Aggregate Blending

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To meet the gradation specifications for a concrete or asphalt mix, we usually have to blend aggregate from several sources together. To find an aggregate source with exactly the right gradation is highly improbable.

If we only have to blend two aggregates together, we can usually calculate the proportions directly. If we need to combine three or more aggregates, we have to resort to trial-and-error.

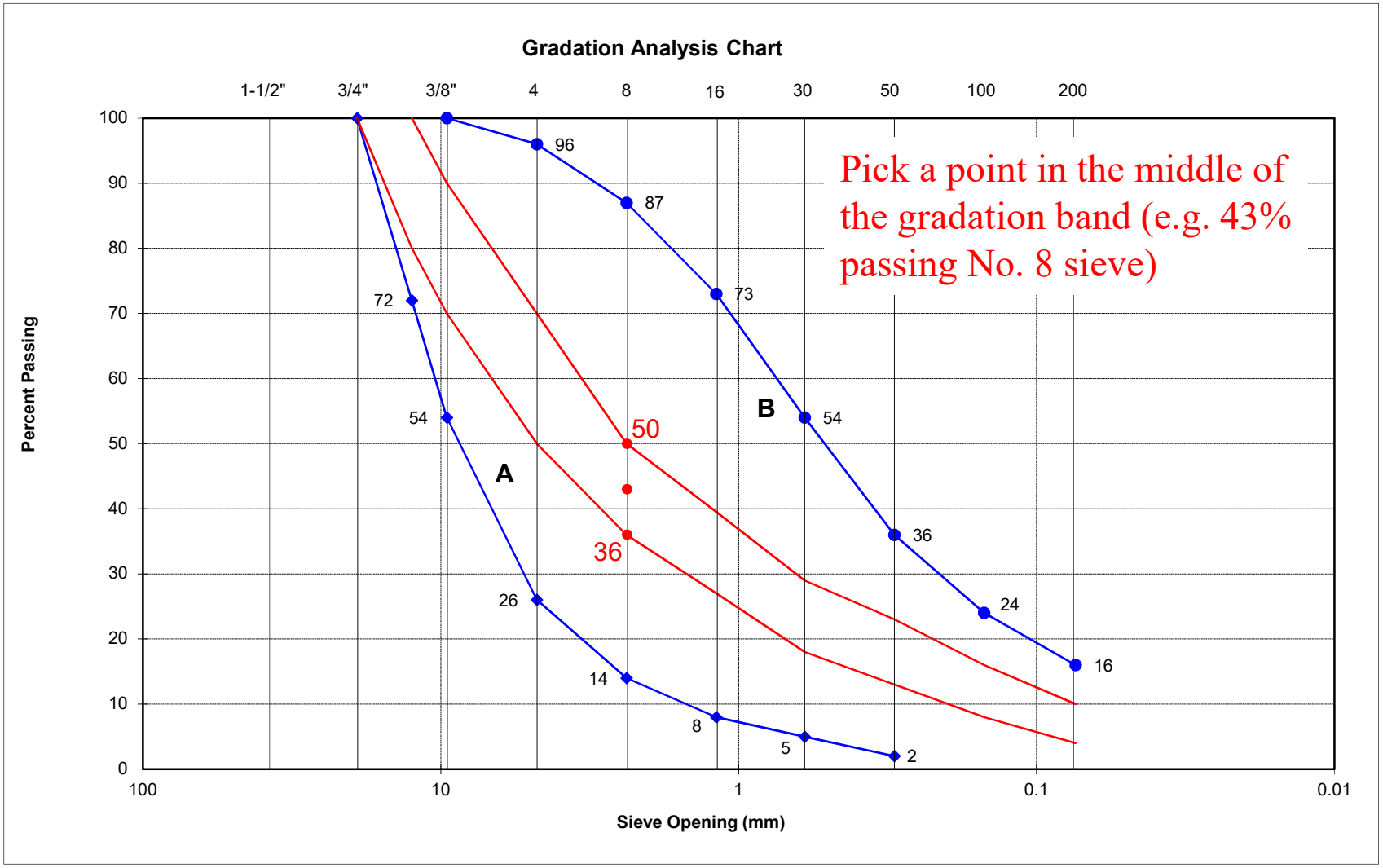
Aggregate Blending

$$p^i_{blend} = f_A\, p^i_A + f_B\, p^i_B + f_C\, p^i_C + \cdots$$

p^i_x = percent of material x passing sieve i

f_x = fraction of blend contributed by material x

Two-Aggregate Example



Two-Aggregate Example

$$p_{blend}^{No.8} = f_A\, p_A^{No.8} + f_B\, p_B^{No.8} = 43\%$$

$$f_A + f_B = 1$$

$$p_{blend}^{No.8} = f_A\, p_A^{No.8} + \left(1 - f_A\right) p_B^{No.8} = 43\%$$

Solution

$$43 = f_A 14 + (1 - f_A)87$$

$$43 = f_A 14 + 87 - f_A 87$$

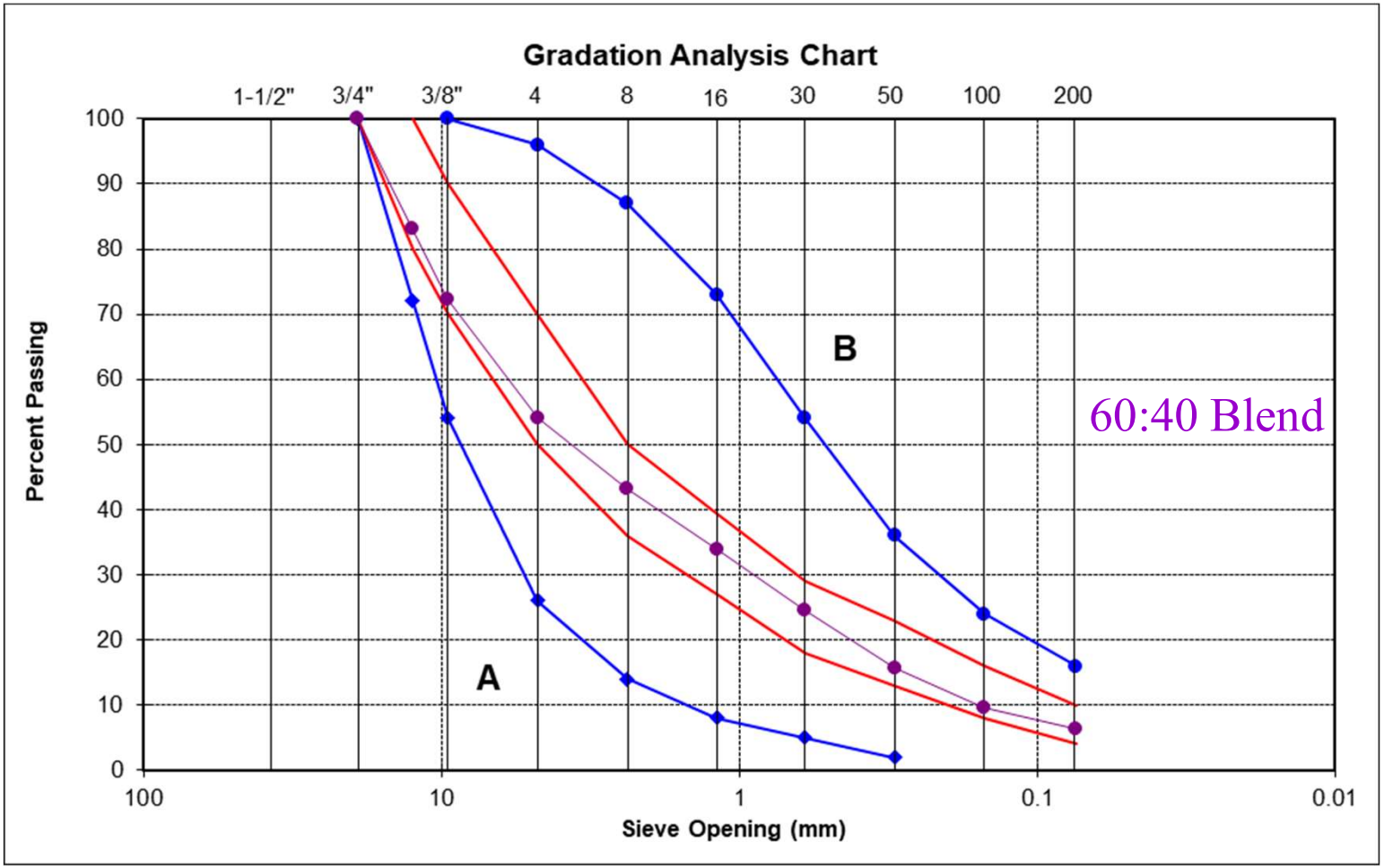
$$-44 = -73 f_A$$

$$f_A = 0.6$$

Solution

Sieve	Percent Passing		
Number	A	Blend	B
3/4 in	100	0.6 (100) + 0.4 (100) = 100.0	100
1/2 in	72	0.6 (72) + 0.4 (100) = 83.2	100
3/8 in	54	0.6 (54) + 0.4 (90) = 72.4	100
No. 4	26	0.6 (26) + 0.4 (70) = 54.0	96
No. 8	14	0.6 (14) + 0.4 (50) = 43.2	87
No. 16	8	0.6 (8) + 0.4 (40) = 34.0	72
No. 30	5	0.6 (5) + 0.4 (29) = 24.6	54
No. 50	2	0.6 (2) + 0.4 (23) = 15.6	36
No. 100	0	0.6 (0) + 0.4 (16) = 14.4	24
No. 200	0	0.6 (0) + 0.4 (10) = 4.0	16

Solution


Gradation Analysis Chart
1-1/2"
3/4"
3/8"
4
8
16
30
50
100
200
100
90
80
70
60
50
40
30
20
10
0
Percent Passing
B
A
60:40 Blend
100
10
1
0.1
0.01
Sieve Opening (mm)

Trial-and-Error Solution

Let's look at the TDOT specification for an asphalt concrete mix that would be used on the shoulders of an interstate highway (411-E).

An asphalt plant in Middle Tennessee had stockpiles of No. 78 stone, natural sand, and screenings. What proportions of these three materials are needed to meet the TDOT specification?

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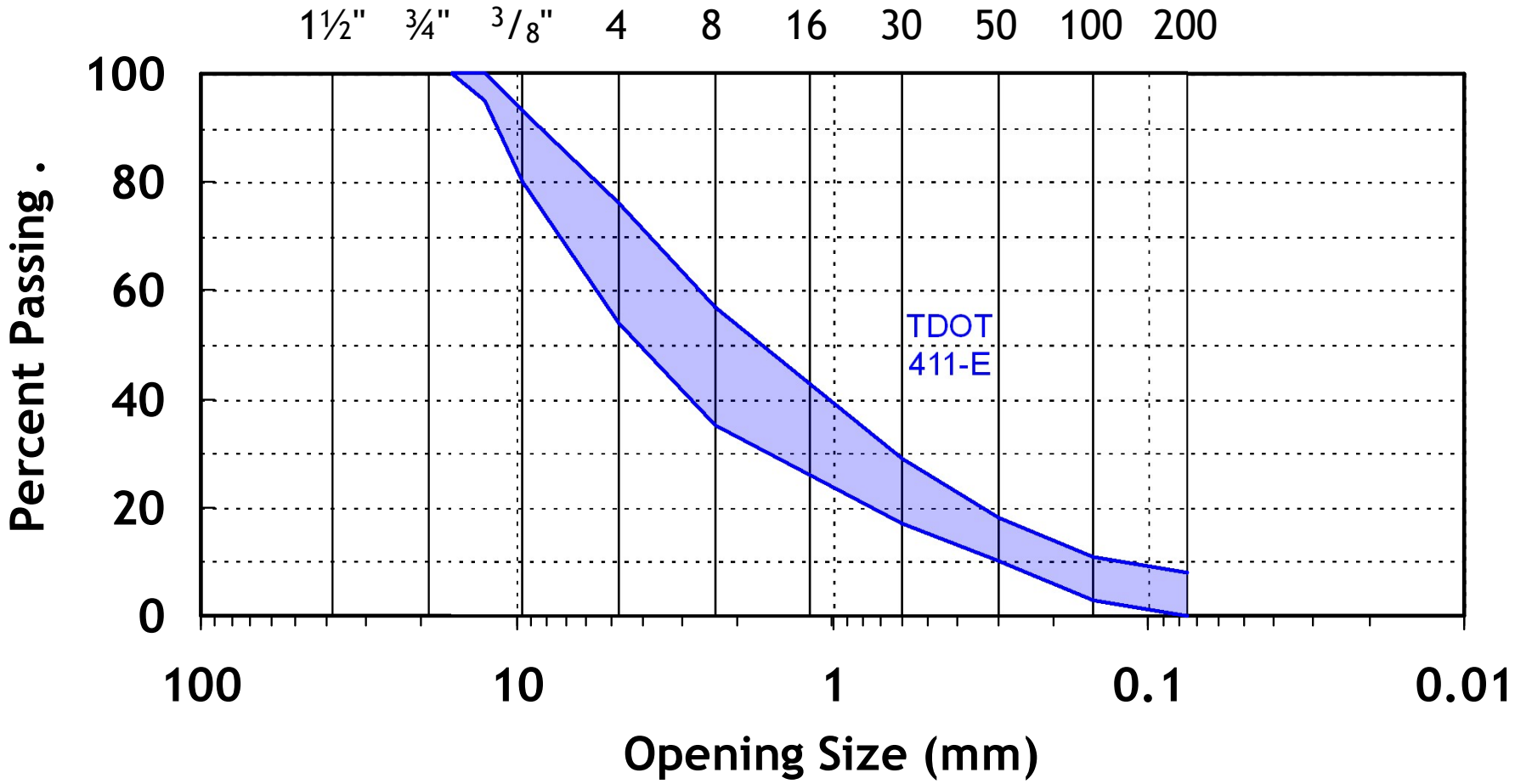
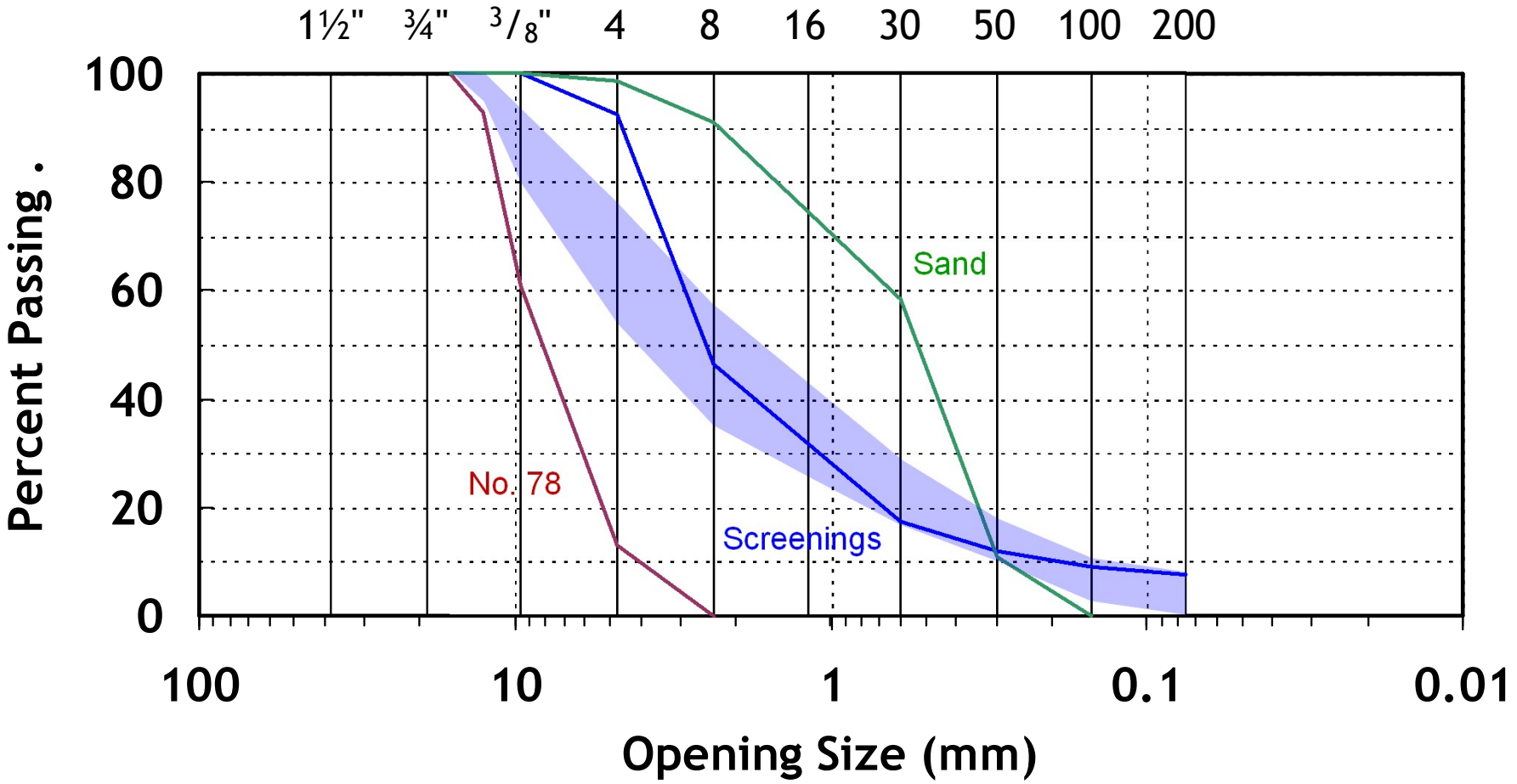


Aggregate Blending

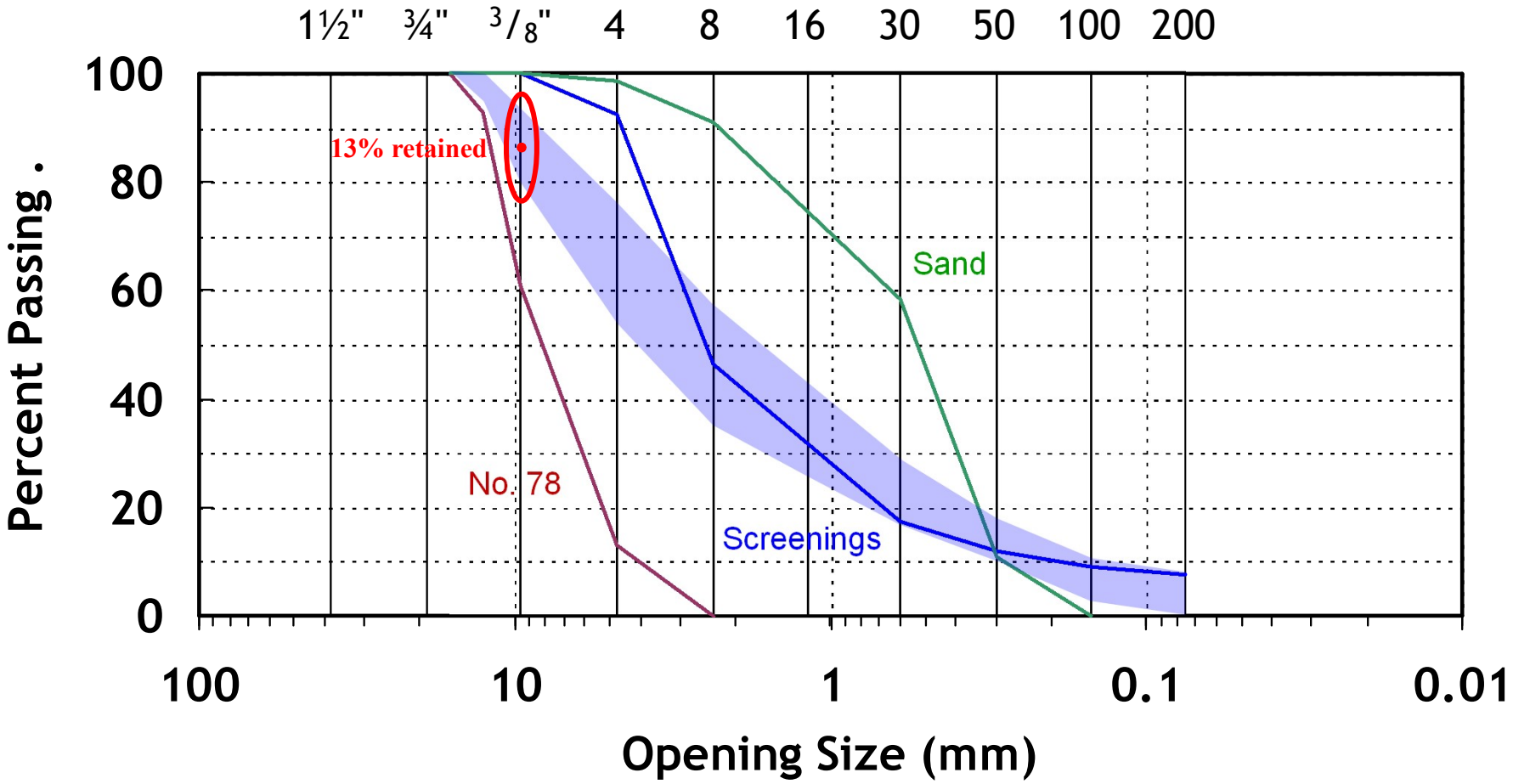


Aggregate Blending

The TDOT specification requires approximately 13% be retained on the 3/8" sieve but the screenings and sand have nothing retained on that sieve, so all of the coarse sizes will have to come from the crushed stone.

The crushed stone has 38% retained on the 3/8" sieve, so the crushed stone should be roughly $13/38 \approx 1/3$ of the blend.

Aggregate Blending



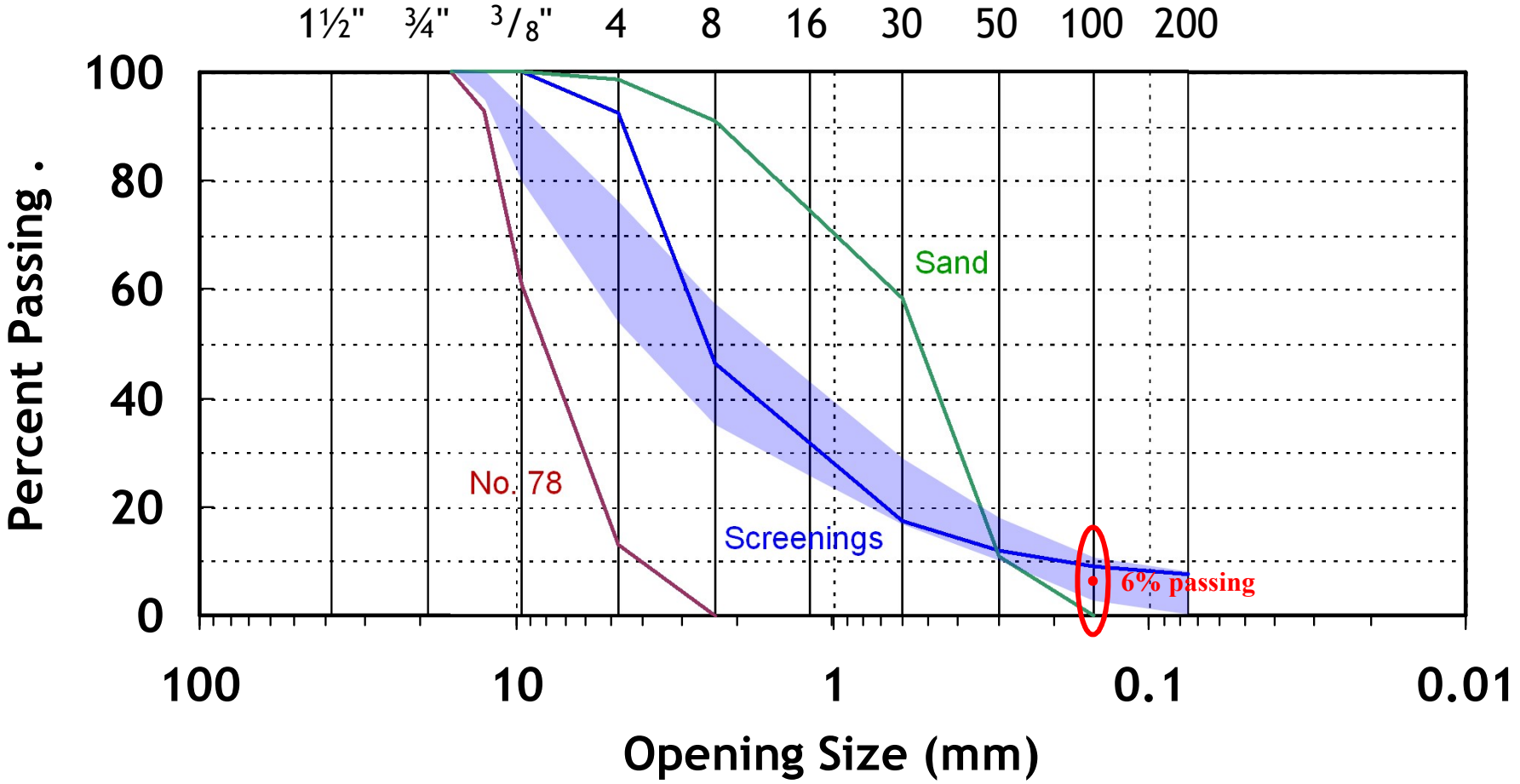
Aggregate Blending

The TDOT specification requires approximately 6% pass the No. 100 sieve but the sand and stone have nothing passing the No. 100 sieve, so all of the fine sizes will have to come from the screenings.

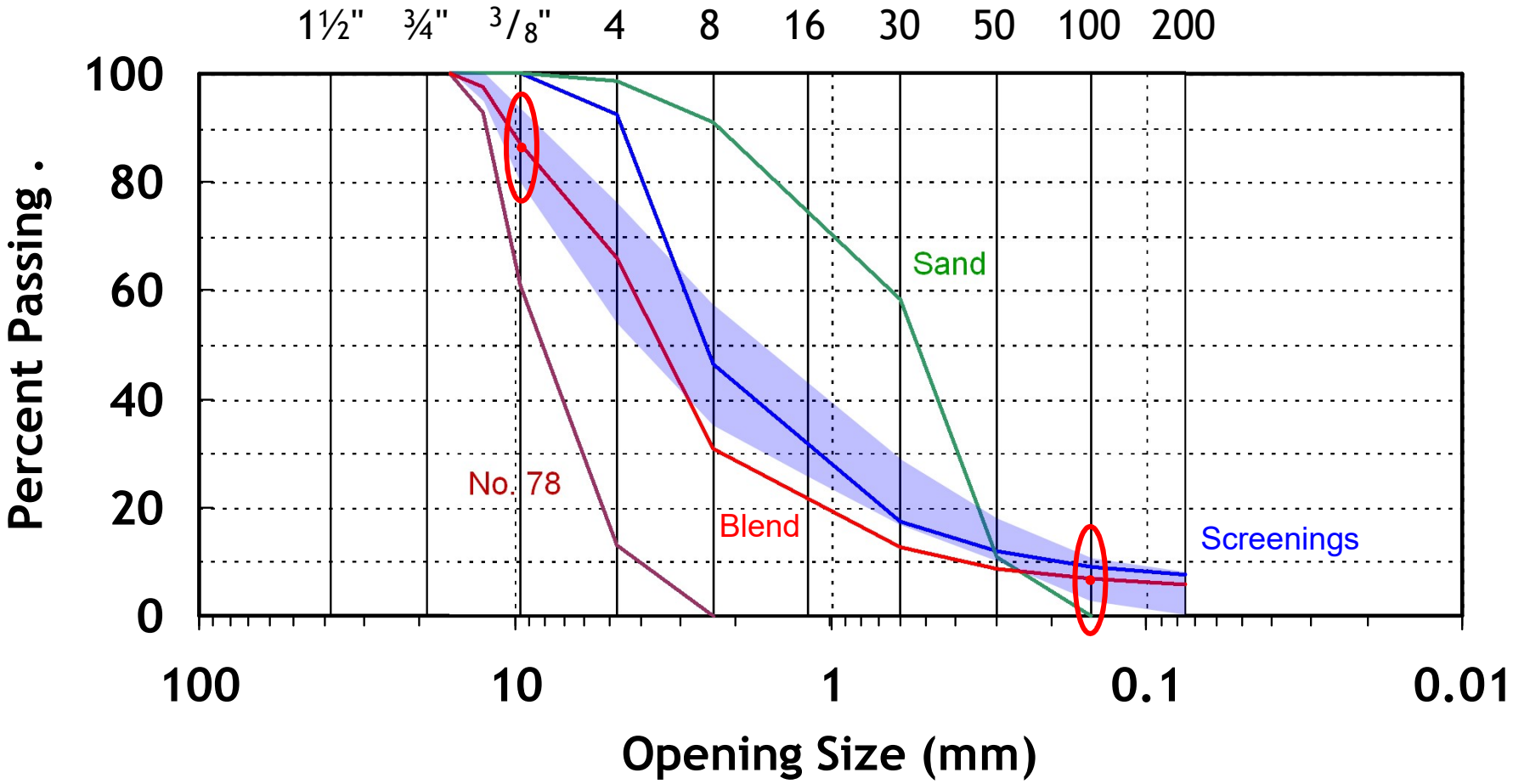
The screenings have 9% passing the No. 100 sieve, so they will have to be $6/9 \approx 2/3$ of the blend.

This suggests that a blend of 1/3 crushed stone and 2/3 screenings will get us in the ballpark.

Aggregate Blending



Aggregate Blending



Aggregate Blending

As we expected, we fit the specifications at the two ends, but we don't have enough material between the No. 8 and No. 50 sieves. That's where the sand comes in. Most of its particles are in that size range.

We now need to start adding sand into the blend until we get a gradation curve we're happy with. As the amount of sand goes up, the amount of screenings and stone will have to go down to make room.

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