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Physical and mechanical characteristics of crushed limestone aggregates from Greece: Preliminary data evaluation

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Introduction: Despite the widespread use of grey and red granite in the Athens Metro and many of the most recent office buildings the country lacks granite $(s.l.)$ deposits suitable for building cladding or pavement blocks. Furthermore, Greek aggregate producers are fairly traditional in their preference for limestone $(s.l.)$; a rock type that is widespread; satisfies most of the currently in-place compressive strength criteria [1]; and it has a relatively low production cost. Despite the lack of official data, we anticipate Greek limestone production to exceed the levels reported in [2] for US natural crushed stone production. In Greece, limestone aggregates are mainly used for base and sub-base construction and production of cement, concrete, and bituminous mixtures. Quarries location is understandably dictated by construction activity and transportation economics. The major producers that also happen to be active internationally have put in place and maintain factory production quality control protocols. Under pressure by EU directives for CE marking [3] and market competition mid- and small-size aggregate producers that make up a small percentage of the Greek market but may have a significant share at the local level have followed suit. Factory production control is typically realized through outsourcing to decrease the cost of creating and maintaining well-equipped factory laboratories. Considering the lack of materials testing tradition in the Greek private sector that is also dominated by small- and mid-size companies such a development is encouraging.

Discussion: Presently, we have been performing weekly, monthly, and annual testing

of aggregates according to EN test methods from a variety of locations and producers in Greece. The majority of the crushed aggregates that we have been examining are classified as limestone. Needless to say, their geological origin and history may differ considerably. Concurrently with testing we have been building a data base of quarries and aggregate characteristics as well as mineralogy and geochemistry data. Here, we present a preliminary evaluation of such data to contribute to the current body of knowledge for a commodity that will continue to play a major role in the European economy [4, 5]. Despite the disparate locations and producers the examined materials are all crushed limestone aggregates that more or less have been produced with similar equipment and procedures. The examined fractions (0/4mm, 4/16mm, 4/31,5mm, 31,5/63mm) have particle densities between 2,628 – 2,728 g/cm^3 with 24h water absorption values from 0,2 to 1,3 %. The average values are 2,693(30) g/cm^3 and 0,6(4), respectively. Particle morphology indices such as the Flakiness and Shape Index respectively range from 13,6 to 21,6 and 9,0 to 23,0. The respective average values presently are 16,8(2,7) and 16,1(5,3). We also find a weak negative correlation between Flakiness and Shape Index values (correlation coefficient of -0,65). Aggregate resistance to wear and abrasion testing according to wet and dry Micro-Deval and Los Angeles abrasion EN procedures gave values of M_{DE}, M_{DS}, M_{DE}RB, and LA that cluster around 12, 6, 13, and 27, respectively. As expected, Polishing Stove Values (PSV) are low and in the range of 30 to 40. Susceptibility to stripping as measured by the rolling bottle test shows mean coverage of 95% after 6 hrs and 85% after 24 hrs. Even though there is greater loss of coverage after 48 and 72 hrs, and despite the subjective nature of the test, coverage loss does not seem to exceed 50% [6]. Lastly, we note that the crushed limestone aggregates tested lack potentially harmful organic or inorganic constituents.

References: [1] ELOT 408, draft standard, “Crushed aggregates for common types of concrete”. [2] http://nationalatlas.gov/articles/geology/a_aggregates.html. [3] http://ec.europa.eu/enterprise/construction/internal/cpd/cpd.htm. [4] European Aggregates Association: Annual Report 2007. [5] European Aggregates Association: Hafedh Ben Arab (2006) Aggregates from Construction & Demolition Waste in Europe. [6] Torbjørn Jørgensen (2002), “Water Damages on Asphalt - Laboratory Testing of the Adhesion between Bitumen and Aggregate”, Nordic Road and Transport Research No 2.