TECHNICAL BULLETIN # 10

Modulus of Elasticity

As current concrete construction market drivers continue to focus on sustainability, there is a trend toward achievement of higher performance using less raw materials. Structural design criteria in CSA A23.3-19 using serviceability limit states (SLS) require that the concrete materials used in the job site achieve higher structural performance to provide equivalent performance using smaller elements. The modulus of elasticity is increasingly becoming a critical factor when calculating the serviceability limit states for structures. As such, designers have begun to seek high modulus values when designing concrete structures.

The Modulus of Elasticity of a concrete mix design, for the most part, is a direct result of the materials from which it is produced. While there are certain mix design proportions that can improve the results, the actual elastic modulus performance of a concrete mix made from viable local raw materials, is, for the most part, outside of the concrete producer's control, in the Alberta market. With very few exceptions, where mineralogically diverse aggregate sources are available, and appropriately qualified for use in concrete production, it may be impossible to achieve any meaningful change in concrete modulus values without importing materials from significant distances.

Data provided by concrete suppliers from Calgary, Edmonton and Red Deer has demonstrated an average achievement of 82.6% of the calculated modulus compared to the simplified equation in CSA A23.3-19 Clause 8.6.3.2. The lowest value in the data set provided, achieved 70.2% of the calculated modulus and the highest value in the data set provided 95.1% of the calculated modulus. While limited testing data is available, these results are generally representative of well-proportioned concrete mixes using local market raw materials.

CSA A23.3-19 Clause 8.6.3.2 notes specifically that the MOE value will commonly range between 80-120% of the estimated value. However, areas exist where these range values are not conservative enough. CSA A23.3-19 Clause 8.6.2.1 describes the best practice as "If the modulus of elasticity is critical to the design, the designer should establish whether such concrete can be produced." Modulus of Elasticity is acknowledged by the standard to be a highly variable value.

Where 100% of the calculated modulus is required for a given concrete mix design for SLS design criteria, it may not be achievable at the expected design compressive strength in many Alberta markets. This would require evaluating the SLS design based on a higher compressive strength to achieve a nominal modulus of elasticity value or consideration given to sourcing imported raw materials capable of achieving the required performance. Given the importance of sustainability and economic viability of concrete construction, the implications of proposed modulus values from these perspectives must always be considered.