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Determination of Thermal Properties of Autoclaved Aerated Concrete Wall Sections Constructed with Distinct Mortars by the Experimental and Theoretical Data

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Abstract: This study investigated the thermal properties of autoclaved aerated concrete (AAC) wall sections constructed with distinct mortars. Within the scope of the study, four distinct wall sections of 25x25x5cm dimensions were created using AAC special adhesive mortar, cement mortar, lime mortar and cement-lime mortar. The thermal conductivity(λ_{EXP}) that was determined by the heat flow meter (HFM) method and bulk density(ρ_{EXP}) of each wall section was determined in the laboratory. Specific heat values(c_{EXP}) of mortars and aerated concrete material were determined experimentally in the study. The thermal diffusivity value(α_{EXP}), thermal effusivity value(e_{EXP}) and volumetric heat capacity (VHC_{EXP}) of each wall sample were calculated using the experimental data obtained in the laboratory. In addition, α_{TEO}, e_{TEO} and VHC_{TEO} of each wall sample were calculated theoretically using the thermal conductivity, bulk density and specific heat value given in the literature and standards for the same wall sections. In the study, experimental data was compared to the theoretical data. As a result, the thermal properties of walls constructed with distinct mortars and thermal differences formed in the walls due to the effect of these mortars could be determined with experimental data. However, it was observed that theoretical data were insufficient to detect these thermal differences.

Keywords: Autoclaved aerated concrete wall, thermal conductivity, specific heat value, thermal diffusivity, thermal effusivity.

Farklı Harçlarla İnşa Edilen Gazbeton Duvar Kesitlerine Ait Isıl Özelliklerin Deneysel ve Teorik Verilerle Belirlenmesi

Öz: Bu çalışmada, farklı harçlar ile inşa edilmiş gaz beton duvar kesitlerinin ısıl özellikleri incelenmiştir. Çalışma kapsamında gaz beton özel yapıştırma harcı, çimento harcı, kireç harcı ve çimento-kireç harcı kullanılarak 25x25x5cm boyutunda dört farklı duvar kesiti oluşturulmuştur. Her bir duvar kesitinin, ısıl iletkenlik hesap değeri (λ_{EXP}) ısı akış ölçer (HFM) yöntemiyle ve birim hacim ağırlığı (ρ_{EXP}) standartlarda tarfilenen şekliyle laboratuvarda elde edilmiştir. Çalışma kapsamında kullanılan harçların ve gaz beton malzemenin özgül ısı değeri (c_{EXP},) deneysel olarak belirlenmiştir. Laboratuvarda elde edilen bu deneysel veriler kullanılarak her duvar örneğinin deneysel ($_{EXP}$) termal efusivite/ısıl dağınırlık (α_{EXP}), termal efusivite/ısıl dağınırlık (e_{EXP}) değeri ve hacimsel ısı kapasitesi (VHC_{EXP}) hesaplanmıştır. Aynı duvar kesitleri için literatürde ve/veya standartlarda verilen teorik ısıl iletkenlik hesap değeri, birim hacim ağırlığı ve özgül ısı değeri kullanılarak her bir duvar örneğinin termal difüzivite/ısıl yayınırlık (α_{TEO}), termal efusivite/ısıl dağınırlık (e_{TEO}) değeri ve hacimsel ısı kapasitesi (VHC_{TEO}) teorik olarak belirlenmiştir. Çalışmada deneysel veriler ile teorik veriler karşılaştırılmıştır. Sonuç olarak; farklı harçlarla inşa edilmiş duvarların ısıl özellikleri ve bu harçların etkisiyle duvarlarda oluşan ısıl farklılıklar deneysel veriler ile tespit edilebilmiştir. Teorik verilerin ise bu ısıl farklılıkları tespit etmede yetersiz kaldığı görülmüştür.

Anahtar kelimeler: Gaz beton duvar, ısıl iletkenlik hesap değeri, özgül ısı değeri, ısıl yayınırlık, ısıl dağınırlık.

1. Introduction

Today, many masonry building materials such as brick, pumice concrete block and autoclaved aerated concrete are used in the construction of building walls. The mechanical, physical and thermal properties are decisive in choosing these building materials. Autoclaved aerated concrete (AAC), which has low density and low thermal permeability due to its light and porous structure, is a widely used building material [1-2]. Autoclaved aerated concrete is defined as lightweight concrete formed by lightening a mixture prepared with finely ground siliceous aggregate and an inorganic binder (lime/cement) by adding a pore-forming agent and hardening this mixture through steam curing [3-4]. Autoclaved aerated concrete consists of approximately 70%-80% pores by volume. Thanks to its high porosity, autoclaved aerated concrete has a low density compared to other wall-filling materials [5], and several of its physical properties vary depending on density. The density of autoclaved aerated concrete has values in the range of 300 kg/m^3-1800 kg/m^3 [6-7]. However, there are also aerated concretes with

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different physical, mechanical, and thermal properties formed by adding different materials in the literature [8-10].

Autoclaved aerated concrete also has a lower thermal conductivity value than other masonry wall materials. The calculated thermal conductivity value of autoclaved aerated concrete building slabs, according to TS EN 771-4, used with distinct mortars and different joint thicknesses, is in the range of 0.11 W/mK-0.29 W/mK [11]. It is known that this material with thermal conductivity has a higher thermal performance than other wall-filling materials; that is, its thermal resistance is better. For this reason, walls built with autoclaved aerated concrete are expected to have high energy performance and low energy consumption. However, there are certain other factors that affect this situation. The calculated thermal conductivity value is affected by the physical properties of the material, such as density, moisture content, and porosity [12]. There is a direct relationship between density and the calculated thermal conductivity value. In particular, the thermal conductivity value of building materials with a density below 3000 kg/m^3 shows a positive correlation [13]. In addition, defects such as air leaks and thermal bridges caused by labor faults and material deterioration also negatively affect the thermal performance of the wall [14]. The properties of the binding material used in mortar joints on the walls also change the total thermal performance of the wall. Thus, in order to determine the thermal performance of a building wall, it is necessary to know the thermal properties of both the masonry block material (aerated concrete) and the mortar materials used in its joints. But there is still very little information about the thermal properties of building materials [1, 15]. Compared to the thermal conductivity value, it is more difficult to find the thermal properties of materials, particularly properties such as specific heat, thermal diffusivity value, and volumetric heat capacity, in the literature. The specific heat values of building materials are expressed in general round numbers in the literature and standards. Moreover, the specific heat value of building materials is given in a wide range as 300 J/kgK-2500 J/kgK [13]. In the TS EN 1745 standard, the specific heat value of all building materials and mortars, including aerated concrete, is stated as 1000 J/kgK. The specific heat value given in the literature for autoclaved aerated concrete is in the range of 837 J/kgK-1050 J/kgK [5, 15-20].

The lack of reliable technical information about the thermal properties of materials and the energy performance of autoclaved aerated concrete walls [15] leads to differences between design thermal values and actual thermal values. Therefore, this study, which was conducted to determine the essential physical and thermal properties of autoclaved aerated concrete and the walls built with aerated concrete, is significant in the sense that it will contribute to overcoming the lack of technical information in the literature. This study examines the thermal performance of autoclaved aerated concrete walls constructed using distinct mortars. Basic thermophysical properties such as thermal conductivity (λ, W/mK), specific heat value (c, J/kgK), and bulk density (ρ, kg/m^3) of representative autoclaved aerated concrete walls built as part of this study were determined by laboratory experiments. Using the experimental data obtained and theoretical data taken from the literature/standards, important thermal variables of each wall section (such as thermal diffusivity, thermal effusivity, and volumetric heat capacity) were calculated. The thermal performances of autoclaved aerated concrete wall sections produced with distinct mortars were compared based on the results. According to the reviewed literature, the thermal conductivities of mortars and aerated concrete block material were determined separately in previous studies. What makes this study different is the determination of thermal conductivity calculation values over the wall cross-section. Another thing is the experimental determination of the specific heat value of aerated concrete and each mortar material. Specific heat value has constituted a basic source for the literature. The study is considered to be important in this respect.

2. Materials and Methods

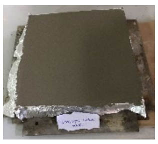
The autoclaved aerated concrete wall sections were created using autoclaved aerated concrete wall-filling material and four distinct mortars as part of this study. Among the mortars commonly used as joint filling material today, the types of mortars preferred in this study are autoclaved aerated concrete special adhesive mortar, cement mortar, lime mortar, and cement-lime added mortar [21] The binding material-sand ratio in the mortar mixture was kept constant at 1/3. The water ratio used in the study varied according to the consistency of the mortar. The mixing ratios of all materials used in the study are presented in Table 1.

Table 1. Material mixing ratios of the autoclaved aerated concrete wall sections

Materials	Material Properties	Sand (0-4 mm)	Cement	Lime	Adhesive mortar of AAC	Water
		kg	kg	kg	kg	kg
Autoclaved aerated concrete (AAC)	The sample of aerated concrete	-	-	-	-	-
AAC adhesive mortar (AACM)	Cement-based autoclaved aerated concrete mortar	-	-	-	5.0	1.70
Cement mortar (CM)	Cem IV/B 32.5 R pozzolanic cement	6.0	2.0	-	-	1.45
Lime Mortar (LM)	Slaked lime	6.0	-	2.0	-	1.20
Cement+lime mortar (CLM)	The cement: lime ratio of 3/1	6.0	1.33	0.67	-	1.45
Note: Mixing ratios for AAC volume (1 m^3).						

Autoclaved aerated concrete was cut into equal pieces of 12x25x5 cm (width x length x thickness) with cutting in the laboratory. After cutting, no visible cracks were observed, and very fine rough surfaces were created on the side edges of the autoclaved aerated concrete to increase adhesion. A basic wall section was formed by filling the joint between two rough surfaces with mortar material with a thickness of 10 mm [22], nearly. This procedure was implemented on each wall section sample, which was constructed using four distinct mortars. Furthermore, those mortar samples were produced from each mortar variant with a size of 25x25x5 cm. Table 2 shows the details of the mortar samples and the wall sections crafted utilizing these mortars.

Table 2. Definitions, photographs, and codes of autoclaved aerated concrete wall sections and mortars

Material Code	Material Description	Material View	Material Code	Material Description	Material View
AAC	The autoclaved aerated concrete materials		-	-	-
AACM	Adhesive mortar of autoclaved aerated concrete		W1	The wall sample section (W1) is constructed of autoclaved aerated concrete (AAC) and adhesive mortars (AACM).	
CM	Cement mortar		W2	W2 is constructed of autoclaved aerated concrete (AAC) and cement mortars (CM).	
LM	Lime Mortar		W3	W3 is constructed of autoclaved aerated concrete (AAC) and lime mortars (LM).	
CLM	Cement+lime mortar		W4	W4 is constructed of autoclaved aerated concrete (AAC) and cemen+lime mortars (CLM).	

This study has determined various thermophysical properties such as thermal conductivity, specific heat value and bulk density for both the mortars and the autoclaved aerated concrete wall sections produced as part of the study. The thermal conductivity of wall sections was measured by the HFM 300 coded "heat flow meter" method in the Civil Engineering Laboratory of Kastamonu University. In the HFM 300 test method, the thermal conductivity is measured on samples of 30x30x5 cm in size. In order to make the produced samples ready for measurement in the HFM test method, the edges of the wall were covered with insulation material to prevent heat loss around the samples (Figure 1). The experiment was then initiated by putting the wall section sample within the HFM test method according to the standard BS EN 12667 [23] (Figure 1).

Figure 1. Heat flow meter method (coded HFM 300)

The wall sections were tested using the HFM 300 coded heat flow meter method, and thermal conductivity (λ, W/mK) and thermal transmittance value (U, W/m^{2}K) results were obtained. The thermal resistance value (R, m^{2}K/W) of the wall sections was also calculated (R=1/U) [11] by employing these U values.

The specific heat value of autoclaved aerated concrete and mortar materials was determined with a simple experimental setup prepared in laboratory conditions, taking the TSE 4048 standard [24] as a reference [25]. An insulated calorimeter box that prevents heat transfer, with the features specified in the TSE 4048 standard, is required to set up a test device for measurement specific heat value. The basic principle in setting this experimental setup is Energy Conservation, the first law of Thermodynamics [26]. The experimental setup involved the utilization of two hot water thermoses, each with a capacity of 1500 ml. A lid was created using insulating material to cover the mouths of the thermoses and prevent heat loss. A thermometer that can monitor the temperature change of the water in the thermos was positioned centrally within this lid. Figure 2(a) shows the specific heat experimental setup. The material samples of the specific heat value to be determined must be sized enough to fit into the experimental setup. Figure 2(b) shows that the autoclaved aerated concrete material and mortar samples were prepared for the experimental setup of the specific heat value. The initial masses of the prepared samples were measured, and the samples were subsequently placed in an oven at a temperature of 40°C until their material masses reached a stable state (Figure 2(c)). Upon reaching a stable mass, the materials were kept in the oven at 60°C for a duration of 24 hours. The materials taken from the oven were placed in the experimental setup filled with 1/2 liter of distilled water. The temperature of the water in the experimental setup was checked at 2-minute intervals. The experiment was concluded following three consistent temperature measurements. The last temperature that remained stable for three measurements was taken as the equilibrium temperature of the system. The data has been used in Equation 1 to calculate the specific heat value of the samples [24, 25]. Figure 2 shows the photographs of the experimental setup and test samples.

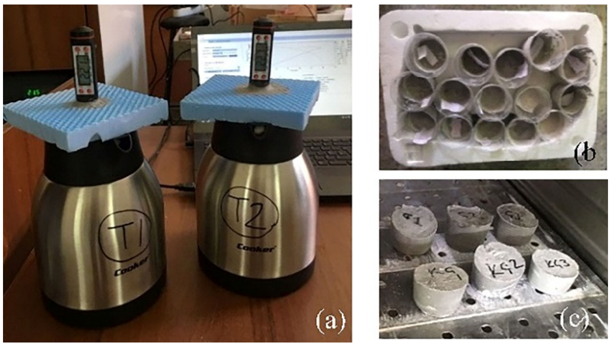


Figure 2. Views of the calorimeters (a) that were used in the experiments and test samples (b, c) for the specific heat value

$$M_s c_s \Delta T_s = M_n c_n \Delta T_n \tag{1}$$

Where; M_S: the mass of the calorimeter water (g); c_s: the specific heat capacity of the calorimeter water (cal/g°C); ΔT_s: the temperature change undergone by the calorimeter water (°C), M_n: the mass of the sample (g); c_n: the specific heat capacity of the sample (cal/g°C); ΔT_n: the temperature change undergone by the sample (°C).

The bulk density of a material represents the ratio of the mass to the bulk volume of that particular material [27]. The bulk density of distinct mortars and autoclaved aerated concrete wall sections produced with them was determined by using RILEM (1980) [27] and TS EN 1936 (2007) [28] standards. Figure 3 shows the determination of the mass of the test samples.

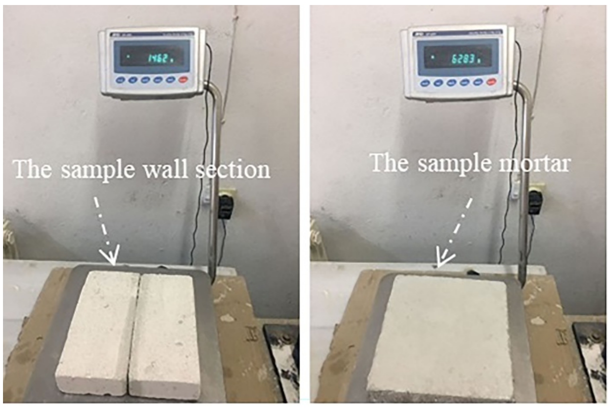


Figure 3. Determination of the mass of autoclaved aerated concrete wall sections and distinct mortars.

The thermal conductivity value obtained as a result of the experiments was used to determine important thermal parameters such as the thermal diffusivity (α, m^2/s), thermal effusivity (e, $Ws^{½}/m^2K$), and volumetric heat capacity (VHC, J/m^3K) of the wall sections. In addition, theoretical α, e, and VHC values were determined for the materials forming the wall sections used in the study, employing data obtained from the literature and/or standards. Both experimental and theoretical α, e, and VHC values of the wall sections were calculated with Equation 2, Equation 3, and Equation 4, respectively.

$$\alpha = \frac{\lambda}{c \times \rho} \tag{2}$$

$$e = \sqrt{\lambda x \rho x c} \tag{3}$$

$$\text{VHC=p.c} \tag{4}$$

Where *c:* specific heat capacity value (J/kgK), ρ: bulk density (kg/m^3), and λ: thermal conductivity (W/mK)

3. Results and Discussion

Thermophysical properties such as thermal conductivity value, specific heat, and bulk density of the wall sections constructed with autoclaved aerated concrete and distinct mortars used in the study were determined from laboratory experiments.

The thermal conductivity (λ_{EXP}, W/mK) and thermal transmittance value (U_{EXP}, W/m^{2}K) of the wall sections were determined by experiments conducted in the laboratory environment, and the thermal resistance value of the wall sections (R_{EXP}, m^{2}K/W) was calculated using these data (Table 3). According to these data, the thermal conductivity of jointless autoclaved aerated concrete (AAC) prepared as a single piece was determined as 0.116 W/mK, and the thermal transmittance value was identified as 2.286 W/m^{2}K. The thermal properties of the wall sections, which were prepared in two pieces and joined by applying a thin layer of mortar between them, were also determined. The λ_{EXP} and U_{EXP} values of the wall section coded as W2 and W3 are presented respectively as graphics in Figure 4 (A) and (B). As a result of the experiments, the effect of mortars on the thermal performance of the autoclaved aerated concrete wall section was determined. Based on the acquired data, the thermal resistance of the wall section (W1) constructed employing autoclaved aerated concrete special adhesive mortar was determined as 0.431m^{2}K/W. The wall section was observed to have better thermal resistance than other wall sections. The thermal resistance values of the wall sections with codes W2 and W4 using cement and cement-lime based mortar were determined as 0.355 m^{2}K/W and 0.359 m^{2}K/W, respectively. The W3-coded wall section made with lime mortar was the wall section with the lowest thermal resistance with a value of 0.248 m^{2}K/W. There was a significant increase in the thermal conductivity of the W3-coded lime mortar wall section compared to other wall sections. Thermal conductivity is a property that varies depending on the density, pore structure, and moisture content of the material [1, 9] and is also affected by problems in the material (such as air leakage, thermal bridge). The adherence between lime mortar and autoclaved aerated concrete was weaker than other wall sections. This led to air leakage at the joint section of the lime mortar wall section, in addition to causing the thermal conductivity and thermal transmittance values to be higher. Furthermore, the moisture content of the W3-coded wall section was determined as 17.53% and the moisture content of the lime mortar (LM) was identified as 29.70% (Table 5). The thermal conductivity is a value affected by the moisture content of the material. According to Narayanan et al., a 1% increase in the mass moisture content of a material increases the thermal conductivity by approximately 42% [12].

Table 3. Definition of materials used in AAC wall samples in terms of their thermal properties such as thermal transmittance value (U), thermal resistance (R), and thermal conductivity (λ).

Material Code	Thermal transmittance	Thermal conductivity	Thermal resistance	The thermal conductivity was taken from TS 825	The sequence number in TS 825
	U_{EXP} (W/m^{2}K)	λ_{EXP} (W/mK)	R_{EXP}(m^{2}K/W)	λ_{TS825} (W/mK)	
AAC	2.286	0.116	0.437	0.130	6.1.2
W1	2.322	0.118	0.431		
W2	2.814	0.143	0.355	0.200	6.1.1
W3	4.041	0.218	0.248		
W4	2.783	0.141	0.359		

The specific heats of the autoclaved aerated concrete and four distinct mortars used in the study were determined through experiments carried out in the laboratory. The data obtained are presented in Table 4. According to the test results, the specific heat value (c_{EXP}) of autoclaved aerated concrete was approximately 1020 J/kg°C; the specific heat of cement mortar, lime mortar, and cement-lime mortars were determined to be approximately 998 J/kgK, 848 J/kgK, and 819 J/kgK, respectively. When literature data and standards are examined, one finds different specific heat information for the autoclaved aerated concrete and mortars used in the study. Although the specific heat value (c_{TEO}) commonly given in the literature for autoclaved aerated concrete is 1000 J/kgK [5,16,19], there are also publications stating it in the range of 837-1050 J/kgK [15, 17,18, 20]. The specific heat value of autoclaved aerated concrete special adhesive mortar (AACM) could not be accessed as part of the literature research.

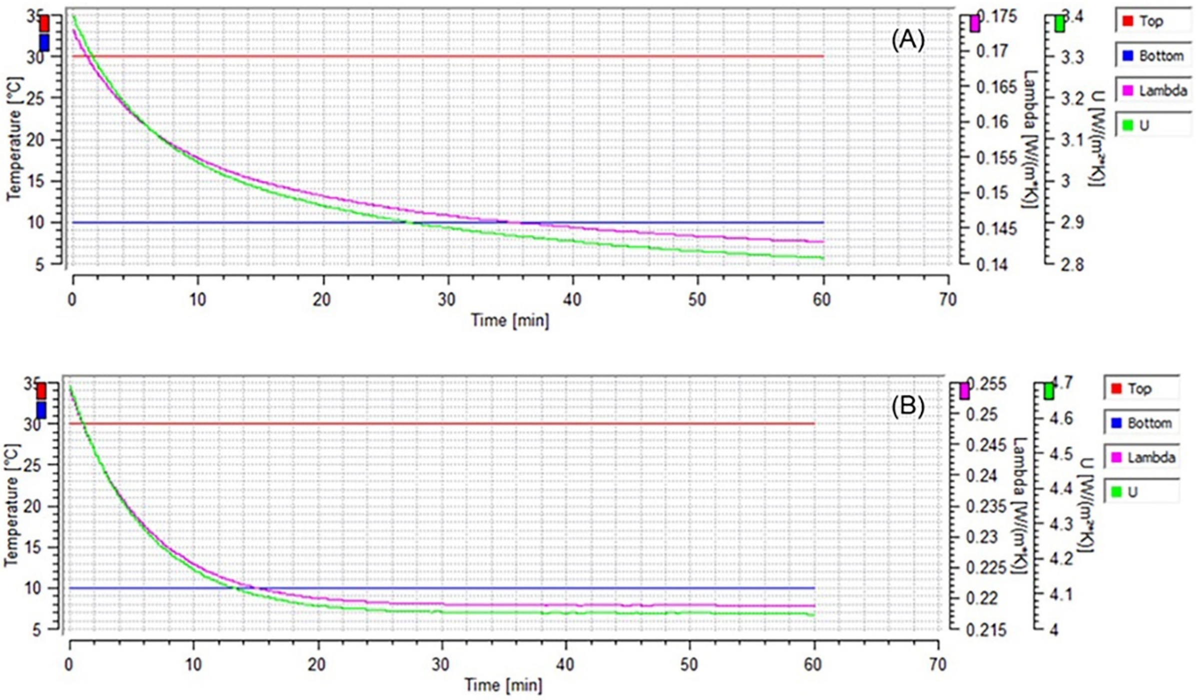


Figure 4. The thermal conductivity (λ_{EXP}) and thermal transmittance value (U_{EXP}) of W2(A) and W3(B).

The specific heat of AACM-coded mortar was determined as 692 J/kgK as a result of the experimental study. In the TS EN 1745 standard, the specific heat value for all masonry materials is 1000 J/kgK. To research the thermal properties and thermal performances of materials, the reference specific heat value of the material must be ascertained. So, it is understood that these data need to be included in the literature.

Table 4. Specific heat values of autoclaved aerated concrete and distinct mortars

Code	Specific Heat Value (c, J/kgK)						
	Experimental data (c_{EXP})	[5]	[15]	[16]	[17]	[18]	[19]
AAC	1020	1000	1050	1000	837	840	1000
AACM	692	-	-	-	-	-	-
CM	998	-	-	1000	837	840	837
LM	848	-	-	1000	-	840	-
CLM	819	-	-	1000	-	840	840

The bulk density information of aerated concrete, mortar plates, and wall sections used in the study is given in Table 5. According to these data, the density of jointless autoclaved aerated concrete (AAC) constructed as a single piece was determined as 419 kg/m^3. The bulk density of the CM-coded cement mortar, the CLM-coded mortar, and the LM-coded mortar were determined as 2011 kg/m^3, 1960 kg/m^3, and 1754 kg/m^3, respectively. Within the array of the mortar plates, it was noted that those containing cement components manifested a higher density by anticipated outcomes. Again, upon further examination of the wall sections, it was observed that those constructed with high-density mortars exhibited elevated density levels. These density data obtained through experiments were similar to literature data [11, 17, 18, 29].

As a result of the study, experimental ($_{EXP}$) and theoretical ($_{TEO}$) thermal diffusivity value (α, m^2/s), thermal effusivity value (e, Ws^{½}/m²K), and volumetric heat capacity (VHC, J/m^{3}K) of aerated concrete, mortars and wall sections were calculated by using the thermophysical properties obtained experimentally and taken from the standards. The thermal conductivity value of the mortars could not be determined as experimental data. So, the theoretical λ_{TEO} values given in [11] were used to calculate α_{EXP}, e_{EXP}, and VHC_{EXP} values for mortars.

Experimentally determined λ_{EXP} and ρ_{EXP} for wall sections were used to determine the α_{EXP} and e_{EXP} values of the wall sections. In addition, the specific heat of wall sections could not be determined experimentally. Therefore, the specific heat data obtained by weighted averages of experimentally determined specific heats of mortar and autoclaved aerated concrete forming the wall section were used to calculate α_{EXP}, e_{EXP}, and VHC_{EXP} values of the wall sections. Both theoretical data and experimental data were determined for both mortar and wall sections given in Tablo 5. The α_{EXP} value of autoclaved aerated concrete was determined as 2.72x10^{-7}, and the α_{TEO} value was determined as 3.25x10^{-7}. In the literature, the thermal diffusivity value of autoclaved aerated concrete with different densities is given as 2.2x10^{-7}-2.8x10^{-7} [2].

Table 5. Thermophysical properties of aerated concrete, distinct mortars, and wall sections

Code	Mass (kg)	Volume (m^3)	Bulk Density (kg/m^3)	Moisture Content (%)	Thermal Diffusivity Value (m^2/s)		Thermal Effusivity Value ($Ws^{½}/m^2K$)		Volumetric Heat Capacity (J/m^3K)	
	m	v	ρ_{EXP}	w	α_{EXP} x10^{-7}	α_{TEO} x10^{-7}	e_{EXP}	e_{TEO}	VCH_{EXP}	VCH_{TEO}
AAC	1.507	0.0036	418.61	11.30	2.717	3.250	222.553	228.0351	426982	400000
AACM	1.515	0.0031	484.8	-	3.516	3.250	199.006	228.0351	335622	400000
CM	6.283	0.0031	2010.56	12.60	7.976	8.000	1791.579	1788.8544	2006097	2000000
LM	5.48	0.0031	1753.60	29.70	6.721	5.556	1219.765	1341.6408	1487824	1800000
CLM	6.126	0.0031	1960.32	19.73	6.239	5.556	1266.063	1341.6408	1602915	1800000
W1	1.515	0.0031	484.80	11.57	2.417	3.250	240.001	228.0351	488141	400000
W2	1.542	0.0031	493.44	11.30	2.844	5.000	268.161	282.8427	502870	400000
W3	1.42	0.0031	454.40	17.53	4.735	5.000	316.797	282.8427	460370	400000
W4	1.541	0.0031	493.12	14.23	2.826	5.000	265.251	282.8427	498992	400000

Thermal diffusivity values of autoclaved aerated concrete and wall sections calculated by experimental and theoretical data were compared. As a result of this comparison, it was seen that the α_{EXP} value calculated through the experimentally obtained λ_{EXP}, p_{EXP}, and c_{EXP} data was lower than the α_{TEO} value calculated by theoretical data (Figure 5). As a result of the calculation made using theoretical data, the α_{TEO} value for jointless autoclaved aerated concrete (AAC) and W1-coded wall section was determined as 3.25x10^{-7}; regardless of the mortar type, the α_{TEO} value was found to be a similar 5.0x10^{-7} for all constructed wall sections (wall sections coded W2, W3, and W4) (Figure 5 and Table 5). Since it was understood in this study that the thermal properties of mortars produced from different materials exhibit variances, it is anticipated that the thermal properties of walls built with various mortars will also be other. However, these differences could not be revealed using standard data because there is an absence of comprehensive theoretical data capable of delineating each material distinctly. Conclusively, through this study, the differences in the thermal properties of wall sections made with distinct mortars could be determined numerically by incorporating experimentally obtained thermophysical properties into the calculations.

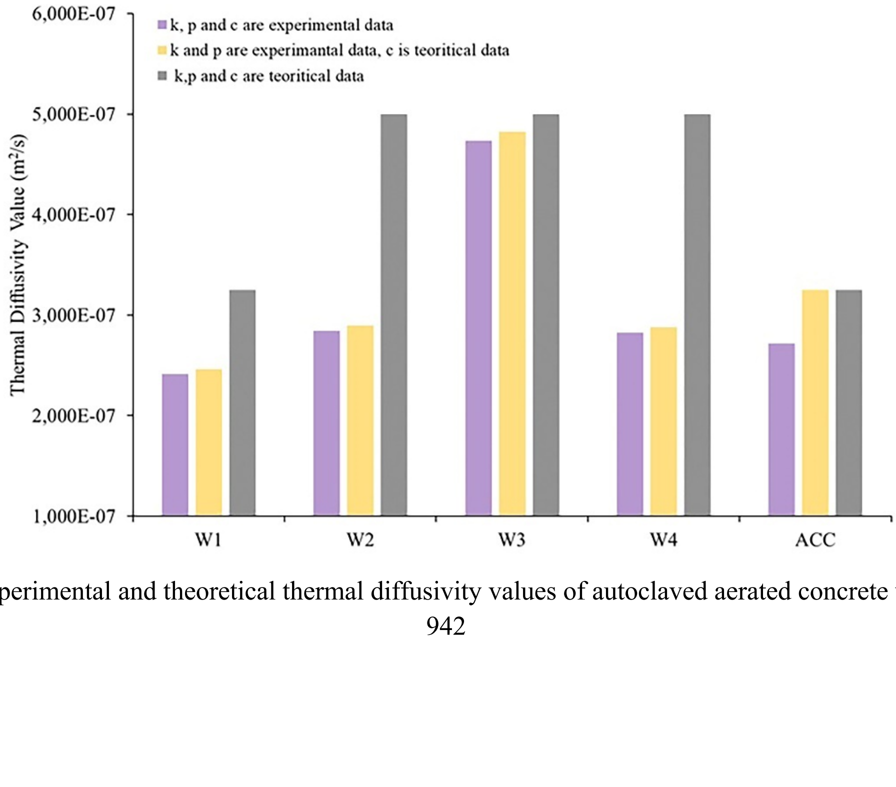


Figure 5. Experimental and theoretical thermal diffusivity values of autoclaved aerated concrete wall sections

It has been evaluated that some thermal properties defining construction materials are not commonly found in the literature. The accuracy of the data obtained as a result of the experiments carried out in this study was ensured by taking gas concrete as a reference. The experimental data obtained for gas concrete are compatible with the literature data. This situation shows the accuracy of the experimental results obtained for other materials as a result of this study. However, more similar studies are needed in this field to reach a definite conclusion.

4. Conclusion

In this study, wall sections were created using four distinct mortars, such as autoclaved aerated concrete adhesive mortar, cement mortar, lime mortar, and cement-lime mortar at the joints of the autoclaved aerated concrete wall-filling material. Certain basic thermophysical properties of both materials (autoclaved aerated concrete and mortars) and wall sections were determined. Through the data obtained, the thermal diffusivity, thermal effusivity, and volumetric heat capacities of the wall sections constructed with distinct mortars were identified. The experimental data resulting from the study were compared with theoretical data, and the thermal performance of the wall sections was discussed. The results obtained within the compass of this study are summarized below.

- The experimentally determined thermal properties of the wall sections were similar to the values listed in the literature. However, a significant increase was observed in the thermal conductivity of the W3-coded lime mortar and wall section compared to other wall sections. Adequate adhesion was not attainable between the aerated concretes and lime mortar, leading to air leakage at the joint. It was also observed that the moisture content of lime mortar was high. Both air leakage and moisture content caused the thermal conductivity and thermal transmittance value to be high in this wall section.
- It was observed that the mortar with a cement mortar had the highest density among the mortar plates. Again, upon further examination of the wall sections, it was observed that those constructed with high-density mortars exhibited elevated density levels.
- The specific heat values of the autoclaved aerated concrete and mortars used in the research were determined by laboratory experiments. It turned out that each material had a different specific heat value. However, it is seen that the specific heat values presented in the literature/standards for all masonry materials are similar. In future studies, the specific heat values of the materials must be determined experimentally. A data archive should be created for the correct specific heat values of materials, and this deficiency in the literature should be addressed.
- Thermal properties of materials directly affect the thermal performance of the structural element in which that material is used. Determining the real thermal performance of structures is very important in terms of increasing energy efficiency. Therefore, it is necessary to know the real thermal properties of materials.

In conclusion, it is known that the thermal performance of walls constructed with mortars possessing varied thermophysical properties will be different. However, these differences cannot be revealed with theoretical data taken from the literature/standards. The actual thermal properties of the walls can only be determined by incorporating the experimentally obtained thermophysical properties in the calculations. This study revealed that autoclaved aerated concrete wall sections built with distinct mortars possess distinct thermal properties. The literature review conducted as part of the study unveiled the need for more information on specific heat, a fundamental thermal property of building materials. Therefore, it is recommended that new research be conducted and a large data archive created to determine the basic thermal properties of existing building materials, especially specific heat values. It is essential to contribute the data concerning these thermal properties currently absent in building materials to the literature. It will facilitate access to accurate data, which is especially necessary for theoretical studies. Thus, it is thought that it will contribute to studies to determine the real energy performance of buildings and building elements.

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