

CEMENT COMPARISON STUDY TYPE I AND TYPE III

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## INTRODUCTION

This study was undertaken to help determine the economic and structural feasibility of using concrete containing Type III (High Early Strength) cement as compared with concrete containing Type I (Normal) cement. To date, the Vermont Highway Department allows only Type I cement in structural concrete. Although durability was not considered, compressive strength comparisons at early ages were made and economic considerations discussed.

## MIX DESIGN AND MATERIALS

All aggregates were supplied by J. P. Carrara & Sons, North Clarendon, Vermont.

Portland Cement was contributed by Iron Clad Portland Cement Company of Glens Falls, New York.

Air-entraining admixture was manufactured by Grace Chemical Company under the trade name of Darex.

The above combination of materials are currently being used on Rutland area projects. Vermont Standards Specifications Item 401-AA, Concrete, was batched having a maximum aggregate size of 3/4".

The mixes were 1.8 cu. ft. in size with the following design weights:

	6½ Bags	7 Bags	7½ Bags
3/4" Stone	1757 lbs.	1698	1639
Sand	1176	1136	1097
Cement	611	658	705
Yield %	100.6	99.1	98.5

## PROCEDURE

The test batches were mixed using rigid controls as specified in ASTM C 192-65. Tests performed on the plastic concrete included slump, air content, unit weight, and yield. Four batches were mixed to compare a 6½ bag Type III with a 6½, 7, and

7½ bag Type I cement concrete. Each batch yielded six cylinders which were broken at ages of 1, 3, and 7 days. The average of the two cylinder strengths at each age were then compared with the corresponding average of the reference (Type III) batch.

#### TEST RESULTS

Compressive strength results are shown in the accompanying Table. These results support the fact that as cement content increases, so the compressive strength of concrete increases. They also indicate that as time increases, the variation in strength converges as shown in the accompanying graph. Thus, there can be some strength advantage by using Type III cement up to seven days.

#### COST COMPARISON

Consideration should be given to the costs of Type III cement as compared with Type I. Quantity is a contributing factor since bulk cement is always less expensive than bagged cement. Currently, Type III cement prices average approximately 8% more than Type I. If it is necessary to batch small quantities of Type III cement by the bag in lieu of using Type I cement in bulk, the increase in price will approach 17%. Note that this increase applies to the price of cement as delivered to the Ready-Mix supplier and will be partially reflected in the total price increase of the concrete.

#### CONCLUSION

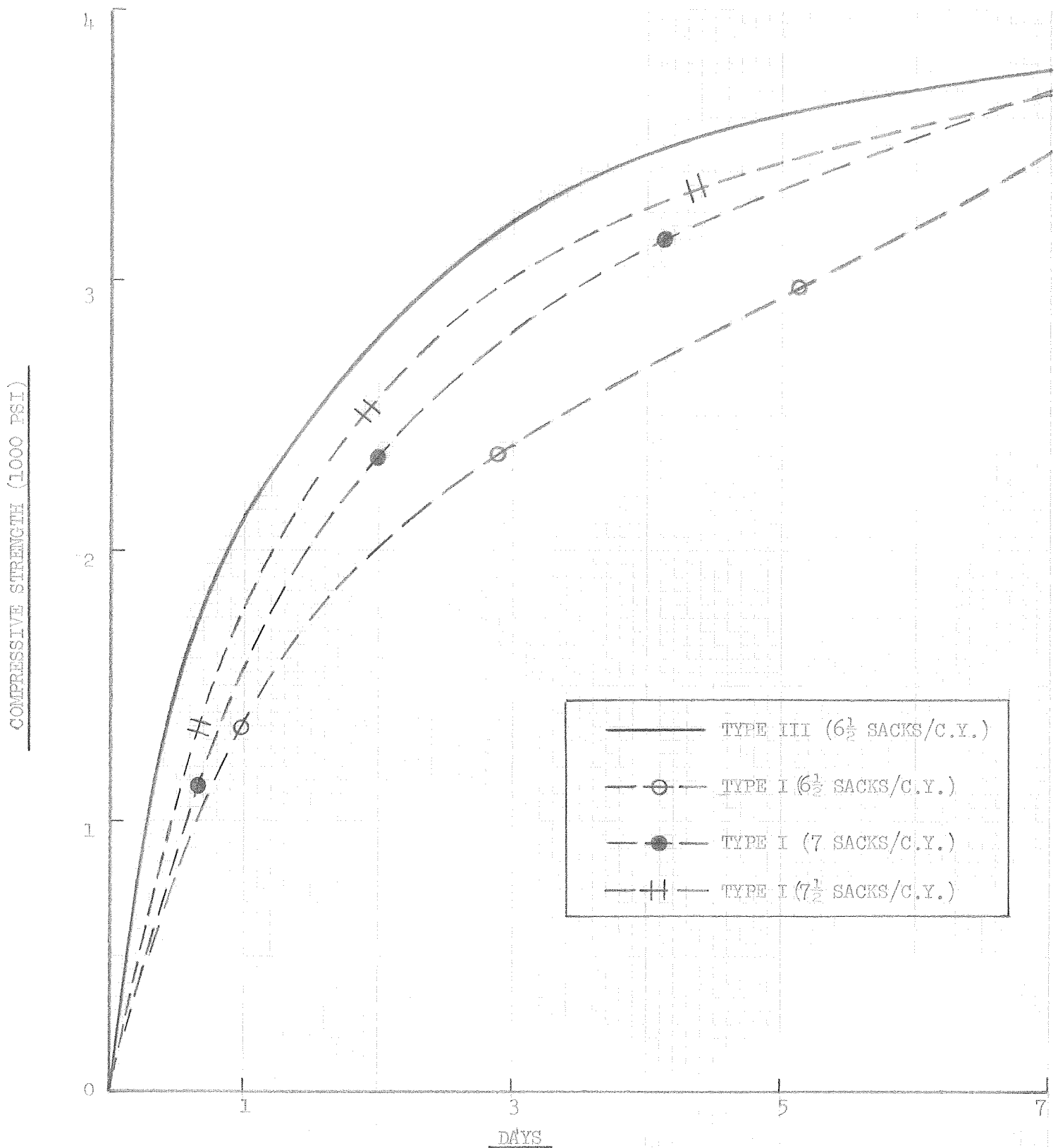
Under special conditions requiring early form removal or early emergency loading, Type III cement could have a valuable application. Concrete containing Normal Cement will not gain strength at a rate equal to that containing High Early Strength Cement within the initial seven days regardless of an increased cement content. Use of Type III should be limited since durability has yet to be proven by the Vermont Highway Department and considerable cost increases may be incurred.

TYPE III VS. TYPE I

EARLY STRENGTH COMPARISON TABLE

(PERCENTAGE OF STRENGTH OF TYPE III CONCRETE)

	ONE DAY		THREE DAY		SEVEN DAY	
	BREAK	AVERAGE	BREAK	AVERAGE	BREAK	AVERAGE
TYPE III 6½ Bags/Cy	2157 2113	2135	3254 3183	3219	Void 3784	3784
TYPE I 6½ Bags/Cy	1371 1388	1380 = 65%	2440 2343	2392 = 74%	3564 3395	3480 = 92%
TYPE I 7 Bags/Cy	1680 1441	1561 = 73%	2812 Void	2812 = 87%	3714 3687	3700 = 98%
TYPE I 7½ Bags	1777 1804	1791 = 84%	Void 3006	3006 = 93%	3696 3678	3687 = 97%



## TYPE I & TYPE III CEMENT STRENGTH COMPARISONS