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Guidelines for the Verification of the ASR Resistant Property of the Selected Precast Concrete Mixes in Texas

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GUIDELINES FOR THE VERIFICATION OF THE ASR RESISTANT PROPERTY OF THE SELECTED PRECAST CONCRETE MIXES IN TEXAS

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DISCLAIMER

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GUIDELINES FOR THE VERIFICATION OF THE ASR RESISTANT PROPERTY OF THE SELECTED PRECAST CONCRETE MIXES IN TEXAS

The performance-based approach with four recommend steps, which was developed in the previous projects, was applied to verify the ASR resistant property of the selected precast concrete mixes in Texas. The steps that are involved in verifying an ASR resistant precast mix are listed below:

Step 1. Determination of compound activation parameter (CAP) and threshold alkalinity (THA)/total alkali loading (TAL) by the volumetric change measuring device method. The VCMD method has been published as a full AASHTO Standard (AASHTO T364-17).

Step 2. Reproduce the selected precast concrete mixes in the lab. Use of 20 percent Class F fly ash replacement (i.e., TxDOT option 1) is a common practice by the precast producers in Texas.

Step 3. Mix design verification based on THA-pore solution alkalinity (PSA) relationship (optional but recommended). Determination of PSA of the mixes in Step 2 using the pore solution extraction method is recommended. If the extraction method is not available, a combined use of the NIST model (estimating PSA contribution from cement portion) and ASTM C311 (determining available alkalis from the supplementary cementitious material [SCM] used) was found to be effective to estimate PSA of the cement-SCM combination with acceptable accuracy. The prediction of ASR potential of the precast mixes (Step 2) is performed in this step based on the PSA-THA relationship (i.e., PSA needs to be below THA to mitigate ASR). These predictions are validated in Step 4.

Step 4. Mix design validation through concrete testing, use of the accelerated concrete cylinder test (ACCT) method to measure ASR expansion of concrete mixture after Step 2/3 over time in a relatively short time (75-90 days).

Table 1 presents guidelines of different options on utilization of the four steps depending on the need of testing duration and reliability for formulating ASR resistant precast concrete mixes.

Table 1. Different Options for Verification of ASR Resistant Property of the Precast Mixes.

Option	Recommendation on Utilization of Step(s)/Method	Test duration	Reliability	Outcomes
I	Use of all the 4 steps	~ 2–3 months	Highest	Use of all the four steps provides the highest reliability but it takes time – recommended for new source of aggregates or aggregates with high source variability and complex nature of reactivity
II	Use of Steps 1 to 3	≤ 20 days	Medium	To save time (quick verification), the use of Step 4 can be considered optional in the future if a strong agreement between mixes verified through Steps 1–3 and validation testing in Step 4 is observed based on large number of testing using Option I.
III	Use of mainly Steps 2 and 4 with PSA estimation (NIST model + C 311) in Step 3	45–75 days	High	In this option, the direct use of the ACCT method is recommended to test the ASR potential of precast job concrete mixes without conducting Step 1. Elimination of Step 1 is permissible when the aggregate reactivity prediction based on the current test methods seems to be satisfactory.

OPTION I

All mix design Steps 1 to 4 are recommended to verify ASR resistant precast mixes (performance based) with the highest reliability based on CAP-based aggregate reactivity and TAL (lb/cy). TAL is calculated from the measured THA (Step 1) using the established relationship between THA and PSA (detailed procedure is provided in the main report). PSA can be determined quickly (9 days – extraction technique; 28 days – estimation based on the new approach [i.e., NIST model + C 311]) and be used to verify the precast mix designs in a short time (within 9 days in case of PSA by the extraction method and 28 days in case of PSA estimation) based on THA-PSA relationship (i.e., PSA needs to be below THA to prevent/minimize ASR; Step 3). The prediction of ASR potential of the precast mixes (Step 2) is performed in the Step 3. To validate the predicted ASR potential (Step 3), it is recommended to perform mix design validation through ACCT based concrete testing (Step 4).

OPTION II

If a strong agreement between mixes verified through Steps 1–3 and validation testing in Step 4 (Option I) is observed, then requirement of concrete validation testing (Step 4) can be considered optional. However, the user needs to take this decision based on experience and proper judgement. In order to eliminate the concrete validation testing (Step 4) in this option, effective utilization of Step 3 using PSA measurement by extraction technique (high reliability) is recommended. However, the utilization of proposed combined use of the NIST model and ASTM C311 to estimate PSA was found to be acceptable and can be used with acceptable reliability.

OPTION III

In this option, the ACCT method is used directly to test precast job concrete mixes. Reproduction of the selected precast mixes in the lab followed by casting cylindrical specimen (3 × 6 inches) is conducted in this option. PSA needs to be known to design the soak solution for testing using the ACCT method. The estimated PSA based on the newly developed approach (i.e., NIST model + ASTM C 311) is acceptable if the extraction technique is not available. The testing in accordance with the ACCT method is then conducted using the cylindrical specimen immersing in a soak solution with chemistry equal to the estimated/measured PSA. Option III is recommended when the aggregate reactivity prediction (preferably moderate range of reactivity) based on the current test methods (e.g., ASTM C1260 and ASTM C1293) seems to be satisfactory. However, the ACCT method using recommended standard mix can be used to determine aggregate reactivity (within 45 days) if a reliable reactivity prediction is warranted.