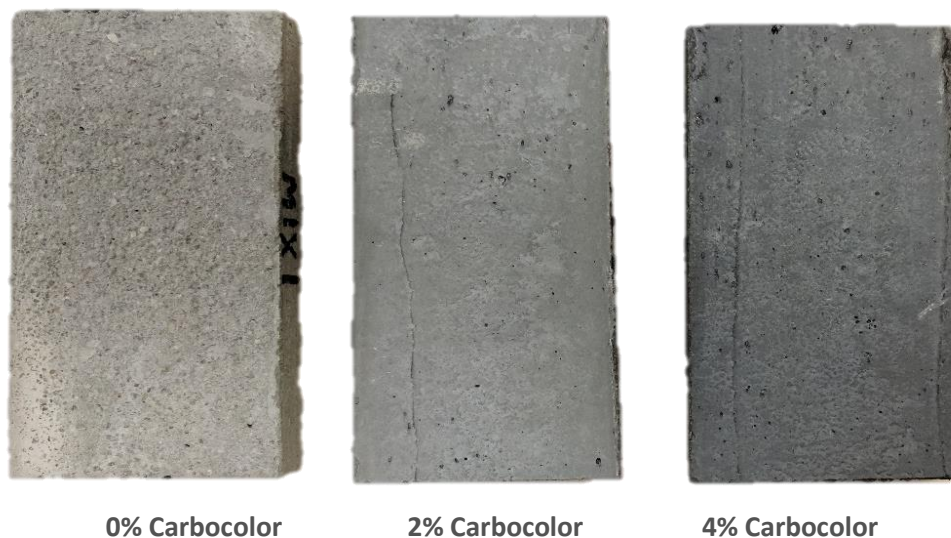


TECHNICAL REPORT

Carbocolor for concrete pigmentation

Concrete can be pigmented to a dark grey colour using carbon black. Specifically, Carbocolor is known to produce a dark grey coloured concrete with blue undertones instead of the red undertones realized with iron oxide. This low blue hue value is demonstrated by the b^* value during $L^*a^*b^*$ testing. The large particle sized carbon black allows for effective colouring and mixing. A loading of 4% Carbocolor, based on total cementitious weight is recommended. Excess pigment will not provide any additional benefits. To test properties of the cement, Carbocolor pigmentation was measured at 0%, 2% and 4% loadings by weight. Samples were compared to a black iron oxide pigment at equal loadings.

Figure 1. Concrete with Carbocolor at 0%, 2%, and 4% loadings. Note that exact colour depends on the concrete mixture used and may not exactly match those seen below.



Concrete darkens with the addition of Carbocolor. This can allow for more heat storage in colder climates.



Table 1. Concrete colour properties

Concrete Colour	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
Carbocolor pigment, % by weight of cement	0	2		4	
Iron Oxide Jet Black pigment, % by weight of cement	0		2		4
Lightness (L*)	63.7	51.49	59.59	45.66	49.41
Undertone (b*) ¹	4.41	0.11	3.34	1.04	2.34
Gloss 20°	0.9	0.4	0.6	0.3	0.4
Gloss 60°	0.9	1.7	1.9	1.0	1.2
Gloss 85°	0.1	3.2	0.8	1.3	0.8

Carbocolor at equal loading provides more darkness, a blue undertone and comparable gloss to its iron oxide counterpart in concrete.

¹ Undertone (b*) signifies the hue of the colour. A high value indicates a yellow colour while a low value is representative of a blue undertone.



Mechanical Properties

Table 2. Concrete properties with the addition of 2% and 4% pigment







Concrete Properties	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
Carbocolor pigment, % by weight of cement	0	2		4	
Iron Oxide Jet Black pigment, % by weight of cement	0		2		4
Unit Weight, lb/ft ³	151.4	149.9	151.1	149.5	148.7
Slump, in.	4.0	5.5	5.5	5.5	6.0
Air Content, %	1.0	1.2	1.5	1.4	0.9
Water-Cement Ratio	0.62	0.62	0.62	0.62	0.62
Workability (cohesiveness)	Good	Slight Bleeding	Good	Good	Good
Initial Set (min)	249	285	277	310	287
Final Set (min)	327	387	369	414	381
28-day Compressive Strength (psi)*	5150	5250	5340	4720	4980

*average of three cylinders, except for the un-pigmented control, which was an average of two cylinders.

Weathering

Reservations regarding the use of carbon black for concrete colouring are typically concerning weathering resistance of the coloured concrete. Carbocolor's proprietary formula is the largest particle sized carbon black available, limiting leaching of colour over time when exposed to the elements, as seen with other carbon blacks. Weathering testing was completed using cyclical Xenon Arc Weathering Resistance exposure over 1000h including spray cycles².

Table 3. Xenon-arc weathering tests

	Before Weathering	After Weathering
No pigment		
2% Carbocolor		
2% Iron Oxide		

² General Motors Worldwide Standard 16146 for Xenon Weathering Testing

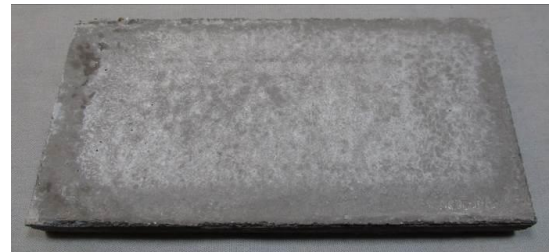
Before Weathering

After Weathering

4% Carbocolor



4% Iron oxide



Samples with Carbocolor were poured outside the Cancarb manufacturing plant in Medicine Hat, Alberta to observe the effects of the demanding climate. The weathered concrete (right) shows little to no leaching or loss of colour, consistent with lab results shown above.

Figure 1. Untouched (left) and weathered (right) samples of Carbocolor pigment in concrete

