

# Low-Carbon Concrete— Code Requirements and Commentary

Reported by ACI Committee 323

ACI CODE-323-24



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## **Low-Carbon Concrete—Code Requirements and Commentary**

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# Low-Carbon Concrete—Code Requirements and Commentary

An ACI Standard

Reported by ACI Committee 323

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*“Low-Carbon Concrete—Code Requirements and Commentary” (“Code”) provides provisions for concrete where reduced global warming potential (GWP) is required. The Code was developed by a consensus process and addresses cast-in-place concrete with specified compressive strength greater than 2500 psi and less than or equal to 8000 psi. Precast concrete, tremie concrete, auger-cast concrete/grout, shotcrete, pavers, and masonry units are not included in the scope of the Code. This is the first edition of the Code and the scope is limited by the available benchmark data. Future editions of the Code will be broader in scope as data beyond strength benchmarks and for other types of concrete becomes available.*

*The Code may be adopted as a stand-alone code or can be used in combination with a structural design code or low-carbon material code adopted by an authority having jurisdiction. The Code is in a format that allows reference to a set of chapters based on the structure type. Adoption would include all of Chapters 1 to 4, the applicable Chapter(s) of 5, 6, 7, and/or 8, plus Appendix A. This Code is written in a format that allows reference without change to its language. Therefore, background details or suggestions for carrying out the requirements or intent of the Code provisions cannot be included with the Code itself. The Commentary is provided for this purpose.*

*Some considerations of the committee in developing the Code are discussed in the Commentary along with references for the user desiring to study individual questions in greater detail.*

**Keywords:** baseline; benchmark; bridge; building; compressive strength; concrete; cradle-to-gate; environmental product declaration (EPD); environment; global warming potential (GWP); hardscape; life cycle assessment (LCA); low-carbon concrete (LCC); low-embodied carbon concrete; pavement; performance requirement; residential; sustainability; sustainable; structure.

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## CODE

## CHAPTER 1—GENERAL

**1.1—Scope of ACI CODE-323**

**1.1.1** This Code shall apply to cast-in-place concrete structures as:

1. A reference in a building or structural design code.
2. A reference in a design and construction standard, rule, or regulation.
3. A reference in a sustainable construction code.
4. A reference in a code, standard, rule, or regulation governing the global warming potential (GWP) of materials.
5. A reference in construction documents, or
6. A stand-alone code governing the GWP of concrete.

**1.1.2** The provisions of this Code shall be in addition to those of the governing building or structural design code, standard, rule, or regulation.

**1.1.3** The provisions of this Code shall not be deemed to supersede any provisions of local, state, or federal law.

**1.2—General**

**1.2.1** ACI CODE-323, “Low-Carbon Concrete—Code Requirements and Commentary,” is hereafter referred to as “this Code.”

**1.2.2** The official version of this Code is the English language version, using inch-pound units, published by the American Concrete Institute, except for GWP values expressed as kg CO<sub>2</sub>e.

**1.3—Purpose**

**1.3.1** The purpose of this Code is to provide requirements for limiting the maximum GWP of concrete on a project.

**1.3.2** This Code does not provide for public health, safety, and general welfare.

## COMMENTARY

## CHAPTER R1—GENERAL

**R1.1—Scope of ACI CODE-323**

**R1.1.1** The Code includes provisions for low-carbon structural concrete governed by a building code, bridge code, or other infrastructure code that governs the use of concrete. Throughout the Code, the term “structure” means a building, non-building structure, member, system, or element, if the construction includes concrete. Pavements are considered structures for purposes of the Code.

Chapters 1 through 4 of the Code apply to all structure types. Chapters 5 through 8 of the Code include requirements by structure type.

Refer to **Chapter 2** for definitions of global warming potential (GWP), structural concrete, and low-carbon concrete.

**R1.1.2** The Code is used in addition to building or structural design code requirements.

The regional nature of concrete as a material requires that data used for benchmarking also be regional. The requirements of the Code permit the use of values collected for eight regions of the contiguous United States and published in *Appendix C: NRMCA Member National and Regional LCA Benchmark (Industry Average) Report – V 3.2* (Athena Sustainable Materials Institute 2022).

The overall concept of the Code can be followed with the use of locally developed benchmark values within or outside of the United States.

**R1.2—General**

**R1.2.2** GWP values in the Code are provided in kg CO<sub>2</sub>e (kilograms carbon dioxide equivalents) per yd<sup>3</sup>. Kilograms are the worldwide accepted units for CO<sub>2</sub>e emissions and are the traditional unit used in EPDs and LCAs. For this reason, they are maintained in this inch-pound unit version of the Code. Benchmark data referenced in the Code also use kg CO<sub>2</sub>e for GWP.

**R1.3—Purpose**

**R1.3.1** The Code is intended to provide additional requirements to a building or structural design code. The licensed design professional (refer to Chapter 2 for definition) may specify project requirements that exceed the minimum requirements of the Code.

**R1.3.2** While the immediate concerns of public health and safety provided by a building or structural design code are not the intent of the Code, the reduction of greenhouse gas

## CODE

## COMMENTARY

**1.3.3** This Code does not address strength, stability, serviceability, durability, and integrity of concrete structures. This Code shall not supersede specified requirements for strength, stability, serviceability, durability, or integrity of the concrete structure.

**1.3.4** This Code does not address construction means and methods.

#### 1.4—Applicability

**1.4.1** This Code shall apply where reduced GWP is required for concrete structures.

**1.4.2** Provisions of this Code shall be permitted to be used for repair, alterations, and additions to existing structures.

**1.4.3** This Code shall not apply to precast concrete, tremie concrete, auger-cast concrete/grout, shotcrete, pavers, masonry units, or concrete with specified compressive strength less than or equal to 2500 psi or greater than 8000 psi.

**1.4.4** The authority having jurisdiction or entity adopting this Code shall be permitted to limit or exclude GWP requirements of the Code if it determines the requirements in Chapters 5 through 8 are not feasible for a project.

**1.4.5** The licensed design professional shall be permitted to specify more stringent requirements than those provided in this Code.

#### 1.5—Administration

**1.5.1** Where referenced in a code adopted by the authority having jurisdiction, the provisions of this Code shall not

emissions contributes to the long-term health of the planet and the health of its occupants.

**R1.3.3** In many cases, concrete mixtures that are proportioned for performance may result in a reduction in the concrete's GWP. Collaboration between the parties involved can often aid in the development of a lower GWP solution that meets or exceeds all other performance requirements.

#### R1.4—Applicability

**R1.4.1** The Code provides minimum requirements to reduce greenhouse gas emissions from manufacturing concrete mixtures. The user is encouraged to exceed the minimum requirements to further reduce greenhouse gas emissions from concrete mixtures as well as to examine methods to reduce emissions in other aspects of the life cycle of a structure.

**R1.4.2** Specific provisions for assessment, repair, and rehabilitation of existing concrete structures are provided in **ACI CODE-562**. Existing structures in ACI CODE-562 are defined as structures that are complete and permitted for use.

When a structure can be reused, repaired, or rehabilitated rather than entirely replaced, greenhouse gas emissions will be significantly reduced compared to new construction (Hasik et al. 2019; Padgett and Tapia 2013; Meryman et al. 2013).

The Code is intended to apply to new concrete that meets the provisions of 1.4.3, including concrete used for additions to existing structures.

**R1.4.3** The scope is limited in the first edition of the Code due to available benchmark data. As noted in 1.4.5, the licensed design professional may specify requirements beyond those listed in the code, thus GWP limits for the applications listed in 1.4.3, or concrete specified by flexural strength, could be made if data are available.

**R1.4.4** The reasons for limiting or excluding the requirements of the code should be listed with detail provided to demonstrate what exceptions, if any, should be made.

For instance, in some regions, concrete suppliers and materials may be limited. This may restrict the feasibility of meeting all project requirements along with GWP requirements.

#### R1.5—Administration