HIGHWAY RESEARCH REPORT

A COMPARISON OF 1½-INCH AND ¾-INCH MAXIMUM SIZE AGGREGATE CONCRETE

67-30

STATE OF CALIFORNIA

TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

NO. M & R 635148-2

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STATE OF CALIFORNIA—TRANSPORTATION AGENCY

RONALD REAGAN, Governor

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DIVISION OF HIGHWAYS
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June, 1967

Research Report
M&R No. 635148-2

Mr. J. A. Legarra
State Highway Engineer

Dear Sir:

Submitted herewith is a research report titled:

A COMPARISON OF
1-1/2-INCH AND 3/4-INCH
MAXIMUM SIZE AGGREGATE IN CONCRETE

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Very truly yours,

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REFERENCE: Spellman, D. L., Ames, W. H., and Woodstrom, J. H., "A Comparison of 1-1/2-inch and 3/4-inch Maximum Size Aggregate in Concrete", State of California, Department of Public Works, Division of Highways, Materials and Research Department. Research Report No. 635148(2), June 1967.

ABSTRACT: Concrete was made from aggregate obtained from nine aggregate sources located through California. Concretes containing 1-1/2-inch and 3/4-inch maximum size aggregate at cement contents of 6 and 7-1/2 sacks per cubic yard were compared.

Each concrete was tested primarily for compressive strength and drying shrinkage. In addition, some aggregate tests were made prior to using the aggregate in concrete, and tests were made to determine physical properties of the fresh concrete.

Test results indicated that concrete made with 1-1/2-inch aggregate generally has lower drying shrinkage, lower water-cement ratio, higher density, and less entrapped air than that made with 3/4-inch aggregate. Compressive strength was shown to be dependent on individual aggregate characteristics, cement contents, and age.

The variation in drying shrinkage of concrete made from the nine aggregate sources is much greater than that attributed to variation of maximum aggregate size.

It is concluded that where strength and shrinkage are important factors, each case must be considered individually when deciding whether to use 3/4-inch or 1-1/2-inch maximum size aggregate.

KEY WORDS: Concretes, Portland Cement Concretes, Aggregates, Concrete Aggregates, Compressive Strength, Shrinkage, Size, Concrete Properties

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The opinions, findings, and conclusions expressed in this report are those of the authors and are not necessarily those held by the Bureau of Public Roads.

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A COMPARISON OF 1-1/2-INCH AND 3/4-INCH MAXIMUM SIZE AGGREGATE IN CONCRETE

INTRODUCTION

It is generally agreed that "proportions for concrete should be selected to make the most economical use of available materials to produce concrete of the required placeability, durability, and strength."[1] In selecting proportions for a given concrete, one of the important decisions that must be made is that of specifying the maximum size aggregate. Criteria for this selection is often prescribed in tabular form where the maximum size of aggregate is related to the dimensions of the structure and the spacing of the reinforcing steel. There is obviously an element of subjectivity involved in making the final decision for a specific concrete. The question often arises as to relative importance of factors affected by varying the aggregate size and how much one is willing to sacrifice to obtain ease of placeability.

In highway construction, there are broad guidelines for the use of 1-1/2-inch or 3/4-inch maximum size aggregate. For example, in pavements, thick sections, unreinforced or "lightly" reinforced, the 1-1/2-inch size is commonly used. In thin sections, "heavily" reinforced sections, or in thin prestressed

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sections, the 3/4-inch size is the norm. Terms such as "thick" or "heavily reinforced", etc., are not dimensionally defined. Thus, there are often situations where arguments may be advanced for each of the maximum sizes under consideration.

With the increased use of portable concrete pumping machinery, there is further emphasis for using the smaller size aggregate. Concrete pumps are mounted on light trucks or small trailer units and force the concrete through 3-inch or 4-inch diameter lines for considerable distances to the point of deposit in the work. Depending on job conditions, pumping can sometimes replace more expensive and hazardous methods of placement, such as crane and bucket, elevators, buggies, and wheel-barrows. If pumping were to be considered as an acceptable alternate in the bidding stages of a contract, direct savings might be realized by the consumer.

Portable concrete pumps currently available generally have difficulty in handling the standard 1-1/2-inch size material, or cannot handle it at all. The engineer thus must decide if he is willing to accept the smaller size aggregate and perhaps over-sanded mixes in order to realize the potential benefits of placement by pumping.

Other investigators have conducted studies on the effect of the maximum size aggregate on properties of concrete.[2,3,4] In much of this work, concentration has been placed on the property of compressive strength. With the large variations in the mineralogical composition of aggregates from various

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sources in California, some of which produce concrete with extremely high shrinkage characteristics, it was decided that a study of several of the typical commercial material sources would be necessary. The effects of aggregate source, aggregate size, and cement content on compressive strength, shrinkage, water-cement ratio and unit weight of the concrete were investigated and are discussed in this report.

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CONCLUSIONS

The following conclusions are based on this laboratory study of concrete made using aggregate from nine California sources, with selected batch proportions comparable to those likely to be used in the field.

1. Concrete mixes made with 3/4-inch maximum size aggregate generally have higher shrinkage. They also have higher water demands, lower unit weights, and more entrapped air than those containing 1-1/2-inch aggregate.
2. Concrete containing 6 sacks of cement per cubic yard and 1-1/2-inch maximum size aggregate has a slightly higher average compressive strength than concrete made with 3/4-inch maximum size aggregate at all ages tested. Concrete containing 3/4" maximum size aggregate and 7-1/2 sacks of cement per cubic yard had a higher average strength at 28 and 91 days.
3. Concrete made from aggregate which is primarily uncrushed and naturally rounded shows the greatest increase in compressive strength when the maximum aggregate size is reduced. The three crushed aggregates showed greater strengths with the larger maximum size aggregate at both cement contents.
4. The amount of drying shrinkage is much more dependent on inherent aggregate characteristics than on whether the maximum size of aggregate selected is 1-1/2-inch or 3/4-inch.

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TESTING PROGRAM

Nine aggregate sources from locations throughout the State were selected for testing. Nominal 1-1/2-inch and 3/4-inch maximum size aggregate concrete at cement contents of 6 and 7-1/2 sacks per cubic yard were produced, giving four basic mixes for comparison.

In selecting the mix proportions to be used in the test program, consideration was given to the need for a reasonably well-sanded mix for placement by pumping. As a result, the 1-1/2-inch maximum size aggregate concrete was proportioned, by weight, 62% coarse and 38% fine, and the 3/4-inch maximum size was proportioned 50% coarse and 50% fine for both cement factors. All aggregates were screened in the laboratory, then recombined to give uniform coarse aggregate gradation for all mixes of a given maximum aggregate size. The sand was used in the "as received" gradation of the stockpiled material. The combined gradations conform to the California Highway Standard Specifications and are shown in Table 1. Aggregate descriptions and pertinent properties are shown in Tables 2 and 3.

Three batches of concrete were made on different days for each mix condition. Physical properties of the fresh concrete are given in Table 4. From each batch, one 4x5x18-inch shrinkage bar and six 6x12-inch compressive strength cylinders were fabricated, giving a total of three shrinkage

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bars and 18 cylinders for each concrete mix.

Specimens were stripped the day following fabrication and placed in the moist curing room at 73°F. The compressive strength specimens were kept in the moist room until tested. Two cylinders from each batch of each mix were tested at ages of 7, 28, and 91 days. The shrinkage specimens were stored in the moist room for seven days, then measured and placed in the drying room which is controlled at 50% relative humidity and a temperature of 73°F. Length measurements were made at 0, 7, 14, 28, 56, and 91 days of drying. The drying shrinkage was determined by comparing each measurement to the length of the specimen when it was placed in the drying room at age of 7 days.

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DISCUSSION OF TEST DATA

A tabulation of test data is shown in Tables 4, 5, and 6. In addition, compressive strength s and shrinkage data are shown graphically in Figures 1 and 2, respectively.

Compressive Strength

The compressive strengths shown in Table 5, and Figure 1, show that at the 6-sack level, there are generally higher strengths with the 1-1/2-inch aggregate. The average of the nine sources shows a 28-day strength of 4700 psi for the 1-1/2 inch and 4515 psi for the 3/4-inch size. This difference is not very great and two of the nine individual aggregate sources were found to be contrary to the general trend. At the 7-1/2-sack level, the general trend is reversed showing a 28-day average strength of 5855 psi for the 3/4-inch aggregate concrete as compared to 5480 psi for the 1-1/2-inch size.

At both cement factors, concrete containing essentially all crushed coarse materials indicated greater strengths with 1-1/2-inch aggregate at all ages.

The following illustrations show the effect of age in comparing the strength when different aggregate sizes and cement contents are used for the nine sources:

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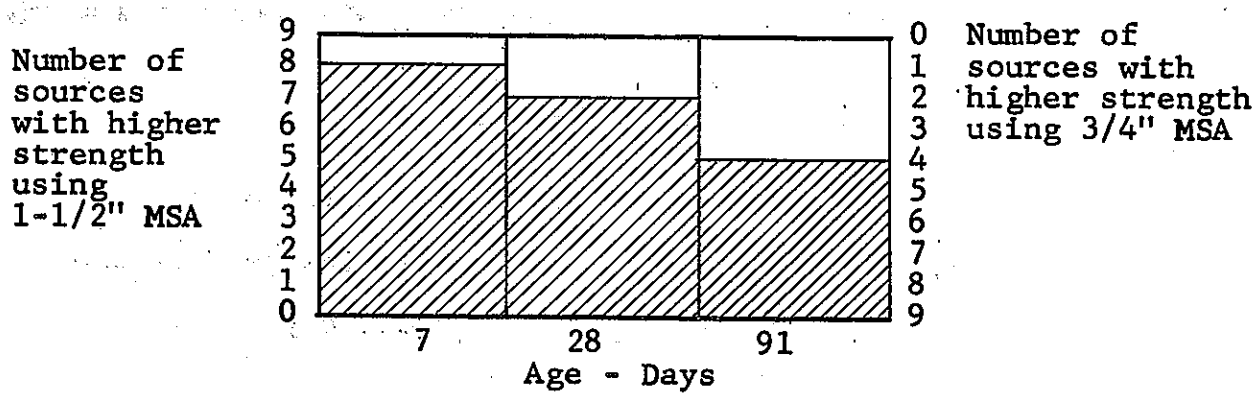
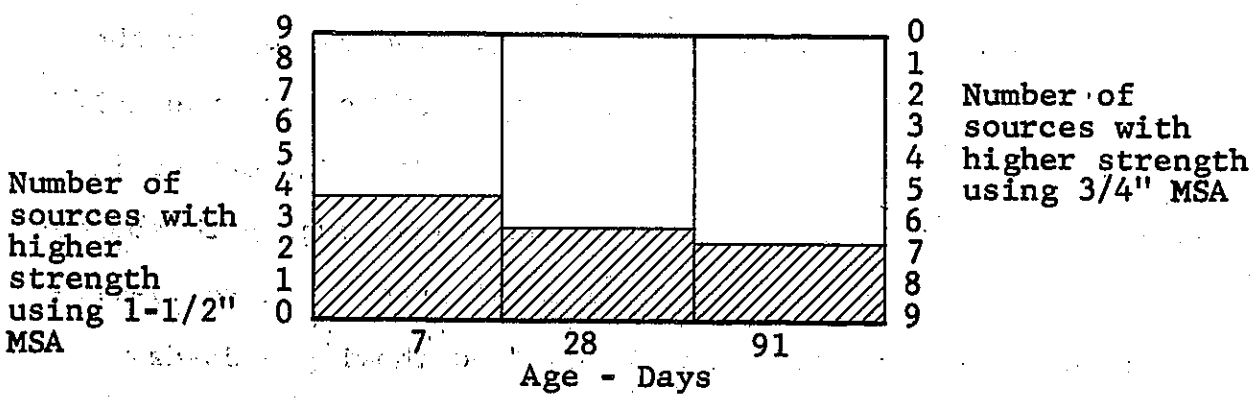


Strength - Age Relationship
6-sack Mix



Strength - Age Relationship
7-1/2-sack Mix

It is seen that the age of concrete is a factor that must be considered in making compressive strength comparisons between 3/4-inch and 1-1/2-inch maximum size aggregate concrete under moist curing conditions. There is a definite trend wherein the 3/4-inch size attains a strength advantage as the age of concrete increases regardless of the cement factor or whether the aggregate is crushed or uncrushed. It should be realized that the rate of strength gain and the ultimate strength of concrete

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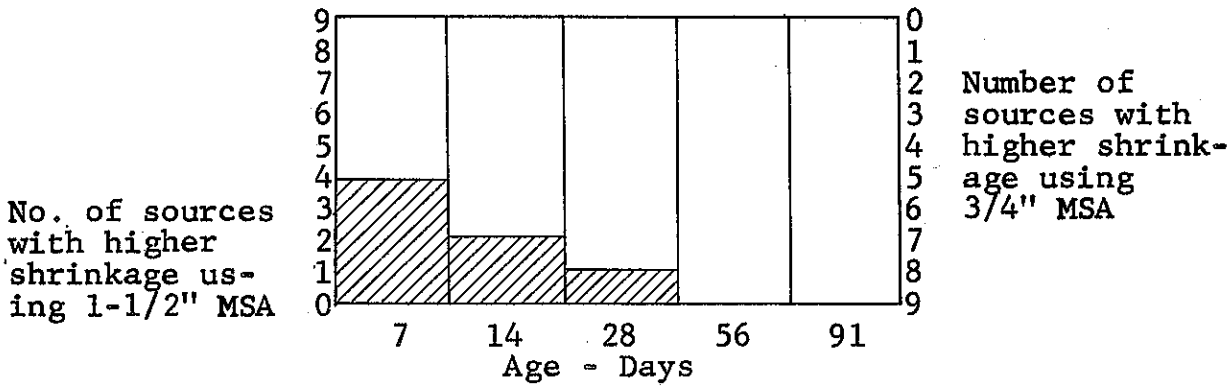
placed in the field would generally be lower due to the difference in curing and exposure conditions.

Shrinkage

Drying shrinkage in percent for each concrete mix is shown in Table 6 and in Figure 2. The extreme range in the property of drying shrinkage of concrete made from the various aggregate sources is graphically apparent in Figure 2. In general, the shrinkage of the 3/4-inch maximum concrete at a given age is higher than that of the 1-1/2-inch maximum concrete at the same age. The following illustrations show the effect of drying time in comparing the shrinkage when different aggregate sizes and cement contents are used for the nine sources:



Shrinkage - Age Relationship
6-Sack Mix

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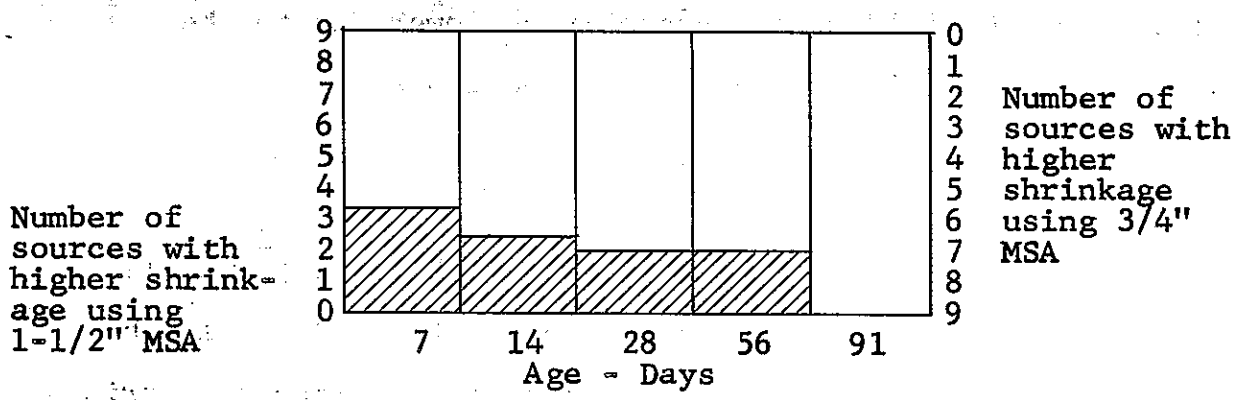

Shrinkage - Age Relationship
7-1/2-Sack Mix

From the above illustrations, it is seen that the smaller sized aggregate definitely has higher shrinkage characteristics regardless of cement contents. Drying time is again a factor in the comparison, and the lower shrinkage with the 1-1/2-inch aggregate becomes more pronounced with an increase in drying time.

Earlier work[5] indicates that the shrinkage of a 4x5x18-inch specimen that occurs in a drying room in 28 days approximates what might be expected ultimately in a structure in semi-arid valley areas of California. Therefore, the shrinkage at the ages of 56 and 91 days might be considered extreme when considering concrete highway structures. They may be appropriate when considering slabs or walls inside buildings however.

In evaluating the property of drying shrinkage of the various concretes, some pertinent facts should be considered. All the sources tested have been used in concrete bridge and

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pavement construction; normally this has been limited to use of 1-1/2-inch maximum size aggregate. In the limited amount of data available comparing laboratory drying shrinkage as affected by aggregate characteristics to structural cracking[10], it is evident that increased drying shrinkage causes increased structural cracking. However, no general correlation of drying shrinkage characteristics of concrete to amount of cracking in a structure has been made on a large scale. To obtain such information would involve a comprehensive research program, certain aspects of which have been under consideration by this laboratory for some time.

It is well-known that aggregates with high shrinkage characteristics contribute to adverse performance of concrete pavement. Generally, this is manifested in pavement slabs that have a marked amount of curling and an early loss of aggregate interlock between slabs at weakened plane contraction joints.

Concrete containing aggregates with high shrinkage also quite often has high creep characteristics. There are known instances where use of these aggregates has contributed to cracking and deflection problems in buildings and other structures. Specifications to preclude the use of high shrinkage, high creep concrete aggregates are now being used by a number of engineers and architects throughout the State.

The shrinkage data in this report show that concrete made from aggregates with high shrinkage characteristics may shrink over 100% more than others, regardless of maximum size

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aggregate. Furthermore, unreported test data obtained by this Laboratory show this ratio to exceed 200% for some aggregate sources used both in pavement and structures. Data reported herein show the average increase in shrinkage of 3/4-inch over 1-1/2-inch aggregate at 28 days was only about 10%. This indicates that control of shrinkage might best be accomplished by aggregate source selection rather than limiting maximum size of the aggregate. The primary factor contributing to the increased shrinkage using the smaller aggregate is probably the increased water demand which by coincidence, also averaged about 10% in this study.

Some interesting shrinkage information became apparent from analyzing the shrinkage data, specifically the effect of increasing the cement content in a mix. Comparing concrete containing 6 sacks of cement to that containing 7-1/2 sacks of cement with the same maximum size aggregate, no significant effect on shrinkage can be associated with the additional cement. In fact, at 28, 56, and 91 days of drying, the 3/4-inch, 6-sack concrete shows a slightly higher average shrinkage than the 3/4-inch, 7-1/2-sack concrete. In many cases for both comparisons, there is actually a decrease in shrinkage with the 7-1/2-sack concrete. These decreases are more predominant at ages greater than 14 days. This general finding agrees with others, as shown in Figure 7 of the Seventh Edition of the U.S. Bureau of Reclamation Concrete Manual.

It is important to recognize that there are certain

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limitations in evaluating the significance of laboratory shrinkage data. Drying shrinkage measurements are determined by standardized laboratory procedures that allow excellent comparative figures within the scope of the test program. However, no convenient method has been found to analyze what happens to the concrete during the first 24 hours after specimens are cast. In structures, much of the drying shrinkage cracking apparently propagates from plastic shrinkage cracking which occurs within the first few hours after concrete is placed. Adverse construction practices, such as high slumps, over mixing, poor vibration, high concrete temperatures, improper finishing, inadequate curing, etc., all contribute to plastic shrinkage cracking. These factors may affect cracking to a greater degree than would normally be associated with the inherent shrinkage characteristics of the aggregates or the maximum sized aggregate selected for the mix.

Water-Cement Ratio, Unit Weight

Table 4 shows a tabulation of the physical properties of the fresh concrete. An examination of the data shows that for equal slumps, the maximum size of aggregate has a significant effect upon the water demand and the unit weight of the fresh concrete. In going to the small aggregate size, an increase in water-cement ratio ranging from 3.9 to 7.3 lbs. per sack is required at the 6-sack level and 0.7 to 4.8 lbs. per sack at the 7-1/2-sack level. A decrease in unit weight ranging from

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2.9 to 5.4 lbs. per cubic foot at the 6-sack level, and 2.2 to 4.7 lbs. per cubic foot at the 7-1/2-sack level, is also noted. The amount of entrapped air increases for the smaller aggregate size for both cement factors. This variation is between 0 and 1.0% with an average variation of 0.6% for all sources. Concrete with more water and lower density has greater absorption and permeability and would be expected to have a lower overall durability, and provide less protection for reinforcing steel.

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TABLE 1

Combined Aggregate Gradings (Percent Passing)

Source	Bear River		Centerville		Irwindale		Sun Valley		El Rio		Healdsburg		Mission Valley		Otay		Aromas Hollister		Specs.	
Sieve Size	1-1/2"	3/4"	1-1/2"	3/4"	1-1/2"	3/4"	1-1/2"	3/4"	1-1/2"	3/4"	1-1/2"	3/4"	1-1/2"	3/4"	1-1/2"	3/4"	1-1/2"	3/4"	1-1/2"	1"*
2"	100		100		100		100		100		100		100		100		100		100	
1-1/2"	98		100		100		99		98		96		100		98		95		90-100	100
1"	68	100	72	100	72	100	69	100	71	100	72	100	72	100	71	100	69	100	50-86	90-100
3/4"	55	94	60	94	56	94	58	94	59	95	58.5	94	58	95	57	94	58	94.5	45-75	55-100
3/8"	42	56	44	56	42	55	43	55	45	56.5	42	53.5	43	56	43	55	43	55	38-55	45-75
#4	38	50	38	50	38	50	38	50	38	50	38	50	38	50	38	50	38	50	30-45	35-60
#8	29.5	38	28	39	32	43	33	42	32.5	42.5	31	40.5	29	37	31	42	30	39.5	23-35	27-45
#16	23	30	20	26	26	34	25	31	25.5	33.5	22	29	20	26	24	33	22	29	17-27	20-35
#30	16	21	13	18	18	25	16	21	16	21	14.5	19	14	18	17	22	15	20	10-17	12-25
#50	5	6.5	6	8	8	10	7	9	6.5	8.5	6.5	8.5	6	8	8	10	5.5	7.5	4-9	5-15
#100	1	1	2	2	2	2.5	2	2.5	2	2.5	2.5	3.5	2.5	3	2	2.5	2	2.5	1-3	1-5
#200	0.5	0.5	1	1	1	1	1	1	1	1.5	1	1.5	1	1	1	1.5	1	1	0-2	0-2

*A nominal size gradation that conforms to the requirements for 3/4-inch maximum size aggregate is considered under the 1-inch maximum size aggregate as defined in the California Division of Highways Standard Specifications.

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TABLE 2

AGGREGATE DESCRIPTIONS

Source	Deposit	Primary Shapes	Primary Petrographic Classification
Coarse Aggregate			
1 Bear River	Streambed	Rounded	Quartz, Quartzite, Quartzitic Meta Sedimentary
2 Centerville	Streambed	Subrounded	Sandstone, Vein Quartz, Volcanic & Meta Volcanic
3 Irwindale	Streambed	Subrounded	Granitic & Meta Granitic, Schist, Meta Diorite
4 Sun Valley	Alluvial Fan	Subangular	Granite, Quartz Diorite, Gabbro, Anorthosite
5 El Rio	Streambed	Subrounded	Sandstone and Meta Sandstone, Granitic and Meta Granitic
6 Healdsburg	Streambed	Rounded, Subrounded	Sandstone and Meta Sandstone, Volcanic, Vein Quartz
7 Mission Valley	Streambed	Angular	Rhyolite, Dacite
8 Otay	Streambed	Angular	Dacite, Basalt, Silicified Volcanic, Diorite, Gabbro
9 Aromas	Ledgerock	Angular	Quartz Diorite
Sand			
1 Bear River	Streambed	Angular	Quartz, Sandstone and Meta Sandstone, Volcanic
2 Centerville	Streambed	Rounded, Subrounded	Sandstone and Meta Sandstone, Vein Quartz, Volcanic and Meta Volcanic
3 Irwindale	Streambed	Angular, Subrounded	Granitic, Volcanic, Quartz
4 Sun Valley	Alluvial Fan	Subangular	Granitic, Quartz, Volcanic, Feldspar
5 El Rio	Streambed	Subangular	Quartz, Granitic, Quartzite, Volcanic
6 Healdsburg	Streambed	Rounded, Subrounded	Sandstone, Vein Quartz, Volcanic, Quartzite
7 Mission Valley	Streambed	Angular	Granitic, Volcanics and Meta Volcanics, Quartz
8 Otay	Streambed	Subangular	Dacite, Basalt, Silicified Volcanic, Diorite Gabbro
9 Hollister	Streambed	Angular, Subrounded	Quartz, Granitic, Sandstone, Volcanic

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TABLE 3

Aggregate Properties

Aggr. Size	1-1/2" x 3/4"			3/4" x No. 4			Sand			
Source	Spec. Grav.	Absorp. Percent	Clean-ness Value	Spec. Grav.	Absorp. Percent	Clean-ness Value	Spec. Grav.	Absorp. Percent	Sand Equiv.	Mortar Strength Percent
1 Bear River	2.60	0.9	97	2.61	0.9	91	2.59	0.9	100	110
2 Centerville	2.65	1.4	89	2.65	1.4	91	2.63	1.4	89	120
3 Irwindale	2.65	1.0	94	2.66	1.0	95	2.62	1.1	91	120
4 Sun Valley	2.68	1.1	91	2.68	1.1	90	2.64	1.1	91	120
5 El Rio	2.60	1.6	91	2.61	1.4	94	2.56	1.8	81	115
6 Healdsburg	2.69	1.4	89	2.67	1.5	89	2.63	1.9	79	120
7 Mission Valley	2.62	1.0	86	2.60	1.5	79	2.59	1.3	90	105
8 Otay	2.67	0.9	94	2.62	1.5	92	2.60	1.2	85	105
9 Aromas, Hollister	2.91	0.6	91	2.90	0.9	86	2.60	1.4	82	125

TABLE 4

Physical Properties of Fresh Concrete
(Average of 3 Rounds)

Mix Designation M.S.A.	C.F.	Slump, Inches	Air* %	Unit Wt. Lbs./CF	W/C Lbs./Sk.	Net Free Water Lbs./CY
Bear River						
3/4	6	3-1/2	1.4	146.6	49.8	297
1-1/2	6	3-1/2	1.0	150.1	43.0	261
3/4	7-1/2	3-1/2	1.6	147.2	40.0	304
1-1/2	7-1/2	4	1.1	150.2	36.5	279
Centerville						
3/4	6	2-3/4	1.8	148.0	48.0	287
1-1/2	6	3-1/2	1.6	150.9	43.2	261
3/4	7-1/2	3-1/2	2.0	148.2	40.2	303
1-1/2	7-1/2	4	1.3	150.4	37.5	283
Irwindale						
3/4	6	3-1/2	2.1	145.4	53.9	320
1-1/2	6	3-1/2	1.2	150.3	46.6	278
3/4	7-1/2	3-1/2	1.7	146.0	44.9	336
1-1/2	7-1/2	3-1/2	1.1	149.7	40.4	301
Sun Valley						
3/4	6	3-1/2	2.2	146.3	52.6	319
1-1/2	6	3-1/2	1.3	150.5	48.3	290
3/4	7-1/2	3-3/4	2.0	146.8	43.8	330
1-1/2	7-1/2	3-1/2	1.6	150.1	40.4	303
El Rio						
3/4	6	3-1/2	2.3	143.3	51.1	307
1-1/2	6	3-1/2	1.3	147.1	44.0	264
3/4	7-1/2	2-3/4	2.3	144.4	40.7	305
1-1/2	7-1/2	4	1.3	147.2	37.7	283
Healdsburg						
3/4	6	3-3/4	1.5	148.0	50.7	303
1-1/2	6	3-1/2	0.8	151.5	46.8	280
3/4	7-1/2	3-1/2	1.6	148.0	40.8	306
1-1/2	7-1/2	3-3/4	1.0	150.9	39.5	295
Mission Valley						
3/4	6	3-1/2	1.0	143.9	57.8	346
1-1/2	6	3-1/2	0.7	147.3	50.5	304
3/4	7-1/2	3-1/2	1.3	144.5	45.7	341
1-1/2	7-1/2	3-1/2	1.3	147.3	40.9	308
Otay						
3/4	6	3-1/2	1.3	145.3	57.8	343
1-1/2	6	3-1/2	0.6	149.2	51.5	309
3/4	7-1/2	3-1/2	1.4	145.6	47.0	348
1-1/2	7-1/2	3-1/2	0.9	149.5	42.2	316
Aromas - Hollister						
3/4	6	3-1/4	1.7	150.5	53.2	320
1-1/2	6	3-1/4	1.0	155.9	48.0	288
3/4	7-1/2	3-1/4	1.8	150.8	43.3	324
1-1/2	7-1/2	3-3/4	1.1	155.5	40.7	304

*Air determination made on only one batch from each mix.

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TABLE 5

Compressive Strengths (PSI)
Average of 6 Cylinders

Source		3/4" maximum size aggregate			1-1/2" maximum size aggregate		
Age		7 days	28 days	91 days	7 days	28 days	91 days
6 sks.cu.yd.							
1. Bear River	N*	3300	5160	5840	4060	5500	6370
2. Centerville	N	3020	4970	6020	3010	4770	5730
3. Irwindale	N	2550	4510	5200	3090	4710	5450
4. Sun Valley	N	2720	4400	5070	2920	4500	5000
5. El Rio	N	2790	4530	5130	3190	4450	5100
6. Healdsburg	N	2820	4730	5380	3250	4830	5310
7. Mission Valley	C	2160	3750	4720	2680	4310	5100
8. Otay	C	2330	3750	4730	2740	4080	5040
9. Aromas, Hollister	C	2930	4830	5640	3580	5160	6190
Average		2735	4515	5300	3165	4700	5475
7.5 sks./cu.yd.							
1. Bear River	N	4790	6450	7260	4690	6100	6750
2. Centerville	N	4010	5820	6810	3630	5210	5980
3. Irwindale	N	3740	5560	6450	3900	5550	6020
4. Sun Valley	N	3810	5370	6050	3740	5200	5870
5. El Rio	N	3920	5560	6290	3530	4920	5340
6. Healdsburg	N	4130	6130	6770	4030	5620	6270
7. Mission Valley	C	3440	5260	6290	3940	5490	6530
8. Otay	C	3200	4830	5740	3550	5110	5790
9. Aromas, Hollister	C	4020	5900	7000	4390	6120	7000
Average		3895	5655	6515	3930	5480	6170

*N - Naturally rounded primarily uncrushed aggregate
C - Crushed aggregate

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TABLE 6

Drying Shrinkage (Percent)
4x5x18-inch Specimens
Average of 3 Bars

Source	3/4-inch maximum size aggregate					1-1/2-inch maximum size aggregate				
	Days of Drying									
	7	14	28	56	91	7	14	28	56	91
6.0 Sks./cu.yd.										
1. Bear River	.017	.020	.030	.040	.048	.016	.020	.026	.031	.036
2. Centerville	.028	.040	.055	.079	.089	.032	.041	.054	.076	.085
3. Irwindale	.016	.025	.039	.054	.064	.017	.023	.034	.048	.053
4. Sun Valley	.018	.027	.039	.054	.065	.019	.028	.038	.052	.060
5. El Rio	.021	.029	.043	.057	.068	.022	.031	.041	.054	.063
6. Healdsburg	.024	.038	.058	.083	.094	.024	.034	.051	.070	.081
7. Mission Valley	.015	.024	.037	.056	.064	.015	.023	.031	.042	.048
8. Otay	.020	.029	.042	.058	.066	.018	.023	.033	.044	.051
9. Aromas-Hollister	.015	.022	.034	.047	.054	.013	.020	.028	.037	.043
Average	.019	.028	.042	.059	.068	.020	.027	.037	.050	.058
7.5 Sks./cu.yd.										
1. Bear River	.019	.022	.031	.040	.048	.018	.022	.028	.036	.041
2. Centerville	.029	.040	.054	.074	.085	.031	.041	.055	.073	.084
3. Irwindale	.018	.027	.040	.054	.064	.018	.026	.037	.048	.055
4. Sun Valley	.021	.030	.042	.055	.066	.021	.030	.040	.051	.060
5. El Rio	.021	.030	.041	.056	.064	.025	.032	.043	.056	.063
6. Healdsburg	.027	.039	.057	.077	.091	.025	.035	.049	.067	.078
7. Mission Valley	.019	.028	.038	.053	.061	.019	.027	.034	.048	.053
8. Otay	.020	.028	.041	.055	.064	.019	.026	.035	.045	.052
9. Aromas-Hollister	.016	.025	.036	.047	.055	.015	.021	.030	.038	.043
Average	.021	.030	.042	.057	.067	.021	.029	.039	.051	.059