

## Proportioning Determinations

**A.07 COMBINING TWO AGGREGATES**—The basic formula for combining two aggregates is:

$$P = Aa + Bb \quad (2)$$

Since  $a + b = 1$ , then  $a = 1 - b$ . Substituting this into Eq. 2 and solving for  $b$ :

$$b = \frac{P - A}{B - A} \quad (3)$$

An expression for  $a$ , can also be found:

$$a = \frac{P - B}{A - B} \quad (4)$$

Assume that a single aggregate stockpile is to be blended with sand to meet grading requirements for an asphalt paving mixture. These are given in Figure A-3a as aggregates A and B. To make a determination:

1. Examine the two gradations to determine which aggregate will contribute most of the material for certain sizes. In this case, most of the minus No. 8 aggregate will be furnished by aggregate B.

2. Using the percentages for the No. 8 sieve and substituting into Eq. 3, the proportions are determined to meet the midpoint of the specification (Figure A-3b).

3. Inspection of the blended gradation shows the percent passing No. 200 close to the lower specification limit. Increase the proportion of aggregate B (in this case to 0.55) and compute the gradation of the revised blend (Figure A-3c).

4. Inspection now shows the gradation is critical on the No. 30 sieve. Reduce the proportion of aggregate B to 0.52 or 0.53 and compute the gradation of the revised blend (Figure A-3d).

The two aggregates may be combined graphically (Figure A-4) as follows:

1. The percents passing the various sizes for aggregate A are plotted on the right-hand vertical scale (representing 100 percent aggregate A).

2. The percents passing the various sizes for aggregate B are plotted on the left-hand vertical scale (representing 100 percent aggregate B).

### PER CENT PASSING

Sieve	3/4"	1/2"	3/8"	No. 4	8	30	50	100	200
Spec.	100	80-100	70-90	50-70	35-50	18-29	13-23	8-16	4-10
Aggr. A	100	90	59	16	3.2	1.1	0	0	0
Aggr. B	100	100	100	96	82	51	36	21	9.2

(a) Grading Specification and sieve analyses of aggregates

For (No. 8),  $b = \frac{P-A}{B-A} = \frac{42.5-3.2}{82-3.2} = 0.50$ ,  $a = 1-0.50 = 0.50$

Sieve	3/4"	1/2"	3/8"	No. 4	8	30	50	100	200
.50 x A	50	45.0	29.5	8.0	1.6	0.6			
.50 x B	50	50.0	50.0	48.0	41.0	25.0	18.0	10.5	4.6
Total	100	95.0	79.5	56.0	42.6	25.6	18.0	10.5	4.6
Spec.	100	80-100	70-90	50-70	35-50	18-29	13-23	8-16	4-10

Minus No. 200 low, increase b to 0.55, a to 0.45

(b) First trial combination

Sieve	3/4"	1/2"	3/8"	No. 4	8	30	50	100	200
.45 x A	45	40.5	26.6	7.2	1.4	0.5			
.55 x B	55	55.0	55.0	52.8	45.1	28.0	19.8	11.5	5.1
Total	100	95.5	81.6	60.0	46.5	28.5	19.8	11.5	5.1
Spec.	100	80-100	70-90	50-70	35-50	18-29	13-23	8-16	4-10

Minus No. 30 high, let b = 0.52, a = 0.48

(c) Second trial combination

Sieve	3/4"	1/2"	3/8"	No. 4	8	30	50	100	200
.48 x A	48	43.2	28.3	7.7	1.5	0.5	0	0	0
.52 x B	52	52	52	49.9	42.6	26.5	18.7	10.9	4.8
Total	100	95.2	80.3	57.6	44.1	27.0	18.7	10.9	4.8
Spec.	100	80-100	70-90	50-70	35-50	18-29	13-23	8-16	4-10

(d) Third trial combination

Figure A-3—Trial-and-error calculations for combining two aggregates

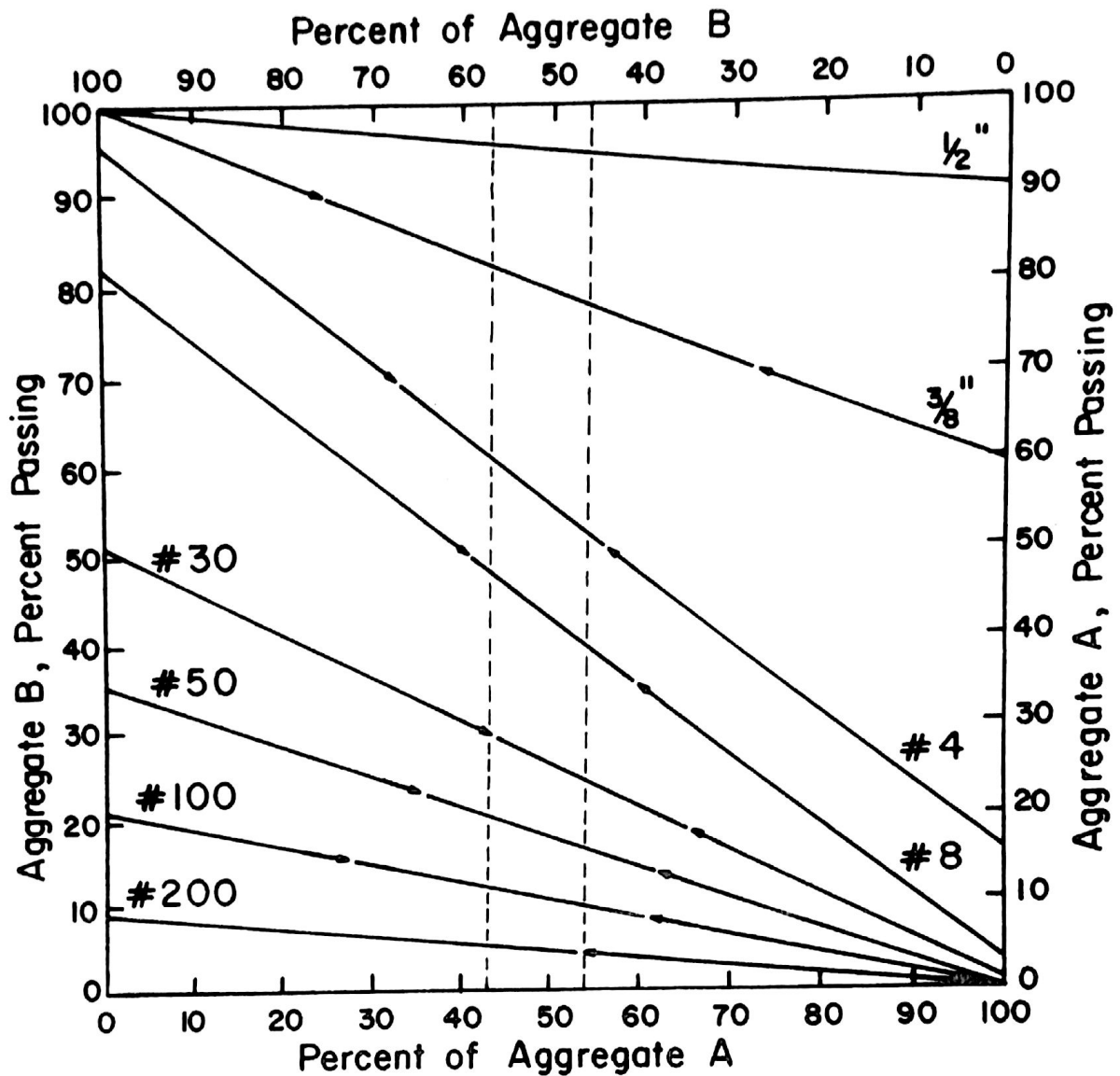


Figure A-4—Solution for proportioning two aggregates

3. Connect the points common to the same size with straight lines, and label.

4. For a particular size, indicate on the straight line where the line crosses the specification limits measured on the vertical scale. (Note that for the 3/8-in. (9.5 mm) size, two points are plotted on the line at 70 and 90 percent on the vertical scale.)

5. That portion of the line between the two points represents the proportions of aggregates A and B, measured on the horizontal scale, that will not exceed specification limits for that particular size.

6. The portion of the horizontal scale designated by two vertical lines, when projected vertically, is within specification limits for all sizes and represents the limits of proportions possible for satisfactory blends. In this case, 43 to 54 percent of aggregate A and 46 to 57 percent of aggregate B will meet specifications when blended. It can

also be seen that the percent of blended material passing the No. 30 and 200 sieves will be the critical or controlling values for keeping the blend within specification limits.

7. For blending, usually the midpoint of that horizontal scale is selected for the blend. In this case, 48 percent aggregate A and 52 percent aggregate B.

**A.08 COMBINING THREE AGGREGATES**—Assume that mineral filler, C, is to be blended with aggregates A and B to obtain a gradation meeting specification requirements. The specification and gradations are given in Figure A-5 where:

1. An inspection of the gradations indicates that there is a reasonably clean separation between the plus No. 8 sizes and minus No. 8 sizes. Aggregate A will furnish most of the plus No. 8 sizes.

2. Determine the approximate proportion of aggregate A required to obtain 42.5 percent passing the No. 8 sieve (midpoint of specification range), using Eq. 4. (See Figure A-5).

3. The percentages passing No. 200 sieve are examined next. Values are substituted into Eq. 1. The remainder of the calculations are self-explanatory.

Should the blended gradation exceed specification limits, that proportion in the blend apparently responsible should be altered, with the other proportions altered to make up a total of 100 percent.

Trial-and-error solutions are just that. An inspection of the gradations for indications to assist in establishing proportions narrows the number of solutions considerably.

Graphical methods usually help in trial-and-error solutions; when they do not, it is necessary to determine the proportions in cases of aggregate gradations having overlapping grading curves. Several graphical methods are possible, but this appears to be one of the more practical procedures. Each of the aggregates is divided into the following gradings:

- (a) percent material retained on No. 8 sieve
- (b) percent material passing No. 8 but retained on No. 200 sieve
- (c) percent material passing No. 200 sieve.

The specification limits are divided in a somewhat similar manner: allowable percentage limits retained on a No. 8 sieve, and allowable percentage limits passing No. 200 sieve.

Points representing each of the three aggregate gradings are plotted on a chart, Figure A-6. Although only the portion retained on the No. 8 sieve and the portion passing the No. 200 sieve are used for each of the