

# Oklahoma Department of Transportation Office of Research and Implementation

FFY 2023 Request for Proposals

*Implementation Statement Title:*

 **Effectiveness of Magnesium-Alumino Liquid Phosphate=Based Concrete as a Repair Material**

*Problem Statement:*

Magnesium-alumino Liquid Phosphate (MALP) is a relatively new material for concrete structure repair. MALP concrete consists of a pre-packaged magnesium-alumino aggregate dry powder with a mono-aluminum-liquid phosphate activator and is fast-setting with high-early strength (Phoscrete 2014). MALP materials should not be confused with traditional magnesium-ammonia-phosphate cements even though they produce similar properties. No water is used for mixing and placement of MALP concrete. In general, magnesium phosphate cements set and gain strength very rapidly, have high bond strength and have high durability (e.g., Ding and Li 2005, Yue and Bing 2013). Traditionally, magnesium-phosphate cements consisted of magnesia and ammonium phosphates, which react rapidly, but produce ammonia gas during mixing and after setting (Yue and Bing 2013, Ding et al 2014). MALP was initially developed for patching concrete industrial floors but has recently found use as a repair material for transportation structures (Fournier 2014). This material can be used for repair of horizontal, vertical, and overhead surfaces with a rapid strength gain that brings the structure to service faster. Once the MALP is cast, it expands and creates an excellent bond with the substrate and provides very low permeability for chloride ions. It also stops the corrosion of steel reinforcement by converting the iron oxide to metal phosphate which coats the reinforcement and prevents further corrosion (Concrete repair products 2020). Limited research has been conducted specifically on MALP concrete.

*Proposed Research:*

This project should address the corrosion performance of conventional reinforcing steel in uncracked and cracked MALP concrete in simulated repairs of Portland cement concrete of both high and low quality. Reinforcing bars will be evaluated in both a clean and passive state and in an actively corroding state. The project will also evaluate the ability of MALP concrete to withstand freeze-thaw cycles both as an individual material and in conjunction with Portland cement concrete, and the ability of MALP concrete to provide minimum crack widths at the boundaries of a repair.

*Suggested Tasks:*

The work to be performed includes, but is not limited to the following:

1. Perform literature search

2. Evaluate corrosion performance of uncorroded and corroded reinforcing steel in uncracked and cracked concrete, including bars that extend from sound existing concrete into MALP repair concrete. Consider use of MALP repair concrete in conjunction with both high quality and low quality Portland cement concrete.

3. Evaluate the freeze-thaw performance of MALP concrete individually and in conjunction with Portland cement concrete.

4. Measure shrinkage properties and ability of MALP concrete to minimize crack widths internally and adjacent to sound concrete at a repair site.

5. Prepare research deliverables

*Benefits:*

If the evaluation tests indicate that MALP concrete is an effective repair material, the primary benefits will be a reduction in labor, leading to a reduction in cost for repairs, and minimum periods required for repair operations and, thus, time out of service, greatly improving safety during repairs for both the repair personnel and the traveling public while minimizing traffic disruption.

*Deliverables:*

All projects require the submission of the following reports:

* Monthly Progress Reports
* Multi-Year Projects require a Year-End Annual Report
* Copies of the project Draft Final Report in Microsoft Word and ADA accessible Adobe Acrobat pdf electronic formats
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The Year-End Annual Report, Draft Final Report, and Final Report should be submitted to satisfy all federal and state requirements pertaining to the accessibility of documents including but not limited to:

* Oklahoma State Statute 62 § 41.5e and the Americans with Disability Act (ADA) of 1990, 42 USC 12.01 et seq.

The PI must also participate in the following project meetings:

* New project initiation meeting
* Semi-annual project meeting
* Close-out project meeting
* Continuing project meeting

*Existing Research Found in Separate attached file:*

