1.14.4. CONCRETE PROPERTIES DETERMINING BY ULTRASOUND

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Introduction. In structural design, concrete is classified by its compressive strength (f_{ck}) 28 days after molding. On the other hand, tests to determine the modulus of elasticity, which for concrete is normally called the modulus of deformation, are more intricate and require specific equipment that is not always available.

Because of the difficulties with testing, these values are not always available to the designer, so the standard of the Design of Concrete Structures [1] provides empirical equations that associate the modulus of deformation Eci to the concrete characteristic strength (f_{ck}). Experimental determination of the Poisson's ratio (υ) is even more complex, so that the standard [1] assumes a fixed value equal to 0.2. However, several studies have shown that although the longitudinal modulus of deformation has a direct relationship with the characteristic strength, this relationship changes as a function of several parameters, so, the adoption of a single relationship is not adequate [2]. With regard to Poisson's ratio (υ), many technical papers have demonstrated that there can be major changes around the normally adopted value, both as a function of aggregates and as a function of the measurement method [2, 3; 4; 5; 6]. Values of Poisson's ratio vary from 0.22 to 0.34 for concretes molded with Portland cement (CPI).

Previous research [7] on the assessment of the capacity of non-destructive testing (NDT) to evaluate concrete integrity showed that the modulus of elasticity obtained by ultrasonic methods was 8% greater than that found by destructive testing (static tests), and the author concluded that ultrasonic tests were feasible for assessing the material. The ratio between the static tangent modulus and the dynamic modulus (ultrasonic) obtained by [3] was around 0.5 for low-strength concretes, and increased to approximately 0.8 for higher-strength concretes. The authors explained the similarity of values for high performance concretes as resulting from the quality of the concrete transition zone. It is important to note that both [3] and [7] compare E_{ci} with the dynamic modulus obtained through the expression $E_d = \rho V^2$, and not with the modulus found from the flexibility matrix, which takes into account Poisson's ratio.

Taking into account the above mentioned aspects, the goal of this work is to evaluate the use of ultrasonic technique to determine the stiffness matrix of concrete, and through it the elastic parameters (E, G and υ).

Basic Results e Mainly conclusions. It was generally observed that speeds increased with f_{ck}, indicating that the method for assessing the mechanical properties of concrete had good sensitivity. The modulus of elasticity (E) obtained with the stiffness matrix from the ultrasonic testing were compared to the moduli obtained from the axial compression testing (E_{ci} and E_i) using ANOVA and a Multiple Range Test. The results showed that there is no statistical difference between these two methodologies.

The statistical comparison of the values of moduli obtained from ultrasonic testing and from correlations with f_{ck} [1] verifies that they cannot be considered statistically equal to the latter. This indicates the standard gives a greater deviation from the actual value of the modulus than that predicted by the ultrasonic tests.

Considering that the value of G proposed by the standard is even more conservative than the value of the moduli, it is expected that the values obtained from ultrasonic tests will always be greater than those predicted by the standard's equation. The value of G predicted by the standard was 0.65 of G determined by ultrasonic testing.

In the case of Poisson's ratio, [3] proposed to adopt a value of 0.20. The results obtained from the stiffness matrix vary from 0.24 to 0.32. Concretes with f_{ck} above 30 had average Poisson's ratios of 0.32, while up to 18 MPa those ratios were 0.27. Therefore, the Poisson's ratios were always greater than that proposed by the standard (0.20). Interval variation for Poisson's ratio from 0.22 to 0.34 was obtained by [4].

Previous researches [4, 5, 6, 7, 8] also demonstrate that there is a large variation in Poisson ratio, so, the adoption of a fixed value is not adequate. The Poisson's ratio of concrete, obtained in compression tests, is different at different points of measurements, increasing as the point approaches the sections centroid, where it reaches its maximum value [7]. The results of this author [7] showed that the value of the Poisson's ratio obtained at the centroid of the section was about 56 percent larger than that obtained at the edge of the section. Since the ultrasonic measurement correspond an internal measure, the results obtained are compatible with the results from [7].

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