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Sıfır Enerji Bina Hedefleri Doğrultusunda Pomza ve Perlit Bileşenleriyle Şap Tasarımı

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Anahtar Kelimeler:
Pomza, genleştirilmiş perlit, şap, ısı transferi, döşeme, sıfır enerji.

Öne Çıkanlar:
- İnşaat malzemesi olarak pomza ve perlitin tanıtılması
- Pomza ve perlit malzemesinin şapının mühendislik özellikleri üzerine etkileri
- Geleneksel şap üretimi yerine üretiminde pomza ve perlit kullanımıyla daha üstün mühendislik ve yalıtım özelliklerine sahip, enerji tasarrufuna katkıda bulunan şap üretilebilir.

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Amaç
Bu çalışmada, sıfır enerjili bina hedeflerine yönelik olarak pomza taşı ve genleştirilmiş perlit malzemeleri kullanılarak şap tipinin tasarlanması amaçlanmaktadır. Bu amaçla günümüzde kullanılan geleneksel şap çeşidini temsil edecek ve çalışmada kontrol örneğini temsil edecek şap için dere kumu ile üretilmiş şap çeşidi üretilmiştir.

Metot
Pomza taşı ve genleştirilmiş perlit malzemeleri içeren 8 farklı karışım üretilmiştir. 28 günlük kürleme sürecinden sonra bu 9 farklı şap örneğine ultrasonik ses hızı (USH), basınç dayanımı ve ısıl iletkenlik testleri uygulanarak mühendislik özellikleri belirlenmiştir.

Sonuçlar
Ultrasonik ses hızı (USH) sonuçları incelendiğinde en yüksek değer (3797,2 m/s) kontrol serisinde elde edilmiştir. Buna en yakın değer BR-3 (3713,1 m/s) pomza serisinden elde edilmiştir. Basınç dayanımı sonuçlarına bakıldığında BR-3 (12,76 N/mm^2) serisinin kontrol serisine göre daha iyi sonuç verdiği görülmüştür. En düşük veriler ise BR-7 (1,68 N/mm^2) ve BR-8 (0,96 N/mm^2) perlit serisinde gözlenmiştir. Isıl iletkenlik test sonucu incelendiğinde en yüksek değer kontrol örneğinde (0,441 W/m.K) bulunmuş, buna en yakın değerler BR-4 (0,436 W/m.K) ve BR-2'de (0,304 W/m.K) pomza serisinde elde edilmiştir. En düşük değer ise BR-7 (0,191 W/m.K) ve BR-8 (0,105 W/m.K) perlit serisinde elde edilmiştir. Yapılan test sonuçları sektörde kullanılan şaplara göre pomza ve genleştirilmiş perlitli şap üretiminin mümkün olduğunu göstermiştir. Ancak genleştirilmiş perlit kullanımı ile basınç dayanımı önemli ölçüde azalırken, ses ve ısıl iletkenlik katsayıları çok daha iyi sonuçlar elde edilmiştir. Pomza taşının farklı ebatlarda kullanılması ise ses ve ısıl iletkenlik sonuçlarında iyileşmeler gösterirken, basınç dayanımı özelliklerini de değiştirmektedir.

Research Article
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The Screed Design with Pumice and Perlite Components in Zero Energy Building Targets

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Highlights:

- Engineering properties of conventional screed
- Introducing pumice and perlite as construction materials
- Effects of pumice and perlite materials on the engineering properties of screed

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Abstract

In this study, it is aimed to design a screed type using pumice-stone and expanded-perlite materials towards zero energy building goals. For this purpose, a screed type produced with river sand was produced for screed, which will represent the traditional screed type used today and will represent your control sample in our study. Then, 8 different mixtures containing pumice stone and expanded perlite materials were produced. After a 28-day curing process, nine different screed samples underwent engineering property tests: ultrasonic pulse velocity (UPV), compressive strength, and thermal conductivity. The control series showed the highest UPV value at 3797.2 m/s, followed closely by pumice BR-3 at 3713.1 m/s. BR-3 also outperformed the control series in compressive strength (12.76 N/mm^2), while perlite series BR-7 (1.68 N/mm^2) and BR-8 (0.96 N/mm^2) had the lowest values. In thermal conductivity, the control sample had the highest value (0.441 W/m.K), with pumice BR-4 (0.436 W/m.K) and BR-2 (0.304 W/m.K) close behind, and perlite series BR-7 (0.191 W/m.K) and BR-8 (0.105 W/m.K) having the lowest values. Using pumice and expanded perlite as screed materials offers improved sound and thermal conductivity results compared to traditional screed. However, expanded perlite leads to a significant decrease in compressive strength. Incorporating these alternatives has the potential to reduce building weight and enhance heat and sound insulation properties.

Keywords: Pumice, expanded perlite, screed, heat transfer, flooring, zero energy.

1. Introduction

The issue of energy in the world has not lost its importance since the beginning of the energy crisis, on the contrary, it has come to this day with increasing importance. Developments in energy have evolved from issues such as energy consumption-energy saving-renewable energy to issues such as low energy-nearly zero energy-net zero energy. One of the sectors where energy is consumed the most is building and construction, after industry and transportation. In this respect, zero energy building targets have become one of the most important concept issues today. Although insulation materials come to the fore in this regard, they are not sufficient on their own to achieve this goal. Along with insulation materials, other elements that make up the buildings should be designed in accordance with these objectives and have positive contributions [1,2]. In this context, the subject of this article emphasizes that the screed material used on building floors and back floors can be designed to reduce the dead load of the building and to contribute to sound and heat insulation at the same time. Today, technology is advancing rapidly and brings with it many innovations. One of the sectors where we feel the presence of technology the most is the construction sector [3,4]. Researchers further promote the construction industry by doing research and inventions to improve building materials, meet the needs better, keep up with the speed of technology and complete the deficiencies.

Concrete, which has an extensive and widespread usage area, is one of the first products that come to mind regarding building materials. Concrete and concrete-like materials have many advantages as well as disadvantages [3,4]. Researchers have focused on addressing the drawbacks of concrete, the primary building material. In this context, efforts have been made to enhance the screed material used for floor applications. Screed provides a smooth surface necessary for proper floor coating, offering advantages such as high strength and insulation properties. Its usage aims to provide floor insulation, improve aesthetics, increase resistance to external factors, and extend the lifespan of the concrete subfloor. Screed finds applications in various areas, including parking lots, water-exposed regions, factories, sports and exhibition halls. There are two main types of screed application: poured with cement and ready screed. These advancements contribute significantly to the overall enhancement of building systems [5].

Pumice is a type of natural stone with a spongy structure, which is formed because of volcanic eruptions, with many macro and micro cavities that are independent of each other [6-7]. The maximum particle porosity is 85%, the remaining 15% is solid material [7]. Pumice, which is a volcanic rock, is a natural, low cost and very light material with low permeability, high heat and sound insulation thanks to its independent macro and micro cavities [6,8]. Besides these, pumice has reasonable flexibility and good fire resistance [7]. Pumice has a light or dark color structure and is highly resistant to chemical and physical events. Due to these superior properties, pumice has gained value in the construction sector and has become a frequently preferred building material in advancing and developing technology. The world is very rich in terms of pumice reserves

[9]. Turkey is in one of the most important positions in terms of ownership of pumice deposits [6]. The pumice reserves in the world are approximately 18 billion m^3 and approximately 2.8 billion m^3 of these reserves are in Turkey. Bitlis province is the leading province in terms of pumice reserve due to the geological structure of Bitlis province and being built on a volcanic area, pumice deposits have an important potential. The deposits in question are in Tatvan and Ahlat districts of the province and there are 81,500,000 m^3 of good quality pumice deposits that do not require partial washing [6]. 80% of the pumice produced in Turkey is used as lightweight concrete aggregate in the construction industry [9]. Due to pumice concrete is a very light construction material compared to normal concrete [9]. Pumice is used in many sectors apart from the construction sector. Some of those; textile, agriculture, and chemical sectors. Pumice stone is divided into two as acidic pumice stone and basic pumice stone [4]. In this study, acidic pumice was used as pumice stone and specific weight between 0.69 and 0.95 kg/dm^3 obtained from Bitlis region [10].

Perlite is a pearly, acidic volcanic glass that becomes very light and porous when suddenly heated to a suitable temperature. The word perlite is used for both raw perlite and expanded perlite [11]. When raw perlite is suddenly heated to a temperature between 800 and 1100 °C, the perlite particles expand as the water in it comes out as steam, increasing its volume to about 20 times the original, and as a result, expanded perlite is formed [12]. The color of raw perlite varies from transparent light gray to glossy black, while the color of expanded perlite is white. In terms of its lightness, heat and sound insulation and cheapness, it is the most suitable material known to produce light construction materials [11]. Expanded perlite is a material used worldwide. Due to its low mass density, it is a material used especially in building materials technology, lightweight composites, heat, and sound insulation. Dust formation is the most important factor that complicates the use of expanded perlite due to its extremely low bulk density [13].

In this article, first, the properties of the screed varieties available in the market were investigated. Then, it was aimed to investigate whether it is possible to produce a screed type with better and more advantageous engineering properties by producing the screed application applied in the buildings with acidic pumice stone and expanded perlite. For this purpose, different from the ready-made screeds in the market, mixtures were prepared from acidic pumice stone and expanded perlite materials in different proportions and different particle sizes using chemical additives, and some engineering properties of the produced samples were investigated. In addition, the other aim of this study is to discuss increasing the usage areas of acidic pumice stone, which is a natural material of the Bitlis region, which has a significant proportion of the world's pumice reserves, and expanded perlite, another material with similar properties in the construction sector. Taking advantage of the physical and chemical properties of acidic pumice stone and expanded perlite material, reducing the structural load, which is a very important problem for the construction industry, benefiting from the advantages of sound and heat insulation, which

Table 1. CEM-1 42,5 N Portland cement properties

Analysis results	CEM I 42.5 N	TS EN 197-1 [4]
2 days compressive strength (MPa)	22,4	≥20
7 Days Compressive Strength MPa)	39,4	-
28 Days Compressive Strength (MPa)	51,0	62,5 ≥ x ≥ 42,5
SO_3 (%)	2,6	≤ 3,5
MgO (%)	2,1	≤ 5
CI (%)	0,007	≤ 0,1
LOI (%)	1,7	≤ 5
Insoluble matter (%)	0,3	≤ 5
Specific surface (cm^2/g)	3749	-
Initial setting time (min)	161	≥ 60
Shrinkage (mm)	0,4	≤ 10
Free lime (%)	0,5	-
Water demand (%)	29,6	-

Table 2. Physical properties of acidic pumice aggregate

Aggregate Group	0-4 mm	4-8 mm	8-16 mm
Water absorption rate (%)	40,16	38,9	51,8
Loose unit weight (kg/m^3)	450,1	381,7	295,5
Dry specific gravity (kg/m^3)	940	880	690

Table 3. Chemical composition of acidic pumice [6]

Chemical composition (%)	Acidic pumice
SiO_2	70
Al_2O_3	14
Fe_2O_3	2,5
CaO	0,9
MgO	0,6
Na_2O+K_2O	9
LOI	3

Table 4. Chemical composition of expanded perlite [6]

Chemical composition (%)	Expanded perlite
SiO_2	71-75
Al_2O_3	12,5-18
Fe_2O_3	0,3-1,5
CaO	0,3-2
MgO	0,1-0,5
Na_2O	2,7-4
K_2O	3,5-5
LOI	2-5

Table 5. Technical specifications of expanded perlite aggregate [14]

Properties	Expanded perlite aggregate
Color	White
Hardness (Mohs Scale)	5-5,5
pH	6,6-8
Specific mass (g/cm^3)	2.300
Dry Unit Volume Weight (kg/m^3)	40-220
Water absorption (%)	40-60
Solidity ratio (%)	1,80-9,60
Actual porosity (%)	98,2-90,4
Sulfur analysis (%)	0,34
Structural degradation (°C)	870
Melting point (°C)	1100
Fire resistance	Fireproof
Fire retardant (hour)	3
Specific heat capacity (kcal/kg℃)	0,200-0,215
Thermal conductivity (W/Mk)	0,040-0,050
Sound Transmission Coefficient	0,25
Sound absorption (dB)	35-40

Table 6. Physical properties of sand

Properties	Sand
Water absorption rate	3.72
Specific weight (kg/m^3)	2.22

are the physical properties of expanded perlite and acidic pumice stone, and resistance to physical and chemical events, and another important factor, it is aimed to gain from the cost, which is one of the problems.

2. Material and Method

In the experimental study, CEM I 42.5 N type Portland cement obtained from Elazığ Cement Factory, water absorption rate of 3.72, creek sand of Bitlis-Ahlat region with a specific weight of 2.22 kg/m^3, acidic pumice stone from Bitlis region, expanded perlite, Plastocrete N (water impermeability additive), Sika Lightcrete I-500 (air entraining additive), Sika Viscocrete Hi-Tech 28 (hyper plasticizer additive) and Bitlis Eren University drinking water was used as mixing water. The properties of the materials used are presented in Table 1 to Table 6. The properties of CEM-1 42,5 N Portland cement in Table 1, the physical properties of acidic pumice aggregate belonging to Bitlis region in Table 2, the chemical composition of acidic pumice belonging to Bitlis region in Table 3, the chemical composition of expanded pearlite in Table 4, the technical properties of expanded pearlite aggregate in Table 5, the physical properties of sand in Table 6 are given. The mixture calculations were made by taking into account the properties of the materials given in the tables.

In the study, mixing ratios were calculated by using 0-4 mm, 4-8 mm, 8-16 mm acidic pumice stones and fine and coarse expanded perlite together with and without 3 different chemical additives. In addition to these, a sand-mixed screed sample, which is mostly used today, was created for comparison. Calculated mixing ratios are given in Table 7. Then, the casting process was started according to the mixing ratios given in the table. All materials were mixed in a 50 dm^3 concrete mixer and placed in sample molds measuring 100x100x100 mm, which were previously cleaned and lubricated. A stand type vibrator was used to place the mixtures in the sample molds without gaps. After the poured samples were kept in the molds for 24 hours, they were removed from the molds and subjected to a 28-day water cure in the curing tank. UPV, compressive strength tests were applied to the samples that completed their curing periods. Each experiment was performed on 3 samples and the average of the obtained results was taken. Then, the thermal conductivity coefficients of the samples that completed the curing age of 28 days were determined. Finally, result graphics were created with the obtained data.

The compressive strength test of concrete is a concrete test applied to cube or cylindrical specimens to determine the compressive strength of hardened concrete at certain curing ages [15]. The compressive strength test was carried out after 28 days of curing, and the results were recorded and converted into tables and graphics. The compressive strength test was applied based on TS EN 1354 and TS EN 12390-4 standards [16,17].

The UPV test is an experiment in which the compressive strength of concrete is measured with a non-destructive method based on the principle that sound does not propagate in a air [18]. The wave velocity is calculated by measuring the time it takes for the ultrasonic pulse waves sent to the sample to reach the other side of the sample. With this wave velocity found, the compressive strength properties of the sample are obtained. This test was applied to specimens those curing period had expired before applying the compressive strength test. However, in this study, it was applied to obtain information about the sound permeability of the samples created beyond the purpose of obtaining information about the compressive strength.

Determining the thermal conductivity of the material is very important for building materials. A thermal conductivity test is performed to determine the heat conduction coefficients of the material. In the thermal conductivity test, the desired temperature difference is created on the two surfaces of the sample, and the heat transmission coefficient of the sample is calculated by controlling and measuring the heat flux passing through the sample. The thermal conductivity coefficient is the amount of thermal energy passing through the perpendicular unit thickness of the unit area per unit mass when the temperature difference between two surfaces is 1 degree. Thermal conductivity (k) and specific heat (Cp) of 10*10*10 cm samples were calculated by hot wire method according to DIN 51046 norm.

Table 7. Mixing ratios (kg)

Type	Water	Cement	Sand	Acidic pumice			Expanded perlite	Chemical Additives (%)
				0-4 mm	4-8 mm	8-16 mm		
Control	60	150	1331	-	-	-	-	-
BR1	60	150	-	619	-	-	-	-
BR2	60	150	-	468,6	105,6	-	-	-
BR3	60	150	-	406,12	84,48	46,2	-	-
BR4	60	150	-	624,8	-	-	-	1.5
BR5	60	150	-	468,6	105,6	-	-	1.5
BR6	60	150	-	406,12	84,48	46,2	-	1.5
BR7	60	150	-	468,6	-	-	52,8 (coarse)	1.5
BR8	60	150	-	-	156,2	-	158,4 (fine)	1.5

* Each different chemical additive, whose names are specified in the materials section, was used at 0.5%.

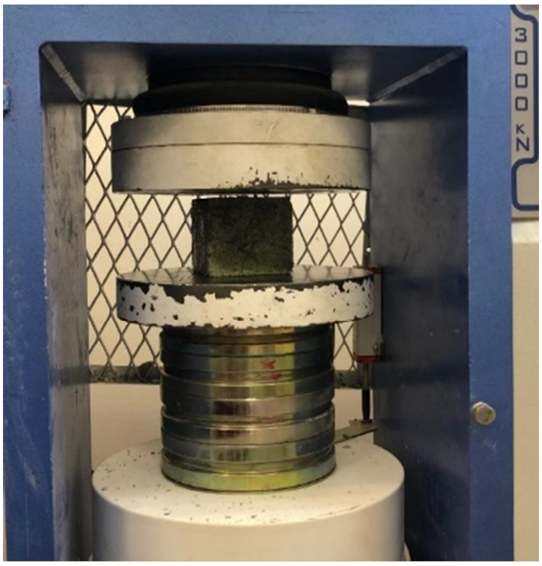

Figure 1. Compressive strength test

Figure 2. UPV test

The thermal conductivity values of the samples were measured using the ISOMET 2104 model heat transfer device. Measurements were taken from different points on each sample at room temperature, the average of these measurements was taken, and the thermal conductivity (k) and specific heat (Cp) values of the samples were calculated. ISOMET 2104 heat transfer device measures the heat transfer coefficients of the samples with 5% precision in the range of 0.04-6 W/mK, and the volumetric specific heat with 5% precision in the range of 4.0*104 – 4.0*106 J/m^{3}K. Ambient temperature and heat transfer coefficient can be read from the device's screen. The ISOMET 2104 model device has been developed especially to determine the thermal properties of natural stones and building elements. The device has 3 different solid surface probes, these probes are used for different measuring ranges [19].

3. Results and Discussion

3.1 Ultrasonic Pulse Velocity Test Results

Ultrasonic Pulse Velocity (UPV) test is a non-destructive concrete test performed without damaging the concrete to obtain information about the physical properties of building materials, concrete quality, and concrete strength [20,21]. There is a connection between UPV and concrete compressive strength and of course sound isolation. UPV value in concrete varies depending on the number of pores in the structure [22]. When the UPV test results are examined, a general judgment can be made about the concrete compressive strength of all series. There is no direct relationship between the strength of the concrete and the P wave passing through the concrete, but there is a relationship between it and the concrete density. The transition time of P wave velocity from one surface of the concrete to the other surface of the concrete is longer in concretes with low density, that is, with a large concrete void volume. In other words, the P wave velocity is lower in concrete with a higher concrete void ratio and pore amount [23]. When the UPV test results in Fig. 5 are examined, it is seen that the series with the lowest UPV value, that is, the void ratio, is the control sample. It is seen that the BR3 pumice series with different grain sizes and different mixing ratio gives the closest value to these results. The judgment that should be understood from here is that the small diameter pumice stones fill the voids created by the larger diameter pumice stones, causing the concrete void volume to decrease, resulting in a higher UPV value. Unlike BR1, BR2 and BR3 series, BR4, BR5 and BR6 series were created by adding 3 different chemicals into the mixture. When these two groups are compared, there is no big difference between the UPV values, but it is assumed that the reason for the small decreases is the air-entraining additive used in the mixture. The lowest UPV value was obtained from the BR8 series in which perlite, pumice and chemical additives were used. It is understood that the reason for this is the difference in aggregate used in the mixture, the mixing ratios and the large volume of concrete voids depending on these. In general, it is understood that the BR3 sample, which is the closest to the control sample, has the densest structure after the control sample, and the BR8 sample has the lowest density. It was concluded that the reason for the lowest results in the BR8 sample was the air voids created in the concrete

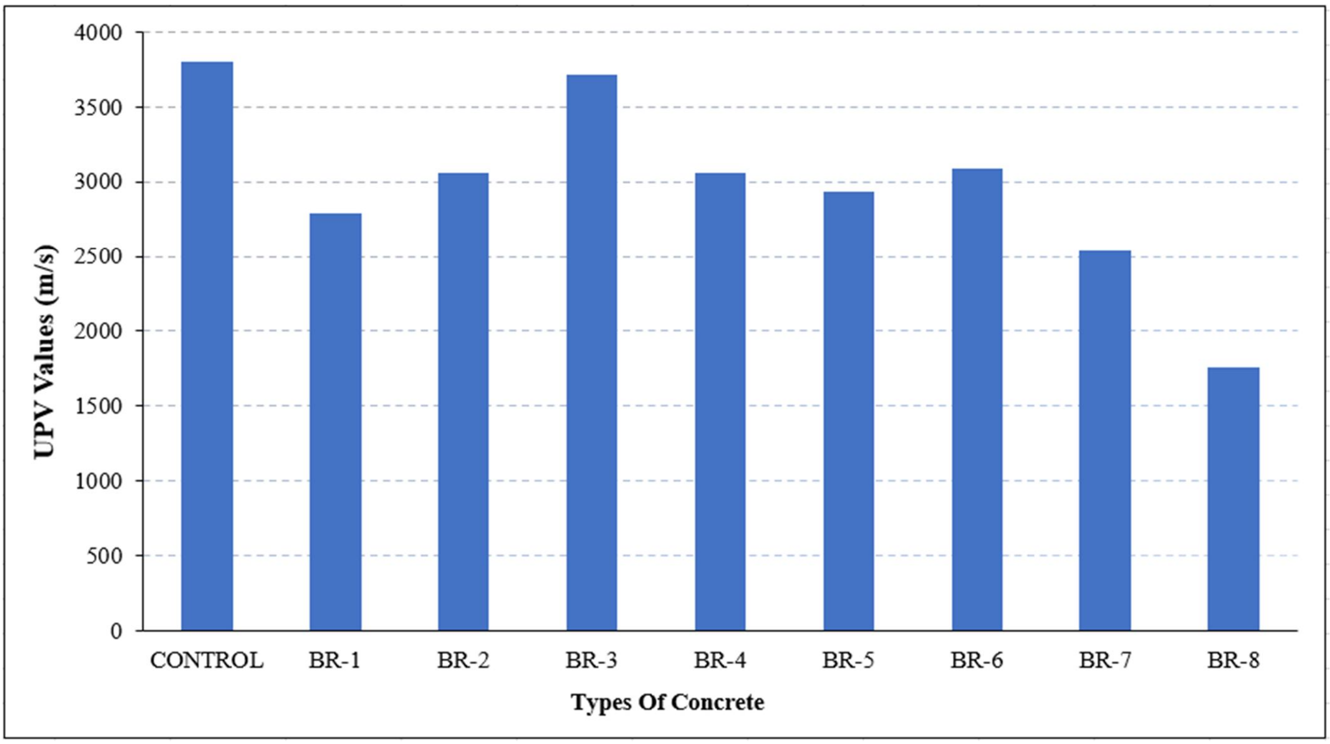

Figure 5. UPV test results

by the air-entraining admixture used in the mixture, in addition to the porous structure of perlite and pumice. When the compressive strength results are examined, the highest-compressive value was obtained from the BR3 series with high density and strong skeleton structure, and the smallest compressive strength value was obtained from the BR8 series with the lowest density and weak skeleton. It is understood from these results that the UPV and compressive strength results support each other. On the other hand, these results emphasized that the use of pumice or perlite in the mixture indicated a decrease in compressive strength as well as an improvement in sound insulation.

3.2 Compressive Strength Test Results

The compressive strength test results are given in Fig. 6. The series presented with the control code from the samples created here represents the incoming screed method produced today. For this reason, each series was compared with the results of this series. When BR1, BR2 and BR3 series are compared with the control series, BR1 and BR2 gave lower compressive strength than the control series, while the BR3 series has higher compressive strength than the control series. In the BR1 series, a content equivalent to the control series was created by using only 0-4 mm fine aggregate, and the compressive strength decreased because the aggregate used in the BR1 series was pumice stone aggregate. These results were obtained because the river sand used in concrete and concrete materials is physically stronger than the porous pumice aggregate. When BR1, BR2 and BR3 are examined among themselves, it is seen that the strength increases in each sample, respectively. The reason for the increase here is that the use of coarse aggregate in the spine structure of the samples was preferred and the maximum aggregate grain diameter was increased in each series, resulting in an increase in strength. With the use of 0-4 mm pumice, 4-8 mm, and 8-16 mm coarse pumice stone aggregate in the BR3 series, the compressive strength values of this series were higher than the compressive strength values of the control series. When the BR1 and BR4 series are evaluated among themselves, 0-4 mm pumice stone was used as an aggregate in the BR4 series, as in BR1, but 3 different chemical additives were used in the mixture in addition. Therefore, a more fluid mixture is obtained. The reason for using hyper-plasticizer from 3 different chemicals is to produce self-leveling screed. However, when the material with such a low specific gravity is liquefied, segregation and vomiting problems arise. These problems were avoided by using an air-entraining additive and a uniform fluid mixture was obtained.

When the UPV result graph was examined, the UPV value of the BR4 sample was higher than the BR1 sample. The reason for this is the water impermeability and air-entraining chemical additives used in the mixture. Considering these results, it is an expected result that the compressive strength value of the BR4 sample is higher than that of the BR1 sample.

When the BR2 and BR5 samples are compared among themselves, the difference between the two mixtures is the use of 3 different chemical additives in the BR5 sample, unlike BR2. When the UPV test results are examined, there is no big difference between the two series. Although the UPV values are close to each other, the compressive strength of the BR5 series was lower than the BR2 series. It has been concluded that the reason for this result is the voids created by the air-entraining admixture in the concrete.

When the BR3 and BR6 samples are compared, the difference between the series is the chemical additives used in the BR6 sample. When the UPV values are examined, there is no big difference between the BR3 and BR6 series. When the compressive strength values are examined, the compressive strength value of the BR3 series is higher than that of the BR6 series. As evaluated in other series, it was concluded that the reason for this in this series was the air voids formed in the concrete due to the air-entraining additive.

The mixture content of the BR7 and BR8 series varies. In addition to pumice stone, perlite material was also used. While 0-4 mm fine pumice stone, coarse perlite and 3 chemicals were used in the BR7 sample, on the contrary, 0-4 mm fine perlite and 4-8 mm coarse pumice were used in the BR8 sample. Since a high percentage of pumice stone and low percentage of perlite were used in BR7 sample, a stronger skeleton structure was formed compared to BR8. Therefore, the BR7 sample gave a higher compressive strength value. These results can also be understood by looking at the UPV results. The high void ratio of the BR8 sample can be explained as the reason for the low-compressive strength value.

The physical, mineralogical, and textural properties of the aggregate, which constitutes 60-80% of the concrete, directly affect the concrete compressive strength [22]. The porosity ratio of the concrete, the void volume, that is, the internal structure affects the compressive strength of the concrete. To obtain information about the void ratio in the concrete, the UPV test is performed and the transition time of the P wave velocity in the concrete is found. Even if the transition time of the P wave velocity does not directly give information about the compressive strength, it allows us to indirectly obtain information about the compressive strength of concrete by enabling us to establish a connection between the concrete density and the concrete compressive strength. Concrete with a large void structure and low P-wave velocity has less density and, accordingly, concrete compressive strength is lower [23]. These results show that, considering the destructive effect of the earthquake and dead load, which is one of the most important problems in buildings, it is possible to design concretes with high strength, economic, load bearing, lightweight, high heat and sound insulation properties due to their independent cavities.

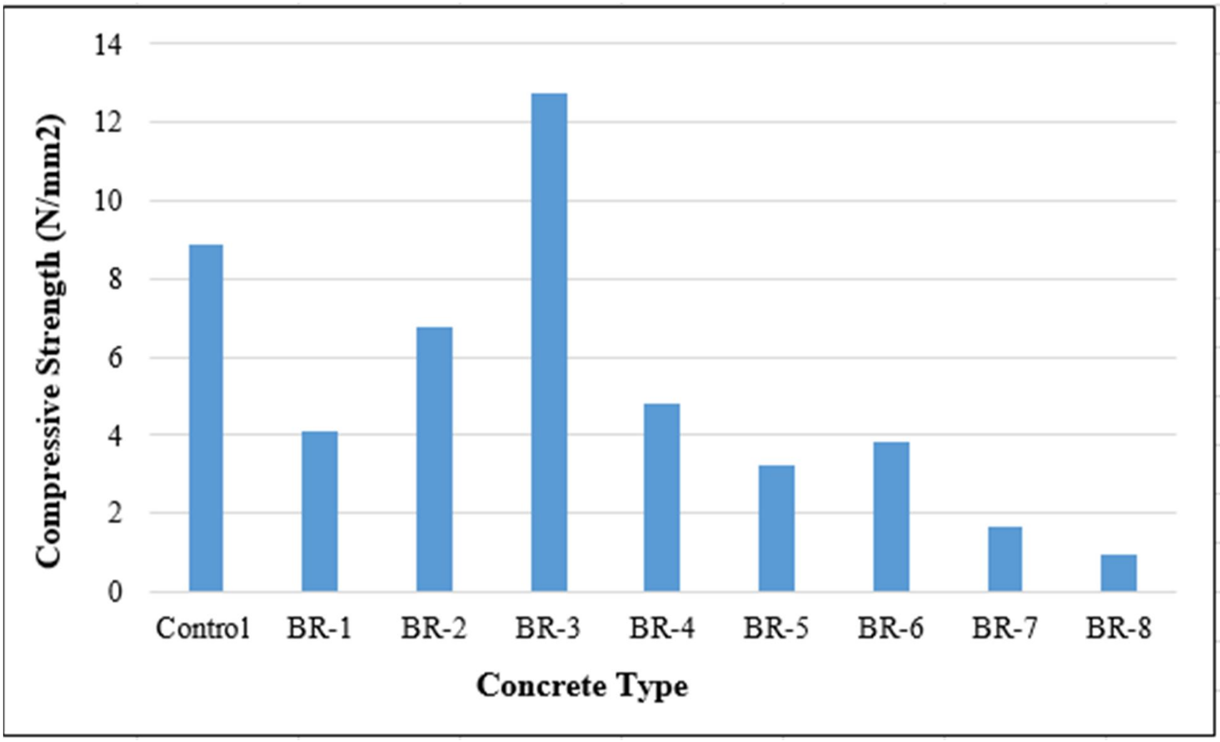

Figure 6. Compressive strength test results

Table 8. Compressive strength classes for screed materials [28]

Class	C5	C7	C12	C16	C20	C25	C30	C35	C40	C50	C60	C70	C80
Compressive strength value (N/mm^2)	5	7	12	16	20	25	30	35	40	50	60	70	80

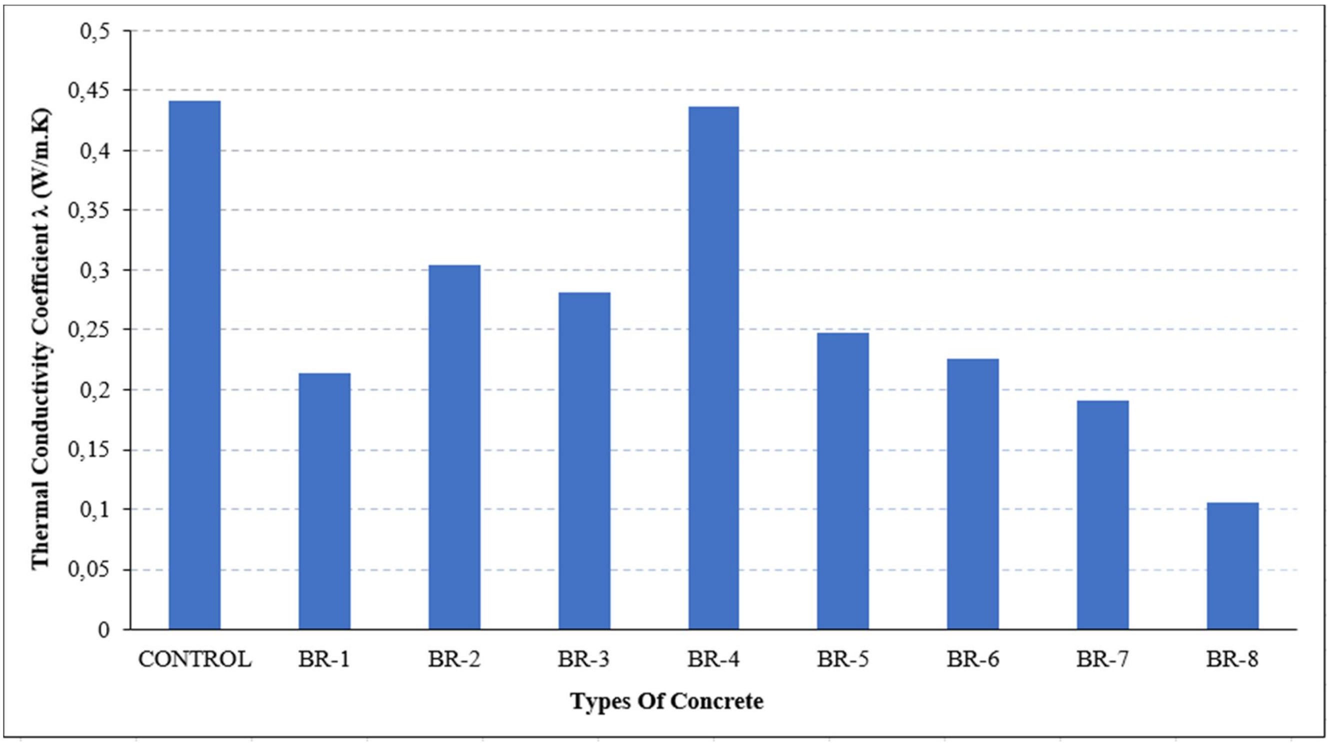

Figure 7. Thermal conductivity test results

Engineering properties of ready-made screed brands such as Ardex, Roxol, Baumit, Bonafix in the market were examined. It is seen that they have different compressive strength due to their properties and different concrete classes. The compressive strength of the screeds belonging to different concrete classes has taken values such as 12, 16, 20, 25, 30, 40 [24-27].

In the TS EN 13813 standard, the concrete compressive strength values of the screeds according to the concrete classes are examined and indicated in Table 8. The desired compressive strength values for the C5, C7 and C12 concrete classes in the TS EN 13813 standard were obtained in the BR2, BR3 and BR4 series. The highest compressive strength value was obtained from the BR3 sample [28].

3.3 Thermal Conductivity Test Results

The lower the thermal conductivity coefficient value, the better the thermal insulation of the material. Figure 7 illustrates the thermal conductivity coefficients. The thermal conductivity coefficient varies with the change of aggregate type used in the production of screed concretes and the change of consistency according to the chemical additives used.

While the highest thermal conductivities (0.441 W/mK) were obtained in the control series, the lowest thermal conductivity was obtained from the BR8 screed concrete series (0.105 W/mK). After the control series, the highest value was obtained from the BR-4 (0.436 W/mK) series. An irregularity was observed between the BR1-BR3 series in terms of thermal conductivity coefficients. The expectation here was actually a decrease in the thermal conductivity coefficient from BR1 to BR3. However, since these series are created without using any chemical additives and are prepared in the consistency of screed used in the field, that is, in a solid consistency, it is assumed that this data irregularity occurs due to the adverse effects of material distribution in the molds or the formation of undesired irregular air spaces. On the other hand, this data formation was observed in the BR4-BR6 series. In these samples, where pumice stone material of different sizes was used together with chemical additives, a decrease was observed in the thermal conductivity coefficient as the size of the pumice stone used increased. However, the use of expanded perlite along with pumice stone in the mixture further reduced the thermal conductivity coefficient and provided better results. When the control series is compared with the BR8, there is an improvement of 76.2% in terms of thermal conductivity coefficient. It is clear that using such materials instead of traditional screed will contribute to sound and heat insulation as well as to lighten the weight of the building. This result reveals that in these days when zero energy buildings are targeted, other elements or materials that make up the building can also help to achieve this goal besides insulation materials.

4. Conclusion and Recommendations

As a result of the laboratory studies, the engineering properties of the screed samples designed with pumice stone from the Bitlis region were determined and it was determined that they could be used in flooring. An improvement in concrete compressive strength was observed by increasing the maximum aggregate particle size of the pumice stone used. An increase of 45% was observed in the compressive strength obtained from the BR-3 sample. The use of perlite material in the mixture affected the concrete compressive strength negatively. Considering compressive strength results, the best result was obtained from the mixture formed with BR-3, and the worst results were obtained from the perlite samples for all experiments. When all these results are taken into consideration and evaluated, it is seen that it is possible to produce screed with pumice material when the data obtained from the calculation of the mixture made according to 150 kg dosage, the characteristics of the screed types used in the market and TS-EN-13813 standards. On the other hand, it has been determined that the use of perlite significantly reduces the compressive strength by approximately 81% (BR-7) and 89% (BR-8) but improves the insulation properties by approximately 57% (BR-7) and 76% (BR-8). In this type of designs, it is recommended to add perlite as an additive instead of using it as an aggregate, thus keeping the aggregate skeleton structure strong in terms of strength. By using pumice and perlite materials, screed types can be produced that will have a low dead load on the building and show similar properties to their counterparts in the market. In addition, with the increase of the energy crisis today, the importance of the energy issue is increasing day by day. Reducing energy consumption to a minimum and ensuring energy savings has made it necessary to turn to the design of low-energy or even zero-energy buildings. the construction sector is a very important sector in terms of energy consumption potential. This makes the work on increasing zero-energy buildings in the construction sector more important. Even though insulation applications provide energy savings, these materials alone are not enough. for this reason, the other elements that make up the buildings should be in accordance with the concept of zero energy. For this reason, the types of screeds to be made with these materials will gain even more importance in these days when individual heating and insulation on the floors come to the fore.

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