



# **AGGREGATES**

## **Section 5 – Developing A Job Mix Formula (JMF)**

# Developing a Job Mix Formula

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**The actual calculations in this section will not be on the exam but you would need to have an appreciation to the process. In addition, you would need to be able to answer general questions about the process.**

# Developing A JMF

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- **JMF – The optimum combination of materials meeting all mix design and specification requirements**
  
- **Two parts (minimum)**
  - ▶ **Gradation established by blending**
  
  - ▶ **Asphalt Content – Mix Design**
  
  - ▶ **Adjustment of blends if mix design doesn't meet all requirements.**

# Trial and Error Method

- **Step 1 – Gather Data**
  - ▶ **Gradation of each aggregate**
    - ◆ **AASHTO T 11 & T 27**
  - ▶ **Specification Tolerances**
- **Step 2 – Select Target Values**
  - ▶ **Center of Limits As a Starting Point**

# Trial and Error Method (continued)

- **Step 3 – Make a Guess**
  - ▶ **Select Percentages of Each**
  - ▶ **Start with Control Sieves; #4, #200**
- **Step 4 – Perform Calculation**
  - ▶ ***Multiply selected % x % passing each sieve***
  - ▶ ***Add amounts from each material***

# **Trial and Error Method (continued)**

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- **Step 5 – Compare With Target Values**
  - ▶ **Compare each sieve**
  - ▶ **Determine adjustment to meet target**
  
- **Step 6 – Repeat To Find Optimum**

# Example 1a

<b>Material</b>	<b>AGG #1</b>		<b>AGG #2</b>		<b>Combined Gradation</b>	<b>Target Value</b>	<b>Specification Limits</b>
<b>Percent Used</b>							
<b>U.S. Sieves</b>	<b>Percent Passing</b>	<b>Percent Batch</b>	<b>Percent Passing</b>	<b>Percent Batch</b>			
<b>3/8"</b>	<b>100</b>		<b>100</b>				<b>100</b>
<b>No. 4</b>	<b>90</b>		<b>100</b>				<b>80-100</b>
<b>No. 8</b>	<b>30</b>		<b>100</b>				<b>65-100</b>
<b>No. 16</b>	<b>7</b>		<b>88</b>				<b>40-80</b>
<b>No. 30</b>	<b>3</b>		<b>47</b>				<b>20-65</b>
<b>No. 50</b>	<b>1</b>		<b>32</b>				<b>7-40</b>
<b>No. 100</b>	<b>0</b>		<b>24</b>				<b>3-20</b>
<b>No. 200</b>	<b>0</b>		<b>10</b>				<b>2-10</b>

# Example 1b

Material	AGG #1		AGG #2						Combined Gradation	Target Value	Specification Limits
Percent Used	50%		50%								
U.S. Sieves	Percent Passing	Percent Batch	Percent Passing	Percent Batch	Percent Passing	Percent Batch	Percent Passing	Percent Batch			
2"											
1.5"											
1"											
3/4"											
1/2"											
3/8"	100									100	100
No. 4	90									90	80-100
No. 8	30		100							83	65-100
No. 16	7		88							60	40-80
No. 30	3		47							43	20-65
No. 50	1		32							23	7-40
No. 100	0		24							12	3-20
No. 200	0		10							6.0	2-10

GUESS

CALCULATIONS

$100 * 0.50 = 50$   
 $90 * 0.50 = 45$   
 $30 * 0.50 = 15$   
 $7 * 0.50 = 3.5$   
 $3 * 0.50 = 1.5$   
 $1 * 0.50 = 0.5$



# Example 1c

Material	AGG #1		AGG #2		Combined Gradation	Target Value	Specification Limits
Percent Used	50%		50%				
U.S. Sieves	Percent Passing	Percent Batch	Percent Passing	Percent Batch			
3/8"	100	50	100	50	100 ✓	100	100
No. 4	90	45	100	50	95 ↓	90	80-100
No. 8	30	15	100	50	65 ↑	83	65-100
No. 16	7	3.5	88	44	47.5 ↑	60	40-80
No. 30	3	1.5	47	23.5	25 ↑	43	20-65
No. 50	1	0.5	32	16	16.5 ↑	23	7-40
No. 100	0		24	12	12 ✓	12	3-20
No. 200	0		10	5.0	5.0 ↑	6.0	2-10

# Example 1d

Material	AGG #1		AGG #2		Combined Gradation	Target Value	Specification Limits
	30%		70%				
Percent Used	Percent Passing	Percent Batch	Percent Passing	Percent Batch			
U.S. Sieves	Percent Passing	Percent Batch	Percent Passing	Percent Batch			
3/8"	100	30	100	70	100 <sup>✓</sup>	100	100
No. 4	90	27	100	70	97 <sup>↓</sup>	90	80-100
No. 8	30	9	100	70	79 <sup>↑</sup>	83	65-100
No. 16	7	2.1	88	61.6	63.7 <sup>↓</sup>	60	40-80
No. 30	3	0.9	47	32.9	33.8 <sup>↑</sup>	43	20-65
No. 50	1	0.3	32	22.4	22.7 <sup>✓</sup>	23	7-40
No. 100	0	-	24	16.8	16.8 <sup>↓</sup>	12	3-20
No. 200	0	-	10	7.0	7.0 <sup>↓</sup>	6.0	2-10

# Example 1e

Material	AGG #1		AGG #2		Combined Gradation	Target Value	Specification Limit
	35%		65%				
Percent Used	Percent Passing	Percent Batch	Percent Passing	Percent Batch			
U.S. Sieves	Percent Passing	Percent Batch	Percent Passing	Percent Batch			
3/8"	100	35	100	65	100 <sup>✓</sup>	100	100
No. 4	90	31.5	100	65	96.5 <sup>↓</sup>	90	80-100
No. 8	30	10.5	100	65	75.5 <sup>↑</sup>	83	65-100
No. 16	7	2.4	88	57.2	59.6 <sup>✓</sup>	60	40-80
No. 30	3	1.0	47	30.5	31.5 <sup>↑</sup>	43	20-65
No. 50	1	0.3	32	20.8	21.1 <sup>↑</sup>	23	7-40
No. 100	0	-	24	15.6	15.6 <sup>↓</sup>	12	3-20
No. 200	0	-	10	6.5	6.5 <sup>↓</sup>	6.0	2-10

# Example 2a

Material Percent Used	Crushed Gravel		Crushed Sand #2		Fine Sand #3		Filler		Combined Gradation	Target Value	Specification Limits
	U.S. Sieves	Percent Passing	Percent Batch	Percent Passing	Percent Batch	Percent Passing	Percent Batch	Percent Passing			
1.5"	100									100	100
1"	93									95	90-100
1/2"	54		100							70	60-80
No. 4	5		99		100					43	25-60
No. 8	1		94		90					30	15-45
No. 50	0		12		65		100			11	3-18
No. 200	0		1.0		12		80			4.0	1-7

# Example 2b

Material Percent Used	Crushed Gravel #1		Crushed Sand #2		Fine Sand #3		Filler		Combined Gradation	Target Value	Specification Limits
	68%		14%		15%		3%				
U.S. Sieves	Percent Passing	Percent Batch	Percent Passing	Percent Batch	Percent Passing	Percent Batch	Percent Passing	Percent Batch			
1.5"	100	68	100	14	100	15	100	3	100 ✓	100	100
1"	93	63.2	100	14	100	15	100	3	95.2 ✓	95	90-100
3/4"											
1/2"	54	36.7	100	14	100	15	100	3	68.7 ↑	70	60-80
3/8"											
No. 4	5	3.4	99	13.9	100	15	100	3	35.3 ↑	43	25-60
No. 8	1	0.7	94	13.2	90	13.5	100	3	30.4 ✓	30	15-45
No. 16											
No. 30											
No. 50			12	1.7	65	9.8	100	3	14.5 ↓	11	3-18
No. 100											
No. 200			1.0	0.1	12	1.8	80	2.4	4.3 ↓	4	1-7