TECHNICAL INFORMATION ON BUILDING MATERIALS

TIBM-8

FOR USE IN THE DESIGN OF LOW-COST HOUSING

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CALCIUM CHLORIDE AS IT AFFECTS PORTLAND CEMENT AND CONCRETE

This is a brief digest of Research Paper R.P. 782, "Effects of Calcium Chloride on Portland Cements and Concretes", (April 1935),[1] by Paul Rapp, issued by the National Bureau of Standards, covering a study to determine the effect of the addition of calcium chloride to portland cement mortars and concretes on the setting times, heats of hydration, consistencies, and the strengths at various ages under several curing temperatures.

Materials used: Eight commercial portland cements (hereafter referred to as standard cements), one high-early-strength and two white portland cements were used, which were of widely varied composition and physical properties.

The calcium chloride was a commercial product complying with American Society of Testing Materials Standard Specification D 98-34.

The concrete tested was of a 1:2:4 mix by volume, using local (District of Columbia) sand and gravel. To the gaging water (6.5 gallons per sack) commercial calcium chloride in varying amounts was added. Standard sand mortar (1:3 mix) and plastic mortars were also tested. Since it was shown that the use of from 1 1/2 to 2 percent of commercial calcium chloride (by weight of cement) gave the best and most economical results, this digest confines its discussion chiefly to the effects of calcium chloride in those proportions.

[1] Available from Superintendent of Documents, Government Printing Office, Washington, D. C. (Price 5 cents)

It was shown on an average that with standard cements at the curing temperature at 70° F without the admixture, initial set took place in approximately 3 hours and 15 minutes, and the final set in approximately 6 hours, while those same standard cements with 2 percent calcium chloride reached the initial set in approximately 1 hour and the final set in approximately 2 hours and 30 minutes. In general, it was noted that the average setting time together with the spread of the time of set, decreased as the amount of calcium chloride increased. The addition of calcium chloride affected white and high-early-strength cements similarly. Greater ease of placing and increased workability were noted in both mortar and concrete with the admixture present.

Since there is a direct relation between the rate of evolution of heat or temperature rise, and the rate of hardening or set, too great an increase in either or both may cause a time of set so rapid that finishing of placed concrete would be difficult.

Effects of curing temperatures on the strength of concrete (based on plastic mortar cubes) were determined, the early strength decreasing very markedly as temperatures approached the freezing point. However, with the addition of calcium chloride it was evident that the lower the initial curing temperature, the more effective was the calcium chloride in producing early strength; thus, the proportional effect of adding calcium chloride is much greater at the lower temperatures.

Construction at low temperatures requires special measures to assure a rate of hydration of cement that will develop early strength. An added advantage in using calcium chloride in cold weather is the earlier development of heat. In thin concrete slabs, where the heat may be readily dissipated, the increased rapidity of heat development will compensate for some of the heat lost and will decrease the curing time and time necessary for the protection of concrete by the use of coverings, etc.

Compressive strength tests conducted with specimens of mortar with 2 percent calcium chloride and cured at 70° F showed at 1 year approximately 15 percent greater strength than plain mortar. The strength at 1 day was practically doubled. Concretes of standard cements with 2 percent calcium chloride added showed an average strength at 1 day of 128 percent higher than plain concrete, at 28 days 13 percent, at 90 days 9 percent, and at 1 year 8 percent. White and high-early-strength cements were likewise increased in strength.

Based on plastic mortar cubes, effects of curing temperatures and the addition of calcium chloride on the length of time required for

1:2:4 concrete to attain a compressive strength of 2,500 pounds per square inch are shown below.

Cement	Number of Days To Reach 2500 lbs. per sq. in. at Curing Temperatures		
	40°F	70°F	90°F
Standard (without admixture)	14	6	4
Standard plus 2% commercial calcium chloride	8	3	
Standard plus 1 1/2% commercial calcium chloride			2
High-early (without admixture)	5	2	1
High-early plus 2% commercial calcium chloride	3		
High-early plus 1 1/2% commercial calcium chloride		1	1

As indicated by these tests, the proportions of commercial calcium chloride required for the three curing temperatures studied are:

Temperatures	Commercial Calcium Chloride	Type of Cement
°F	Percent	
40	2	All cements
70	2	Normal and white
70	1.5	High-early
90	1.5	All cements

Note: Calcium chloride should be added in proper proportions (by weight of cement) to the gaging water prior to use.