PRODUCING LIGHTWEIGHT CONCRETE USING TOBACCO WASTES

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Abstract

This study was carried out to determine the possibilities of using tobacco wastes in lightweight concrete production. The mixture combinations of materials such as tobacco waste, pumice, sand and cement were used to produce the samples. The results showed that produced material samples were in the lightweight concrete class according to values of consistency, unit weight, compressive strength and thermal conductivity. It was determined that the unit weight of lightweight concrete material samples ranged between 0.48–0.58kgdm^{-3}, compressive strength values ranged between 0.25–0.58Nmm^{-2} and thermal conductivity coefficients ranged between 0.198–0.250Wm^{-1}K^{-1}. According to the observations, tests, experiments and evaluations on lightweight concrete material samples, it was concluded that the lightweight concrete with tobacco waste additives could be used as a material in construction.

Keywords: *compressive strength, lightweight concrete, thermal conductivity coefficient, tobacco waste*

Introduction

In order to provide comfortable conditions for up-to-date buildings, it is important to consider the most costly component, which is energy. Therefore, the most important component of construction designing is heat isolation. In order to take necessary actions concerning heat isolation in the constructed buildings, it is necessary to provide the needed thermal comfort for shelters so that they are not affected negatively from temperature effects. By taking this into account, the design can result in relaxing conditions for people (Postacıoğlu, 1986; Yağanoğlu *et. al.*, 1999).

Due to the low unit weight and high porosity, at present time, lightweight concrete elements are preferred as isolation materials. Comfort temperature values can be provided with lower energy consumption by using lightweight concrete in the construction elements. Recently, due to the superiorities in the lightweight concrete, the production in this field has increased from the early 1980’s until present day and an important industry has developed in that area (Rossignolo and Agnesini, 2001).

According to the density, lightweight concretes are classified in three groups. Low density and compressive strength concretes which are used in isolation, middle density and middle compressive strength concretes which are used for briquette producing, and the carrier lightweight concretes create the opportunity to use them for constructing foundations and supporting parts (Short and Kinniburg,1978; Bhatty and Reid,1989).

By producing lightweight concrete, a lot of methods are used. The most popular method for lightweight concrete production is to use natural or synthetic lightweight aggregates. Some of the lightweight aggregates used for concrete productions are pumice, coal slag, flying ash, rice husk, straw, sawdust, cork granules, wheat husk and coconut fibbers and coconut shell. The organic wastes that have been used in lightweight concretes are mainly of plant origin and include rice husk, straw, sawdust, cork granules, wheat husk and coconut fibbers and coconut shell. Besides these, leather wastes of animal origin are worth researching (Basri *et al*., 1999; Khedari *et al.*, 2000; Manan and Ganapathy, 2002).

Generally, the concretes which have a unit weight under $2.0 kgdm^{-3}$ are in the lightweight concrete class. The lightweight concretes which have a unit weight between $1.6–2.0 kgdm^{-3}$ can be used constructive elements, unit weights between $0.5–0.6 kgdm^{-3}$ can be used isolation material (Aka,2001; TS 11222,2001).

The lightweight concretes which have a compressive strength under $1 Nmm^{-2}$ are used for isolation purposes. In spite of this, if the compressive strength is over $1 Nmm^{-2}$, the lightweight concretes can be used in the load carried construction elements (Ujhely, 1983).

The compressive strength of lightweight concretes are related to the mixing ratio and quality, quantity of moulding water, mixing and moulding methods of the used material. Generally, as the unit weight and compactness values increase, the compressive strength and heat conduction increase. The compressive strength and thermal conductivity decrease when porosity increases (Tekinsoy, 1984).

The objective of this study was to determine the possibilities of using tobacco waste in lightweight concrete production.

Material and methods

The main material used in this study was tobacco waste, which was the waste left over from cigarette production at a Cigarette Factory (Fig.3.21). Furthermore, mixed pumice aggregate under 10mm sieve (Fig.3.22), river sand and Portland Tokyo cement were used as binding materials. The chemical composition and physical properties of the materials used in the study are summarized in Tables 3.7, 3.8 and 3.9.

Table 3.7: Chemical composition tobacco waste

Component	**(%)**
Fe	0.46
Zn	0.0098
Mn	0.026
Cu	0.0021
Ca	5.72
Mg	0.80
K	1.03
Na	0.09
P	0.20
Organic matter	66.21
Water	25.45

Source: Gülser and Candemir, 2004

Table 3.8: Chemical composition and physical properties of pumice aggregate

Chemical composition		**Physical properties**	
Component	**(%)**		
SiO_2	70.50	Specific gravity (kg dm^{-3})	1.80
Al_2O_3	15.00	Bulk density (kg dm^{-3})	0.65
Fe_2O_3	3.50	Water absorption (%)	42
CaO	3.00		
Na_2O	4.26		
K_2O	2.75		
MgO	0.99		

Source: Gündüz et al., 2004

Table 3.9: Mechanical and physical properties of Portland Tokyo cement (TS 12143, 2005).

Mechanical and physical properties	
Specific gravity (kgdm^{-3})	3.0
Setting time, initial (min.)	230
Setting time, final (min.)	295
Volume expansion (Le Chatelier-mm)	1.0
7 day compressive strength (Nmm^{-2})	23.9
28 day compressive strength (Nmm^{-2})	35.0

Figure 3.21: Tobacco waste (under 10mm sieve)

Figure 3.22: Pumice aggregate (under 4mm sieve)

To prepare the lightweight concrete materials samples, nominal mixing techniques were applied because of the organic origin of tobacco waste (BS 5328, 1976).Organic material contains of the material decreases the compressive strength (Schieder, 1961). Due to the high organic material ratio of the tobacco waste (66.21%), the tobacco waste ratio of the mixing was fixed as a limit value of 40%.

At the first stage of the study, in order to have some specifications in a mixing such as holding itself, limited shrinkage shrinking and having a half fluid consistency, the mixing ratios of the materials were used with hold the W/C value as a constant of 0.44 as given in Table 3.10. The experimental samples were prepared as shown in the Fig.3.23. In addition to these, the consistency, unit weight, compressive strength and thermal conductivity test were performed upon produced lightweight concrete samples.

Figure 3.23: Lightweight concrete samples

Table 3.10: Mixtures used in the study according to appearance of concrete samples (by weight)

Sample No	Mixing (%)			
	Portland Cement	Tobacco waste	Sand	Pumice aggregate
1	40	20	40	-
2	30	20	20	30
3	40	20	-	40
4	30	20	25	25
5	35	15	25	25
6	40	15	15	30

Results and discussion

The test results obtained concerning the effects of the applications on some specifications of Produced lightweight concrete samples are given below and discussed.

1 Unit weight

The test results of the unit weight of the produced lightweight concrete samples are given in Table 3.11.

Table 3.11: Unit weight testing results

Sample No	Unit weight($kgdm^{-3}$)
1	0.58
2	0.55
3	0.48
4	0.55
5	0.58
6	0.55

The unit weight values of the produced material samples changed between 0.48–0.58$kgdm^{-3}$. If there is excess porosity in the material, this is an indicator that the concrete has a low compressive strength (Uluata, 1981). The reflection of this situation was also observed in the produced material samples. Furthermore, the results concerning the unit weight values given in Table 3.11 showed that the produced lightweight concrete samples were in the heat isolated lightweight concrete class (Şahin *et.al*., 2000).

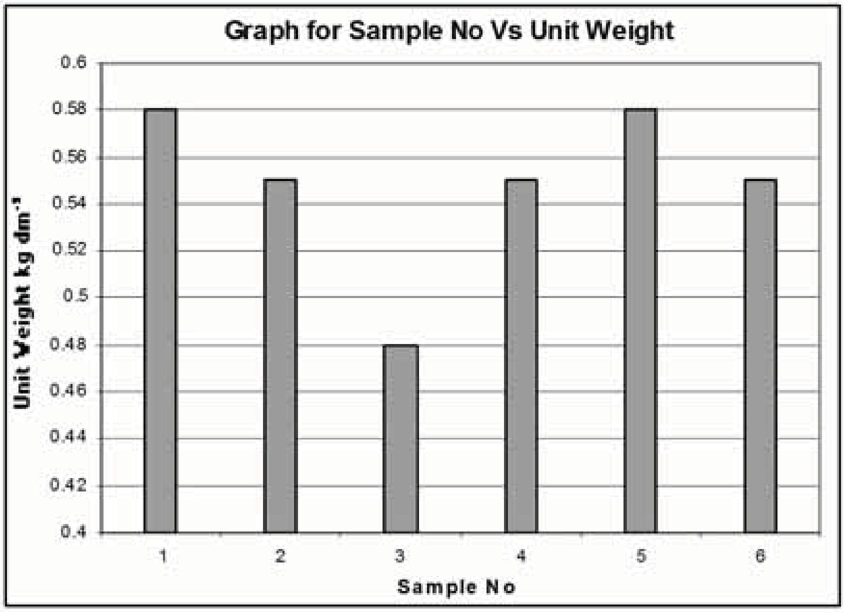

Figure 3.24: Sample no.vs. unit weight

2 Compressive strength

The data concerning the 28 days cube compressive strength values of the materials are given in Table 3.12.

Table 3.12: Compressive strength values

Sample No	28 days cube compressive strength(Nmm^{-2})
1	0.25
2	0.34
3	0.58
4	0.25
5	0.53
6	0.46

The 28 days cube compressive strength values of the concrete samples were changed according to the material mixing ratios. Due to low C/N ratio of the tobacco waste, using low amount of organic lightweight aggregate (tobacco waste) in the material composition caused maximum compressive strength values finally at the end of 28 days.

The compressive strength values of lightweight concrete samples were under $1Nmm^{-2}$.By reason of its low compressive strength and insulating materials, the lightweight concrete with tobacco waste additive can be recommended for use as a coating and dividing material in constructions because of its insulating features.

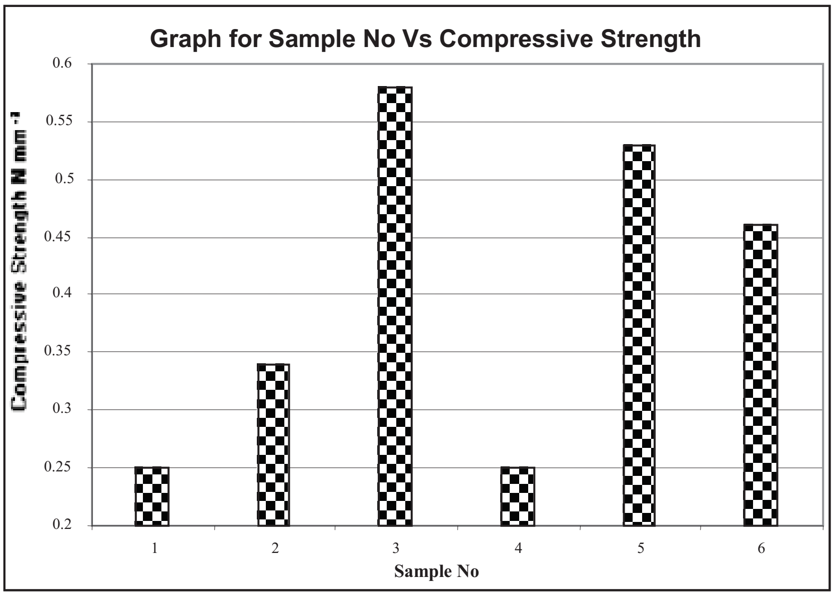

Figure 3.25: Sample no.vs compressive strength

3 Thermal conductivity

The thermal conductivities of produced material samples in the scope of the research are given in Table 3.13.

Table 3.13: Thermal conductivity

Sample No	Thermal conductivity ($Wm^{-1}K^{-1}$)
1	0.210
2	0.250
3	0.198
4	0.225
5	0.226
6	0.225

The minimum thermal conductivity of produced material samples was observed in sample no 3 as $0.198Wm^{-1}K^{-1}$. Besides this, the thermal conductivities of samples no 4 and 6 were determined as $0.225Wm^{-1}K^{-1}$. Evaluating the thermal conductivities of produced material samples together with their compressive strengths, it can be suitable to use lightweight concrete to be produced with tobacco waste additive in buildings as a coating and dividing material insulation.

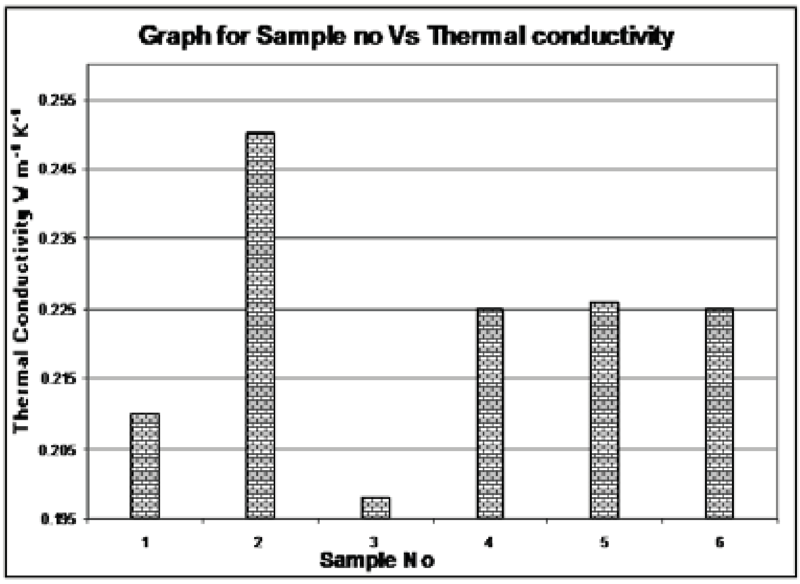

Figure 3.26: Sample no vs. thermal conductivity

Conclusions

In this study, the possibilities of using tobacco wastes in lightweight concrete producing were researched and the following conclusions were obtained:

- Since the unit weights of the produced lightweight concrete samples varied between 0.48 and 0.58kgdm^{-3}, they were into the class of heat insulating lightweight concrete in respect of their unit weight values.
- When the material samples had a fine aggregate composition (approximately 50%), the compactness and the compressive strength decreased.
- Due to low C/N ratio of the tobacco waste, using low amount of organic lightweight aggregate (tobacco waste) in the material composition caused maximum compressive strength values finally at the end of 28 days.
- It was showed that the 28 days cube compressive strength values were lower than 1Nmm^{-2} for the whole of the lightweight concrete samples. Therefore, it is possible to say that the lightweight concretes including tobacco waste used as a coating and dividing material in buildings is useful because of its insulating features.
- Comparing the thermal conductivity values of the produced lightweight concrete samples with the materials such as brick (0.45–0.60Wm^{-1}K^{-1}), briquette (0.70–1.0Wm^{-1}K^{-1}), pumice concrete (0.29Wm^{-1}K^{-1}) and ytong (0.23Wm^{-1}K^{-1}), which have a widespread usage area in the buildings, it is seen that the lightweight concretes samples including tobacco waste have lower values (0.198–0.250Wm^{-1}K^{-1}) compared to other masonry materials (Öztürk, 2003).

- The material used in this research was waste produced at the end of cigarette production at a Factory. According to other building insulation materials, it could be supplied cheaply. Furthermore, decomposition was not observed producing lightweight concrete samples. As to the observations, tests, experiments and evaluations on lightweight concrete material samples, it was concluded that the lightweight concrete with tobacco waste additive can be used as a coating and dividing material in constructions.

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