

SPR RESEARCH PROGRAM

SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

27-39: Practical Concrete Mixtures Containing Blended Cements

PROBLEM SUMMARY

A popular alternative to ordinary Portland cement is blended cement, which employ materials such as limestone, fly ash, silica fume, and others to reduce the amount of Portland cement used to make concrete mix. One specific type of blended cement is Portland limestone cement, and it has been approved for use by nearly all fifty U.S. states over the last three years for the construction of infrastructure projects. The feasibility of several other types of blended cement for use in transportation infrastructure remains to be determined, including Portland pozzolan cements which employ pozzolans, a siliceous/aluminous material found relatively abundantly in Oregon. This research proposes to study the performance of blended cements and identify materials that can be deployed for use in infrastructure projects in the near future.

ODOT OBJECTIVES

The objective of this research is to understand the mechanical and durability characteristics of blended cements in infrastructure project applications such as bridge decks, continuously reinforced concrete pavements, and structural components. Once these properties are well understood, the research team will identify tests and evaluation procedures for QA/QC control of concrete mixes that employ blended cement.

BENEFITS

Blended cements have the potential to reduce the carbon footprint of infrastructure projects while maintaining the same service life as traditional concrete mix. Furthermore, blended cements have the potential to use materials sourced within the state in infrastructure projects. At the end of this research, certain materials will have been demonstrated to be direct replacements of ordinary Portland cement thus incentivizing the private sector to invest in equipment to extract and process supplementary cementitious materials sourced within the state.

SCHEDULE, BUDGET AND AGENCY SUPPORT

Estimated Project Length: 36 months.

Estimated Project Budget: \$400,000

ODOT Support:

David Dobson – Structural Materials Engineer – David.Dobson@odot.oregon.gov (970) 900 - 7118

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:

<https://www.oregon.gov/odot/Programs/ResearchDocuments/27-39.pdf>

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2027

PROBLEM NUMBER AND TITLE

27-39: Practical Concrete Mixtures Containing Blended Cements (ASTM C595)

RESEARCH PROBLEM STATEMENT

Blended cements (ASTM C595) are becoming increasingly popular for use in concrete rising to over 2/3 of the cement used in the US. These cements are being used to reduce clinker content and greenhouse gas emissions. Blended cements have the advantage that they enable use at facilities with limited silo capacity, which is common at concrete production facilities throughout Oregon. This research will examine concrete made using these new blended cements. This research will examine the mechanical and durability properties comparing them with more conventional ASTM C150 cements where ODOT has longer experience. The work will also work to quantify the variability that may be expected with these mixtures due to process variations to determine if the approaches are similar to more conventional mixtures or if changes are needed for process control or curing specifications. ASTM C-595 is currently changing rapidly with new blends being proposed and this work will help monitor the impacts of these changes for ODOT. Further, there is a gap between these specifications and the use of these materials in concrete. This work is being done to help ODOT be in a strong position to ensure when these materials are used on ODOT projects the level of performance that is needed is achieved, specifically as it relates to material variation. As needed, ODOT's specifications will be updated to consider these blended cements in concrete.

RESEARCH OBJECTIVES

The goal of this research is to evaluate the use of blended cements in concrete to support the implementation of blended cementitious systems by ODOT. The work is intended to aid ODOT by better understanding the performance requirements of concrete made using blended cements to reduce greenhouse gas emissions. Specific attention will be paid to ODOT specification requirements, process variations, and curing requirements.

To meet the goal above the following objectives are envisioned:

- 1 – Identify and quantify sources of the blended cements that can be used to produce concrete locally that meet the projected needs for ODOT's concrete transportation infrastructure. This is especially important for ODOT as many of the clinkers used in cements are imported and ground locally. This work will examine the potential for intergrinding and blending locally and what the impacts of constituent variation may have on concrete performance.
- 2 – Work with producers to examine the potential impact on concrete property requirements, curing specifications, and process control procedures.
- 3- Develop guidelines for ODOT inspectors and engineers to deal with these blended cements. This may take the role of a workshop that can be done in conjunction with a group like OCAPA.

WORK TASKS, COST ESTIMATE AND DURATION

Work Tasks:

1. Work with ODOT to project the type (general category – pavement, structural, bridge deck) and quantity of concrete materials projected to be needed on a 5-, 10- and 25- year horizon.
2. Identify and quantify potential blended cements – Work directly with known suppliers and identify potentially new sources of blended cement. Determine which ready mix concrete suppliers that have an interest in making concrete using blended systems already under production and available to the Oregon market.
3. From available materials and suppliers obtain representative samples of materials, both blended, and individual components for laboratory investigations.
4. Optimize the mixture for performance for concrete including fresh properties (workability, setting time, air content) and hardened properties (early and later-age strength gain), durability (e.g. volume change/cracking risk, transport properties, critical chloride threshold).
 - a. The aggregate will also be optimized for gradation, workability, and economy using up to 3 representative sources of natural and/or manufactured sources.
5. In conjunction with ODOT project champions, and relevant ODOT engineers and designers, develop specification language, if needed, for the incorporation of blended cementitious materials into ODOT projects.
6. Produce a final comprehensive report that includes documentation of Work Tasks 1-4, Draft Specification Language, and a roadmap for implementation and further needs.

Key Deliverables: Mechanical and durability properties of blended cement concrete mixes for infrastructure construction applications.

Estimated Project Length: 36 months.

Estimated Project Budget: \$400,000

EXPECTED ODOT IMPLEMENTATION ACTIONS

Once the findings of this research are available, ODOT will develop material specifications permitting the use of blended cements beyond Portland limestone cement. These specifications will include recommendations for QA/QC procedures to ensure adequate material mixing, placement, and curing. ODOT will also develop implementation guidance and training materials to facilitate the adoption of blended cements by the infrastructure construction industry.

POTENTIAL BENEFITS

Blended cementitious materials will be increasingly used to make concrete that is designed to provide ODOT with desired service life. This research will examine the mechanical and durability properties of concrete made with these materials. This research will identify most likely local materials that can be used, will assess the fresh and hardened characteristics of these systems, and will propose needed changes to ODOT specifications for these new materials. This work will examine how curing conditions, design targets, and process control approaches need to be updated for ODOT to ensure the satisfactory use of these blended systems in providing the required service life. Further this will help ODOT reach its carbon reduction goals, constructability, and performance

goals.

PEOPLE

ODOT champion(s):

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Problem Statement Contributors:

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REFERENCES

None

STAFF REVIEW PAGE

LITERATURE CHECK

TRID&RIP

A review of TRID & RIP databases found no existing research that answers the research question

ODOT DECISION LENSES

Climate: Portland limestone cement (a type of blended cement) has gained tremendous popularity across the country because of its demonstrated potential to reduce the amount of ordinary Portland cement needed by cement mixes. The reduction in the amount of Portland cement needed has a direct impact in the carbon footprint of infrastructure construction since the production of Portland cement is very carbon intensive. Similarly, the use of materials sourced locally to replace Portland cement has significant potential to even further reduce the carbon footprint of infrastructure construction given the reduced travel distances required for this supplementary material.

Equity: This research is not focused on equity.

Safety: While this research is focused on reducing the carbon footprint of traditional concrete mix, the material characteristics and evaluation methods developed during this research have the potential to improve the safety of infrastructure materials by providing current and accurate characterization of these blended materials. This information is useful in establishing reliable service life expected of these materials that are new to Oregon.

TECHNOLOGY & DATA ASSESSMENT

No Identified T&D output

At the end of this project, the implementing unit(s) within ODOT will need to coordinate the adoption of new technology or data in order to realize the full potential of this research.

CROSS-AGENCY IMPACTS

- List ODOT partners or impacted units.
 - Pavement Services Unit
 - Structural Services Unit

- Identify any issues of concern raised by an ODOT partners. Note expected mitigation that addresses these concerns.
 - None