

IGEM Grant Report

☐ Progress (due January 1) ☒ Annual (due July 31) ☐ Final (due August 31)

IGEM Grant # 26-005 Principal Investigator Mustafa Mashal
Name/Full Title of Project A sustainable AI powered Low-Carbon Emission Concrete (SCALE Concrete): Leveraging Agricultural Byproducts and Wastewater for Circular Economy Solutions

Submission Date 7/18/2026

Primary Institution Idaho State University

Instructions: Complete each section of this report directly on this template. Completed reports must be limited to 1 page for Progress Reports and 2 pages for Annual or Final Reports in 12 pt Arial or similar font, excluding the expenditure report. Simple and concise answers will be appreciated, and even bullet lists of information will be sufficient. Reports that do not follow these requirements will be returned for revision. Submit reports by the appropriate due date to HERC@edu.idaho.gov.

Section 1: Project and its goals

The project evaluates Idaho's sugar beet-derived precipitated calcium carbonate (PCC) as a partial cement replacement in concrete. Idaho State University is investigating its effects on key mechanical, durability, and material properties to assess its suitability for infrastructure applications. The goal is to develop practical concrete mixture guidelines that reduce cement consumption while beneficially reusing a locally generated industrial byproduct, addressing both environmental security and PCC storage challenges.

Section 2: Summary of accomplishments and future plans

During the current reporting period, the project made significant progress through expanded laboratory testing, pilot-scale demonstrations, and industry collaboration. Testing evaluated compressive and tensile strength, elevated-temperature performance, microstructural characteristics, and material properties, including penetration, specific gravity, fineness, and sieve analysis.

The project advanced beyond laboratory research through demonstration projects, including PCC-based pavers, benches, a concrete table, decorative flower pots, and the Kloepper Asphalt Wash Pad Project, which incorporated PCC in a full-scale concrete application. These accomplishments place the project ahead of its planned Year 1 objectives and provide a strong foundation for future optimization, field validation, and commercialization.

Laboratory work transitioned to field implementation with the successful installation of PCC pavers at the Engineering Research Complex (ERC) and continued progress on the Kloepper wash pad project. Ongoing activities include long-term strength and shrinkage monitoring, Blaine fineness and Vicat testing, ASTM C1797 preparation, and additional material characterization. Together, these efforts continue to generate valuable technical data while supporting industry outreach and technology transfer.

Section 3: Summary of budget expenditures

Project expenditures remain on schedule and consistent with the planned budget. Funding has supported personnel, laboratory testing, materials, equipment, student researchers, and the construction of demonstration projects. Remaining funds are allocated to ongoing laboratory testing, long-term performance monitoring, field evaluations, and completion of demonstration projects during the next reporting period. No significant budget concerns are anticipated.

Section 4: Economic development/impact

The project continues to generate significant economic and industry impact through technology development, workforce training, and stakeholder engagement. A non-provisional patent application is pending, demonstrating the commercialization potential of the technology. Idaho State University has hired a full-time staff member to support project activities, expanding research capacity while contributing to workforce development. Industry engagement has grown to include six active partners participating in pilot projects and technology evaluations, with non-disclosure agreements executed to facilitate collaboration and technology transfer.

Industry awareness has also increased through several demonstration projects, including the Engineering Research Complex PCC paver installation, the Kloepper Asphalt Wash Pad Project, and PCC-based benches, tables, and flower pots. These projects demonstrate practical applications of PCC in hardscape, precast, ready-mix, and site-cast concrete, helping accelerate the transition from laboratory research to commercial implementation. By transforming sugar beet-derived PCC into a value-added construction material, the project supports Idaho's economy through beneficial reuse of a local industrial byproduct while reducing cement consumption and environmental impacts. The project also provides hands-on training for students in sustainable concrete technologies. To support continued development, a proposal was submitted to the Federal Highway Administration for additional funding. Collectively, these efforts position the technology for future commercialization, broader industry adoption, and long-term economic and environmental benefits for Idaho.

Section 5: Participants

The project team consists of nine faculty and staff members and twelve student researchers, with students performing most of the hands-on research under faculty supervision. Student activities include concrete batching, specimen fabrication, mechanical and durability testing, shrinkage monitoring, material characterization, data analysis, and technical reporting.

Students have also contributed to demonstration projects, including paver installations and precast products, while supporting the project's artificial intelligence/machine learning efforts to analyze data and optimize PCC replacement levels. These activities provide comprehensive training in concrete materials, field implementation, and data-driven engineering.

Section 6: Long-term sustainability plan

The project is progressing toward pilot-scale implementation of PCC-based concrete in Idaho through collaboration with Idaho State University, local industry partners, and the Idaho Transportation Department (ITD). Future work will focus on long-term field monitoring, expanded use of PCC and other industrial byproducts, AI/ML-assisted mixture optimization, and securing additional external funding for larger-scale implementation.

The next phase will build on the successful Year 1 results by developing practical engineering guidance supported by field performance data from the ERC paver installation and the Kloepper wash pad. Continued laboratory testing, demonstration projects, and outreach activities will support technology transfer and industry adoption.

The project has also expanded to evaluate complementary industrial byproducts, including Amalgamated Sugar wastewater, creating a pathway for SCALE Concrete to evolve into a broader circular-economy concrete platform that supports future funding, commercialization, and large-scale implementation.

Section 7: Expenditure Report (Attached). Please note that the reported \$17,884.87 overage was attributable to additional labor costs incurred during the pilot project. Sufficient funds were available from other sources to cover this overage, and no funding shortfall resulted.



Summary by Hierarchy - Current Year

(Data as of 07-13-2026 05:29:43 AM)

Period Jun-2026 (Open) | By Acct | Budget Annual Adjusted Budget | Chart = 9 | Fund = 110000 ISU General Clearing | Orgn = 630054 IGEN SCALE Concrete | Acct <> 8951 Administrative Recovery Assessment | Prog = 04ORO Organized Research on Campus

Acct	Title	Annual Budget	Jun-2026 YTD Actual	Encumbrances	Budget Available	Budget Fav/Unfav
Operating Expenses						
610	Salaries	-65,761.00	47,973.17	603.08	17,184.75	26.1%F
620	Irregular Help	-56,433.00	91,869.65	3,174.10	-38,610.75	68.4%U
630	Fringe Benefits	-18,902.00	19,822.44	508.87	-1,429.31	7.6%U
	Subtotal	-141,096.00	159,665.26	4,286.05	-22,855.31	0%U
	Total Expenses	-141,096.00	159,665.26	4,286.05	-22,855.31	0%U
Operating Expenses						
700	Travel	-3,000.00	2,175.94	0.00	824.06	27.5%F
720	Services	-8,720.00	9,702.84	0.00	-982.84	11.3%U
730	Supplies	-12,227.00	7,158.11	0.00	5,068.89	41.5%F
740	Rentals and Operating Leases	-450.00	450.00	0.00	0.00	
780	Miscellaneous Expenditures	0.00	23.51	0.00	-23.51	U
800	Capital Expense	-4,632.00	4,632.16	0.00	-0.16	U
870	Educational and Training Assistance	-3,636.00	3,552.00	0.00	84.00	2.3%F
	Subtotal	-32,665.00	27,694.56	0.00	4,970.44	0%F
	Total Expenses	-32,665.00	27,694.56	0.00	4,970.44	0%F
	Total All Expenses	-173,761.00	187,359.82	4,286.05	-17,884.87	0%U
	Total Revenues Less Expenses and Transfers	173,761.00	-187,359.82	-4,286.05	-17,884.87	0%U