DEPARTMENT OF TRANSPORTATION
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METHOD OF TEST FOR EVALUATION OF AGGREGATE FOR LEAN CONCRETE BASE (LCB)

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section J of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

This test method describes the procedure for (1) evaluating the strength-producing properties of aggregate for use in lean concrete base (LCB), and (2) determining the amount of portland cement needed in LCB to achieve the compressive strength design criteria with a given source of aggregate.

B. MATERIALS

1. Aggregate shall be representative of that to be used on the job.

2. Cement for the tests shall be the same brand as to be used in the proposed work, if available.

   If not available, cement conforming to the Standard Specifications for Type II Modified may be used.

C. EQUIPMENT

1. Cylinder Molds: 150 mm diameter by 150 mm high.

2. Unit Weight Measure.

3. Slump Cone.

4. Air Meter.

5. Tamping Rod:

   Round straight steel rod 15 mm diameter with tamping end rounded to hemispherical tip of the same diameter as the rod.

6. Concrete Mixer:

   A power-driven revolving drum tilting mixer, revolving pan, or revolving paddle mixer capable of thoroughly mixing batches of the prescribed sizes at the required slump.

D. PROCEDURE

1. Design the lean concrete base at 155, 170, and 185 kg of cement per cubic meter. The size of the batch shall be at least 0.011 m^3 or a minimum of 50 % the capacity of the mixer, whichever is larger.

2. Prior to batching the test mixes, combine and thoroughly mix all materials of each primary size as submitted from the job. Quarter or split into design batch quantities using accepted procedures outlined in California Test 201 (Section H).

3. Prepare three separate batches for each mix design.

NOTE: The intent is to have 3 batches mixed with cement content below the specified minimum, 3 above the specified maximum, and 3 in-between the specified limits. If the distribution of the actual cement contents calculated (Section F below) does not meet this distribution, make additional batches until there are at least 3 in each cement content category. Do not discard any data except as described in Section G below.

4. Mix each batch according to established laboratory procedure (ASTM C-192).

   Prior to starting rotation of the mixer, add the aggregate, some of the mixing water, and the solution of admixture. Admixtures shall be dispersed in about one-half of the mixing water before addition. Start the mixer, then add the cement and remaining water with the mixer running. If it is impractical to add the cement and water while the mixer is running, these components may be added to the stopped mixer after permitting it to turn a few revolutions following charging with aggregate and some of the water. Mix the concrete, after all ingredients are in the mixer, for 3 min. followed by 3 min. rest, followed by 2 min. final mixing. Cover the open end or top of the mixer to prevent evaporation during the rest period. Take precautions to compensate for mortar retained by the mixer so that the discharged batch, as used, will be correctly proportioned. To eliminate segregation, deposit machine-mixed concrete in a clean, damp mixing pan and remix by shovel or trowel until it appears to be uniform.

   It is difficult to recover all of the mortar from mixers. To compensate for this difficulty, the following procedure may be used to ensure the correct final proportions in the batch:

   Just prior to mixing the test batch, the mixer is "buttered" by mixing a batch proportioned to simulate closely the test batch. The mortar adhering to the mixer after discharging is intended to compensate for loss of mortar from the test batch.

5. Adjust the water content to obtain a slump of 65 ± 15 mm (ASTM C-143).

6. Adjust the amount of air-entraining admixture to result in an air content of $3^1/_2$ % ± $^1/_2$ % (California Tests 504 or 543, the latter to be used with slag or other highly porous aggregates).

7. Determine Unit Weight of the fresh concrete (California Test 518).

8. Fabricate a minimum of three cylinders for 7-day tests. Additional cylinders may be fabricated for special tests from the remaining mixture if desired. Concrete should be placed in the molds in two approximately equal layers, each of which is rodded 25 times. Gently pat the sides of the molds after rodding each layer to remove any air entrapped along the sides of the mold.

9. After the top layer has been rodded and the sides of the mold patted, strike off the surface of the concrete even with the top edge of the mold. Wipe the sides of the mold free of excess concrete and place lid on the can to prevent evaporation.

E. HANDLING OF SPECIMENS

1. Store specimens in a vibration free environment at 23° ± 1½°C for approximately 24 h.

2. On the day after fabrication (24 ± 4 h), remove lids and place specimens in a moist room or cabinet or in saturated limewater. DO NOT ATTEMPT TO REMOVE MOLDS PRIOR TO OR DURING THE MOIST CURE PERIOD.

3. At the age of 7 days after fabrication, remove the specimens from moist curing, strip from molds, cap (ASTM C-617) and

test in compression (California Test 521). Use care in handling the specimens.

F. CALCULATIONS

1. The volume of LCB, S, per batch is calculated as follows:

$$S = (W_a + W_f + W_c + W_w)/W$$

Where:

S = Volume of concrete per batch in m^3.

W_a = Total mass of cement in the batch in kg.

W_f = Total mass of fine aggregate, including moisture as batched, in kg.

W_c = Total mass of coarse aggregate, including moisture as batched, in kg.

W_w = Total mass of water added during mixing per batch, in kg.

W = Unit weight of the fresh LCB as determined under D-7 above, in kg/m^3.

2. Cement Content:

The cement content, "CC", in kg/m^3 of LCB produced is calculated as follows:

$$CC = N/S$$

Where:

CC = The cement content in kg/m^3.

N = The mass of cement in the batch, in kg.

S = Volume of LCB produced per batch in m^3 as determined in F-1, above.

3. Compressive Strength:

Calculate the compressive strength as the average of the three LCB cylinders tested. Round off test results to two significant figures. Do not make any compressive strength corrections for LCB specimen lengths.

G. EVALUATING THE AGGREGATE FOR SPECIFICATION COMPLIANCE

1. Record all LCB test results as shown in Table 1.

2. Prepare a graph using the data as illustrated in Figure 1. Plot individual compressive strengths (ordinate) versus Portland cement contents (abscissa).

3. Calculate a least square best fit line by linear regression, using all available data points.

4. Plot the regression line on the graph.

5. Examine the graph for any outlying data points that obviously do not fit the trend. Eliminate outliers from the data and recalculate the regression line.

6. Plot the specification requirement for strength vs. cement content (aggregate qualification point).

7. If the point established in G-6 is on or below the line established in G-4 or 5, the aggregate complies with the specification. If it is above the line, the aggregate does not meet the specification.

NOTE: Use the graph format shown in Figure 1.

H. DETERMINING RECOMMENDED MINIMUM CEMENT CONTENT (For

aggregate complying with specification requirements)

1. Determine the point where the design strength intersects the strength curve.

2. Read the cement content on the abscissa.

3. Increase this cement content to the next higher multiple of 5kg. This is the recommended minimum cement content for LCB to be reported.

4. Alternatively, insert the design compressive strength into the regression equation calculated in Part G above to determine the corresponding portland cement content and round up as in H-3 above.

I. REPORTING OF RESULTS

The test report shall include:

1. A statement as to aggregate compliance to specifications.

2. Recommended minimum cement content for LCB.

3. Summary of all test data and mix design information.

4. Copy of graph used to determine the cement content.

J. SAFETY AND HEALTH

Portland cement, when mixed with water, makes an alkaline solution. Contact with the skin can cause drying and cracking. Take care to prevent skin contact by wearing impervious gloves. If skin contact occurs, wash promptly with soap and water.

Mixing and fabricating concrete specimens often involves lifting and stooping. Use proper lifting practices to prevent injury.

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCES:

ASTM Designations C-143, C-192, C-617
California Tests 201, 206, 208, 504, 518, 521, 543

End of Text (California Test 548 contains 5 Pages)

Aggregate Source	Dist. Co. Rte	Date
	Contract	

Mix #	Density	Slump	Air Content	Cement Content	7d Strength
155A	2200	65	1.5	155.70	3.57
155B	2190	70	3.1	154.70	3.27
155C	2190	60	2.5	155.00	3.18
170A	2205	65	2.9	165.80	4.02
170B	2195	80	2.0	171.30	4.18
170C	2195	65	2.7	170.60	4.40
185A	2210	70	3.2	188.90	5.78
185B	2200	75	3.0	184.10	5.52
185C	2200	60	3.1	184.20	5.07

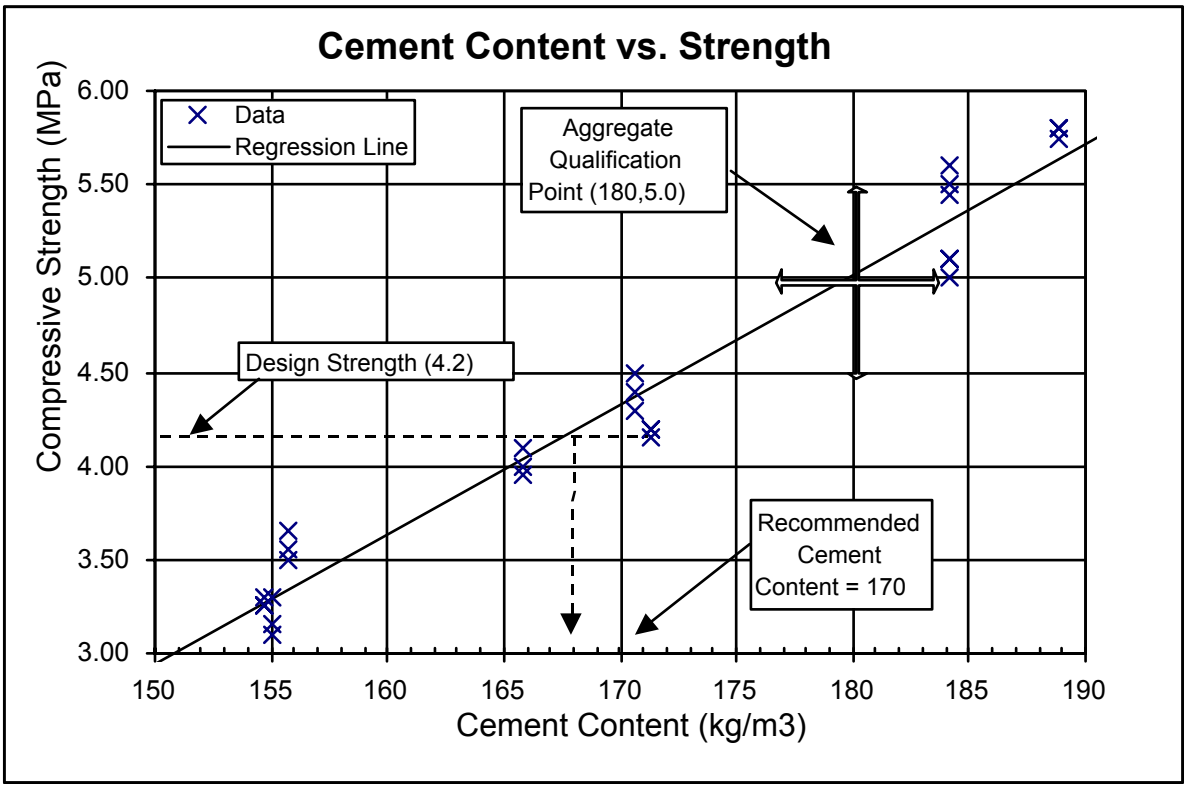

FIGURE 1