In House Research
NDOR Research Section

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High Early Concrete Evaluations with IPF Cement

Nebraska Department of Roads

Research Project:
High Early Concrete Evaluations with IPF Cement

Location: In- House

Project Number: N/A

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Purpose of In-House Investigation: Nebraska Department of Roads determined the need for the use of cementitious materials; such as IPF, in the concrete pavement to mitigate the Alkali Silica Reaction (ASR). Materials and Research started an evaluation of the use of IPF cement type in the 47BHE class of concrete which is currently being used in the paving operation. This particular mix design requires developing strength of 3500 psi in 48 hours. The admixtures used were accelerator (Type C), water reducer (Type A) and air entraining agent (AEA). In the investigation was studied the effects of different accelerators in the attempted to simulate the temperature variations in the field during construction season.

Objective of this Investigation:

- To determine the effect of substituting Class F Fly ash in the High Early mix design.
- To determine the early compressive strength of different types of IPF cements in Nebraska
- Meeting the minimum compressive strength properties.
- Meeting the allowed time to be open to traffic.
- To ensure mix design will meet NDOR requirements for lower temperatures.
- To ensure workability and constructability so that the mixes can be easily used in the field.

Conducted in the Laboratory:

1. Two cubic yards were ordered for each mix design from Ready Mix Concrete Company supplying 47BHE with base cement type (1PF). The following Table 1 describes the specifications for the blends tested in the laboratory:

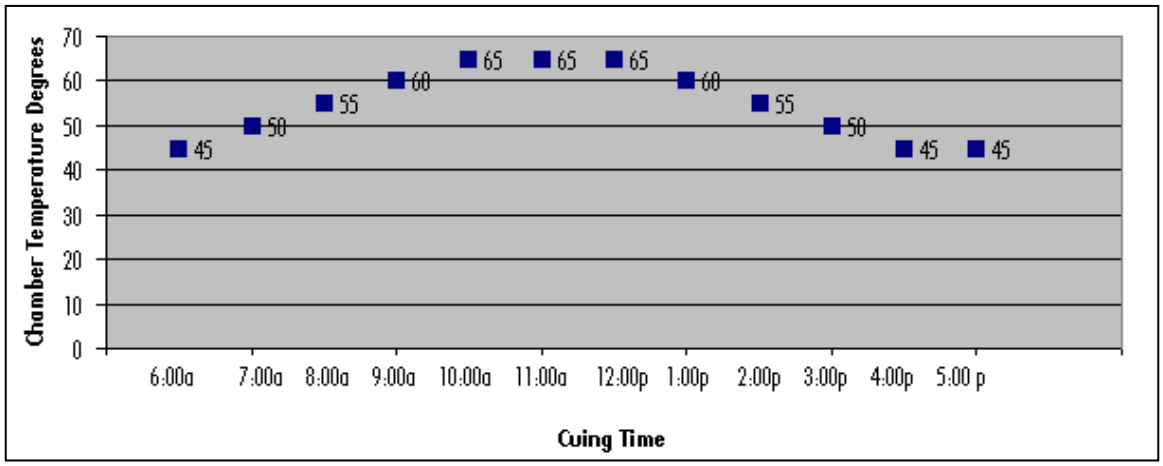
Table1. Mix Design Tested in the Laboratory

Paving Blend/ Cement Type	Admixture	Total Cementitious Materials	Water Cement Ratio	Plastic Air Content	Slump	Required Time For Design Strength
		Lbs/cy	-	%	in	Hrs / Cure Temperature
47B HE/IPF	Mix A-None	752	0.38	7.9	2 1/4	48 / 45°F and Ambient
	Mix B-None	752	0.38	9.2	4.75	48 / 45°F and Ambient
	Mix C-None	752	0.38	7.2	5	48 / 45°F and Ambient
	Flake Calcium Chloride	752	0.38	6.7	3	48 / NA
	Flake Calcium Chloride HRWR	752	0.34	7.8	3	24 / NA
	Mix A Pozzolith NC534 Polyheed 997	752	0.38	7.0	1 3/4	48 / 45°F and Ambient
	Mix A Daraset 200 WRDA 82	752	0.38	6.2	3	48 / 45°F and Ambient

2. Cure Temperature: it was investigated the influence of varying time temperatures to reflect the actual curing of a cool spring day in the field. Two sets of three cylinders where made for each batch of concrete. One set was cured at the ambient room temperature and the other set was put into a chamber.

The chamber was used to simulate a day in April with the fluctuations of temperature through the day with high temperature of 65°F and the low being 45°F. The Figure 1 is shown the chamber used and Figure 2 is shown the different temperatures during the curing process the specimens experienced in the chamber. For the specimens an ambient temperature where placed in the M&R's Lab at approximate temperature of 72°F.

Figure 2. Different Temperatures Experienced in the Chamber



3. Mechanical Properties:

1. ASTM C39 Compressive Strength corresponds to the requirements by NDOR specifications to meet the minimum specifications before opening to traffic. The following Table 2 shows the results for compressive strength.

Table 2. Results of Compressive strength

Paving Blend/ Cement Type	Admixture	Average Compressive Strength **Laboratory Ambient Temperature (72°F)**				Average Compressive Strength **Chamber Temperature 45°F to 65°F**			
		Hrs/Psi	Hrs/Psi	Hrs/Psi	Hrs/Psi	Hrs/Psi	Hrs/Psi	Hrs/Psi	Hrs/Psi
47B HE/IPF	Mix A-None	24/2943	32/3273	48/3587	56/3637	24/1683	32/2303	48/2790	56/3123
	Mix B-None	24/1793	32/2083	48/2380	56/2520	24/680	32/1140	48/1480	56/1840
	Mix C-None	24/1720	32/1873	48/2257	56/2390	24/737	32/1190	48/1610	56/2093
	Flake Calcium Chloride	20/3400	24/3680	32/3880	48/4250	N/A	N/A	N/A	N/A
	Flake Calcium Chloride HRWR	6/1130	9/2340	12/2860	18/3430	N/A	N/A	N/A	N/A
	Mix A * Pozzolith NC534 Polyheed 997	24/3253	32/3738	48/4163	56/4233	24/1707	32/2559	48/3200	56/3590
	Mix A * Daraset 200 WRDA 82	24/2930	32/3270	48/3700	56/3650	24/1610	32/2280	48/2900	56/2960

***Admixture amount was added per manufactures recommendation. This evaluation did not address increasing the amount of admixture for cooler temperatures.**

Conclusions to Date:

This evaluation has shown that using IPF in the High Early concrete can slow compressive strength gain in lower ambient temperatures, commonly experienced in spring or fall paving operations. This investigation has also proven that non-chloride accelerators can be used to achieve the design strength in 48 hours or less.

Ambient temperature and cementitious chemical variations can reduce the initial setting times and compressive strength gain. Understanding the effects of these properties may result in a need to alter admixture dosage, and ensure proper curing methods are used to best facilitate the hydration process on cool days.