2019 UDOT RESEARCH PROBLEM STATEMENT

**** Problem statement deadline is Feb. 6, 2019. Submit statements to UTRAC@utah.gov. ****

Title: Chloride Ion Ingress in Concrete Bridge Decks Containing Lightweight Aggregate **No. (Office Use):** 19.04.07

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Select ONE Subject Area ☐ Materials/Pavements ☐ Maintenance ☐ Traffic Mgmt/Safety ☒ Structures/Geotech ☐ Planning ☐ Perf Mgmt/Data Analytics ☐ Public Transportation ☐ Other

1. Describe the problem to be addressed:

While the use of lightweight aggregate in concrete bridge decks has obvious benefits in terms of weight reduction and internal curing, for example, previous research on bridge decks in northern Utah has documented accelerated chloride ion ingress in decks with lightweight aggregate compared to decks without lightweight aggregate (in the absence of surface treatments). On decks without lightweight aggregate, diffusion typically governs chloride ion ingress; deicing salts dissolve in water on the deck surface to create a solution and then gradually migrate from that solution into the pore water within the concrete, with the diffusion process being primarily governed by the chloride concentration gradient. However, on decks with lightweight aggregate, the possibility exists for the solution on the deck surface to be absorbed by the aggregates in the concrete and transported by convection deeper into the deck; this process is primarily governed by moisture content gradients. Thus, decks with lightweight aggregate may be subject to chloride ion ingress through both diffusion and absorption mechanisms, with the absorption mechanism being active with each wet-dry cycle that occurs at the deck surface (lightweight aggregate has an absorption value that can be approximately 10 times greater than that of a conventional aggregate). Accelerated chloride ion ingress would then potentially lead to reduced service life of the affected decks through premature chloride-induced corrosion of the reinforcing steel within the decks.

2. Write the project objective (25 words or less):

Investigate the influence of lightweight aggregate on chloride ion ingress in concrete mixtures subject to chloride exposure through constant surface wetting or wet-dry cycling.

3. Explain why this research is important:
(In response, consider addressing specific UDOT goals, applicability in Utah or other states, etc.)

Because of the frequent use of lightweight concrete in construction of bridge decks in northern Utah and the adverse effect of chloride ion ingress on bridge deck service life, understanding the influence of lightweight aggregate on the rate of chloride ion ingress in concrete mixtures is critical for optimizing bridge deck management and thereby maximizing deck service life while minimizing life-cycle costs. This research applies broadly to all regions of the developed world in which lightweight concrete is used for concrete bridge deck construction. Specific to UDOT, it applies to the goal of preserving infrastructure.

4. List the major tasks:

1. Perform a comprehensive literature review on the subject of chloride ion ingress in lightweight concrete.
2. Design and execute a laboratory experiment in which specimens representing standard UDOT concrete mixture designs (with and without lightweight aggregate) and typical bridge deck thicknesses would be subjected to chloride exposure through constant surface wetting or wet-dry cycling and then afterwards be tested for chloride concentration with depth.
3. Design and execute a field experiment in which chloride concentration profiles of bridge decks constructed with lightweight concrete would be compared to those of bridge decks constructed without lightweight aggregate.
4. Prepare and deliver a written report and a presentation documenting the findings.

5. List the expected deliverables (reports, manual, specification, design method, training, etc.):

1. Written research report
2. Oral presentation

6. Describe how the research results will be implemented:
(In response, consider addressing UDOT leader support, process or standard improvement, etc.)

Depending on the outcome of the research, specifications requiring the placement of surface treatments, densifiers, or other products on lightweight concrete bridge decks, to seal them against chloride ion ingress, may be implemented. Alternatively, adjustments to concrete mixture designs may be proposed to minimize the effects of the absorption mechanism. Finally, performance expectations may be more accurately characterized for the bridge deck management process.

7. Requested from UDOT: $40,000 **Other/Matching Funds:** $TBD **Total Cost:** $
(or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates:

1. Literature review, including collection of typical UDOT concrete bridge deck mixture designs: 2 months
2. Laboratory experimentation: 10 months
3. Field experimentation, including identification of candidate bridge decks: 3 months
4. Preparation of deliverables: 3 months