CHAPTER 5

Evaluation of Natural Stones in Different Usage Areas, Samsun Example

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INTRODUCTION

After the quarry of materials from the Kızılırmak and Yeşilırmak deposits, which are two long rivers of our country and spill into the sea in the districts of Bafra and Çarşamba, was stopped due to low sediment transport, the orientation towards quarries for the production of crushed stone for use in concrete batching plants increased (Çakoğlu, 2011). In addition, other natural Januaryries other than limestone have been put into operation for decorative or local services. Although there are more natural Januaryries in terms of number and type throughout the province, they are open to development in terms of production capacity and diversity. According to the reports Dec by the MTA, it was determined that Samsun has a limestone-dominated rock structure between Kızılırmak and Yeşilırmak and towards the south (Hakyemez et al., 1989). In addition, there are other volcanic rock structures in different districts (Öztürk, 1979). The region known as Mahmurdağı consists of basalt, andesite, tuff, agglomerate and basaltic batholith, dykes and sills. It is observed in the form of scattered surfaces (Yoldaş, 1985). Basalts in Mahmurdağ are typically surfacing. Basalts are porphyric in texture, dark black and cream-white in color. Currently, there

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are Januaryries operating here, and the extracted material is used for stone laying, ballast purposes, except for the production of concrete. However, aggregates taken from the basalt quarry in Ayvacık district are mixed with limestone sand and used in concrete plants due to the lack of sufficient January for the production of concrete. It is known that the high water absorption rate of basalt stone here is an obstacle to obtaining the desired result in concrete strength. Andesite, on the other hand, is a natural stone that is mostly used for visual purposes in building facade coatings and pedestrian sidewalks, and it is understood from the results of the experiment that it does not have the appropriate properties for the manufacture of concrete. Granite is a class of heavy natural stones with a high specific gravity. It can be used to create a weight in the manholes in the construction of ports and fishing shelters, as well as processed in workshops to obtain a decorative building material. Here, the possibility of introducing new production to the economy through the operation and installation of natural stones located within the borders of Samsun province was investigated.

MATERIAL AND METHODS

Basalt, granite and other natural rocks are mostly found in the Central Black Sea Region, especially limestone . The areas of production and use of limestone, basalt, granite and andesite types of these natural stones with volcanic properties have been mentioned. January Information about the rock structure of the city was obtained from reports prepared by the General Directorate of Mineral Exploration, production locations and numbers of natural quarries were taken from the Samsun Governorate, and Dec results of experiments on these rocks were used from analyzes conducted by authorized organizations. These analyses are experiments that give an idea of the mechanical and strength properties of the stones and show that the stones in question can also be preferred for different purposes for the purpose of use and for the future. There are January factories operated not only by private companies, but also by public organizations such as the Regional Directorate of Highways, Metropolitan Municipality, DSI Regional Directorate, Çarşamba and Ayvacık district municipalities. First, information was given about the general characteristics of natural stones, which are most often found throughout the province.

Limestone

There are rich limestone quarries especially in Kavak district. Most of them are also used for the manufacture of concrete aggregates. Even aggregate material is transported from here to concrete batching plants in neighboring

provinces and districts. In addition to the January construction sites located in the active quarries, there are also many lime manufacturing companies in the district. As is known, lime is obtained by calcining limestone containing at least 90% CaCO3 in lime kilns above 900-1000 °C and converting it into calcium oxide (MTA, 2022).

Basalt

Basalt, which is a natural stone that is a common type of volcanic rock in our country, is very dark in color and has a very solid, durable structure. It is a dense and heavy rock. In general, the suction strength is low water, wear, weather conditions, and resistance against a lot of pressure because the top and bottom being the type of natural stone as a construction material are characterised by a lot more preferred, especially as seen from the results of the experiment, located in Ayvacik, basalt rocks, unlike in the manufacture of concrete due to high availability of power, water suction, however, together with the use of a mixture of limestone, the material is considered appropriate. The results of the analysis of the basalt January located in the Çamlıyazı locality of Atakum district are positive. Main areas of use; as kırmataş, concrete aggregate, railway infrastructure material in the form of ballast, small sculptures, decorative household items with the production of baubles, paving stones, curbs, cut stone cladding, insulation material such as different purposes are produced. It is also a preferred rock of sculptors

Andesite

It is a preferred building material for both beautiful appearance and coating purposes in order to benefit the structure in terms of aesthetics and function. Paving stone, curbstone, disabled ramp, building exterior cladding, outdoor products can also be manufactured according to preference. Its surface is rough, so it is resistant to slipping. Due to the high water holding capacity of the andesite stone located in Samsun, it is not suitable for the manufacture of concrete, but rather the production of materials for decorative purposes is carried out. Its specific gravity is also low compared to other types of rocks. On the other hand, there is a study that the mechanical and physical properties of concretes can be improved by using andesite mineral wastes (Soykan O., et al.)

Figure 1. Andesite paving stone

Granite

A magmatic origin, which is tough and durable granite rock in the construction industry, paving stone, curbstone, ice, landscape arrangements can be used as easy to be deformed because it is harder than marble, and be more economical due to characteristics such as the preference in terms of visuals, especially the use of the kitchen counter has increased. In addition, with the use of granite powder in kitchen utensils, pans, pots, toasters that last longer and do not scratch can be manufactured. External factors such as humidity and high temperature resistant to rust, scratches, and breakage to avoid problems such as acid-based substances to be resistant against wind and natural appearance is important.

Figure 2. Granite chaise lounges.

Figure 3. Granite Japanese umbrella Figure 4. Granite outdoor kitchen countertops

FINDINGS

The results of the analysis of the mentioned natural stones are given in the following tables.

Table 1. Sample properties of Andesite and Granite. (TS EN 1097-2)

Sample Specifications	Unit	Andesite	Granite
Density	(gr/cm³)	2,63	3,1
Unit volume weight	(gr/cm³)	2,28	3,1
Absorption of water in boiling water (by mass)	(%)	5,5	0,1
Water absorption in boiling water (by volume)	(%)	12,2	0,4
Pressure resistance after frost	Mpa	89,3	211,4
Loss Of Frost	(%)	0	0,07
Impact Resistance	(kgf.cm/cm³)	34,3	141
Bending Resistance	MPa	9,4	25,9
Visible Porosity	(%)	9,1	0,3
Occupancy Rate	(%)	86,7	100
Degree of Porosity	(%)	13,3	0
Average Wear Resistance	(cm³/50 cm²)	15,38	10,6

See Table 1. as can be seen from the, the pressure resistance of granite is quite high, and andesite is low. Another important difference is that andesite has a fairly high water absorption rate in boiling water by volume and mass.

Table 2. Results of water absorption experiments of andesite stone

Dry weighing (g)	Sample area (m^2)	Weighing in water (g)	Time (s)	Capillary Water Absorption Coefficient ($g/m^2.s^{1/2}$), TS EN 1925
343,21	0,00283	357	345789	8,294
347,93	0,0029	363,63	345809	9,207
353,29	0,00296	367,04	345823	7,895
344,79	0,00284	358,38	345838	8,144
346,49	0,00294	360,85	345852	8,312
348,22	0,00288	361,75	345866	7,999
		Average		8,308

Table 3. Results of water absorption experiments of granite stone

Dry weighing (g)	Sample area (m^2)	Weighing in water (g)	Time (s)	Capillary Water Absorption Coefficient ($g/m^2.s^{1/2}$), TS EN 1925
484,47	0,00291	484,81	345715	0,199
487,95	0,00293	488,38	345730	0,25
488,95	0,00296	489,35	345742	0,23
483,88	0,0029	484,42	345753	0,317
480,14	0,00293	480,47	345766	0,192
483	0,00292	483,34	345778	0,198
		Average		0,231

Table 4. Test results of water absorption by mass at atmospheric pressure of andesite

Andesite Sample Sizes (mm)	By Mass of Water Absorption at Atm Pressure (%), TS EN 13755)
54*53*54	4,4
54*54*54	4,3
54*53*54	3,9
54*54*54	3,6
54*53*54	4,4
54*54*54	3,8
Average	4,1

Table 5. Test results of water absorption by mass at atmospheric pressure of granite

Granite Sample Sizes (mm)	By Mass of Water Absorption at Atm Pressure (%), TS EN 13755)
54*53*54	0,1
54*54*54	0,1
54*53*54	0,1
54*54*53	0,1
54*54*54	0,1
54*54*53	0,1
Average	0,1

From the tables above, a significant difference was found between the mass water absorption test results of andesite and granite stones with the same sample sizes. This, in turn, indicates that andesite, when exposed to water, absorbs it and increases in mass due to the fact that its specific gravity is low and hollow. The water absorption rate of aggregate is an important property that also affects the permeability of concrete and therefore affects its strength (Erdoğan, 2003).

Table 6. Pressure resistance test and fracture load of andesite stone

Andesite Sample Sizes (mm) Crushing surface (edge*height)	Fracture load (kN)	Pressure resistance (Mpa), (TS EN 1926)
53,8*54,2	271	93
54,2*54,0	302	103
54,1*54,1	305	104
54,7*54,0	288	98
54,6*53,7	261	89
53,5*53,5	268	94
54,8*53,7	267	91
51,4*54,0	203	73
54,2*54,1	227	77
53,7*54,0	291	100
Average		92

Table 7. Pressure resistance test and fracture load of granite stone

Granit Sample Sizes (mm) Crushing surface (edge*height)	Fracture load (kN)	Pressure resistance (Mpa), (TS EN 1926)
53,8*54,0	563	194
53,8*53,6	540	187
54,2*54,0	610	208
54,2*54,0	607	207
54,3*54,7	514	173
54,4*54,7	431	145
54,1*54,6	581	197
54,2*54,7	596	201
54,5*54,5	469	158
54,4*54,5	424	143
Average		181

Again, according to the test results, it was found that the pressure resistance of granite is about twice as high as andesite of the same dimensions. Granite stone can be processed almost like wood in the atelier belonging to the Metropolitan Municipality and different materials can be produced on order. The high pressure resistance of granite is evaluated in this aspect.

The analysis results of limestone and basalt stones in the districts in accordance with TS EN 933-3 and TS EN 1097-2 standards are also given in the following tables.

Table 8. Mechanical and chemical analysis values of Bafra limestone aggregate

	0-4 mm	4-11,2 mm	11,2-22,4 mm
Very fine material content (%)	13,8 f_{16}	-	-
The flatness index of large aggregates	-	7,6	7,6
Loose bulk density (Mg/m3)	1,64	1,48	1,45
Methylene blue (g dye/kg sample)	0,5	-	-
Specific gravity (Mg/m3)	2,69	2,71	2,72
Water Absorption (%)	1,2	0,7	0,4
Alkaline silica reactivity, %	0,06	-	-
The breakdown resistance of coarse aggregates	-	18 LA_{20}	18 LA_{20}
Modulus of fineness (%)	3,2	6,87	7,5
Water content	1,7	-	-
Total sulfur content	%0,07	-	-
Determination of acid-soluble sulfate	%0,10	-	-
Light rganic pollutants	< % 0,001	-	-
An experiment on the determination of water-soluble chlorine salts	%0,001	-	-
Magnesia sulfate test report		%5 MS_{18}	%5 MS_{18}

Table 9. Mechanical and chemical analysis values of Kavak limestone aggregate

	0-4 mm	4-11,2 mm	11,2-22,4 mm
Very fine material content	%10,8 f_{16}	-	-
The flatness index of coarse aggregates (%)	-	17	7
Loose bulk density (Mg/m3)	1,54	1,42	1,39
Methylene blue, g dye/kg sample	0,7		
Specific gravity (Mg/m3)	2,67	2,69	2,70
Water absorption (%)	1,0	0,5	0,2
Alkaline silica reactivity (%)	0,01	-	-
The breakdown resistance of coarse aggregates	-	22 LA_{25}	22 LA_{25}
Modulus of fineness (%)	3,20	6,48	7,90
Determination of acid-soluble sulfate	%0,17	-	-
Light Organic Pollutants	<%0,01	-	-
An experiment on the determination of water-soluble chlorine salts	%0,001	-	-
Magnesia sulfate test report	-	%2 MS_{18}	%2 MS_{18}
Total sulfur content (%S)	%0,06		

Table 10. Mechanical and chemical analysis values of Atakum basalt aggregate

	0-4 mm	4-11,2 mm	11,2-22,4 mm
Very fine material content	% 11,2 f_{10}	0,6 f_4	0,4 $f_{1,5}$
The flatness index of large aggregates	-	8(Fl_{15})	6(Fl_{15})
Resistance to freezing dissolution effect	-	4(MS_{18})	4(MS_{18})
Chlorides	%0,0023	%0,0023	%0,0022
Loose bulk density (Mg/m3)	1,62	1,40	1,40
Methylene blue	0,75	-	-
Specific gravity (Mg/m3)	2,67	2,69	2,70
Water absorption (%)	0,90	0,50	0,40
Alkaline silica reactivity	%0,031	-	-
The breakdown resistance of coarse aggregates	-	20 LA_{25}	20 LA_{25}
Modulus of fineness (%)	3,13	6,43	7,82
Water content	2,6		
Resistance of coarse aggregates to the effect of freezing thawing	-	Percentage loss by mass 4	-

Water absorption rates are especially different basalt stones in Ayvacık and Atakum districts. In addition, there was a significant difference between the results of the breakdown resistances of coarse aggregates, flatness index and methylene blue (Table 10 and 11).

Table 11. Mechanical and chemical analysis values of Ayvacık basalt aggregate

	0-4 mm	4-11,2 mm	11,2-22,4 mm
Very fine material content	2,1	0,4	0,1
The flatness index of large aggregates	16	17, Fi_{20}	16, Fi_{20}
Resistance of coarse aggregates to the effect of freezing dissolution, %	-	16	16
Chlorides	%0,0029	-	-
Methylene blue, g dye/kg sample	1,7	-	-
Specific gravity (Mg/m3)	2,62	2,66	2,67
Water absorption (%)	2,9	2,24	2,15
Alkaline silica reactivity	0,033	-	-
The breakdown resistance of coarse aggregates	-	15 LA_{20}	15 LA_{20}
Modulus of fineness (%)	3,46	6,82	7,81
The shape index experiment	-	22 Si_{40}	22 Si_{40}
Total sulfur content	0,330, %1	-	-
Determination of acid-soluble sulfate	0,099	-	-
An experiment on the determination of water-soluble chlorine salts	%0,01	-	-
Magnesium sulfate test report	-	16 MS_{16}	16 MS_{16}

RESULTS

Basalt, especially because it is a hard rock, can be used as a paving stone by municipalities or can be used as a crushed stone in the manufacture of concrete. It is also used as a ballast material under the tracks on railway lines. In addition, due to the density of the mineral structure, it can contribute to the economy in the production of ceramics and the manufacture of thermal insulation material known as rock wool. Although the mechanical properties of basalt in Ayvacık January have a negative appearance, especially due to

the high water absorption rate, the properties of basalt rock taken from the quarry located in Çamlıyazı in Atakum district are in good condition and its uses other than crushed stone, pavement, ornaments should be investigated. During the periods when energy saving is becoming important in the world, work should be done on the manufacture of products for thermal insulation.

Granite, especially in Samsun, belongs to the Metropolitan Municipality of natural stone processing plant, different shapes are given and optional materials are produced. An example is a chaise longue, an outdoor kitchen, a seesaw for children. As is known, products such as granite-coated pans and pots are causing an increase in demand due to their high temperature resistance and long service life. Granite powder or sand processed in Samsun, where one of the largest capacity facilities in Turkey is located, can also be used in the manufacture of kitchen utensils and brought to the economy.

Limestone is located throughout Samsun, as well as in other provinces of the Black Sea Region. It is used in concrete aggregate and lime factories, especially in Kavak District. Although these limestone quarries, which are more numerous, are important for construction January, as a result of the new studies to be carried out, the production capacity of the region can be increased in the field of building chemicals and economic value can be obtained.

Although andesite is not available much in Samsun, it is not suitable as a concrete aggregate due to its low specific gravity and high water absorption rate. It is preferred for pavement coatings where a slippery surface is undesirable, and for building facades. Especially the detached building is in demand by those who want to get a beautiful appearance by considering it as an exterior cladding in their summer cottage construction. Andesite Decking is not much known among the population. But in recent years, its use has become widespread in the construction of detached buildings, and it is expected that it will be more preferred in obtaining a different outdoor image. In this case, it will be able to cause the emergence of new opportunities in the sector.

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