



## CarbonBuilt CMU Technical FAQ

1. Are the physical properties of concrete masonry manufactured with the CarbonBuilt process the same as the conventional equivalent?

Yes. Blocks produced using CarbonBuilt technology (“CarbonBuilt CMUs”) are compliant with ASTM C90 for load-bearing concrete masonry units. Their performance is equivalent to that of traditional concrete blocks, and their physical properties have been evaluated by the National Concrete Masonry Association (NCMA) and Master Builders Construction Chemicals (Cleveland, OH). These evaluations are available upon request.

2. How have those physical properties been established, and are there any differences that would be relevant to engineers, architects, and contractors?

Based on the performance evaluation of CarbonBuilt tested by NCMA:

- stress-strain relationships: No difference was observed. The stress-strain relationship of a prism assembly constructed using CarbonBuilt CMUs is like that of traditional blocks.
- compressive strength: No difference was observed. All CarbonBuilt CMUs achieved a compressive strength over 13.8 MPa as specified by ASTM C90.
- modulus of elasticity and modulus of rupture: No difference was observed. The modulus of rupture and failure mode are the same as traditional CMUs. The modulus of elasticity was higher than  $900 \cdot f_c$  ( $f_c$ : compressive strength) as specified by TMS 402.
- weight/density: The weight and density of CarbonBuilt CMUs can be adjusted to fulfill density classifications (lightweight, medium-weight, and normal weight blocks) based on customer needs.
- shrinkage and creep characteristics: No difference was observed. The average linear drying shrinkage measurements of CarbonBuilt CMUs at 28 days were less than 0.065% as specified by ASTM C90.
- water absorption properties: The water absorption of CarbonBuilt CMUs is compliant with ASTM C90 requirements.
- thermal properties: This has not yet been evaluated. However, no difference is expected given that the aggregate types and fractions used in CarbonBuilt formulations are typical of traditional blocks. This will be verified in accordance with ASTM C518.
- fire resistance: This has not yet been evaluated. However, no difference is expected given that aggregate types and fractions used in our formulations remain the same as traditional blocks. This will be verified by an analytical approach based on the design mix or equivalent thickness to demonstrate



that the blocks can be added to fire resistance-rated assemblies described in IBC Section 721.

- appearance: No difference is expected. Like traditional blocks, CarbonBuilt CMUs can be treated with efflorescence controlling admixtures to enhance color integrity if required. Due to their lower cement content, CarbonBuilt CMUs can be slightly brighter than traditional blocks. However, the final color depends on constituent materials and their proportions.

3. Have you obtained ICC approvals for both or either concrete and concrete masonry which is manufactured utilizing the CarbonBuilt technology? What is the status of any such agency approvals?

Yes. CarbonBuilt and the International Code Council's Evaluation Service (ICC-ES) have developed acceptance criteria (AC520) to ensure that CarbonBuilt CMUs are compliant for use in construction applications. The code compliance report has been published by ICC-ES.

4. Since the International Building Code (IBC) references the standards developed by the Masonry Standards Joint Committee (MSJC), how does the specification and use of CarbonBuilt concrete masonry products fall under the auspices of the key code documents TMS 402/602, ACI 530, and ASCE 5? What might the differences be in following the code requirements which are referenced?

In accordance with acceptance criteria published by ICC-ES (AC520), CarbonBuilt CMUs can be used as an alternative to load-bearing or non-load-bearing CMUs that are compliant with ASTM C90 and ASTM C129, respectively, under the 2021 and 2018 IBC Section 2103.1 (Article 2.3 of TMS 602), and 2021 and 2018 IRC Section R606.2.1.

These criteria are applicable to hollow/solid normal weight, medium weight, and lightweight concrete CMUs that are made using CarbonBuilt's formulation and curing process. Like traditional CMUs, CarbonBuilt CMUs are designed in accordance with the provisions of TMS 402 (as referenced by Chapter 21 of IBC), or in accordance with IRC Section R606.2.1.

5. For concrete, which construction methodologies are impacted (placement, vibration, finishing methodologies, etc.)?

The manufacturing process for CarbonBuilt CMUs is the same as traditional concrete blocks and no changes to compaction, vibration, finishing, and block handling is required. A gas processing unit designed and installed by



CarbonBuilt is used to condition CO<sub>2</sub> gas for curing within existing curing chambers at block plants which are retrofitted in partnership with CarbonBuilt.

6. For concrete masonry, which construction process in the field is impacted (block-laying process, appropriate grout and mortar properties, breakage characteristics, block size and configuration issues, etc.)?

All dimensions and variations of CarbonBuilt CMUs conform to ASTM C90 specifications. The texture of CarbonBuilt CMUs is like that of traditional blocks. The flexural bond strength of CarbonBuilt CMUs was evaluated by NCMA in accordance with ASTM E518. CarbonBuilt CMUs presented the same modulus of rupture and failure mode as traditional blocks (i.e., failure occurred at the joint), confirming that no difference in bond and breakage characteristics is expected.

7. What is the cost impact of the use of concrete masonry which is manufactured using the CarbonBuilt process as compared with the conventional equivalent?

This decision will be made by our production partners, but our expectation is that CarbonBuilt CMUs will have the same price as conventional blocks. The combination of raw materials cost savings (owing to reduced usage of OPC, increased use of fly ash/slag and potential access to waste hydrated lime) and carbon monetization (driven by carbon removal purchases for the CO<sub>2</sub> consumed in curing, but also including offsets for the avoided emissions resulting from the change in formulation), offset only minimally by some additional cost for electricity, means that the price can stay the same.

8. Where are some examples of the as-built product?

Blocks produced in our pilot demonstrations have been delivered to and used in UCLA, Eastern Shoshone Housing Authority, Pine Ridge Reservation, Crazy Horse Memorial, Habitat for Humanity Tuscaloosa home construction, and other projects.