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MODULUS OF ELASTICITY OF CONCRETE PRODUCED WITH BASALTIC AGGREGATES

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ABSTRACT

The values of the modulus of elasticity used as reference by the Eurocode 2 are for concrete produced with quartzite aggregates. For concretes produced with limestone and sandstone aggregates, the value of the modulus of elasticity should be reduced by 10% and 30%, respectively. For concretes produced with basaltic aggregates, the value should be increased by 20%. The Madeira Island is a volcanic island and as such the aggregates used in the concrete production are of volcanic origin. The tests to determine the modulus of elasticity in concrete are expensive, and so, designers typically are conservative and consider the reference values estimated by the Eurocode 2 (without an increase of 20%). However, it is crucial to investigate whether the values of the modulus of elasticity are appropriate for concretes produced in the Madeira Island. Thus, the main goal of this study was to compare the modulus of elasticity of concretes produced in the Madeira Island with the values estimated by the Eurocode 2. In addition, being aware that after the test of the modulus of elasticity usually the concrete strength test is carried out in the same specimen, a secondary objective of this study was intended to evaluate if the performance of the test of the modulus of elasticity affects the outcome of the compressive strength test when conducted on the same specimen. Finally it is also intended to evaluate the modulus of elasticity in prismatic specimens to compare the results with the ones obtained on cylindrical specimens.

The determination of the concrete modulus of elasticity was performed according to standards (EN 206-1, EN 12350, EN 12390 and E397-1993) which describe the methodology to be applied. Five sets of concrete specimens were collected in two concrete producers. All tests were performed at the age of 28 days.

Keywords: basaltic aggregates, modulus of elasticity, concrete strength, Eurocode 2.

PRELIMINARY RESULTS

The results showed that the performance of the modulus of elasticity in a concrete specimen does not affect the outcome of the compressive strength of that specimen. The results showed that the compressive strength tests conducted in 'specimens that had not previously been subjected to any load' and the ones conducted in 'specimens that had been previously used in the modulus of elasticity test' presented similar f_{cm} values. In fact, it was observed that the average values and their standard deviations were overlapped. Similarly, it was found that the determination of the modulus of elasticity in prismatic specimens was a satisfactory alternative. Table 1 presents the average values and standard deviations of the sets obtained for the modulus of elasticity test.

Comparing the results of the modulus of elasticity obtained with the ones estimated by the Eurocode 2, it was found that the values of the modulus of elasticity estimated by the Eurocode 2 are not appropriate for the concretes studied (instead of an increase by 20%, values of the modulus of elasticity should be decreased in about 16%).

Table 1 - Modulus of elasticity at the age of 28 days

Set of Specimen	Commercial Concrete Strength Class	E _{cm} according to the Eurocode 2 [GPa]		E _{cm} measured [GPa]	
		Quartzite Aggregates	Basaltic Aggregates	Cylindrical specimens	Prismatic specimens
A1	C20/25	30	36	25.2 ± 0.8	-
A2	C25/30	31	37	26.0 ± 0.0	-
A3	C30/37	33	40	27.1 ± 0.4	-
B1	C20/25	30	36	25.6 ± 0.3	25.7 ± 0.4
B2	C20/25	30	36	25.4 ± 0.4	-

FINAL REMARKS

From this experimental work the main remarks are: (i) at the age of 28 days the performance of the modulus of elasticity test does not affect the outcome value of the compressive strength of that specimen, (ii) determining the modulus of elasticity in prismatic specimens lead to similar results to those performed on cylindrical specimens, (iii) the values of the modulus of elasticity for commercial concrete produced in the Madeira Island (using basaltic aggregates) is substantially lower than the values indicated by Eurocode 2 - the concretes evaluated instead of showing a modulus of elasticity 20% higher than the modulus of elasticity of reference concrete of the Eurocode 2, showed a modulus of elasticity about 16% lower.

Thus, it is remarked that possibly commercial concretes produced in the Madeira Island are produced with aggregates with low modulus of elasticity (but more research is needed).

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