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Quality Control of the Suitability of Specific Igneous Rocks for Use as Aggregates in Road Pavement Layers

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This research focuses on accessing the suitability of specific igneous rocks for their potential use as aggregates in road pavement layers. During the current research several quality control tests were carried out on andesite and dacite rocks, obtained from the areas of Methana and Agioi Theodoroi, approximately 60 Km West of Athens.

The quality control test were conducted under the specific guidelines of Hellenic Technical Specifications ELOT and EN <European Standards> for aggregate properties' determination, while the procedure was referred to the estimation of the following parameters:

- Geometrical properties (grain size analysis, flakiness index and sand equivalent value)
- Physical properties (apparent density and water absorption)
- Mechanical properties (Micro - Deval index, Los Angeles Abrasion Value, Aggregate Impact Value)

The laboratory testing results led to the general conclusion that the samples obtained from the andesite and dacite rocks cannot be used as aggregates in road pavement layers, due to their high Los Angeles Abrasion Values (LAAV). High values of LAAV represent a low strength in mechanical corrosion and crush and contribute to the low quality of these geomaterials as aggregates. Only the sample obtained by a basaltic andesite outcrop proved to be suitable for use as aggregate in road pavement layers.

Introduction

Aggregate materials are necessary for the preparation of concrete and mortars, construction of road pavement layers, road embankments, bituminous mixtures, track ballast, drainage and filter materials, and as armour stones. At the same time they are increasingly used in various environmental applications such as, protection of soils from erosion, filters for water purification, stability of natural and artificial slopes, and stabilization of landslides. (Koukis *et al*, 2007).

In road construction, the aggregate materials must be healthy and of high strength. Specifically those used on the bituminous mixtures should have high strength and resistance to friction and impact, as well as a high polishing resistance index. Aggregate specifications are becoming increasingly stringent for materials used in the upper road pavement layers (bases), designed to support high,localised loading. The upper road pavement layers are also subject to greater influence from other external factors, such as atmospheric temperature (Hill *et al*, 2001).

A description of the general requirements of geomaterials used as aggregates in bases and subbases of road pavements are described below. The subbase layers consist of layers, which are placed on the substrate or in the rehabilitation layer, while the base layers are located between the subbase and the surface asphalt layers. Aggregates materials used for bases and subbases should meet certain requirements to ensure satisfactory stability under repeated vehicle loads. Generally, the aggregates used for bases and subbases have to satisfy the requirements of the European Standards EN-13242:2002 «Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road» as well as the Hellenic Technical Specifications ELOT 1501-05-03-05-01.

Methods and materials

In the current research, laboratory tests were conducted on samples of igneous rocks adapted from the areas of Methana and Agioi Theodoroi (Figure 1). These rocks consist the main outcrops of these areas and are mainly constituted by andesites and dacites.

Initially, block samples were collected from the outcrop of the referred geological formations (total block sample weight per site over 50kg). After the collection, pieces of rocks were broken into smaller size in the lab for further processing in the rock crusher. Then, with the help of the crusher and the appropriate setting, particles of 14 mm diameter and smaller were created. Finally, by using the appropriate sieves, the necessary quantity of the required material for each laboratory test was collected.

Results

For the quality control of aggregates' suitability, laboratory tests were carried out in the materials above, in terms of their physical, geometric and mechanical properties. In particular, the following tests were performed: Flakiness Index (I_F), Sand equivalent (SE), Water Absorption (W_a), Apparent Density (ρ_a), Micro-Deval (MD), Los Angeles Abrasion Value (LAAV), Aggregate Impact Value (AIV) and uniaxial compression test.

The results of the laboratory tests performed are shown in Table 1

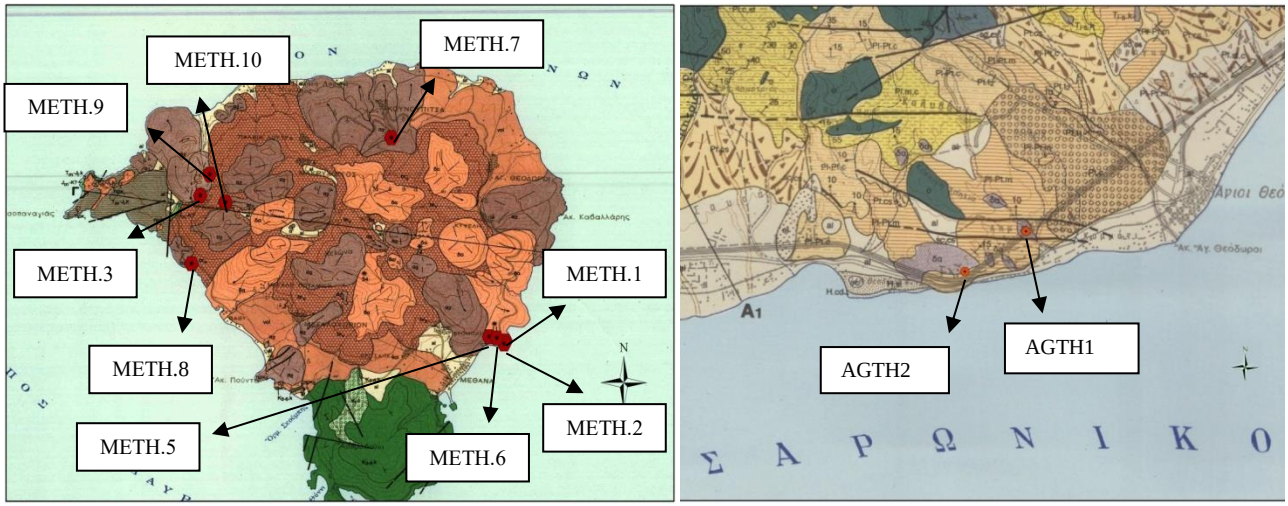

Figure 1: Map of the rock sampling area (Methana and Agioi Theodoroi, Issue sheet Sofikon and Methana, 1979-1981).

Table 1: Results of laboratory tests.

Rock samples	Aggregate test							
	I_F(%)	**SE(%)**	**ρ_a(g/cm^3)**	**Wa(%)**	**MD(%)**	**LAAV(%)**	**AIV(%)**	**σ_c(MPa)**
METH.1 (andesite)	12	76	2.78	3.56	18.02	54.17	32.65	50-86
METH.3 (andesite)	15	76	2.57	3.01	25.08	54	39.38	
METH.8 (andesite)	12	79	2.62	4.39	18.16	46.31	32.35	
METH.9 (andesite)	16	71	2.19	5.3	31.49	51	41.59	
METH.7 (basaltic andesite)	6	79	3.14	0.45	3.78	15.3	17.84	110
METH.2 (dacite)	7	77	2.70	3.36	44.64	43	26.5	25-50
METH.5 (dacite)	15	73	2.35	5.04	52.32	67.9	37.07	
METH.6 (dacite)	9	57	2.23	3.27	26.54	58.56	28	
METH.10 (dacite)	19	76	2.20	5.44	57.1	73	45	
AGTH1 (dacite)	10	81	2.64	3.65	26.87	37.08	28.3	
AGTH2 (dacite)	16	74	2.19	5.54	54.6	75.3	41	
Specification limits for road pavement layers (ELOT)	**≤35 (coarse aggregate)**	**>40% (fine aggregate)**	-	-	-	**≤40 (base) ≤50(subbase)**	-	
European Standards EN-13242:2002	**≤50**	**-**	**≥2**	**<0,5**	**≤50**	**≤60**	**≤38**	

Conclusion

According to the Hellenic Technical Specifications ELOT 1501-05-03-05-01 and the European Standards EN-13242:2002 «Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road» only the basaltic andesite outcrop (**METH.7)** proved to be suitable for use in road bases and subbases**.**

References

Hellenic Technical Specifications ELOT 1501-05-03-05-01, 2009. Road pavement layers with unbound aggregates.

Hill A., Dawson A., Mundy M., 2001. Utilisation of aggregate materials in road construction and bulk fill. Journal of Resources, Conservation and Recycling, Volume 32, Issues 3–4, Pages 305-320, doi.org/10.1016/S0921-3449(01)00067-2.

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