

## Identification of Alternative Pavement Binders and/or Alternative Pavement Materials

### PROJECT SUMMARY REPORT

For more than 100 years, the civil engineering approach to constructing pavements has changed very little. Relatively cheap local aggregates are used as filler, bound together with Portland cement and asphaltic cement. Each binding material has its shortcomings and the overall performance of the resulting pavements is not always adequate.

The objectives of this research were to identify

potential alternative binders for pavements and to explore the possibility of developing a “smart” (self-compensating) mortar.

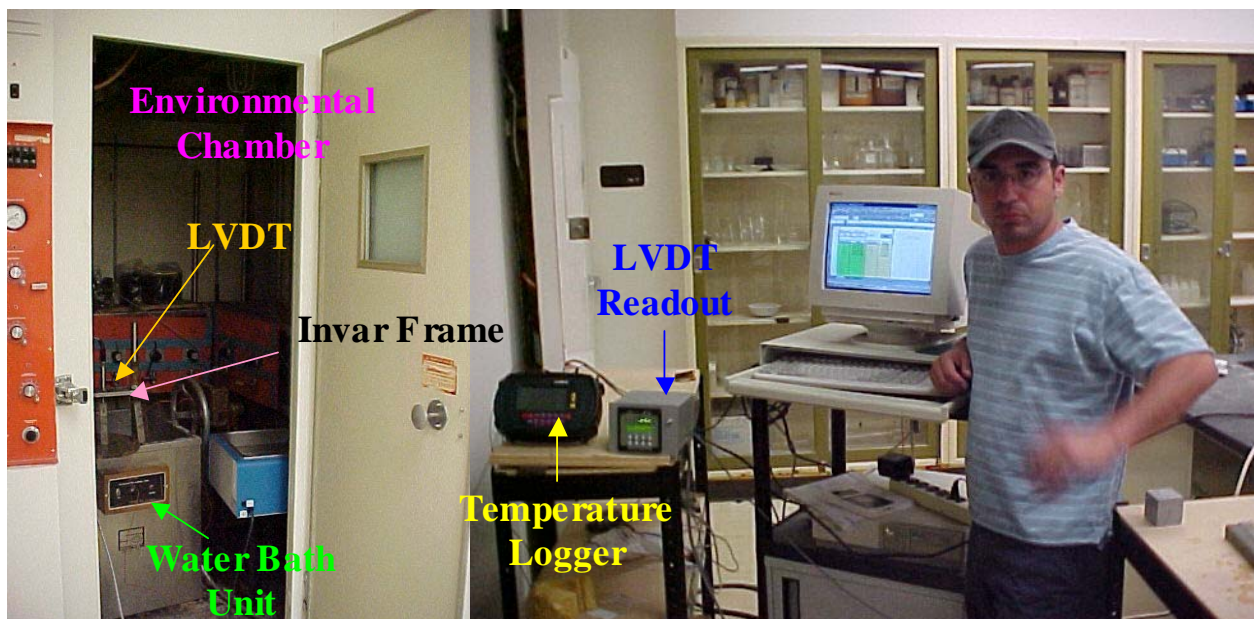
### *What We Did ...*

An extensive literature search was done. Various “smart” materials and applications were identified:

#### • **Self-Repairing Mechanism for Portland Cement Concrete Pavement (PCCP):**

Hollow, porous, polypropylene fibers filled with methyl methacrylate are used for self-repair. At the onset of a crack, the fiber breaks, and the chemical fills the crack and arrests crack propagation.

• **Corrosion-Resistance with Fibers:** Hollow fibers filled with calcium nitrate and coated with polyol are used to combat corrosion. If the alkalinity is reduced, the polyol dissolves and releases the anticorrosion chemical.



- **Traffic-Monitoring**

**Concrete:** A carbon fiber matrix (less than 1% by weight of cement) is used for traffic monitoring and weighing-in-motion. The fibers bridging micro-cracks undergo slight (less than 1 mm) pullout as the concrete is deformed and increase the electrical resistance of the concrete.

- **Self-Stressing Fiber**

**Composite:** Shape memory alloys are used as muscle fibers within composites to allow the composite to change pre-stressing force at any time after the

composite matrix has hardened.

- **Sulfur to Replace**

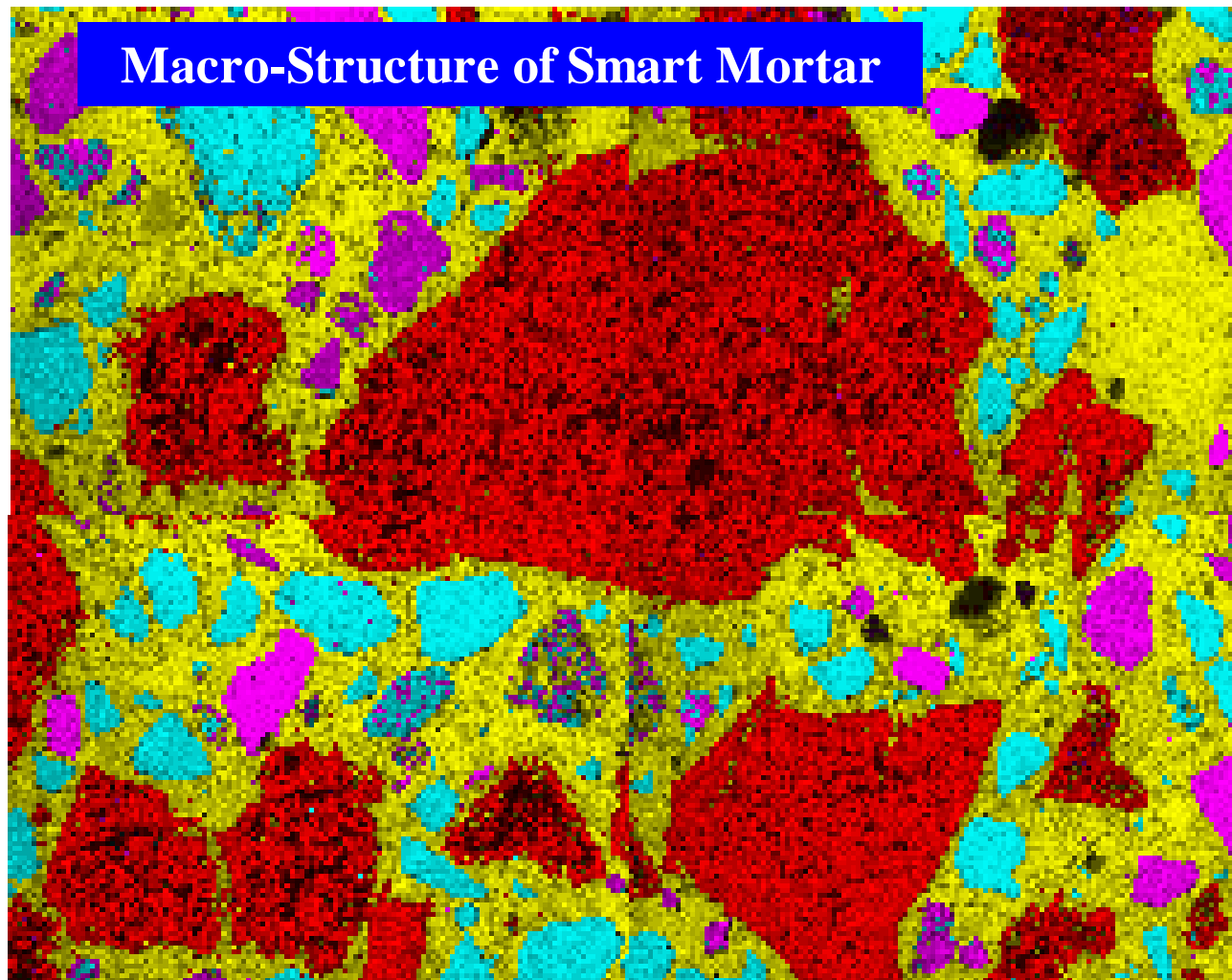
**Asphalt:** Some research has been done on the replacement of asphalt with sulfur.

- **Proprietary Products:**

There are a variety of proprietary systems whose suppliers claim may perform a variety of functions. Some examples are a product used as a base to provide more flexibility under loading and a product to reduce drying shrinkage

The researchers evaluated the concept of a smart

mortar in this research project. They identified the possibility of reducing or minimizing the coefficient of thermal expansion (COTE) of mortar by adding zirconium tungstate (ZT). ZT has a negative COTE and shrinks when heated. This shrinkage should allow room for expanding mortar to fill the created voids as temperature rises. It may not result in a zero COTE composite material but could significantly minimize the COTE of the mortar. It was necessary to evaluate the



mortar composite on both a micro and macro level. The macro-level evaluation involved measurement of COTE changes in lab samples. The micro-level evaluation involved identifying the placement of the ZT within the mortar composite.

Two specimen sizes were used for the COTE testing (1 by 1 by 6 in. bar and 2 by 2 by 1 in. block). TxDOT's test method Tex-428-A "Determining the Coefficient of Thermal Expansion for Concrete" was used with a modification to increase the precision of the test. A strain-gauge measurement test set-up was also developed. All specimens were prepared with 35% cement content and a water-cement ratio of 0.5. ZT

replaced sand content.

Optical metallography and scanning electron microscopy (SEM) techniques were used to identify the distribution and location of ZT within the mortar composite. Since standard specimen preparation procedures have not been developed for mortar composites, the techniques used for metal and ceramics were evaluated and modified so reproducible surface sections of mortar composite could be prepared.

### ***What We Found ...***

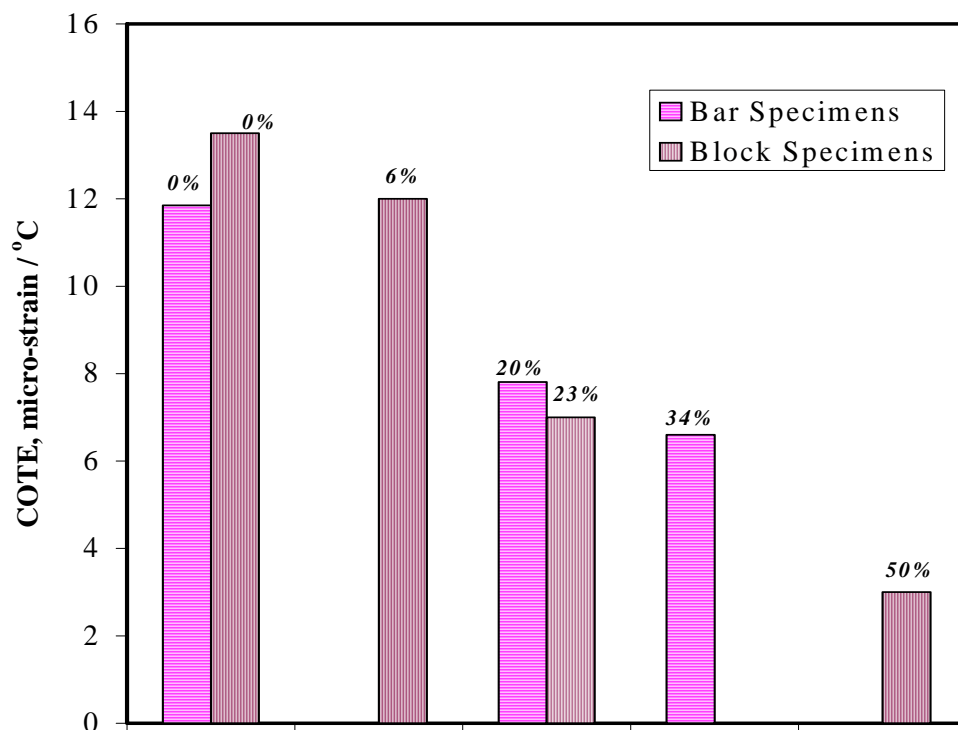
The smart mortar macro-structure evaluation demonstrated that ZT can be placed uniformly (homogenously) within the mortar composite and that

this can be visually verified.

The COTE test results indicated that a reduction in the COTE of the mortar (bar specimens (34% ZT) produced a 44% decrease and block specimens (23% ZT) produced a 48% decrease).

### ***The Researchers Recommend ...***

The test results demonstrate the feasibility of reducing the COTE of mortar by adding a negative COTE material such as ZT. Further research would be needed to determine if this "smart" (self-compensating) additive process would work for PCCP and if there are materials available to do this economically.



***For More Details...***

*The research is documented in the following report:*

- 1786-1F: “Development of Smart Mortar Based on Self-Compensating Concept”

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***TxDOT Implementation Status  
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Implementation of project 0-1786 findings is not economically viable at this time. This research identified some potential materials to decrease the coefficient of thermal expansion (COTE) in concrete pavement. Further research would be required to identify economically viable materials, which could be used in the quantities required to reduce COTE. At this time the results of the research are not ready for immediate implementation.

***YOUR INVOLVEMENT IS WELCOME!***

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