant structures In 2008 the ACI Code allowed for the first time the use of deformed steel fibers as minimum shear reinforcement in beams. To account for differences in performance between various fibers, as well as fiber contents, performance criteria are used for acceptance of fiber reinforced concrete, based on flexural tests as per ASTM 1609. Based on this material test, fiber reinforced concrete is considered acceptable for shear resistance if the residual strength obtained at deflections of 1/300 and 1/150 of the span length of the beam are greater than or equal to 90 percent and 75 percent of the first peak (cracking) strength, respectively.

DURABILITY CONSIDERATIONS for "KANDCRETE" CONCRETE

The three most common durability problems in concrete structures are the following:

1. Corrosion of steel in the concrete:

Corrosion involves oxidation of the reinforcement. For corrosion to occur, there must be a source of oxygen and moisture, both of which diffuse through the concrete. The alkaline nature of concrete tends to prevent corrosion from occurring. If there is a source of chloride ions, these also diffuse through the concrete, decreasing the pH of the concrete where the chloride ions have penetrated. When the pH of the concrete adjacent to the bars drops below about 10 or 11, corrosion can start. The thicker and less permeable the cover concrete is, the longer it takes for moisture, oxygen, and chloride ions to reach the bars. Shrinkage or flexural cracks penetrating the cover allow these agents to reach the bars more rapidly. The rust products that are formed when reinforcement corrodes have several times the volume of the metal that has corroded. This increase in volume causes cracking and spalling of the concrete adjacent to the bars. ACI Code Section 4.3 attempts to control corrosion of steel in concrete by requiring a minimum strength and a maximum water/cementitious materials ratio to reduce the permeability of the concrete and by requiring at least a minimum cover to the reinforcing bars. The amount of chlorides in the mix also is restricted. Epoxy-coated bars sometimes are used to delay or prevent corrosion.

Corrosion is most serious under conditions of intermittent wetting and drying. Adequate drainage should be provided to allow water to drain off structures. Corrosion is seldom a problem for permanently submerged portions of structures.

2. Breakdown of the structure of the concrete due to freezing and thawing:

When concrete freezes, pressures develop in the water in the pores, leading to a break-down of the structure of the concrete. Entrained air provides closely spaced microscopic voids, which relieve these pressures. ACI Code Section 4.4 requires minimum air contents to reduce the effects of freezing and thawing exposures. The spacing of the air voids is also important, and some specifications specify spacing factors. ACI Code Section 4.3 sets maximum water/cementitious materials ratios of 0.45 and minimum concrete strengths of 315 kg/cm² for concretes, depending on the severity of the exposure. These can give strengths higher than would otherwise be used in structural design. A water/cement ratio of 0.40 will generally correspond to a strength of 315 to 350 kg/cm² for air-entrained concrete. This additional strength can be utilized in computing the strength of the structure. Again, drainage should be provided so that water does not collect on the surface of the concrete. Concrete should not be allowed to freeze at a very young age and should be allowed to dry out before severe freezing.

3. Breakdown of the structure of the concrete due to chemical attack:

Sulfates cause disintegration of concrete unless special cementare used. ACI Code Section 4.3 specifies cement type, maximum water/cementitious materials ratios, and minimum compressive strengths for various sulfate exposures. Soils contain sulfates. Some aggregates containing silica react with the alkalies in the cement, causing a disruptive expansion of the concrete, leading to severe random cracking. This alkali-silica reaction is counteracted by changing the source of the aggregate or by using low-alkali cement. It is most serious if the concrete is warm in service and if there is a source of moisture. Reference lists some other chemicals that attack concrete. ACI Code Chapter 4 presents requirements for concrete that is exposed to freezing, thawing, deicing chemicals, sulfates, and chlorides. Examples are pavements, bridge decks, parking garages, water tanks, and foundations in sulfate-rich soils.

STRENGTH CONCRETE USING NANO-SILICA AND SILICA FUME

Based on the present experimental investigation, the following conclusions are drawn

1. While using the Nano silica solution in concrete, the original water-cement ratio of concrete mix is to be corrected by the amount of water available in the Nano silica solution.

2. Cement replacement with 10% Silica Fume leads to increase in Compressive Strength, Split Tensile Strength, and Flexural Strength.

3. For M40 Grade with Silica Fume 10% the percentage increase in Compressive Strength,Split Tensile Strength, and Flexural Strength are 13.21%, 9.5%, and 13.75% respectively.

4. For M50 Grade with Silica Fume 10% the percentage increase in Compressive Strength, Split Tensile Strength, and Flexural Strength are 6.46%, 4.62 %, and 5.17 % respectively.

5. There is an increase in Young`s Modulus of Concrete for M40 & M50 with Silica Fume 10% is 20.16%, and 26.38% respectivelyhigher than Conventional Concrete.

6. 1.5 % Nano silica appears to be the optimum in the Standard concrete mix like M40 without any admixtures. The highest compressive strength with 1.5 % Nano silica and 10% CSF appears to be the optimum in the present blended concrete mixes.

7. For M40 Grade with Nano Silica 1.5% and Silica Fume 10% the percentage increase in Compressive Strength, Split Tensile Strength and Flexural Strength are 19.6 %, 14 %, and 19.06 % respectively.

8. For M50 Grade with Nano Silica 1.5% and Silica Fume 10%the percentage increase in Compressive Strength, Split Tensile Strength and Flexural Strength are 21.79 %, 15.19 %, and 17.3 % respectively.

9. There is an increase in Young`s Modulus of Concrete for M40 & M50 with Nano Silica 1.5% and Silica Fume 10% is 50.70 % and 58.88 % respectively higher than Conventional Concrete.

10. The Compressive Strength of Cylinders for M40 & M50 with Silica Fume 10% is 17.14% and 11.07 % respectively higher than Convectional Concrete.

11. There is an increase in Compressive Strength of Cylinders for M40 & M50 with Nano Silica 1.5% and Silica Fume 10% is 27.12 % and 24.91 % respectively higher than Conventional Concrete.

Silica Fume Properties and Reactions in Concrete: Silica fume affects both the fresh and hardened properties of concrete. The effects on concrete are a result of the physical and chemical properties of silica fume.

Chemical Properties:

- Physical Properties.
- Reactions in Concrete.
- Comparison with Other Supplementary Cementitious Materials.

Physical Properties of Silica Fume:

-Particle size (typical): < 1 µm

-Bulk density (as-produced): 130 to 430 kg/m³

-(Densified): 480 to 720 kg/m³

-Specific Gravity: 2.6

-Specific Surface 15,000 to 30,000 m²/kg

Why Silica fume & Nano Silica is used in "Kandcrete" concrete?

Silica fume is used in concrete because it significantly improves the properties of fresh and hardened concrete. The potential for the use of silica fume in concrete was known in the late 1940s, but the material did not become widely used until the development of another concrete technology. This parallel technology is the use of powerful dispersants known as high-range water-reducing admixtures or super-plasticizers. Once these chemical admixtures became available and accepted, the use and development of silica fume in concrete became possible. Keep in mind that silica fume is a property-enhancing material- it is not a replacement material for Portland cement. Fly ash or ground granulated blast-furnace slag can be used as cement replacement materials. Note that these materials are frequently used in combination with Portland cement and silica fume.

Silica Fume and Fresh Concrete:

Increased Cohesion - Reduced Bleeding.

Silica Fume and Hardened Concrete:

Enhanced Mechanical Properties - Reduced Permeability.

Nano Silica:

Nanotechnology is the use of very small particles of material either by themselves or by their manipulation to create new large-scale materials. The size of the particles, though, is very important because at the length scale of the Nano-meter, 10^{-9} m, properties of the material actually become affected. The precise size at which these changes are manifested varies between materials, but is usually in the order of 100 nm or less.

The industry we see today is the result of a progression in science, technology, process, and business. In the same vein, nanotechnology is not a new science and it is not a new technology either. It is rather an extension of the sciences and technologies that have already been in development for many years and it is the logical progression of the Study and Performance of High Strength Concrete Using with Nano Silica and Silica Fume work that has been done to examine the nature of our world at an ever smaller and smaller scale.

Nano Technology in Concrete Industry:

Nano technology applied to concrete includes the use of Nano materials like Nano silica, Nano fibers, etc. By adding the Nano-materials, concrete composites with superior properties can be produced. The addition of Nano silica (NS) in concretes and mortars results in more efficient hydration of cement. Due to the pozzolanic activity, additional calcium silicate hydrates are formed to generate more strength and to reduce free calcium hydroxide. This also helps in reducing the cement requirements, NS improves the microstructure and reduces the water permeability of concrete thus making it more durable. The use of Nano silica in HPC and SCC improves the cohesiveness between the particles of concrete and reduces segregation and bleeding. Concretes with strengths as high as 100 MPa with high workability, anti-bleeding properties, and short de-molding time can be produced. Nano silica can be used as an additive to eco concrete mixtures.

In the case of eco concrete mixtures, industrial wastes such as fly ash, blast furnace slag are used as admixtures at certain percentages as replacement to cement. Certain problems like longer setting time, lower compressive strength at higher percentages can be overcome by adding NS which improves these properties. Condensed silica fume (CSF) which is a by-product of metallurgical industries when used as a partial replacement to cement (optimum 10 to 15 %) has been formed to contribute towards strength increase of concrete in addition to other beneficial properties.

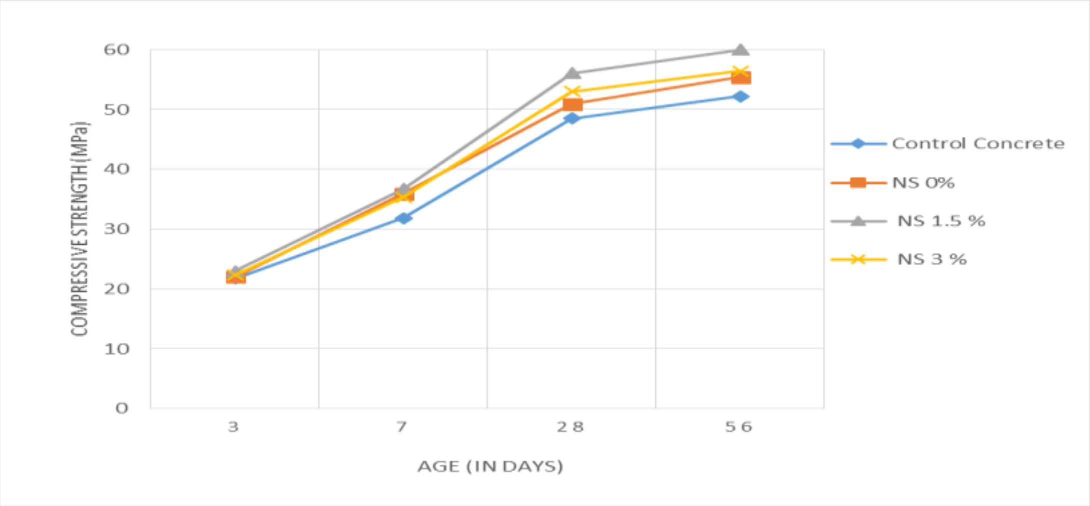


Fig. 2–Variation of Cube Compressive Strength of M40 Grade Concrete with age for different percentages of Nano-Silica and 5% Micro-silica.

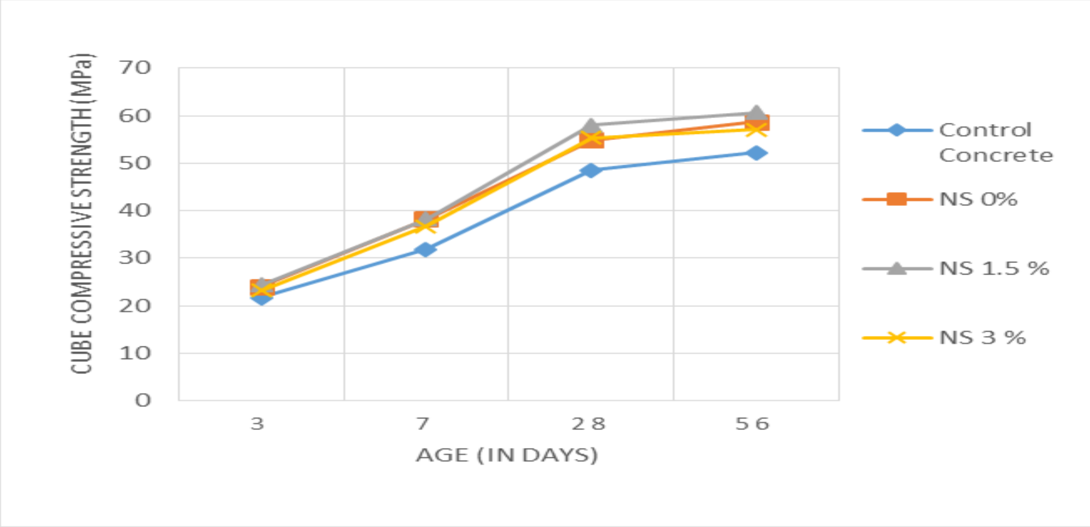


Fig. 3–Variation of Cube Compressive Strength of M40 Grade Concrete with age for different percentages of Nano-Silica and 10% Micro-silica.

"KANDCRETE" CONCRETE: TECHNOLOGY AND APPLICATION

Fresh Concrete: Flowable , Pumpable , easy workability, and no compaction necessary.

Hardened Concrete:

Adjustable in unit weight and strength, durable and stable in shape, Thermal insulating, higher resistance to fire, increased shrinkage, and not decomposable.

"Kandcrete" concrete in comparison with other materials:

When comparing "Kandcrete" concrete with other materials, one must keep in mind that:

• It is ecologically clean, “breathes”, and uninflammable.

• It is easy to produce in steady-state conditions as well as on a construction site.

• It is produced from components available in any region. & **• Its prime cost is low.**

"KANDCRETE" CONCRETE ADVANTAGES

- RELIABILITY: "Kandcrete" concrete is an almost ageless and everlasting material not subject to the impact of time. It does not decompose and is as durable as rock. High compression resistance allows to-use produce with lower volumetric weight while construction, which increases the temperature lag of a wall.

- MICROCLIMATE: "Kandcrete" concrete prevents loss of heat in winter, is humidity-proof, allows to avoid very high temperatures in summer, and control air humidity in a room by absorbing and output of moisture, thus helping create a favorable microclimate (Microclimate in a wooden house).

- QUICKNESS OF MOUNTING: Small density, and, therefore, lightness of "Kandcrete" concrete, large sizes of blocks compared with ordinary concrete, allows increasing the speed of laying by several times. "Kandcrete" concrete is easy to process and trim – to cut channels and holes for electrical wiring, sockets, and pipes. The simplicity of laying is reached through the high exactness of linear dimensions, the tolerance is +/- 1 mm.

- ACOUSTIC INSULATION : "Kandcrete" concrete has a relatively high property of acoustical absorption. In buildings constructed of porous concrete, the acting requirements for acoustic insulation are met.

- ECOLOGICAL COMPATIBILITY : During maintenance, "Kandcrete" concrete does not produce toxic substances and in its ecological compatibility is second only to wood. Compare: the coefficient of ecological compatibility of porous concrete is 2; of wood–1; of brick –10; of keramzite blocks – 20

- APPEARANCE : Due to high workability, it is possible to produce various shapes of corners, arches, pyramids, which will attach beauty and architectural expressiveness to your house.

- ECONOMY : High geometrical exactness of dimensions of concrete produce allows laying blocks on glue, to avoid “frost bridges” in a wall, and to make inner and outer plaster thinner. Foam concrete weighs from 10% to 87% less than standard heavy concrete. Sufficient reduction of weight leads to sufficient economy on basements.

- FIRE SAFETY : "Kandcrete" concrete is produced to protect from fire spread and correspond to the first degree of refractoriness, which is proved by tests. Thus, it is can be used in fire-proof constructions. Under the impact of intensive heat, like a blowlamp, on the surface of foam concrete, it does not split or blow, as it happens with heavy concrete. AS a result, an armature is longer protected from heating. Tests show that "Kandcrete" concrete 150mm wide can protect from fire for 7 hours. During tests carried out, an outer side of a concrete panel 150 mm wide was exposed to temperatures up to 700 C, opposite side heated to 160^c, refer to Fig. 8-Fire resistance test results.

"Kandcrete" As Lightweight Concrete: "Kandcrete"concrete, is a versatile material that consists primarily of a cement-based mortar mixed with at least 20% by volume air.

- It has high flow-ability, lowself-weight,minimal consumption of aggregate,controlled low strength & excellent thermal insulation properties.

- "Kandcrete" Concrete can be placed easily, by pumping, if necessary, & does not require compaction, vibrating or leveling. It has excellent resistance to water & frost, providing a high level of both sound & thermal insulation.

Significant improvements over the past 25 years in production equipment & better quality surfactants (foaming agents) have enabled the use of foamed concrete on a larger scale. Concrete design has evolved rapidly in the last 40 years. These changes have been reflected in national & hopefully will lead to global/international design, standards, performance, specifications & eventually codes. Improvements in factors such as performance, durability, permeability, binder (cement) constituent ratios, & limitations on impurities. This evolution, along with improved reinforcing steel strength, has to lead modifications in design philosophy - most notably the use of thinner structural members.

- Manufacturing: "Kandcrete" concrete is produced primarily by entrapping numerous small bubbles of air in cement paste or mortar. To get high performance, & quality foamed concrete, the selection of the materials is very important.

"Kandcrete" Concrete Raw Materials

- Normal Aggregate.
- Cement, preference Ordinary Portland Cement (OPC) or (SRC) 350 to 400 kg/m3
- Foaming Agent.
- Silica Fume min. 5% of cement content.
- Fiber: fiberglass.
- Water for concrete Mixture.
- Admixtures.

Portland cement: As per ASTM standard type I, II, III is preferred to use, because of their fineness & chemical composition. However, Ordinary Portland Cement [to BS 12:1996 (IS: 8112:1989) or BS EN 197: Part 1: 2000 (IS 1489-1 (1991))] is usually used as main binder for "Kandcrete" concrete.

Fine aggregate: Generally the fine aggregate shall consist of natural sand, manufactured sand, or a combination of them. The fine aggregate for concrete that are subjected to wetting, exposed to humid atmosphere, or in contact with moist ground shall not contain any material that are deleteriously reactive in cement to cause excessive expansion ofconcrete body.

Water: The water used for "Kandcrete" concrete should be potable. The water/cement (or binder) (w/c) ratio of the base mixrequired to achieve adequate workability is dependent upon thetype of binder(s), the required strength of the concrete, &whether or not a water reducing or a plasticizing admixture hasbeen used. In most cases, w/c ratio will be between 0.45 & 0.55.

Properties of "Kandcrete" Concrete

It can be distinguished into two distinct phases; the fresh/green concrete & the hardened concrete. Three main properties should be controlled in fresh concrete: workability, consistency & cohesiveness. On the other hand, for hardened concrete, the strength is the most important property of concrete. The physical properties of "Kandcrete" concrete are closely related to its density, which can be regarded therefore as the main design criterion. It is also dependent on material mix & the way of mixing. Several studies investigated the physical & mechanical properties of "Kandcrete" concrete cast in different densities. Beneficial properties associated with "Kandcrete" concrete include: Workability, Stability, Durability, & Flowability.

"KANDCRETE" concrete main material properties: "Kandcrete" concrete is an improved lightweight concrete with access to benefits of High strength concrete with higher durability & sustainability properties, using ordinary components of common concrete mixture but with some more additives to get our goals. The main properties are:

Semi dry Density: 1650 to **1850** kg/m³

Compressive strength: **Table 1 & (Figure 4,5)**

Sample	Dimension mm	Strength @ 28 days Kg/cm²	Strength @ 45 days Kg/cm²	Strength @ 240day Kg/cm²	Strength @ 570day Kg/cm²
R	Cube150x150x150	**368**	**443**	**523**	**620**
S	Cube150x150x150	**303**	**377**	**423**	**565**

Table 1–Compressive Strength of Cube Concrete (KandCrete) Specimensat different ages

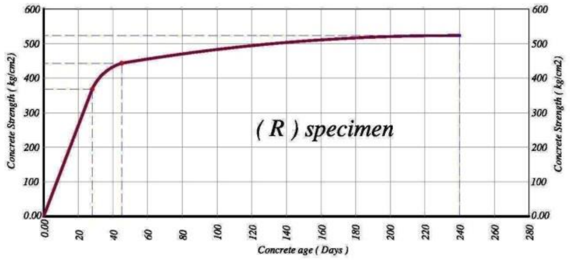


Fig. 4–Compressive strength for "Kandcrete" cube (150x150x150 mm) R specimen

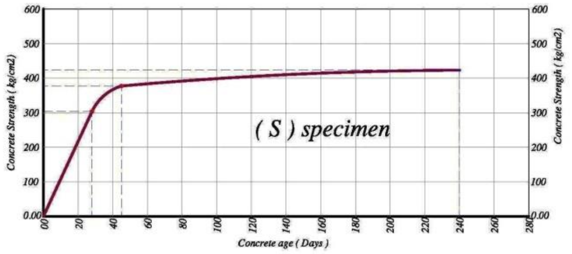


Fig. 5–Compressive strength for"Kandcrete" cube (150x150x150 mm) S specimen

<u>Heat transfer resistance:</u> The previous two types were tested (R & S) samples:

<u>Test method:</u> The lower sample surface displays mounting temperatures, and the corresponding heat is measured on the upper surface (**using aGerman-made PWH device equipped with an automatic printer and digital measuring devices for each sample**).

<u>In the first test:</u> The sample was exposed to a temperature= 65°c for 2.30 hours and then raised to 110° c for 2.30 hours.

<u>In the second test :</u> The sample was exposed to a temperature=110°c for 8 hours, temperature was recorded on the opposite side.

Heat Transfer Test Results

<u>Sample (R)</u>: At the end of the first test, the temperature recorded an increase of 8°c from the start of the test (5 hours) compared to 110°c on the opposite surface.

At the end of the second test, the temperature recorded an increase of 9°c from the start of the test (8 hours) compared to 110°c on the opposite surface.

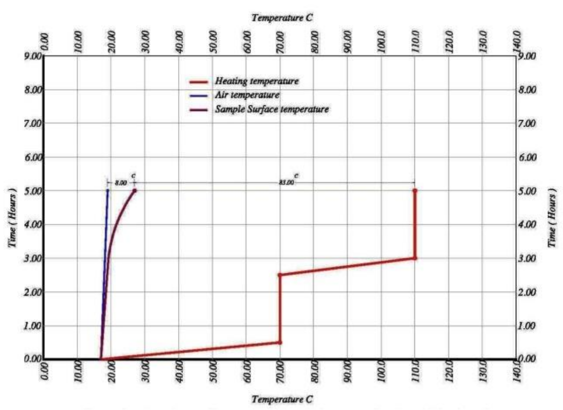
<u>Sample (S):</u>At the end of the first test, the temperature recorded an increase of 8°c from the start of the test (5 hours) compared to 110°c on the opposite surface.

At the end of the second test, the temperature recorded an increase of 9°c from the start of the test (8 hours) compared to 110°c on the opposite surface.

We see that (with the presence of conventional insulating materials) if the temperature outside is 50°c then it will be inside 35°c- but in the case of using Kandcrete, if the temperature outside is 110°c for eight hours continuously, the temperature inside after exposure for all this time, will not exceed 31°c only. (Figure – 6,7) So, by measuring Areas under curves, we get:

<u>Heat Gain %age</u> ("KandCrete" Samples):

= <u>2.58%</u> for first test &<u>2.47%</u> for second test, respectively. <u>**Excellent Results**</u>



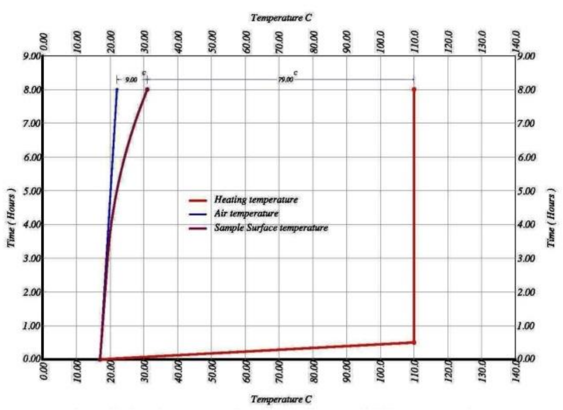


Fig. 6–Heat Transfer for 5 hours Fig. 7–Heat Transfer for 8 hours & 70 to 110^{c} Heating& 110^{c} Cont. Heating

FIRE RESISTANCE TEST RESULT

As mentioned in "Kandcrete" concrete Advantages (FIRE SAFETY) above, & As shown in (Fig. 8–Fire resistance test results), we noticed that the "kandcrete" concrete sample 150 mm thick, one side exposed to fire for 7 seven hours continuously, with 700°c At the end of the test, at opposite side the temperature recorded an increase of 145°c from the start of the test& decrease of 540°cthan side exposed to fire.

Also no defects were shown at "Kandcrete" concrete sample at the end of test.

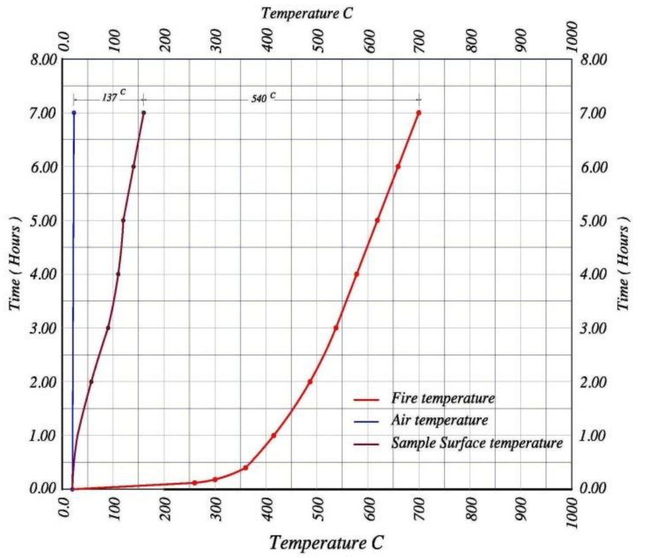


Fig. 8-Fire resistance test results

<u>Water Permeability Test Results:</u>

Typical arrangement for the determination of the water permeability from the concrete cylinder representative sample (15x30cm) when subjected to water pressure of 5bar acting to the mold filling for a period of three days.

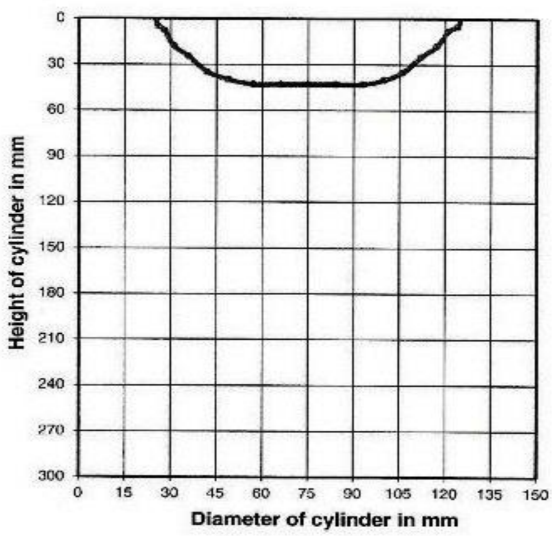


Fig. 9–Water Permeability Diagram

Chemical Analysis Test Results:

Specimen	pH	Chloride Cl %	Sulfate SO4 %	Remarks
S , R	**11.90**	**0.1080**	**0.125**	--

Table 2– Chemical Analysis Test Results for (KandCrete) Concrete Specimens

The practical application of (KandCrete) in the field of buildings

As mentioned in (Introduction) we can easily make **Low to Medium Rise Buildings**: The structural system is: use that concrete as an **external and internal load-bearing walls**, by making a **form for the whole house walls with the synthesis of all openings**, installing all service supplies (plumbing - electricity - air conditioning, etc.) then installing a **single-layer mesh of rebar (or sufficiency)** by placing steel reinforcement in the corners and intersections; and using the fiberglass as an add-on for concrete); then **pouring the ceiling with the same intensity** (or with prefabricated slabs of the same concrete); work is **repeated in the case of repeated floors** with the placement of (vertical dowels) in the lower walls to connect the upper walls to it; thus structurally, we obtain fully structural system integral components and members, where there is no any joints or links, no welds, no (thermal bridges) – we get one body that works as a one structural unit with a full distribution of loads in various loading states, without any opportunity for differential settlement or great settlement or defects in other members (cracking – deflection – deformation - weak connections - buckling – torsion, etc.) – it has high toughness. **There is an added advantage: that is No need to apply plaster (Inside or Outside) because of the fine finished surface of concrete walls**, we apply direct Painting (Rolled or Textured), with any required decorative materials.

Fig. 10–Structure implementation stages, Showing Concrete Walls Arrangement.

CONCLUSION & RECOMMENDATIONS

Sustainable development is a holistic endeavor, making it difficult to define the independent role any of the thousands of materials, products, or technologies used on a given construction site bring to support project-specific green-building objectives.

But cellular concrete (Kandcrete) could be considered as a **combination of high-performance concrete and structural lightweight concrete**; and can do play constructive roles in enhancing the environment, meeting green-building objectives & attaining sustainable development. Cellular concretes help achieve sustainable building solutions in many areas because of their advantages as :

Reduction of dead load - Savings in Raw Material - Considerably Lower Weight - Thermal Insulation - Fire Protection - Sound Insulation - Economical Production – Self-leveling/Self-compacting - Speedier Constructions - Saving time & cost - Durability with lower maintenance costs - Disaster resistance - Seismic resistance - Indoor air quality: Negligible VOC emissions - Locally produced: The raw materials used to make the concrete production are abundant in most areas of the world - Minimal site disruption – high stability – high toughness – strong impermeability to prevent any external moisture or harmful material from entering the building.

(KandCrete) considered as an innovative product for the human civilization, for the days to come & is expected to show its multi-various facets in all the spheres of construction yet to be explored in the hands of future researchers.

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BIOGRAPHY

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