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SUNFLOWERS SEED PEEL POWDER PARTICLES AND CONCRETE BUILDING MATERIALS PERFORMANCE

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Abstract

The study investigated the benefit of utilizing the sustainable materials, as industrial waste materials to construct concrete building materials which has low density and low thermal conductivity, therefore, in this work sunflowers seed peel powder have been added to concrete. Then that concrete used instead of bricks in Iraqi building construction. Experimentally used testing samples of concrete building material by dimensions of (200×200×200) mm3. Were constructed by mixing ratio (1:2:4 by weight), water percentage of 0.5, and peel powder added to that mixture as 5% and 10% from whole cube weight. Which used two different diameters of peel powder particles (4×10-6) m and (4×10-9) m. The data collected in Baghdad city (Latitude = 32.2° N). The thermal behaviour of concrete building material has been studied during summer season of 2019, at 21ts day of each month for 15 hour per day. The results indicate that the adding peel powder was reduced the heat gain and building's cooling load as well as the electrical energy (which consumed for cooling purposes). The ratio 10% of (4×10-9) m diameter particles was more efficient. the density of concrete was reduced when compared with traditional building material, and the density value is reduced to 1664 kg/m3, and the comparison strength also reduced to 17.1 N/mm2. Also, the amount of reduction electrical energy value in summer session for cooling purposes about 40%.

Keywords: Concrete building materials, Energy saving, Low density materials, Low thermal conductivity material, Sunflower's seed peel.

1. Introduction

Iraq located in the moderate northern region with both continental and subtropical climates, like the semi-desert climate. It has 240 clear days in one year with an annual average of 9 hours sun brightness a day, environmental air temperature of 50 °C in shade, an average radiation during the summer at 900 W/m² and 340 W/m² in winter [1].

All of those lead an increase in exposing the outer shell of buildings to big thermal load transfer through the wall components, from outside to inside the buildings, raising the value of air temperature above comfort level. For that reason, people tend to use the air conditioner to decrease temperatures in rooms to tolerable levels. Due to an increase in the difference between the increased air temperatures and the desired room temperatures, an increase in the consumption of electrical energy and out of pocket power costs can be seen.

Residential buildings are widely increasing in numbers when compared to other types of buildings; therefore, residential sectors consume the most amounts of electrical energy in Iraq [2] and worldwide [3]. In general, buildings no longer need to be constructed in the old traditional way. Nowadays building concrete material structure (mostly) and steel structures (sometimes) are used as building frames. Wall building material in that frame building is beneficial because they do not carry the additional dead load. In fact, they are used only to separate between the outer and inner wall building and to provide privacy for those who reside in the buildings. This leads to developments of new building materials such as new-fangled bricks and building concrete material to be used instead of the traditional ones [3]. Bricks have evolved to be used with building concrete material mixture because recycling bricks residues consumes less energy [4]. However, this raises an environmental issue given that bricks production is linked to bad environmental effect [5].

The other new construction building material is concrete, which safer on the environmental than bricks. However, building concrete material requires coating the outer layer of buildings using a reflector material to reduce the environment effect [6]. Moreover, the thermal conductivity of the concrete is high; therefore, many systems are designed to reduce thermal concrete such as: collecting local mud pieces [7], using thermal insulators and soil dust [8], using natural residue (such as feather fibre's [9] and blades [10]) and using eucalyptus bark powdered as smooth aggregation [11]. In addition, plastic material [12] rubber residues [13-15] glass and old thermal insulator [16], and industrial residues [17] all can be incorporated into the concrete mix to reduce the thermal conductivity.

Other methods of reducing the thermal conductivity of concrete include using chemical residues that have gone a series of complex industrial processing to introduce Geo-polymer concrete [18], using different stone types in the concrete mix [19], using renewable materials in the production of building concrete material blocks [20], using cement panel with insulator property [21-23], using change-phase materials within the concrete building materials [24-27] and other materials [28-30].

Furthermore, sunflower plants can be used in many ways such as: using its stem is a natural fiber for concrete construction [31, 32], using the seed husk in removing copper ion's from waste-water and methyl violet from water [33, 34] using the plant as a fuel for boiler combustion [35] and adding the ash [which produces from husk combustion] to the concrete mix in order to improve concrete quality [36, 37], using the sunflowers plant or seed husk to produce the insulation board [38, 39], or manufacturer Bio-concrete and Bricks materials [40, 41].

The building materials that currently available are manufactured overseas using advanced technologies; they are characterized by low values of both density and thermal conductivity. Historically, concrete building materials (as naturally obtained raw material, i.e., gravel and sand) and cement (which is manufactured locally, cement is a binder substance contains inorganic materials like Al, Si, Fe_2O_3, Mn_2O_3, and others) [42] have been used as building materials. However, due to their high values of density and thermal conductivity, it has been suggested to use industrial waste as the building material.

Sunflower (Helianthus annuum) plants can be considered a great resource. They are widespread, easily cultivated, have yield estimated at 1200 kg/hectare [43], and have plant residue value of 3000 kg/hectare [43]. Multipurpose sunflower seeds: They are using in the manufacture of edible oils and food for animals. As well as the husk of the seeds can be used to generate heat (although this can lead to air pollution). The low thermal conductivity of sunflower seed peel powder and the density are superior when compared to other concrete material; therefore, seed peel powder is used in making concrete building materials. Emphasis was placed on the added quantity and the diameter of the added particles. An additional percentage of the total concrete weight was selected at 5% and 10% while the diameter of the particle was changed with two values (4×10^{-6} and 4×10^{-9}) m.

2. Materials and Methods

The effects of particle size and mixing ratio of sunflower seeds peel on the thermal and constructional properties of concrete was obtained. Two concrete cubes different dimensions have been used in the experimental work of this study. one of the cubes by dimensions (150×150×150) mm^3 used for strength test, other cube by dimensions (100×100×500) mm^3 used for rupture test. Testing was performed using E.L.E. international-2007/UK/A.D.R.-2000- standard machine- instrument as shown an Fig. 1. Where the mixing ratios used (1:2:4 by weight) as (following British specifications 882-B.S./1992), while the water ratio was kept fixed in all mixtures at 0.5. Ordinary Portland cement Type 1 along with Karbala area sand and Salah-Alden area crush coarse (river stone) aggregate (widely used in Iraqi construction) were used at mixing formulation following Iraqi specifications (M.Q.A 5/1984). The aggregation materials were washed (used the standard course of treatment), then dried and mixed. The graduated limits of crush coarse and sand are shown in Tables 1 and 2. The industrial test samples were used to thermal examination was done from concrete cubes of dimensions.

Sunflowers seeds peel were used after being ground powder form, with particles size (4×10^{-9} and 4×10^{-6}) m, which were produced in Iraqi (by Iraqi cement organization) and size of particles measured by using micrometre microscope and Image j. Program (for grain size analysis) in the laboratory of Physics department on the Science College, University of Baghdad, Iraq. The microscopic image for each size as shown in Fig. 2.

A sunflower seeds peel powder mixed with ratio 5% and 10% (according to whole cube weight) where mixture have been done with needed water quantity for concrete. This mixture was done by used the electrically stirred to allow for equal distribution and good mixing for all materials.

Fig. 1. Compressive strength testing machine.

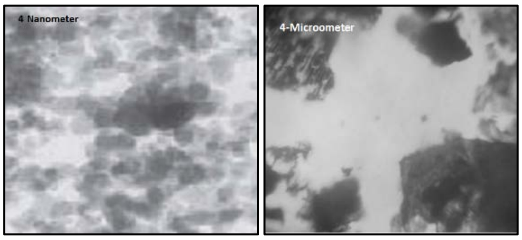


Fig. 2. Microscopic image for each size were studied.

Table 1. The graduated limits of the crushed coarse aggregate in the construction mixture at the study.

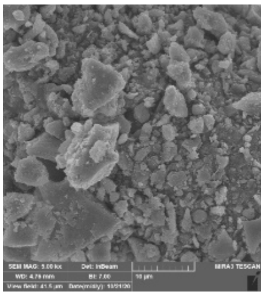
Sieve diameter, mm	Percentage accumulation on the sieve, %	Percentage passing sieve	
		Search measurements	Specification BS:882/1992
37.00	0	100	100
20.00	0	100	100
9.500	22	(70-78)	(50-85)
04.75	66	(6-10)	(0-10)

Table 2. The graduated limits of the fine aggregate in the construction mixture at the study.

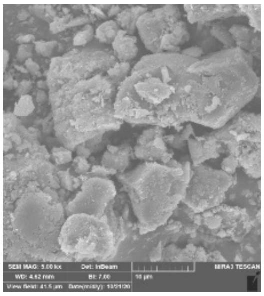
Sieve diameter, mm	Percentage accumulation on the sieve, %	Percentage passing sieve	
		Search measurements	Specification BS:882/1992
10	0	100	100
5	5	95	(89-100)
2.36	12.85	82.15	(60-100)
1.18	15.85	66.3	(30-100)
0.6	21.73	44.55	(15-100)
0.3	29.95	14.6	(5-70)
0.15	11.05	3.55	(0-15)

After that, the mixture was placed into the test cubes and allowed to cure as shown in Fig. 3 (following the standard curing protocols). While the micrographs for resultant concrete building materials was show in Fig. 4.

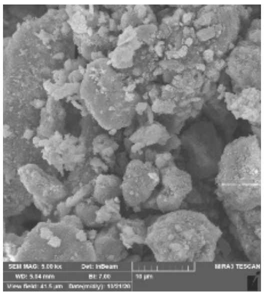
Fig. 3. Studied concrete cube (200×200×200) mm^3.



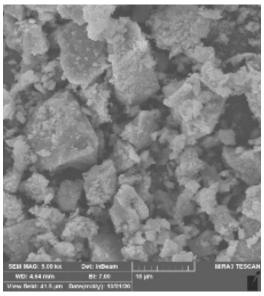
(a) Model A, adding ratio 5%, particles diameter (4×10^{-6}) m.



(b) Model B, adding ratio 10%, particles diameter (4×10^{-6}) m.



(c) Model C, adding ratio 5%, particles diameter (4×10-9) m.



(d) Model D, adding ratio 10%, particles diameter (4×10-9) m.

Fig. 4. Micrographs SEM for resultant concrete building materials.

The testing room, as shown in Fig. 5 with dimensions of (1×1×2) m^3, located on the third floor of a residential building in Baghdad city (latitude 33.2°N). The room is open to the environment, with its ceiling and most of its walls being insulated with sheets of polystyrene (200 mm thickness), except for the testing wall (1×2) m^2.

The testing wall is oriented to the east with a movable part to allow for needed modifications. This wall was built by using the preparation concrete building material and covered by plaster of gypsum from inside.

Wide rubber strips were fixed between the wall of the room and the testing wall to prevent air infiltration. Then, an air conditioner window type with capacity 1 ton of Refrigeration (3.5 kW) was used to keep the temperature of that room at 26.5 °C [44].

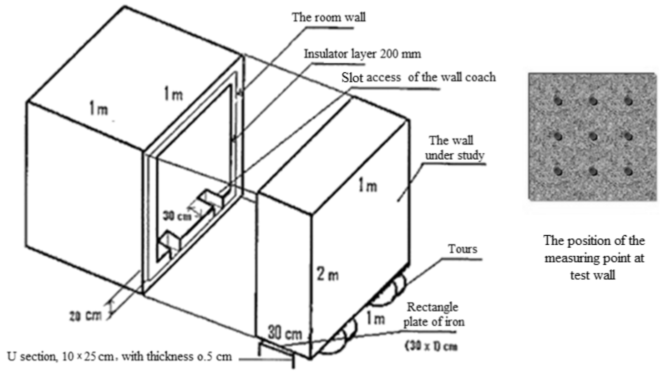


Fig. 5. Schematic illustration the details of the test room.

The two calibrated thermocouple and digital thermometers were used to measure both temperatures for room air (T_r) and interior face of building materials (T_i). Moreover, the intelligent auto digital thermometer was used to measure the environment temperature in the shad (T_{sh}) and external face of building materials (T_o). The experimental reading is recorded all summer months (May-September) 2019 from 6 am to 6 pm for the day 21st per month.

As well as, the amount of electrical energy consumption was measured in kWh using an electrically powered device, which connected to room electrical energy directly. The heat transfer natural convection coefficient (in turbulent flow) (h) of the test room inner surface was then estimated from equation (1) [45].

$$h = 1.31(\Delta t)^{1/3} \tag{1}$$

Then the heat gain (Q) calculated by Eq. (2). Where difference between standard room air temperature (T_r) and the temperature of inner surface for the tested wall (T_i) and this temperature difference denoted (Δt).

$$Q = h.A.\Delta t \tag{2}$$

3. Numerical Analysis

The theoretical methods presented by solution for periodic transient heat transfer problem for building walls will be used for calculating of t_i values and cooling load of any spaces. A theoretical model developed from [46], were the first who used this technique for evaluating heat transfer through multilayer walls.

3.1. Estimation of cooling load temperature difference

Equation (3) can be applied to get the heat,

$$Q_c = h_i A[T(o,t) - T_i] \tag{3}$$

The heat gain is obtained by multiplying *UA*-value of building elements with CLTD value.

$$Q_c = UA(CLTD) \tag{4}$$

where:

U: is the overall heat transfer coefficient of the building wall, from Table 6.

where A is the surface area.

Consequently, the cooling load temperature difference (CLTD) can be calculated using Eq. (3 and 4) as:

$$CLTD = \frac{h_1\ [T(0,t) - T_1]}{U} \tag{5}$$

where:

h_i: is the heat transfer coefficient of the inside building.

$$h = 1.42(^{\Delta t}/_{L})^{1/4} \tag{6}$$

The solar radiation flux on the wall or roofs is most effective for heat gain of any space, as seen in Eq. (6).

$$t_e = T_o + \frac{\propto_S I_T}{h_0} - \frac{\varepsilon \Delta R}{h_0} \tag{7}$$

Parameters used in Eq. (7) for vertical surfaces are taken from [47]. It is common practice to assume ΔR =0 for vertical surfaces. The value of parameter α_s/h_o = 0.039 (represent the usual gray).

3.2. Formulation of the heat transfer problem

Variation at the interior and at any position in the wall structures, which are presented in [48].

$$\frac{\partial^2 T_n}{\partial x_n^2} = \frac{1}{\propto_n}\frac{\partial T_n}{\partial t} \qquad 1 \le n \le N \tag{8}$$

where α_n is the thermal diffusivity ($k_n/p_n\, c_n$).

Two boundary conditions at the inside and outside surfaces are given as:

$$h_1(T_1 - T_1) = -K_1 \frac{\partial T_1}{\partial X_1} \qquad X_1 = 0 \tag{9}$$

$$-K_N \frac{\partial T_N}{\partial X_N} = h_0[T_N - T_0(t)] - \propto_s q_s(t) \qquad X_S = L_N \tag{10}$$

where K is conditions which can be used for solving the differential equation since the periodic solution is independent of the initial temperature distribution. These conditions are known as matching conditions. The thermal conductivity and q_s is the solar absorptivity. It is necessary to give additional.

$$-K_{n-1} \frac{\partial T_{n-1}}{\partial x_{n-1}} (x_{n-1} = L_{n-1}) = -K \frac{\partial T_n}{\partial x_n} (x_n = 0) \qquad 2 \le n \le N \tag{11}$$

$$T\ (X_{n-1} = L_{n-1}) = T\ (X_n = 0\ ) \qquad 2 \le n \le N \tag{12}$$

The dimensionless from of the problem is transformed by an application of the following complex Fourier Transform (CFFT).

$$T_n(z_n, \mathcal{T}) = \sum_{j=-M}^{M} T_{nj}(Z_n) e^{iwj\mathcal{T}} \qquad w_j = 2\pi j \tag{13}$$

$$T_{nj}^{-}(Z_n) = \int_{-1/2}^{1/2} T_n\,(Z_n, \mathcal{T}) e^{-iwj\mathcal{T}} d\mathcal{T}, \qquad T_{n0}^{-} = \int_{-1/2}^{1/2} T_n\, d\mathcal{T} \tag{14}$$

The transformed problem is then solved, and the solution is given in [48] in detail. The general solution is given as:

$$T_{no} = A_n Z_n + B_n \qquad for\ j = 0$$

$$T_{nj} = C_{nj} \sinh(\gamma_{nj} Z_n) + D_{nj} \cosh(\gamma_{nj} Z_n) \qquad for\ j \ne 0 \tag{15}$$

where $T_{10}(0)$ and $T_{1j}(0)$ are transformed temperatures, which are B_1 for j=0d D_{1j} for $j \neq 0$, respectively. These constants of B_1 and D_{1j} are obtained from equations given (13,14).

$$T_1\,(0,t) = \sum_{j-M}^{M} T_{1j}(0)e^{iwj\mathcal{T}} \qquad w_j = 2\pi j \tag{16}$$

Inserted in the derivative of the Eq. (16), the highest and lowest temperatures, and the period can be determined from:

$$B_1 + \sum_{j=-M}^{M} D_{1j}\,[-\sin(2\pi j\mathcal{T}) + i\cos(2\pi j\mathcal{T})] = 0 \tag{17}$$

The procedure given above for the interior surfaces will be applied for the exterior surfaces and for finding the highest and lowest temperatures and the time in reaching these temperatures. Temperature distribution for the exterior wall surface is given as:

$$T_N(1,\mathcal{T}) = \sum_{j=-M}^{M} T_{Nj}\,(1)e^{iwj\mathcal{T}} \qquad w_j = 2\pi j \tag{18}$$

where N is the layer number of the external surfaces, which is inserted into Eq. (13) for dimensionless distances of $ZN = 1$

$$A_N + B_N + \sum\ [C_{Nj}\,sinh(\gamma_{Nj}) + D_{Nj}\cosh\,(\gamma_{Nj})].\,[-sin(2\pi j\mathcal{T}) + icos(2\pi j\mathcal{T})].\,wj = 0 \tag{19}$$

where AN and BN are variables for j=0.There is no need to use zero j indices in numerical calculations.

Heat flow rate from the wall to the space can be calculated by using the temperature variation at the inside surface of the wall, inside room air temperature and convection heat transfer coefficient.

$$q_c = h_i\,[T_1(0,t) - T_i] \tag{20}$$

4. Results and Discussion

This study focuses on determining the effects of both diameters and the amount added of powdered particles on the thermal and constructional properties of the concrete building materials used in construction.

Thermal behaviours of concrete building materials have been obtained and documented in Fig. 6 experimental results and Fig. 7 numerical solution, which shows the variation of temperatures values for inner surface, outer surface and ambient air for different types of walls during the day for the summer months (May, June, July and September). While, Table 3, shows the average temperatures during each summer months. Table 4. shows the value of required cooling and amount of electrical power consumed and saving percentages compared to traditional concrete building material. Table 5. shows construction test results for samples being studied.

4.1. Thermal properties

Thermal conductivity was measured using a hot plate, (which is available at the Heat Transfer Lab, Chemical Industrial Department, Institute of Technology, Baghdad, Iraq). The results shown that thermal conductivity of sunflower seeds peel powdered particles was 0.18 W/m °C, the density of the powders particles was 710 kg/m^3, while the traditional concrete building materials have 2000 kg/m^3.

Table 3. Thermal properties of studied walls/ month.

Studied wall	Size M	%	June		July		September	
			T_{sh}	39.56	T_{sh}	48.80	T_{sh}	40.00
			T_i	T_o	T_i	T_o	T_i	T_o
Model A	4×10^{-6}	5	38.8	47.0	40.5	50.7	40.3	47.2
Model B	4×10^{-6}	10	37	47.1	40.4	51.4	40.2	47.4
Model C	4×10^{-9}	5	37.6	47.8	39.4	51.2	38.1	48.0
Model D	4×10^{-9}	10	36.2	48.0	39.2	51.0	36.6	47.2

For the wall built by traditional concrete building materials, the overall heat transfer coefficient, U was measured will be 2.613 W/m^2 °K, also that value of U Factor for studied concrete building materials which has 5% adding ratio model A and 10% adding ratio model B of sunflowers seed peel powder particles diameter was 4×10^{-6} m was 2.262 W/m^2 °K (14% decreasing percentage), 2.150 W/m^2 °K (18% decreasing percentage), respectively. While that U Factor will be 2.204 W/m^2 °K (16% decreasing percentage), 2.020 W/m^2 °K (23% decreasing percentage) for 5% adding ratio model C and 10% adding ratio model D, respectively for powder particles diameter 4×10^{-9} m.

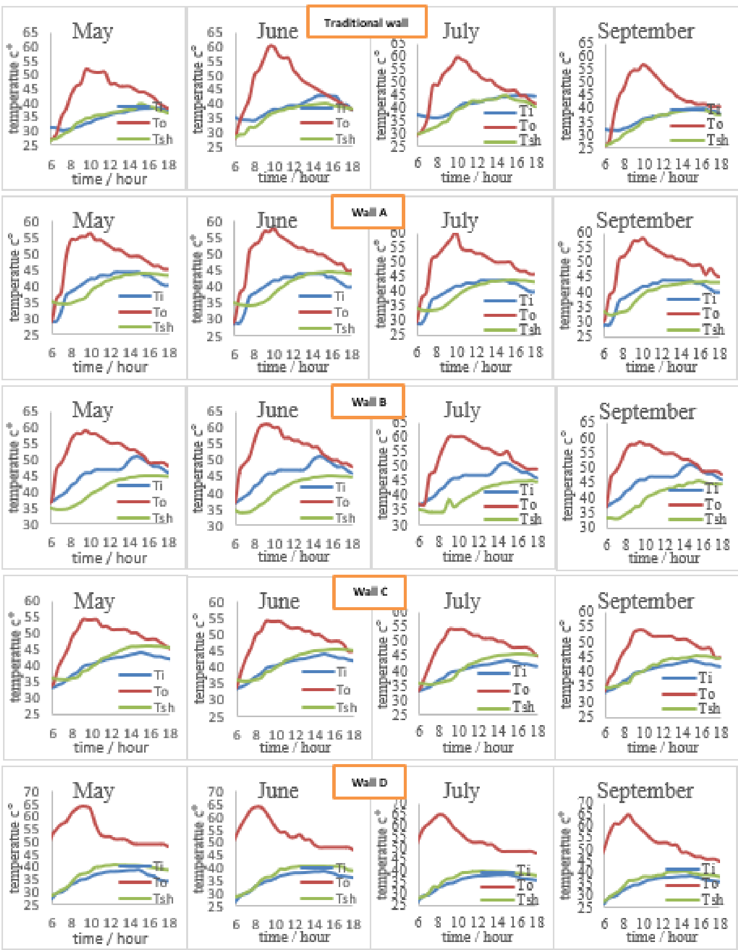


Fig. 6. Hourly thermal behaviour for all studied walls.

Also, the value of the time lag for studied walls were 2.3, 3.3, 4.05, 5 and 6.30 hr. for studied traditional, model A, model B, model C, and model D, respectively. And the decrement factor for that studied walls were 0.4, 0.444, 0.493, 0.54, and 0.694. As shown in Table 6. results show that increasing the adding ratio of powder particles leads to increasing in numbers of that particles added at the concrete volume constant, therefore leading to spread of those particles within concrete building materials.

Table 4. Thermal results of studied walls.

Studied wall	T_o c°	T_i c°	$\Delta(t_{o-i})$ c°	$\Delta(t_{i-r})$ c°	**Colling load***		**Electrical energy**	**Electrical difference**	**Electrical saving %**
					TR	**kW**			
Traditional	47.5	43.5	04.0	17.0	28.1	98.4	62.6	-	-
Model A	48.9	40.0	08.9	13.5	20.8	72.8	46.4	16.2	25.9
Model B	49.3	38.8	10.5	12.3	18.3	64	40.8	21.8	35.0
Model C	49.3	40.0	09.4	13.0	19.7	69	43.9	18.7	29.9
Model D	50.0	38.7	11.0	12.2	17.0	60	38.1	24.6	40.0

* Colling load for summer session per unit wall area.

** Electrical energy for summer session per unit wall area.

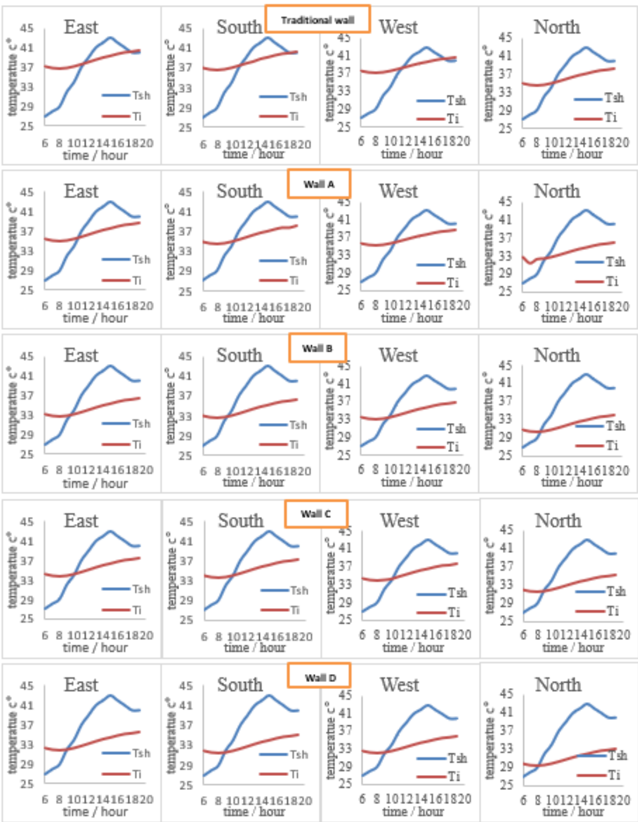


Fig. 7. Numerical results for all studied wall with four orientations in June.

In comparison, decreasing the diameter of that particles lead also to increase in the number of particles added. Therefore, further spread within concrete building materials as shown in Table 6.

These values show that the sunflowers seed peel powder particles mixed within concrete leads to a decrease in overall heat transfer coefficient of the new building. The decreasing in that coefficient in attributed to two reasons, first, random distribution of the added particles which have low thermal conductivity to concrete mixture of building material, this particles leads to more blockade of heat transfer path through that building materials, and further increase in the time required for heat to transferred, second, the particles are soaked in water during the process of being incorporated into the concrete mixture, were setting and drying, were partial loss of water is seen and as well as that leads to creating gaps and pits then caused to reduce in the rate of heat transfer and also decreases the density of the concrete building material. Figure 8 shows a nonhomogeneous irregular section of the concrete building material to which particles of crushed sunflower peel have been added, and the enlarged part shows the preparation of gaps and pits caused by the withdrawal of water during the drying period.

The presence of these pits in large numbers (10-35) gaps and pits/cm^2 (from the researcher's measurements) would lead to an increase in the path followed by the heat flow through the thickness of the building material under study, which was reflected in the increase in the time lag and decrement, as shown in the table 6, as well as the presence of these pits loosened the bonds between the cement and other materials inside the concrete block, which led to a clear decrease of the compressive strength of that building material.

4.2. Temperature of concrete building materials external surface (T_o)

The ambient air temperature has been affected directly on the temperature of concrete building materials surface exposed to the environment. Table 4 shows that the average external surface temperatures for the summer session.

For the wall built by traditional concrete building materials the temperature was recorded will be 47.5 °C, also that surface temperature for studied concrete building materials which has 5% addition ratio (model A) and 10% addition ratio (model B) of sunflowers seed peel powder particle diameter was 4×10^{-6}m were 48.0 °C and 49.27 °C, respectively. While, that temperature will be 49.25 °C and 49.7 °C for 5% addition ratio (model C), and 10% addition ratio (model D), for sunflowers seed peel powder particles diameter were 4×10^{-9} m, respectively. That result, mean, the sunflowers seed peel powder particles which existent in concrete building materials was assisted to repel moves of heat transfer rate through that building materials, because of the seed peel powder particles thermal conductivity was the lowest value (when compared with concrete). Therefore, the surface temperature was a rise, the increase of powder particles was leading to surface building materials temperature was high.

4.3. Temperature of concrete building materials inner surface (T_i)

The average temperature for the summer session of concrete building materials surface exposed to room air (inner surface) were explained in Table 4.

For traditional concrete building materials, the temperature inner surface was recorded 43.5 °C. Also, that temperature for Studied concrete building materials which has 5% addition ratio (model A) and 10% addition ratio (model B) sunflowers seed peel powder particles diameter at 4×10^{-6} m was 40.4 °C and 38.81 °C. While, that temperature would be 39.1 °C and 38.6 °C. for 5% addition ratio (model C) and 10% addition ratio (model D) sunflowers seed peel powder particles diameter at 4×10^{-9} m. From that result, it explains the relationship between heat transfer rate reductions and lowering the inner surface temperature, also, that Temperature was dependent upon increasing the powder particle number.

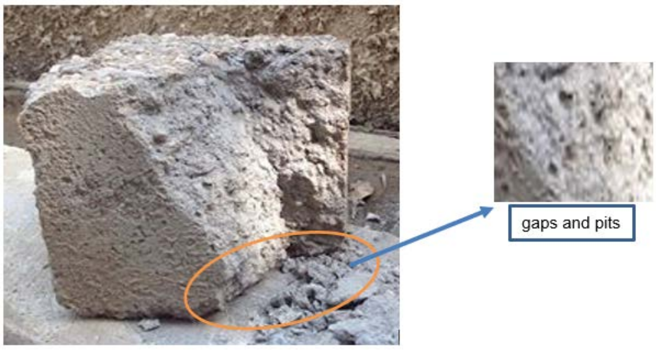


Fig. 8. Nonhomogeneous irregular section of the concrete cube.

4.4. Temperature differences inside air space (ΔT_{i-r})

The amount of heat that must draw from room space by an air conditioner unit is related to inside surface temperature (T_i) and standard comfortable room temperature (T_r) which has been counted on 26.5 °C.

Table 4 shows for traditional concrete building materials wall that the average temperature differences on the summer session have been recorded 17 °C. As well as that temperature differences for studied concrete building materials which contained 5% addition ratio (model A) and 10% addition ratio (model B) sunflowers seed peel powder particles diameter 4×10^{-6} m was 13.5 °C and 12.2 °C, respectively. While that temperature differences have been recorded 13 °C, and 12.2 °C for 5% addition ratio (model C) and 10 % addition ratio (model D) sunflowers seed peel powder particles diameter 4×10^{-9} m, respectively. The cooling load needed for traditional concrete building materials was 98.4 kW/m^2. While that cooling load for four studied concrete building materials that contained sunflowers seed peel powder were 72.8, 64, 69 and 63 kW/m^2, for that walls, model A, model B, model C and model D, respectively.

4.5. Temperature differences between terminal surface (ΔT_{o-i})

Temperature differences between outer and inner surfaces for concrete building materials were explained in Table 4, for traditional concrete building materials was 4 °C.

But that temperature differences for studied concrete building materials which have 5% addition ratio (model A) and 10% addition ratio (model B) sunflowers seed peel powder particles diameter at 4×10^{-6} m would be 8.8 °C and 10.46 °C, respectively.

While that temperature differences became 9.35 °C and 11.0 °C for 5% addition ratio (model C) and 10% addition ratio (model D) sunflowers seed peel powder particles diameter 4×10^{-9} m, the temperature differences about terminal surface were percentage increases 120% and 162% for models A and B , and that percentage would be 134% and 175% for models C and D.

4.6. Energy saving

The effect of the environment has been inverted on the temperature of the inside room; therefore, air temperature would be raised. An air conditioner unit must be draw that heat up to reach the standard comfortable room temperature at a constant level. The work of that unit was consumed electrical energy directly.

Table 4 shows the electrical energy consumption. For traditional concrete building materials would be consumed 62.5 kWh per unit facade area, while the studied concrete building materials which have the sunflowers seed peel powder would be consumed as 46.4, 40.8, 43.9 and 38 kWh for models A, B, C, and D, respectively. Employment the modified walls were conducted to decrease the electrical energy when compared with the traditional concrete building materials and differences between them as 16.2, 21.8, 18.7 and 24.6 kWh.

The electrical energy saving percentage would be 25.9, 35, 29.5 and 40 % for models A, B, C and D, respectively. The highest rate in energy-saving obtained when utilization sunflowers seed peel powder diameter 4×10^{-9} m and 10% add quantity.

4.7. Concrete construction properties

Many tests would be made for concrete building materials which study in this paper, as density, compression strength, absorbability ratio and rupture that results were shown in Table 5. All values were calculated after 7 days in moisture air.

4.7.1. Density of concrete building materials

One of the priorities from this paper, the density of concrete building materials which contained sunflowers seed peel powder was decreased. Table 5 shows that density value for traditional concrete building materials (the reference mixture) was 2000 kg/m^3, the weight of this wall was 500 kg/m^2. While the density quantity of studied concrete building materials which has sunflowers seed peel powder particles diameter 4×10^{-6} m at 5% (model A) and 10% (model B) were recorded 1742 and 1669 kg/m^3, and wall weights 435 and 417 kg/m^2. However, the density was 1728 and 1664 kg/m^3 and walls weight were 432 and 416 kg/m^2 when has sunflowers seed peel powder particles diameter 4×10^{-9} m for model C (5%) and model D (10%).

4.7.2. Compression strength

Table 5 shows that the results of the compression strength examination for all studies of concrete building materials. The traditional wall was recorded 21.2 N/mm^2. While the concrete building materials which contained sunflowers seed peel powder particle diameter 4×10^{-6} m model A (5%) and model B (10%) were recorded 20.1 and 18.1 N/mm^2, respectively. But those values were become 19.1 and 17.1 N/mm^2, for model C (5%) and model D (10%) at concrete building materials which has sunflowers seed peel powder particle diameter 4×10^{-9} m, respectively. That means the additional seed peel powder would be decreased the compression strength value. However, that building which used the seed peel powder would be constructed the walls in traditional building or frame building was safe according to (MSTM, C 567/C 567 M-H/1992) was determined the compression strength value higher than 17 N/mm^2.

That means, the additional ratio of sunflowers seed peel powder in the concrete mixture for building materials was led to decreased density and wall weight.

Table 5. Physical prosperities of studied walls.

Studied wall	Density, kg/m^3	Wall weight. kg/m^2	Compression strength, N/mm^2	Absorbability, %	Settlement, mm
Traditional	2000	500	21.2	1.20	1.3
Model A	1742	435	20.1	1.25	1.3
Model B	1669	417	18.1	1.27	1.3
Model C	1728	432	19.1	1.26	1.3
Model D	1664	416	17.1	1.28	1.3

Table 6. Time lag*, decrement factor * and *U* factor for studied walls.**

Studied case	Time lag (Hours)	Decrement Factor	Overall heat transfer Coefficient (*U*) w/m^2 K
Traditional	2:30	0.400	2.613
Model A	3:30	0.444	2.262
Model B	4:05	0.493	2.150
Model C	5:00	0.540	2.204
Model D	6:30	0.694	2.020

* All This Value were calculated from Fig. 6

****** All values of U Factor were measured in room thermal test/ institute of technology/Baghdad/Iraq.

4.8. Impact of diameter and amount of powder particles

Table 4 shows the data that when the diameter of particles was kept fixed at 4×10^{-6} m, while the addition percentage changed from 5% to 10%, the difference in the percentage conservation achieved to 9.9%.

Also, the diameter was fixed at 4×10^{-9} m, with addition percentage changed from 5% to 10%, the difference in percentage conservation achieved was 13.3%. As well as, when the addition percentage was kept fixed at 5% but the particle diameter changed from 4×10^{-6} m for to 4×10^{-9} m, the percentage conservation achieved to 4%.

Lastly, increasing the additional percentage to 10% and changing the diameter as well leads to increase in the percentage conservation achieved from previously 4% to 10%.

In conclusion, decreasing particle diameter while keeping the size or weight of addition material leads to increasing the number of added particles in the building block which in turn decreases heat transfer in bigger amounts.

4.9. Numerical thermal behaviour

The thermal behaviour of traditional wall and studied models were studied numerically, the hourly behaviour was shown in Fig. 7. The interior surface temperature (T_i) was calculated as 38.3 °C, 37.5 °C, 35.5 °C, 36 °C and 34.2 °C, but that temperature was measured experimentally as shown in Table 3. as 39 °C, 38.8 °C, 37 °C, 37.3 °C and 36.2 °C. The differences percentage between the average values of interior surface temperature for Studied wall in numerical solutions and experimental results were in range.{ -1 - -5 } %.

The numerical studied also declare the effect of building orientation changing on the thermal behaviour. The percentage of the electrical consumption values were 20.2%, 2.61% and 2.6% for North, South and West building direction.

5. Conclusion

The results obtained from the present work can be concluded as follows.

- It is possible to construct the carrying walls (low thermal conductivity and low density) from concrete building materials which was contained a sunflowers seed peel powder.
- The temperature of the external wall surface (exposed to environment) was increased between (1.1 - 3.8) % and (3.7 - 5) % by added a sunflowers seed peel powder at particles diameter (4×10^{-6}) m, and (4×10^{-9}) m, respectively. when addition ratio has been token at the limits (5 - 10) % in both cases.
- The temperature of the inner wall surface (exposed to room) was decreased between (7 - 11) %, and (10 - 13) % by added a sunflowers seed peel powder at particles diameter (4×10^{-6}) m, and (4×10^{-9}) m, respectively. when addition ratio limits (5-10) % in both cases.
- The room cooling load would be decreased in range (27 - 33) %, and (30 - 36) %, by added a sunflowers seed peel powder at particles diameter (4×10^{-6}) m, and (4×10^{-9}) m, respectively. when addition ratio has been token at the limits (5 - 10) % in both cases.
- The density of concrete building materials was decreased in range (13-16) %, and (14-18) %, by added a sunflowers seed peel powder at particles diameter (4×10^{-6}) m, and (4×10^{-9}) m, respectively. when addition ratio limits (5-10) % in both cases.
- The compression strength of concrete building materials was decreased in range (5.2-15) %, and (10-20) %, by added a sunflowers seed peel powder at particles diameter (4×10^{-6}) m, and (4×10^{-9}) m, respectively. when addition ratio limits (5-10) % in both cases.
- Electrical energy consumption was decreased in range (26-35) %, and (30-40) %, by added a sunflowers seed peel powder at particles diameter (4×10^{-6}) m, and (4×10^{-9}) m, respectively. when addition ratio has been token at the limits (5 - 10) % in both cases.
- When powder particles diameter was fixed at (4×10^{-6}) m, and addition ratio was changed in limit (5-10) %, the saving energy percentage would be (9.9) %, but when fixed powder particles diameter at (4×10^{-9}) m, the energy saving ratio become (13.3) %.
- When the amount of addition ratio was fixed at (5) %, and particle diameter was changed in between the limits (from 4×10^{-6} to 4×10^{-9}) m, the saving

percentage became (4) % but when fixing addition ratio at (10) % the saving percentage was becoming (10) %.

- The addition of sunflower seeds peel powder to the concrete mix in the production of building material leads to reduction in the density and compression strength. At the same time, safety still applies when construction bearing walls. In other words, it is applicable to use this type of building material when constructing of. frames and traditional building as well**.**
- When used concrete building materials which were contained the sunflowers seed peel powder to construct the bearing and outside walls which gives the many benefits to the structure as shown above.

Nomenclatures

h_i	Combined heat transfer coefficient at the Inner surface, W/m^{2}K
h_O	Combined heat transfer coefficient at the outer surface, W/m^{2}K
I	Radiation heat flux on horizontal surface,, W/m^2
I_T	Radiation heat flux on tilted surface, W/m^2
K	Thermal conductivity, W/m K
L	Thickness, m
q_c	Heat gain, W/m^2
T	temperature, °C
t	Time, s
T_i	Design inside air temperature, °C
T_o	Outside air temperature, °C

Greek Symbols

α_n	Thermal diffusivity, m$^{2/}$s
q_s	Absorptance of surface

Subscripts

i	Inside
j	Number of terms
N	Number of last layers
n	Number of layers
o	Outside

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