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# Biomanufacturing of High-Strength Concrete: Incorporation of Hemp Fiber to Improve High-Temperature Performance

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# DATA MANAGEMENT PLAN

***Expected Data Type***

The expected data from the proposed research will include the following: (a) meta and experimental data from the thermal, mechanical, and macrostructural (material) property characterization tests at room and high temperature; (b) cleaned and processed test data along with derived graphs, tables, and plots generated using Microsoft Excel and MATLAB; (c) images and video of test specimens and hemp fibers collected via camera, optical and scanning electron microscopy; (d) algorithms for regression, optimization, and experimental design using MATLAB, Python, and/or other software; (e) samples of hemp stalks and fibers, mortar, and concrete.

***Data Format***

Data collected through the course of the study will be made available after a reasonable length of time to afford the investigators an opportunity to first publish the results in conference and journal papers. Images of hemp plants and concrete test specimens will be collected as JPEG or JPG image files or other similar file types, as appropriate. Data from the material characterization tests at room temperature and high temperature will be stored as numeric, tabular data in Excel/CSV (or similar). Processed data, experimental details (including date of test, person conducting the test, equipment used, run time, etc.), and related documents will be stored using Microsoft Excel, Word, PowerPoint, and pdf.

***Data Storage and Preservation***

100% of the data will be stored across a variety of cloud and hardware-based storage systems to avoid data loss or damage. The raw and meta data collected from tests and source imaging will be stored on the local computer and external hard drives and will be backed up within 24 hours of initial collection/creation using Utah State University (USU) and University of South Florida (USF)'s cloud storage capacity. Processed data and images, derived plots, and codes will also be backed up weekly during the project's period of performance. Test specimens and samples will be stored at both USU and USF for a reasonable period after publishing and sharing results. Some representative specimens will be kept for perpetuity for outreach and educational purposes. All Co-PDs plan to use a password-protected and encrypted USU Box cloud-based unlimited storage system for file sharing and management.

USU, through the Merrill-Cazier Library, provides institutional repository services through the bepress Digital Commons platform. DigitalCommons@USU supports all file types and formats. For long-term preservation, efforts will be made to archive the final data generated from this project in the DigitalCommons@USU repository at no additional charge. Readme files providing necessary details will be stored with these data to facilitate long-term discovery. All files in the repository are backed up at multiple sites, including cloud storage. Preservation copies are stored in Amazon Web Services, with redundant storage across multiple facilities and are regularly verified for integrity of data using checksums.

***Data Sharing, Protection, and Public Access***

<u>During the grant:</u> The results of the project will be shared through research publications and public presentations. Collaborators will have access to the data files via sharing through cloud services

described above. Data will be shared through cloud-based systems or email with interested parties as appropriate.

After the grant: Policies for access and re-use of the data will follow the USU and USF policies. Results of the project will be shared through publications and presentations. Access to research data will be available to the public as supplementary material along with the publication. Any raw image files, scripts or code developed using non-proprietary software will be made available upon request by interested parties. Users will be granted rights to reuse the data provided that attribution to the PIs and USDA NIFA is acknowledged. It will be requested that data not be re-distributed in whole by other agencies, but rather appropriate reference to the project be given. Distribution of derivative works will be permitted.

***Roles, Responsibilities, and Reporting***

Data management will be the shared responsibility of PDs Banerji, Bugbee, and Haber, and students funded by the project. PD Banerji and her group will be responsible for managing data related to fiber-reinforced concrete mix designs, property tests at room and high temperatures. Co-PD Haber and his group will be responsible for managing data generated from concrete tests at ambient conditions and sustainability analyses. Co-PD Bugbee and his team will be responsible for managing data related to the hemp plant and fibers. PD Banerji will be responsible for monitoring compliance with this data management plan and transferring the data and responsibilities to new personnel if/when needed. Data collection, storage, sharing and preservation will be monitored by key-personnel of the project team. Reports on data handling will be part of yearly NIFA Reports, including the progress in data sharing through publications.