Specification Guide

Capturing the Value of Low Carbon Mixes

CENTRAL
Stronger, Cleaner, Greener Concrete.

Higher Performing Concrete Lower Carbon Footprint

Today's designs require aggressive performance and sustainability targets. Fortunately, advances in mix designs, including the incorporation of highly effective cementitious materials, carbon dioxide as an additive, returned fresh concrete and much more has resulted in solutions that maintain or achieve higher levels of strength, durability and workability, while significantly lowering the carbon footprint of the mix.

To assist you in specifying the optimal performance-based mix, Central Concrete has created this "At-A-Glance Specification Guide: Capturing the Value of Low Carbon Mixes". See page 2.

References and additional resources we recommend:

- Carbon Leadership Forum's LCA Model Specifications V1
- NRMCA's Specification in Practice #1-5
- CarbonCure's Specification
- ACI 301-16 Specifications for Structural Concrete
- ACI 329.1T-18 TechNote: Minimum Cementitious Materials Content in Specifications
- Lobo, Colin L., *Specifying Requirements for Concrete Mixtures*, STRUCTURE, April 2019, pp. 12-15.

Our technical team members, along with our Sustainability Manager, regularly collaborate with design teams on their projects to achieve their goals. We invite you to contact us today.

Capturing the Value of Low Carbon Mixes

	Minimum Cement Content		Maximum W/CM		Maximum SCM Contents	
Intended concrete performance	Maintain sufficient strength	Maintain adequate paste content	Low permeability	Reduce shrinkage and cracking	Maintain sufficient design strength and set time	Maintain early-age strength
Missed opportunities from these common prescriptive specs	Sufficient strength can still be achieved with lower cement contents by utilizing high strength aggregate, SCMs, admixtures, and/or sequestered CO_2. (For example: CarbonCure, Master X-Seed, & Orca aggregates)	SCMs have a lower density (specific gravity) than cement, so replacing cement with SCMs increases the paste volume of the mix. Additionally, the spherical shape of fly ash particles increases workability of concrete.	In many cases, SCMs can lower permeability more effectively than w/cm. Also, the w/cm instead of f'c often governs the mix design, which limits the ability to reduce the mix carbon footprint.	Many factors other than w/cm affect the shrinkage and cracking potential of concrete, so limiting the w/cm is not always effective for the purpose of crack control.	Strength of high cement replacement mixes can be improved with the use of high strength aggregate, admixtures, and/or sequestered CO_2, making them appropriate for many applications.	Sufficient early age strength for some applications can be achieved with low cement replacement (such as 30% slag) or by using admixture or sequestered CO_2 to improve early age strength of a mix with SCMs.
Alternatives to achieve required performance and low carbon footprint	Specify required compressive strength at specific age instead of minimum cement content.	For finishability of interior slabs, use minimum cementitious quantities given in Table 4.1.2.9 of ACI 301-16.	Do not specify max w/cm for applications that are not exposed to conditions that impact durability (interior columns, elevated slabs, etc.).	Specify a maximum drying shrinkage value or require specific low-shrink aggregate sources.	Specify applicable performance criteria instead of SCM limits: design strength, early-age strength, thermal limits, shrinkage, permeability, etc. Allow set time to be determined post-bid.	
	Specify design compressive strength at age later than 28 days to allow maximum use of SCMs (highest potential for carbon footprint reduction).	Evaluations and test placement for mix design with total cementitious below recommended minimums (ACI 301-16, 4.1.2.9)	Specify maximum w/cm per ACI-318 ONLY when concrete will be exposed to water soluble sulfates in soil/water (S1, S2, S3), water (W1), or external source of chlorides (C2).	Additional options for limiting shrinkage and reducing crack potential include: fibers, shrinkage reducing admixture, joint plan, proper curing, etc.	Specify a maximum global warming potential (GWP) value that is appropriate for each concrete application. This gives flexibility in proportioning SCMs to meet specified strength and constructability requirements, while prioritizing low carbon footprint.	
		Specify aggregates to comply with ASTM C33. Overall aggregate gradation and content should be adequate for concrete placement. (ACI 221R-96)	Specify SCM content that will provide desired permeability.	Do not specify for applications where shrinkage is not problematic (such as columns or slabs to be covered by flooring).	Limit fly ash content for flatwork to a maximum of 25%.	
			Specify maximum rapid chloride permeability test value (coulombs) per ASTM C1202 or consider resistivity test method.	Do not specify when exposure conditions that impact durability are not present (S0, F0, W0, C0, C1).	Use maximum SCM percentages in Table 4.2.1.1 (b) in ACI 301-16 when freeze-thaw conditions apply.	

SCM = supplementary cementitious material (such as slag, fly ash, silica fume, metakaolin, natural pozzolan, etc.)

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