Guidance on Preventing and Mitigating ASR

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SAFETEA-LU Legislation for ASR

- Sec. 5203. (e) Demonstration Projects and Studies

  - (3) **Alkali Silica Reactivity**. Of the funds made available by 5101(a)(1) of this Act, $2,450,000 shall be made available by the Secretary for each of fiscal years 2006 through 2009 **for further development and deployment of techniques to prevent and mitigate alkali silica reactivity**.

FHWA's ASR Development and Deployment Program

(1.) Understanding the ASR Mechanism

(2.) <u>Develop Testing and Evaluation Protocols</u>

(3.) Field Trials

(4.) Assist States in Inventorying Existing Structures for ASR

(5.) Deployment and Technology Transfer

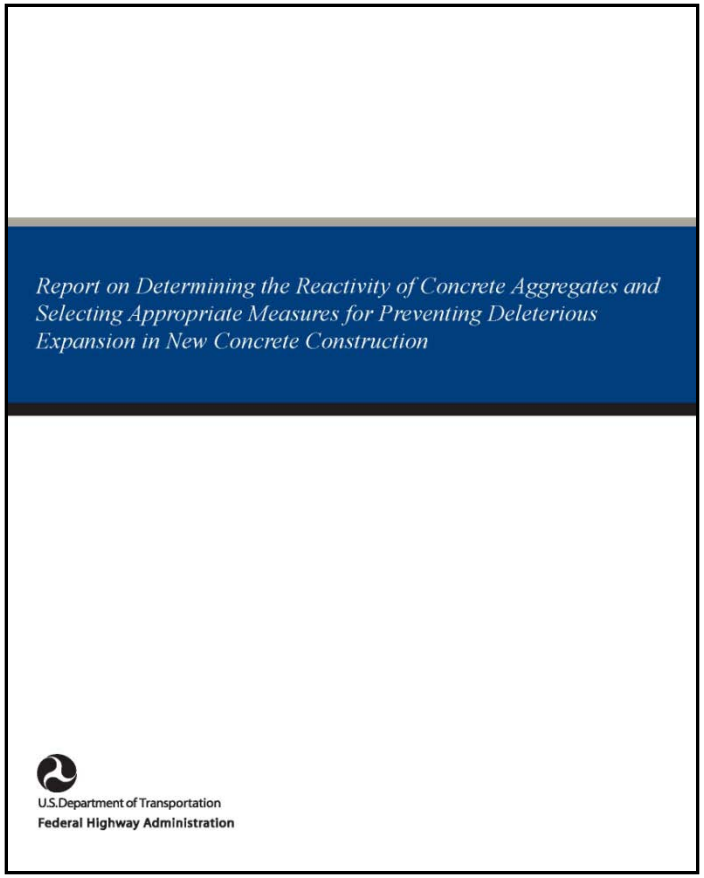
Establishment of a Technical Working Group (TWG) to Monitor the Program

Testing and Evaluation Protocols

- Task Goal
  - Develop a reasonable, effective, and clear decision-making process for methods and techniques to prevent and mitigate ASR

- Protocols Developed
  - ***"Determining the Reactivity of Concrete Aggregates and Selecting the Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction"***
  - *"Diagnosis Prognosis and Mitigation of Alkali-Silica Reaction (ASR) in Transportation Structures"*

FHWA Report for Prevention of ASR in New Construction



FHWA-HIF-09-001

https:// www.fhwa.dot.gov/pavement/concrete/asr.cfm

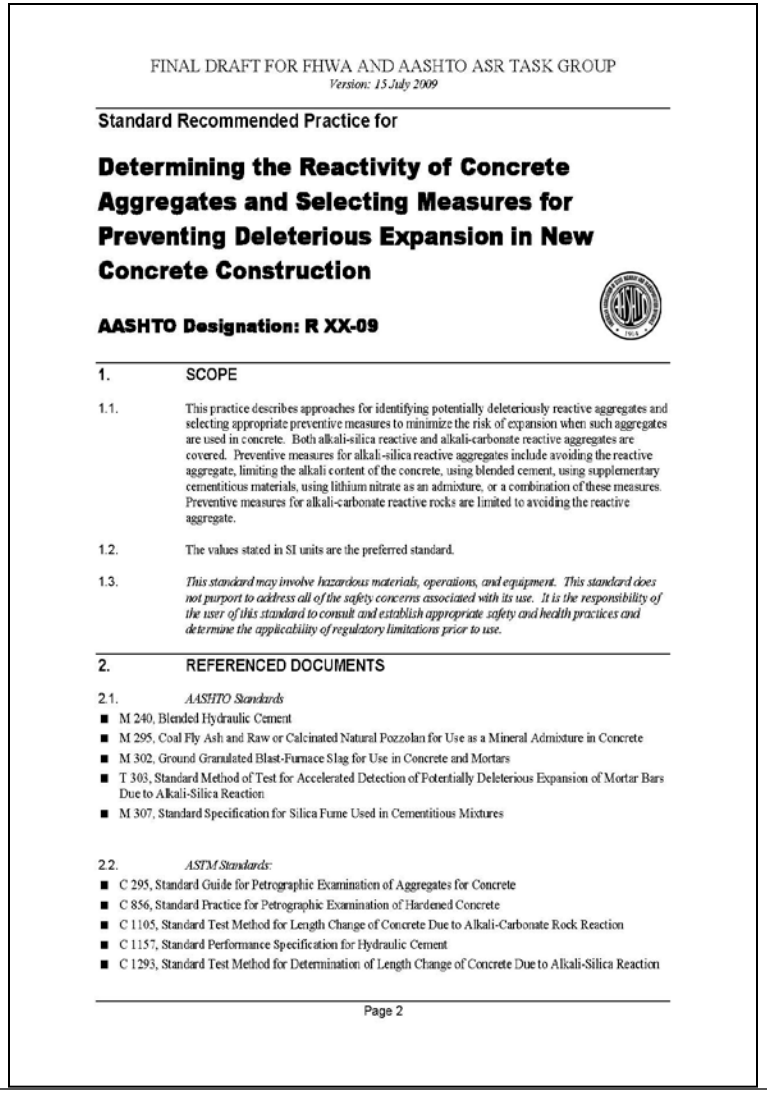
AASHTO Involvement

- After the AASHTO SOM 2007 Meeting an AASHTO ASR Task Group was formed.

- The Task Group was charged with looking at current AASHTO specifications related to ASR.

- In August 2008 the Task Group recommended that additional specifications for ASR be considered because current specification were inadequate.

Recommended Practice Balloted in August 2009



FINAL DRAFT FOR FHWA AND AASHTO ASR TASK GROUP
Version: 15 July 2009

Standard Recommended Practice for

Determining the Reactivity of Concrete Aggregates and Selecting Measures for Preventing Deleterious Expansion in New Concrete Construction

AASHTO Designation: R XX-09

1. SCOPE

1.1. This practice describes approaches for identifying potentially deleteriously reactive aggregates and selecting appropriate preventive measures to minimize the risk of expansion when such aggregates are used in concrete. Both alkali-silica reactive and alkali-carbonate reactive aggregates are covered. Preventive measures for alkali-silica reactive aggregates include avoiding the reactive aggregate, limiting the alkali content of the concrete, using blended cement, using supplementary cementitious materials, using lithium nitrate as an admixture, or a combination of these measures. Preventive measures for alkali-carbonate reactive rocks are limited to avoiding the reactive aggregate.

1.2. The values stated in SI units are the preferred standard.

1.3. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*

- M 240, Blended Hydraulic Cement
- M 295, Coal Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Concrete
- M 302, Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
- T 303, Standard Method of Test for Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction
- M 307, Standard Specification for Silica Fume Used in Cementitious Mixtures

2.2. *ASTM Standards:*

- C 295, Standard Guide for Petrographic Examination of Aggregates for Concrete
- C 856, Standard Practice for Petrographic Examination of Hardened Concrete
- C 1105, Standard Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction
- C 1157, Standard Performance Specification for Hydraulic Cement
- C 1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction

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An Overview...

- Reduce risk by implementing routing testing with petrography and laboratory expansion tests.

- Encouraged to use ASTM C 1293 Concrete Prism Test (CPT) if the owner does not have a good idea of the ASR susceptibility of their aggregate supply.

- The ASTM 1567 Accelerated Mortar Bar Test (AMBT) (to test job mixes) can be used once aggregate history is defined through AASHTO T 303 and ASTM C 1293.

Review of ASR Tests

AASHTO Tests

- T 303
  - Accelerated Mortar Bar Test- tests aggregates only

ASTM Tests

- C 1260
  - Accelerated Mortar Bar Test- tests aggregates only
- C 1567
  - Accelerated Mortar Bar Test- tests job mixes
- C 1293
  - Concrete Prism Test

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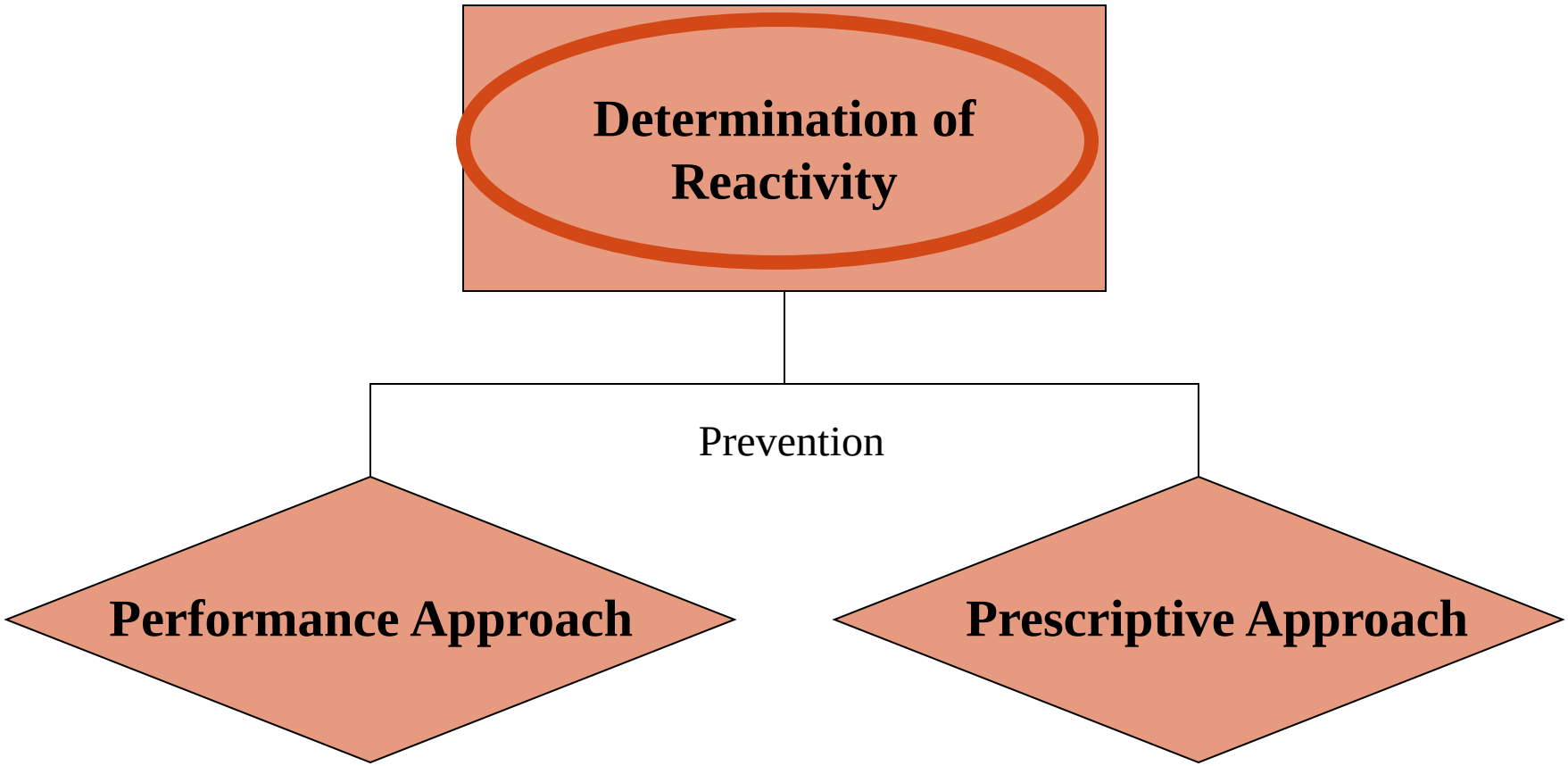

Determining Aggregate Reactivity

- AASHTO T 303 (ASTM C 1260) Accelerated Mortar Bar Test
  - Test is used to determine the reactivity of coarse and fine aggregates separately and not to evaluate job mix combinations.
  - Expansion criteria is ≤ 0.10% at 14 days.

Caution

- Many aggregates fail the AMBT, but do not cause expansion.
- Some siliceous sandstones and granite/gneiss pass the AMBT, but do cause expansion.

Determining Aggregate Reactivity

- ASTM C 1293 Concrete Prism Test
  - Test is to determine reactivity of coarse and fine aggregates.
    - Test can also be used to test a job mix (preventative measures).
  - Expansion criteria is $\leq 0.04\%$ at 1 year.

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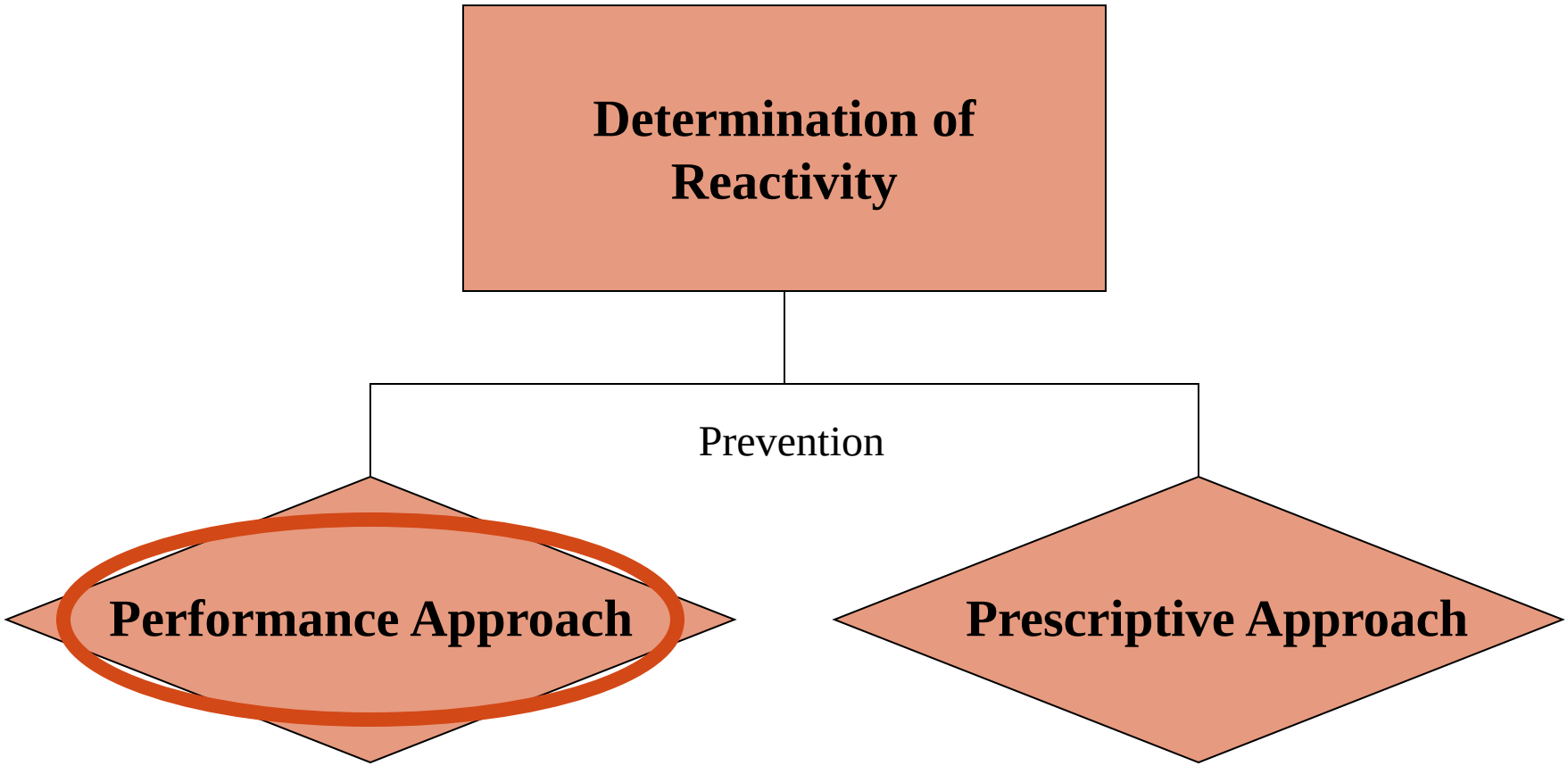


Performance Approach to Preventing ASR

- Preventative measure is tested in combination with the reactive aggregates using either the ASTM C 1293 (CPT) or ASTM C 1567 (AMBT).

Performance Approach

- ASTM C 1293 Concrete Prism Test
  - Testing the ability of SCM's or chemical admixtures, such as lithium, to control ASR.
  - Guidelines provided for testing lithium nitrate.
  - Criteria for expansion is $\leq 0.04\%$ at 2 years.

Performance Approach, cont.

- AASHTO T 303 (ASTM C 1260) Accelerated Mortar Bar Test
  - Determine if the aggregate responds well to the AMBT.
  - Compare results from AASHTO T 303 (AMBT) to ASTM C 1293 (CPT).

Determining Aggregate Reactivity and Selecting Measures to Prevent ASR

Interpreting Test Results

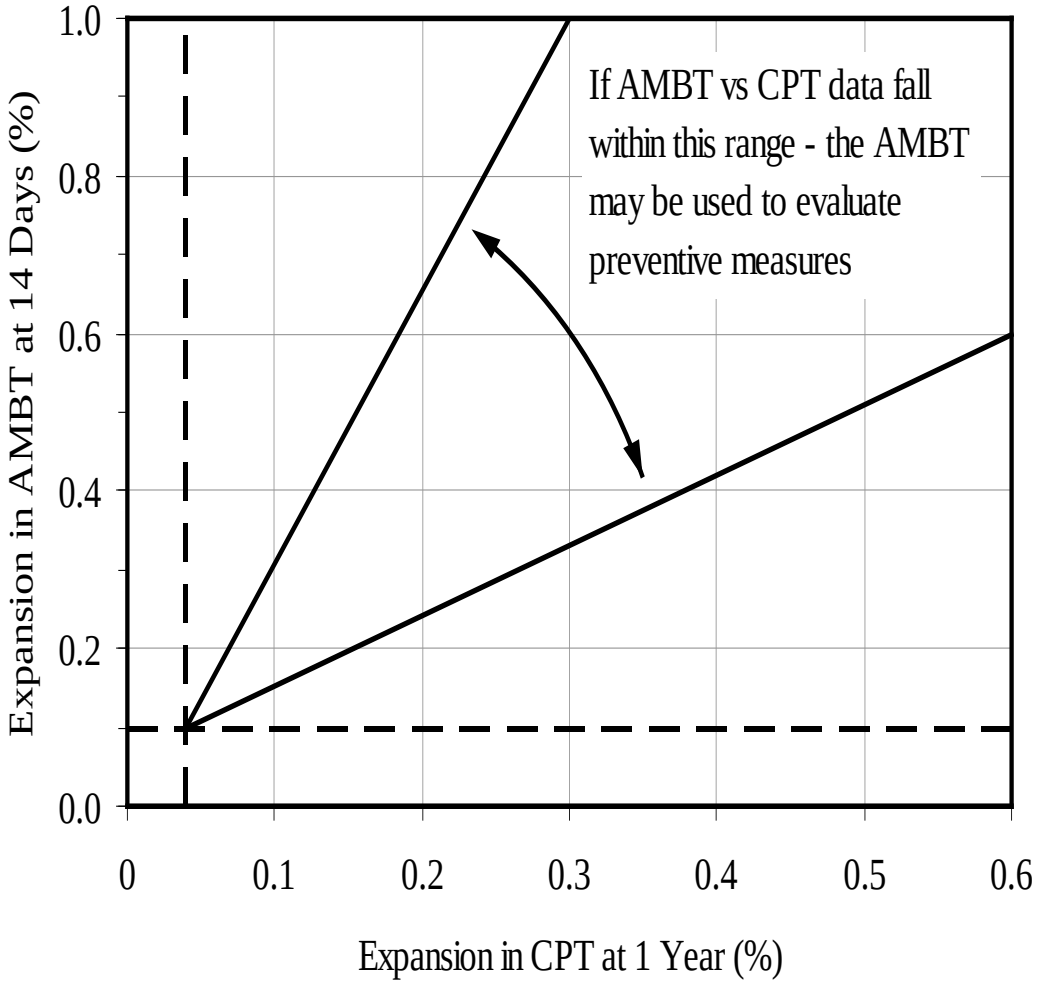
ASTM C 1293

Concrete Prism Test

and

AASHTO T 303

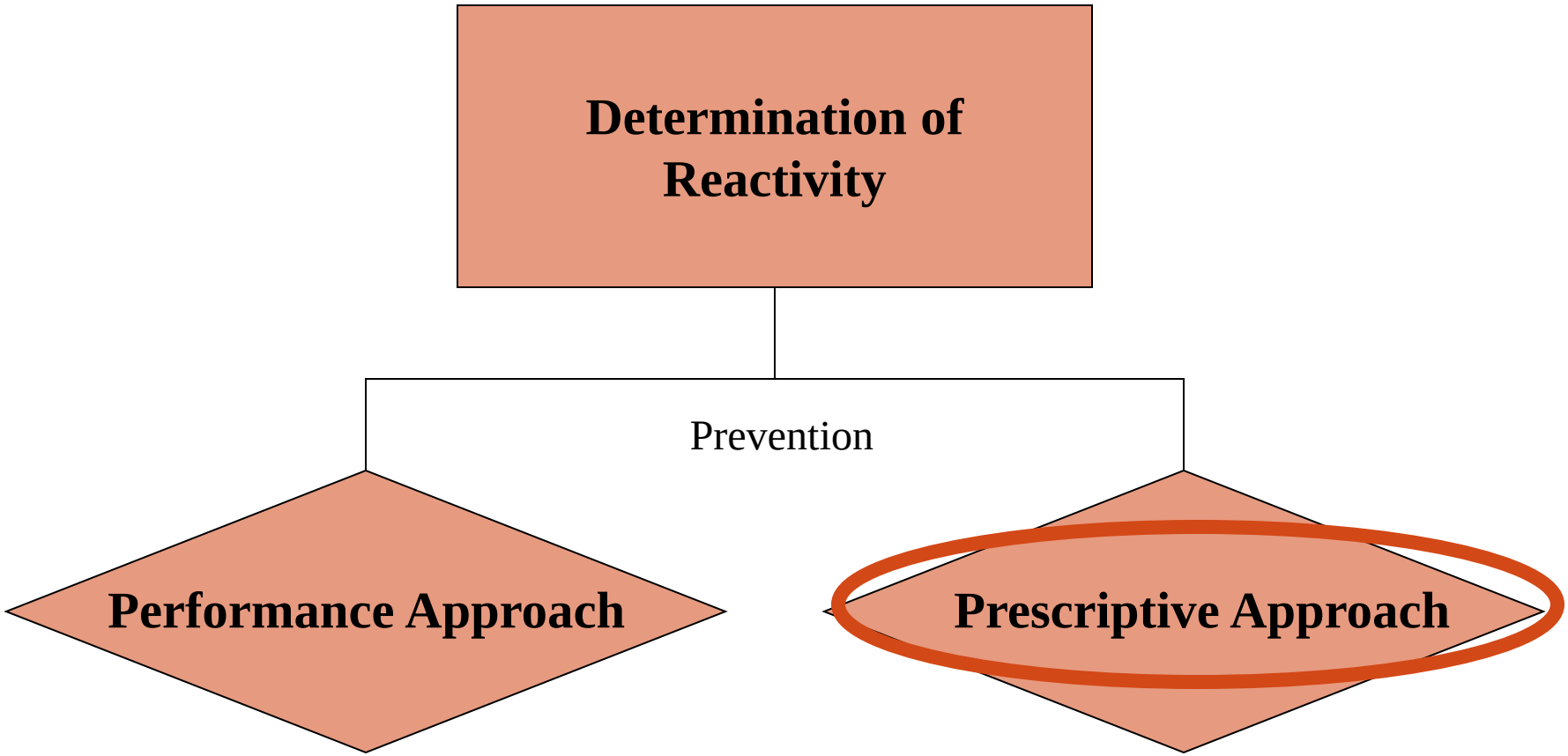
Accelerated Mortar Bar Test



Performance Approach, cont.

- ASTM C 1567 Accelerated Mortar Bar Test
  - Criteria for expansion is ≤ 0.10% at 14 days.
  - Compare the AMBT and the CPT every 2 years unless results of petrography or other tests indicate a significant change in material.

Guidance for Preventing ASR



Prescriptive Approach to Preventing ASR

- Level of prevention is determined by considering the class, size, and exposure condition of the structure, the degree of aggregate reactivity, and level of alkali's from portland cement.

Prescriptive Approach to Preventing ASR

- **Step 1: Determine Degree of Aggregate Reactivity**

Aggregate-Reactivity Class	Description of Aggregate Reactivity	1 Year Expansion in CPT (%)
R0	Non-reactive	<0.040
R1	Moderately reactive	0.040-0.120
R2	Highly reactive	0.120-0.240
R3	Very highly reactive	>0.240

Prescriptive Approach to Preventing ASR, cont.

- **Step 2: Determine Level of ASR Risk**

Size and Exposure Conditions	Aggregate Reactivity Class			
	R0	R1	R2	R3
Non-Massive; Dry Environment	Level 1	Level 1	Level 2	Level 3
Massive; Dry environment	Level 1	Level 2	Level 3	Level 4
All concrete in humid air, buried, immersed	Level 1	Level 3	Level 4	Level 5
All concrete exposed to alkalis	Level 1	Level 4	Level 5	Level 6

Prescriptive Approach to Preventing ASR, cont.

- **Step 3: Determine Classification of Structure**
  - Classification S1, S2, S3, S4 is assigned based on the following factors:
    - Consequences of ASR (safety, economic, environmental, impacts).
    - Acceptability of ASR (low to high risk if ASR occurs).
  - Classification S1= safety, economic, and environmental consequence is negligible & some ASR deterioration is tolerated.
  - Classification S4 = Serious safety, economic, and environmental consequence & ASR cannot be tolerated.

Prescriptive Approach to Preventing ASR, cont.

- **Step 4: Determine Level of ASR Prevention**

Level of ASR Risk	Classification of Structure			
	S1	S2	S3	S4
Level 1	V	V	V	V
Level 2	V	V	W	X
Level 3	V	W	X	Y
Level 4	W	X	Y	Z
Level 5	X	Y	X	XX
Level 6	Y	Z	ZZ	*

* Not permitted. Measures must be taken to reduce level of risk.

Prescriptive Approach to Preventing ASR, cont.

- **Step 5: Determine Prevention Method**
  - Option 1: Limit Maximum Alkali Content.
  - Option 2: Use Supplementary Cementitious Materials (SCM's).
  - Option 3: Control Alkali Level and use SCM's.

* Tables are provided to determine appropriate levels of prevention.

Where are We Now?

- AASHTO balloted the Recommended Practice in 2009.
- Approved with comments. Four negative votes are being addressed.
- Comments have been addressed and the final version has been submitted for publication.
- A commentary for the Recommended Practice will be presented at the AASHTO SOM 2010 meeting in August.

Thank You

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http://www.fhwa.dot.gov/pavement/concrete/asr.cfm