THE UNITED STATES FEDERAL HIGHWAY ADMINISTRATION'S EFFORTS TO ELIMINATE ALKALI-SILICA REACTION IN CONCRETE TRANSPORTATION STRUCTURES

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Abstract

The current United States transportation legislation, The Safe Accountable Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), has provided the Federal Highway Administration with nearly $2 million per year for the next five years to continue efforts to eliminate ASR as a major durability issue. Previous funding was provided to advance the use of lithium compounds. Prior to initiating a new ASR program, the Federal Highway Administration (FHWA) wanted to carefully receive input from customers and stakeholders in Highway agencies, other Federal agencies, industry, and academia. An ASR Benchmarking Workshop was organized in 2006 to review accomplishments of past programs, current state of the practice, and receive recommendations for future efforts. This paper will discuss previous ASR programs, including lithium focused efforts, and discuss current ASR research and implementation programs.

Keywords: United States Federal Highway Administration, Alkali-Silica Reactivity national program, ASR benchmarking workshop, ASR and highway structures

1 INTRODUCTION

Almost 70 years has passed since T.E. Stanton diagnosed the deterioration mechanism known as alkali-silica reactivity (ASR) [1]. Through research and investigation it was found that the geology of reactive rock types, the chemistry of portland cement, and the climate found throughout the United States makes pavements and structures in almost all parts of the country susceptible to the development of ASR. Over the years hundreds of research studies, including the Strategic Highway Research Program (SHRP), have developed methods of detecting aggregates prone to ASR. These studies also provided guidance on how to eliminate deterioration of concrete structures caused by this deterioration mechanism. In spite of these efforts, ASR remains a serious threat to the long-term performance of pavements and other transportation structures. Many questions remain about this complex problem and the numerous efforts underway to increase the knowledge and awareness of the ASR failure mechanism.

2 FACTORS CONTRIBUTING TO ASR IN THE UNITED STATES

Over the past three decades several new issues have emerged to make prevention of ASR more challenging for the transportation industry in the United States. Higher alkali contents in portland cement, restrictions on aggregate supplies, longer life expectations for transportation structures, and the failure of practitioners to recognize the existence of an ASR problem. The combination of issues has expanded the problem rather than reduce the occurrence of ASR.

2.1 Increased Alkali Content

Stanton found that expansive ASR could be prevented if the Na_2O equivalent (alkali content) in the cement was below 0.6%. Based on Stanton's recommendation, many cement specifications for use with potentially reactive aggregates, including the American Society for Testing and Materials

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(ASTM) specification ASTM C 150 Standard Specification for Portland Cement, limit the Na_2O equivalent to 0.6% [2]. Unfortunately, environmental restrictions placed on cement manufacturers have made it difficult, if not impossible, to produce portland cements with low alkali content in some parts of the country. More recent studies indicate that both the ratio of reactive silica to alkali and the total alkali content of the concrete play important roles in the ASR reaction. Studies suggest that the upper limit on the Na_2O content from all sources in the concrete mixture appears to be 4.0 kg/m^3 (6.8 lb/yd^3). While the major source of alkali entering the mixture is portland cement, Supplementary Cementitious Materials (SCMs) and even aggregates can contribute additional alkali to the system. There is an increased use of High Performance Concretes (HPCs) being used in transportation structures. HPCs contain increased cementitious contents and also tend to increase the mass of alkalis per unit volume of concrete. Stanton's simple solution to the ASR problem has limited value in preventing ASR in today's concretes.

2.2 Aggregate Shortages

Today there is a shortage of quality construction aggregates in many parts of the United States. Many issues, including zoning and land use regulations, environmental regulations, and availability issues have made it difficult to open new pits and quarries. In many areas this has made potentially ASR reactive aggregates the only material available.

2.3 Longer Life Expectations

Historically, design life for pavements in the United States was assumed to be 20 years and for bridges was 50 years. Cost and public demands to reduce highway closures have forced many State Departments of Transportation (DOTs) to increase design life expectations. Pavements are being design for 30 to 50 years of service, and some bridges are being built with 100 years of life expectance. Prevention of ASR in these long-life structures has become an important planning consideration.

2.4 Lack of Understanding

Since the SHRP reports were issued in the 1990's there has been a tremendous turnover of technical talent in State DOTs and at the Federal Highway Administration (FHWA), especially in the past decade. Engineers with first-hand knowledge of ASR issues have retired or no longer hold materials and construction positions. SHRP ended and for the most part ASR training was not continued on a national basis. All of these factors resulted in the loss of institutional knowledge and in ASR susceptible aggregates being used without adequate preventive measures.

3.0 RESULTS OF PREVIOUS PROGRAMS

3.1 The Strategic Highway Research Program

In the late 1980's the Strategic Highway Research Program (SHRP) included an extensive study of ASR. Initially three tasks were defined for the ASR efforts [3]:

- Task A: Investigate fundamental aspects of ASR mechanism
- Task B: Develop rapid and reliable test methods to identify potential for deleterious ASR of aggregate and cement-aggregate combinations.
- Task C: Develop methods to mitigate expansive ASR in existing concrete.

A literature synthesis prepared by the SHRP researchers indicated that the Powers and Steinour model for safe and unsafe reactions was generally supported by more recent research. According to this model, alkali and lime first react with silica at the surface of an aggregate particle to form a relatively high lime non-expansive gel product. As reactivity proceeds into the aggregate particle, the greater diffusivity of the alkali ions may result in a lower lime-alkali ratio gel reaction product. Although the reaction itself results in a chemical shrinkage, the gel product may have a great capacity to swell upon absorption of moisture. Swelling due to uptake of moisture apparently can develop when the relative humidity exceeds about 80 percent [3]. It was concluded through field studies that highway concrete is sufficiently damp in all natural climates in the United States to support expansive ASR. Bridge decks in desert regions reach the threshold 80 percent value on seasonal or diurnal cycles. In all climate regions subgrade moisture was sufficient for pavements to reach the ASR moisture threshold.

The survey conducted as part of the SHRP study revealed a wide range of knowledge of ASR within the DOTs. Western States using the 0.6% percent cement alkali limit reported severe cracking due to ASR in spite of the specification requirement. Many States were not aware that ASR could become a problem. Most states relied on ASTM C 856 Petrographic Examination of Aggregates or the UV Test Method to determine the presence of ASR [4]. There was not widespread use of a test method to identify potentially deleterious reactive aggregate and cement-aggregate combinations.

Work done under the SHRP study focused on refining the rapid mortar bar procedures developed in South Africa into the method standardized as ASTM C 1260 Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Mortar Bar Method) [3,5].

The use of lithium salts to prevent and mitigate ASR was also investigated under SHRP. The threshold molar ratio of Na:Li at about 1.0:0.67-11.0 using lithium hydroxide (LiOH) was used to treat existing ASR afflicted pavements. The penetration of LiOH was found to be dependant on the extent and ability of the existing cracks to transport the material into the pavement. Other materials were also used in attempt to mitigate ASR.

The use of high molecular methacrylate treated pavements was found to have less deflection under loading than other mitigation methods. A limited field evaluation of silane/siloxane surface treatments was also carried out. The SHRP study concluded that the efficacy of using surface treatments to prevent expansion due to ASR, but permit vapor diffusion, is questionable.

Restraining expansion was also investigated. From the study it appeared that the application of moderate, one-dimensional restraint can control expansion in the direction of restraint and significantly reduces the rate of expansion in other directions.

The SHRP study identified that the following areas needed further investigation:

1. Further validation of the rapid immersion test method including determining safe cement alkali and pozzolan levels.
2. The use of ASTM C 1293 Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction to evaluate cementitious material and aggregates in the rapid immersion test [6].
3. Field evaluation of LiOH used to combat expansion due to ASR, both as an admixture and as an application to hardened concrete.
4. Test methods to determine remaining potential for expansive ASR in existing concrete.

3.2 Post SHRP Efforts

Following the SHRP program there were several efforts to move SHRP products and technology into the main stream of highway practice. The American Association of State Highway and Transportation Officials (AASHTO) established a program to standardize practices and test methods. Both the procedure for the Rapid Identification of ASR Products in Concrete procedure and the Accelerated Mortar Bar Test became AASHTO standards through this program.

FHWA established a SHRP Implementation Program that conducted ASR Showcases in all nine AASHTO regions. The Agency also provided technical assistance, an equipment loan program, and a verification program of round robin testing.

AASHTO also established an ASR Lead States Teams to provide a clearinghouse to share and deliver information and technical assistance in identification, prevention and rehabilitation of alkali silica reactivity to the public, private, and academic sectors of transportation. The ASR Lead States Team established a web site to make information available to State DOTs, conducted a survey to assess the extent of ASR in the US, developed an ASR Guide Specification and provided technical assistance, and coordinated research on ASR.

3.3 Lithium Research Program

TEA-21 legislation appropriated funds for researching and developing methods to prevent and mitigate ASR with lithium based technologies. The FHWA developed the Alkali-Silica Reactivity Lithium Technology Program and contracted a consultant team to develop guidelines and research the use of lithium to mitigate and prevent ASR.

Initially, a report titled “Guidelines for the Use of Lithium to Prevent or Mitigate Alkali-Silica Reaction in Concrete Pavements and Structures” was developed under this program in 2003 [7]. This report was based on literature reviews and included recommendations for both prescriptive and performance based specifications. The prescriptive specifications outlined the requirements for the appropriate mixture proportioning that is necessary to control ASR. This report specifies the "standard dosage" of lithium, also referred to as 100% dosage and it is equivalent to 0.74 [Li]/[Na+K] molar ratio, as an admixture to prevent ASR. The performance based specification outlined which tests should be conducted on a given aggregate to determine its potential for reactivity and the tests necessary to assess methods of mitigating aggregate reactivity. The report recommends either ASTM C 1293 or ASTM C 1260, the mortar bar method, to determine an aggregate's reactivity. The testing procedures are modified to allow for the addition of lithium nitrate in the soak solution to determine the amount needed to prevent ASR.

A subsequent report entitled "Interim Recommendations for Use of Lithium to Mitigate or Prevent ASR" was published in 2006 and was based on the test results obtained from the research being conducted under the Lithium Technology Program [8]. Significant changes were made to the previously mentioned report. The prescriptive recommendations for the use of lithium as an admixture in new concrete were removed. Recent studies showed that the "standard dosage" of lithium was not adequate to prevent ASR for all aggregates. The updated report recommends that the required dosage to prevent ASR could only be determined by testing lithium's effect on the performance of each aggregate. The recommendation to use the ASTM C 1260 test in the performance specification was removed. The Mortar Bar Test tends to underestimate the amount of lithium required to control the expansion of a number of reactive aggregates.

More work is needed to develop a rapid test that best predicts the performance of lithium compounds in the laboratory and for the development of prescriptive guidelines. It is anticipated that FHWA's Lithium Technology Program will provide guidelines for accelerated testing procedures to determine the amount of lithium necessary for preventing ASR.

4. FHWA'S EFFORTS UNDER CURRENT UNITED STATES HIGHWAY LEGISLATION

4.1 Legislative Requirements

On August 10, 2005, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) became law. Many designated programs were established under SAFETEA-LU and one such program is for Alkali-Silica Reactivity (ASR). Funding has been made available in the amount of $2,450,000 per year from 2006 through 2009 for projects and programs related to furthering the development and deployment of techniques to prevent and mitigate ASR

In order to carry out the provisions of SAFETEA-LU, the FHWA developed an outline for an ASR Development and Deployment Program. The objective of the ASR Development and Deployment program is to more efficiently deploy current techniques to prevent and mitigate ASR, which includes the use of lithium based technologies, into the field. This program is integrated to include bridges, pavements, and other concrete highway structures.

4.2 ASR Benchmarking Workshop

Before the initiation of the new ASR Program, FWHA believed it was necessary to gather expert and stakeholder input regarding a comprehensive program of development and deployment activities addressing techniques to prevent and mitigate ASR.

FHWA organized a two and one-half day facilitated workshop in April 2006 as part of the effort to define the elements for the ASR Program. The 74 workshop participants in attendance represented academia, industry, State Departments of Transportation, the host agency FHWA, and other government agencies. Invited participants were specifically selected because of their knowledge and experience related to ASR.

The workshop was organized to maximize the amount of information and knowledge contributed by the participants. To start the workshop prominent individuals with knowledge of ASR issues made presentations establishing the current state-of-practice related to ASR. Presentations were made on test methods currently used to evaluate the potential for deleterious ASR, results of the ASR SHRP and AASHTO Lead State Programs for ASR, current initiatives using lithium to mitigate ASR, experiences of the Federal Aviation Administration and Department of Defense with ASR, and ASR's impact on long life infrastructure. Workshop participants then discussed challenges related to combating ASR and necessary elements for the ASR Program. The following discusses the elements that were identified by all or a majority of the discussion group members [9].

ASR Test Methods and Identification Techniques

Workshop participants discussed the challenges and suggested ASR Program elements related to ASR test methods, guidance documents and specifications, and identification techniques.

<u>Improvements to laboratory testing for the determination of ASR potential in concrete</u>

In general, the workshop participants felt there were many shortcomings of the current tests available. The current tests are inference tests and are not based on the fundamental scientific properties of ASR development in concrete. The workshop participants felt that data on new test methods and identification techniques were not being directly correlated to actual field performance of structures. Testing the concrete mixtures in conditions similar to field exposure is essential to assessing performance. Workshop participants expressed concerns regarding the duration of the tests required to obtain a reliable answer. States need a reliable test that can assess an aggregate's potential reactivity within a timeframe that meets their contract and materials approval schedules.

<u>Improvements for field identification and verification of ASR</u>

The field identification of ASR is extremely important and petrography is currently the most accurate test to verify ASR in a structure. Petrography can be considered an "art" due to the level of experience and skill required to identify ASR. Most participants felt that due to the subjective nature of ASR identification there is a need for additional training of qualified petrographers. Workshop participants also felt that a quick and reliable performance related test is needed. This test would evaluate concrete mixture constituents such as aggregates, cements, and SCMs and their reactivity potential and effect on the concrete mixture. In addition a quick and reliable test is needed to test the completed concrete mixture. Information on the mixture constituents alone is not enough.

<u>Development and improvements to guidance documents and specifications</u>

Workshop participants stressed it was necessary to develop protocols or a framework that outlines existing tools and guide specifications available today to provide guidance on producing durable concrete. Currently there is a lack of information or direction on how to address ASR from a prevention standpoint. Many workshop participants spoke highly of the Canadian Standards Association (CSA) protocols for ASR. It was suggested that the CSA specifications need to be evaluated for their efficacy in the United States.

ASR Prevention in New Construction

Workshop participants suggested ASR Program elements related to preventing ASR in new concrete structures.

<u>Further investigation and documentation of methods for ASR prevention</u>

One unknown is the amount or dosage of lithium, SCMs, and natural pozzolans needed to effectively prevent ASR. There is research that indicates that mineralogy of the aggregate has an effect on the dosage of lithium necessary to successfully suppress ASR, although this is not fully understood. Methods proven to prevent ASR in the laboratory need to be monitored in the field extended periods of time for correlation. Field trials need to be well document to provide valuable information and could be used to identify successful and unsuccessful preventative methods.

<u>Additional guidance and training</u>

Updating existing guide specifications, inspection protocols, and evaluation protocols are needed. These documents need to be included in training for agency, contractor and consulting personnel. Users need additional information to understand ASR and gain the tools and knowledge to make programmatic decisions on the most effective means of preventing ASR. Training and technology transfer is critical to address these issues.

ASR Mitigation in Existing Concrete

Workshop participants also discussed suggested program elements related to the mitigation of ASR in existing concrete structures.

Additional field trails for ASR mitigation

To practitioners current mitigation techniques are perceived to still be in the research stage. Since SHRP there have been a number of field trials applying lithium to existing concrete structures in an effort to slow the ASR expansion mechanism. Data collection has not been consistent and the results are not well documented. New field trials should be used to evaluate currently existing mitigation strategies and techniques. A clearly defined processes needs to be established to ensure the right data is gathered.

Additional information on ASR mitigation

It is unclear when in the life cycle of ASR various mitigation techniques should be explored. Mitigation may not be effective if it is applied to a structure too early or too late in the life cycle of ASR expansion. There is speculation that lithium may be more effective in suppressing ASR expansion if the structure has moderate or high severity cracking as opposed to low severity cracking. Additional work in this area is needed to provide the necessary tools to agencies so they can effectively manage their structures with ASR. Modification and updates to the existing information may be necessary and new protocols are necessary due to recent advances and research.

Information sharing

Agencies are interested in information sharing and building a knowledge base. The development of a database was suggested to facilitate sharing information on the various field trials for mitigation techniques. The database would include information on timing of the applied mitigation technique, rate or dosage of the technique, and performance data. Agencies believe they will have a better understanding on effective mitigation techniques and strategies by understanding what has been explored and found to be successful.

Development of a quick field test

A quick test is needed for the field verification of ASR. The most reliable current method to determine ASR is through ASTM C 856. However, this is costly and time consuming for agencies due to core extraction and analysis. Concerns were also raised with regards to the accuracy of the petrographic analysis. An ideal quick field test would determine when the ASR occurred, the severity of the ASR, and how much expansion is remaining in the structure.

The Inventory of Structures and Pavements

SAFETEA-LU legislation requires the establishment of an ASR inspection program for existing structures. FHWA will develop tools for State agencies to survey and track their structures with ASR.

Develop tools to assist States

Overall, workshop participants felt that tools need to be developed to allow States to inventory and track structures with ASR. Structures can then be prioritized for future mitigation, rehabilitation, or reconstruction. Workshop participants believed that it would be effective to give the States a process that can be easily included into their current bridge or pavement management systems. The system would ideally include a severity rating system indicating low moderate or high severity ASR potential. Structures would then be flagged for continuous monitoring and steps to verify the presence of ASR.

Training and education

There is a lack of understanding of the extent of ASR in the States. Workshop participants felt that ASR is not easily identified and is not included as part of most regular pavement or bridge inspection programs. Without understanding the extent of the problem, many agencies are not initiating methods or research to address ASR. Practitioners expressed frustration because ASR is a unique deterioration mechanism. The loss of institutional knowledge, lack or training, and poor technology transfer of guidance documents leave agencies wondering how to solve this complex problem.

4.2 Lessons Learned

Many researchers and experts believe that the methods to effectively prevent ASR in new concrete have been fairly well established. However, it was clear from receiving feedback from the ASR Benchmarking Workshop that this information has not reached the end-user. There needs to be a link between laboratory testing and field applications to prove the reliability and performance of the various methods and techniques to prevent and mitigate ASR. State agencies historically are hesitant to try research stage technologies and require very clear performance for full implementation.

5 SCOPE OF FHWA'S ASR DEVELOPMENT AND DEPLOYMENT PROGRAM

Based on feedback from the ASR Benchmarking Workshop, the FHWA drafted a comprehensive program focused on the deployment of current technologies to prevent and mitigate ASR, guidance and training for agencies to implement technologies, and applied research to fill in holes in the current knowledge of ASR. The main objective of the ASR Development and Deployment Program is to more efficiently deploy current techniques to prevent and mitigate ASR, which includes the use of lithium based technologies, into the field. This program shall be integrated to include bridges, pavements, and other highway concrete structures.

The FHWA identified the following ASR Program goals:

- Increase durability, performance, and reduced life cycle costs through prevention and mitigation of ASR in concrete pavements, bridges, and other highway structures.
- More effectively deploy current technologies to prevent and mitigate ASR in the field.

Six tasks were identified to meet the objectives and goals of the program. A description and strategy for each goal follows.

5.1 Task 1: Understanding the ASR Mechanism Process for Mitigation

Applied Research Background Strategies

The objective of this study is to better understand the mechanism of ASR. The result will be the development of prescriptive methodology for durable concrete mix designs free of ASR with available raw material source with no or minimal testing of hardened concrete. The following will be accomplished:

- Perform systematic research to quantify competing chemical reaction rates between various constituents in the concrete mix design and the environment, and identify chemical composition and the structure of the formed products.
- Describe the nature of the reaction products both in the pores and cracks in the interface zone and around aggregate particles in ASR affected concrete.
- Determine the effects that various accelerating admixtures used to extend the construction season, such as cold weather construction, has on ASR.

5.2 Task 2: Develop Testing and Evaluation Protocol

Deployment Background and Strategies

Protocols will be developed to provide guidance to engineer and transportation practitioners, primarily in State DOTs, city/county transportation practitioners, and consulting firms or contractors working for these agencies. The protocols will be developed as three stand alone documents as follows:

1. Rapid test methods and evaluation protocol(s) to select job specific ASR preventative procedures for new pavements, bridges, and other highway structures using specific materials available to the project.
2. Rapid test methods and evaluation protocol(s) to select mitigation procedures for existing pavements, bridges, and other highway structures using a variety of materials.
3. Rapid test methods and evaluation protocol(s) for agencies to determine the future deterioration of a pavement, bridge, or other highway structure afflicted with ASR. The

rapid test and evaluation should be capable of producing reliable predictions is less than six months.

Applied Research Background and Strategies

Currently available rapid test procedures have varying levels of confidence and most have limitations. The objective of this applied research task is to identify recent worldwide advances in rapid test methods, identify the most viable and effective test methods, determine their limitations, assess the required test period, and refine or modify these methods. It may be determined that a new rapid laboratory test method that is reliable and can predict the long-term performance of a concrete mix design in a short period of time needs to be developed.

5.3 Task 3: Selection, Implementation, and Maintenance of Field Application and Demonstration Projects

Deployment Background and Strategies

Demonstration Projects are an effective way to gather States to witness first-hand the application of mitigation and/or prevention techniques. One of the most difficult aspects of implementing field trials is obtaining the actual commitment of a State to try a new technology. States are reluctant for many reasons such as: time and effort required by agencies that are short staffed and under funded and the public perception and maintenance costs of a potential failure. To address these challenges States will be targeted through a comprehensive marketing plan to gain commitment for field trials. A team of technical experts will be available to assist the State in selecting the best treatment option for their particular structure. Technical assistance will be provided for the planning, design, and construction of the field project, which will include the instrumentation of projects for data collection and analysis. Data will be collected, appropriate laboratory testing will be performed, the data will be analyzed, and conclusions will be developed on the efficacy of the prevention or mitigation strategy. A final report will be prepared that presents the findings and conclusions from each field trial. Ultimately an execution plan for the implementation of methods and techniques found to be effective in mitigating and preventing ASR will be developed.

Applied Research Background and Strategies

This task will focus on controlled laboratory experiments to seek new or emerging technologies that may be viable and cost effective for ASR mitigation. The mitigation of ASR will differ for both bridges and pavements and will take the following into consideration when evaluating mitigation techniques:

- In pavements, ASR is affected by subgrade moisture where as bridges do not have this adverse situation. Mitigation techniques need to be cost effective especially for pavements because of their very larger surface areas.
- Silane and other sealers, waterproofing members, and overlays are helpful in controlling moisture from penetrating concrete bridges. They are also useful in controlling corrosion in bridge decks by reducing the penetration of chloride ions into the concrete matrix. Depending upon the applied rehabilitation technique, these approaches may reduce the severity of ASR to a varying degree. Controlled experiments are needed to verify the reduction of moisture for ASR prevention and mitigation.

5.4 Task 4: Assist States in Inventorying Existing Structures for ASR

Deployment Background and Strategies

A system for tracking ASR affected bridge and pavement highway structures will be developed. An evaluation of the current practices that States are using to survey and track ASR affected bridge and pavement highway structures will be performed. A general plan for including ASR indicators in both the State's bridge inspection program and pavement survey/pavement management system will be developed. It is noted that the National Bridge Inspection Program requires that bridges be inspected every two years. As a result States have a bridge management system that is fully implemented. Therefore, the inclusion of inspecting for ASR will be relatively simple for bridges. However, many States do not have a continuous inspection program for pavements resulting in more difficult implementation of an ASR tracking system for pavements.

It will be necessary to develop a strategy that the State DOTs can use to implement the ASR Tracking System. An ASR severity rating system will be developed to assist Sates in prioritizing mitigation techniques. Additional information for further testing to verify that the field identified distress is ASR will be provided to the users. Training will be required to provide State personnel the necessary tools to identify potential ASR in the field.

Applied Research Background

It is important to distinguish between ASR and other deterioration mechanisms so that the appropriate rehabilitation method is determined. Presently the uranyl acetate test method and Los Alamos ASR Detect diagnostic method can detect the presence of ASR. These tests can not predict the total expansion in order to determine the performance of the structure over the intended design life. Petrographic examination of extracted cores coupled with ASTM C 1293 does provide an indication of the severity of ASR and the remaining service life of the structure. These methods are destructive and ASTM C 1293 takes a very long time to perform. The objective of this research is to develop a simple reliable non-destructive field test method that can determine the presence of ASR and predict the total expansion and the rate of expansion. Ideally this test will be used to make decisions regarding rehabilitation techniques in a timely manner.

5.5 Task 5: Deployment and Technology Transfer of Findings

Deployment Background and Strategies

Development of and ASR Data Center

A central data center capable of storing and recording data from past and future field trials and demonstrations will be developed. The data center will be capable of allowing the manipulation of data to develop and validate ASR test methods and performance prediction models.

Facilitation of the adoption of testing procedures

It is anticipated that facilitation of the adoption of testing procedures or modifications to existing specifications by standard setting bodies such as AASHTO and ASTM will be necessary. It is possible that this facilitation may be required for testing procedures or modifications to existing specifications that were developed by other programs or projects not funded by the ASR Development and Deployment Program.

Mid Program Workshop

A mid-program workshop is a useful tool to assess the “state of the program”. A workshop held approximately 2-years into the program will be used as a forum to collect information on the progress of ASR program. The work-to-date will be reviewed, future needs will be identified, and input regarding correction to the course of the program will be obtained from customers and stakeholders.

Applied Research Background and Strategies

As needed round robin and validation testing for the facilitation of the adoption of testing procedures will be performed.

5.6 Task 6: Organization and Facilitation of ASR Stakeholder Technical Working Group

Deployment and Applied Research Background and Strategies

It is necessary to gather experts and stakeholders in the area of ASR. The ASR Benchmarking Workshop is an excellent example of how information sharing can benefit an important program. It is therefore vital that an ASR Stakeholder Technical Working Group (ASR TWG) be established to monitor program implementation and provide technical assistance to FHWA program managers. The ASR TWG will monitor the program to ensure program objectives are met. Members of the ASR TWG will be composed of individuals from FHWA, industry, academia, other federal agencies, and State DOTs.

6.0 CONCLUSION

Currently the FHWA is progressing with the initiation of tasks under the ASR Development and Deployment Program. The ASR Technical Working Group (ASR TWG) has been established and met twice in 2007 and will meet twice in 2008. The ASR TWG is composed of 30 members with representatives from eight State agencies, five academic institutions, nine representatives from concrete, cement, and admixture industries, and eight representatives from FHWA and other government agencies. The development of protocols for the prevention, mitigation, and determination of future expansion of ASR has been initiated and is scheduled for completion in May

2008. The first issue of a quarterly publication aimed at informing our customers about the ASR Development and Deployment Program, field trails, and advancements related to ASR will be distributed in February 2008. Finally, the implementation of field trials exploring the methods and techniques to best prevent and mitigate ASR is planned for late 2008. In conclusion, the goal of FHWA's new ASR program is to provide State agencies and other customers with the tools necessary to address their ASR mitigation and prevention concerns. Additional information on this program can be found at: http://www.fhwa.dot.gov/pavement/concrete/asr.cfm.

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