

Grant Proposal – Charles Pankow Foundation

28 April 2025

Title

Embodied Carbon Reduction Through Review of Current Code Provision

Objectives

The objective of this proposal is to identify and prioritize provisions in current Codes and Standards which if appropriately modified will result in a substantial reduction in embodied carbon.

CPF Mission

This proposal is directly aligned with the Charles Pankow Foundation's mission of supporting Better Ways to Design and Build along with CPF's initiatives regarding Embodied Carbon Reduction.

Industry Need

Justification

Climate change fueled by global warming is one of the greatest challenges ever faced by humankind. Reduction in the emission of greenhouse gases is essential if positive progress is to be made. Embodied carbon attributed to the construction of buildings and infrastructure is a primary contributor to global emissions.

Guiding civil and structural engineering practice are many Codes and Standards including ASCE-7, ACI 318, and the AISC Specification. Included in these Codes and Standards are a broad and comprehensive set of prescriptive provisions that inform design. These prescriptive provisions are used in the vast majority of designs for new buildings. Reviewing these Codes and Standards with an eye toward embodied carbon reduction is an important and critical step. Clear, targeted action is required if substantial reductions in embodied are to be achieved.

Examples

An example of a set of provisions that could be reconsidered is the ASCE-7 Live Load Table. The requirements in this table drive fundamental design requirements, directly resulting in the amount of embodied carbon in building structures. Appropriately reducing some of the values contained in this table will directly and immediately result in less embodied carbon.

As a proof-of-concept, recent research by Corotis et.al. resulted in a successful Code Change Proposal reducing the required live load in office gathering spaces from 100 psf to 50 psf. This change has a direct and immediate impact in reducing the amount of material required and the associated embodied carbon.

Other provisions such as the fundamental target reliabilities which form the basis of ASCE-7 and required load combinations could also be reconsidered in the context of modern design and construction practices in an effort to reduce embodied carbon.

Another example includes the prescriptive provision in ACI 318 requiring concrete mix designs to target $1.1f'_c + 700$ psi when sufficient test data is not available. This requirement can drive the amount of cement included in the mix and thus the embodied carbon impact.

Proposed Research

Phase 1 Research

There are many on-going volunteer efforts targeting embodied carbon reduction attempting to inspire and improve current design and construction practice. One of these efforts is the American Society of Civil Engineers Structural Engineering Institute's SE 2050 Committee and the SE 2050 Commitment Program. The mission of the SE 2050 Commitment Program is to transform structural engineering practices in order to reduce embodied carbon and achieve net zero embodied carbon structural systems by 2050. These volunteer efforts alone however will not be adequate.

While there is growing research on embodied carbon, these efforts have focused on material selection and design (e.g., alternate concretes that are less carbon intensive) and structural

optimization. There has not been a systemic effort to reexamine some of the fundamental engineering design requirements to identify the potential for embodied carbon reduction.

A funded research initiative is needed to review Codes and Standards driving civil and structural engineering practice to identify and prioritize provisions and recommendations that could be reconsidered seeking to reduce embodied carbon without compromising safety. Phase 1 will begin by developing a lengthy list of provisions that may be candidates for further study. This list will be shortened and ranked by collecting evidence from past studies and design projects that demonstrate these provisions have potential for embodied carbon reduction. Phase 1 will also provide a list of key questions to be addressed in future research needs. The results of this effort will identify and prioritize research needs and motivate future Code Change Proposals.

The final work product of this research will be a report detailing recommendations for Code provisions to be reconsidered, a prioritization of these provisions based on anticipated impact, and suggestions to guide the reconsideration of these provisions.

Interim progress reports will be provided quarterly for distribution to all supporting organizations.

The final report will be published as a University of Colorado Boulder Research Report and will be free of charge. The Charles Pankow Foundation will make the report available via the CPF website and the report will be distributed to all supporting organizations for consideration of future Code Change Proposals.

Phase 2

Phase 2 of the work will include any necessary and unique research focused on the reconsideration of specific Code provisions. Subject Matter Experts will be invited to submit Research Need Statements to the Charles Pankow Foundation for consideration and funding. The Charles Pankow Foundation will organize funding coalitions to support the research. Each Grant request will be considered individually for merit and support.

The outcome of Phase 2 will be specific Code Change Proposals supported by appropriate research.

The Phase 2 Schedule will be driven by individual Code cycles, aiming to include revised provisions in the next edition of each Code.

Dissemination Plan

The final report will be made available by the Charles Pankow Foundation and will be distributed to all supporting organizations as well as the civil and structural engineering profession as a whole.

Principal Investigator

Research Team

The Phase 1 Research Team will include invited subject matter experts comprised of practitioners and researchers.

The Phase 1 Research Team will be led by:

Dr. Abbie Liel, PE
Clark Endowed Faculty Fellow
University of Colorado Boulder

Ian McFarlane, PE, SE
Senior Principal
Magnusson Klemencic Associates

Additional Team Members will include:

Dr. Ross Corotis, CU Boulder
Mike Gryniuk, Cora Structural
Jim Harris, J.R. Harris & Company
Shana Kelley, KPFF Consulting Engineers
Dirk Kestner, Walter P. Moore

Additional Team Members as suggested by SEI, AISC, and ACI will also be included.

Assisting the Phase 1 Research Team will be:

Jerome F. Hajjar, Ph.D., PE, NAE, DM. SSR, F.ASCE, F.SEI
CDM Smith Professor, University Distinguished Professor, and Department Chair
Northeastern University

Ron Klemencic, PE, SE, Hon. AIA, Dist. M. ASCE, NAC, NAE
Chairman and CEO
Magnusson Klemencic Associates, Inc.

An Advisory Panel made up of representatives recommended by the co-funding organizations will also be engaged and afforded the opportunity to review and comment on the quarterly reports and final report.

Industry Support

Broad Industry Support exists with formal funding commitments from:

AISC
Magnusson Klemencic Associates Foundation
National Council of Structural Engineering Associations

With pending commitments from:

ACI
ASCE
ClimateWorks

Proposed Timing

It is intended to announce the launch of the Phase 1 effort during the SEI Conference: Toward Zero Carbon 2025: Summit & Symposium
June 26 – 27, 2025
Boulder Colorado.

The Phase1 report will be complete within one year (June 2026). The report will be made publicly available.

Funding Request

Phase 1

Phase 1 funding is to provide stipends to each of the Team members for their work and to offset any travel expenses for in-person meetings.

Total funding = \$250,000

Amount requested from CPF = \$50,000

Current funding commitments are in place from:

Magnusson Klemencic Foundation = \$25,000
American Institute of Steel Construction = \$25,000
National Council of Structural Engineering Associations = \$25,000

Funding is pending from:

American Concrete Institute = \$25,000

ASCE = \$25,000
Climate Works = \$100,000

Phase 2

An estimate of funding requirements for Phase 2 is a range from \$2,000,000 to \$5,000,000. Phase 2 research proposals and funding coalitions will be identified in the future as specific research topics are identified.

Contract Information

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Related Work

Towards Zero Carbon: Developing a Roadmap for the Structural Engineering Profession and the Structural Engineering Institute, ASCE. Final Report of the Workshop Held July 22 – 24, 2024, Northeastern University. June 2025.

ASCE 7-22 Structural Reliability Guidance Document: Principles and Methods. Prepared by ASC 7-22 Load Combinations Subcommittee. April 2025.

ACI 318 Appendix C

