ONLINE LEARNING

MARSHALL MIX DESIGN

Design an economical blend of aggregates and asphalt that meet the design requirements

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HMA Mix Design

- **Design objectives – Develop an economical blend of aggregates and asphalt that meet design requirements**
- **Historical mix design methods:**

1. **Marshall – use impact hammer**
2. **Hveem – use kneading compactor**

New:

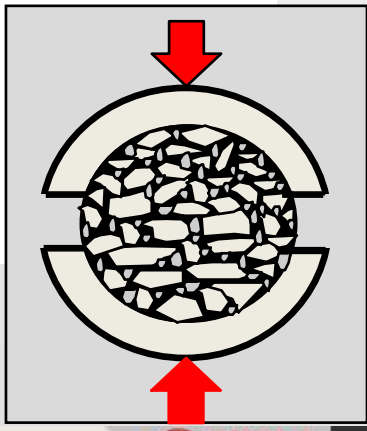
3. **Superpave gyratory – use gyratory compactor to simulate field compaction, able to accommodate large size aggregate**

Mix design methods

Marshall Mix Design

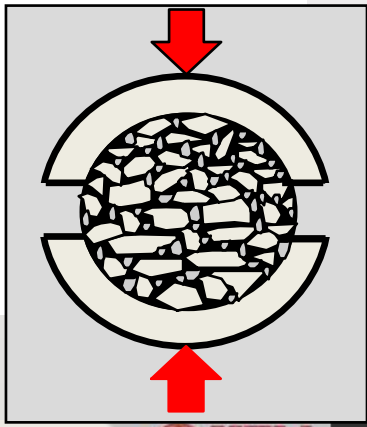
Process of determining what aggregate to use, what asphalt binder to use and what the optimum combination of these two ingredients

Developed by Bruce Marshall for the Mississippi Highway Department in the late 30's



The designed mix should have:

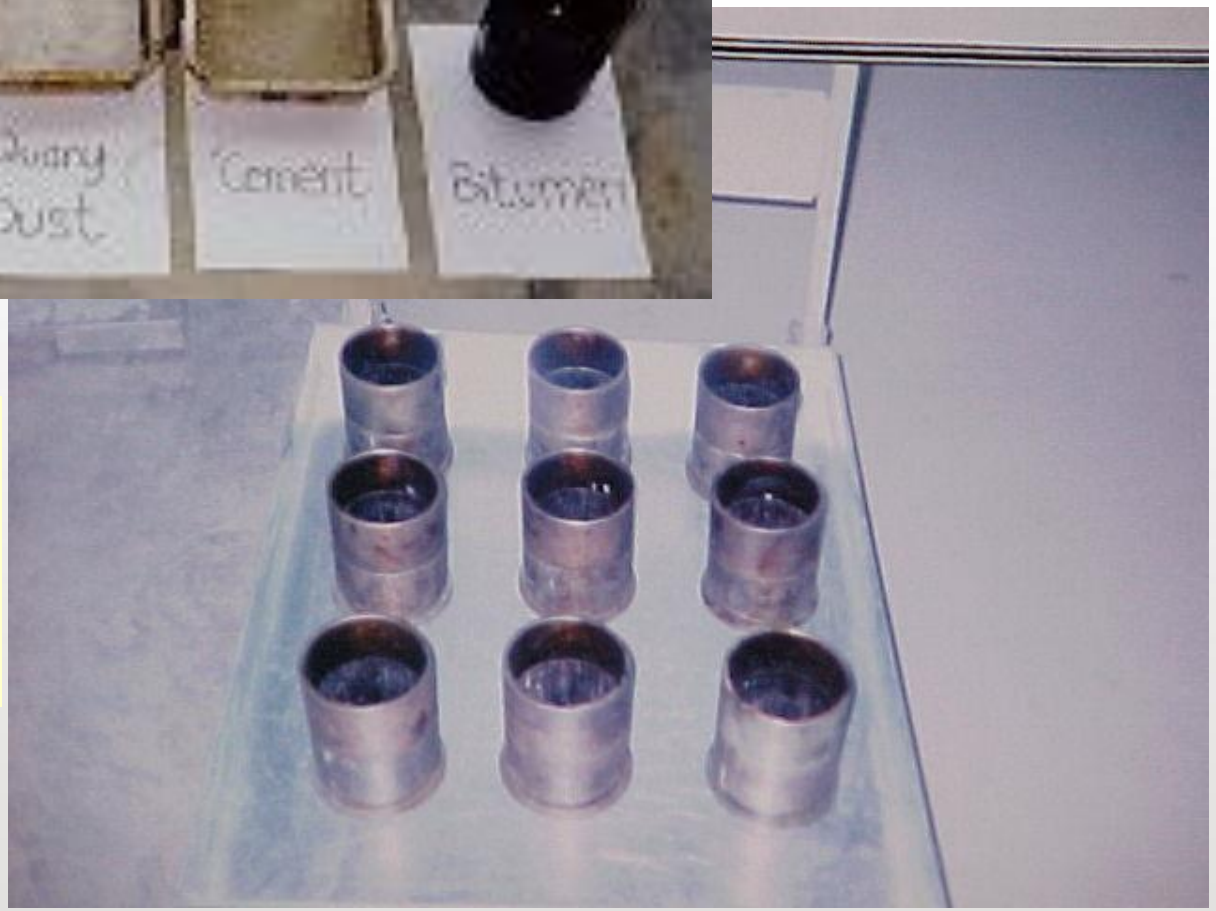
1. Sufficient binder to ensure a durable pavement
2. Sufficient stability under traffic loads
3. Sufficient air voids
   a. Upper limit to prevent excessive environmental damage
   b. Lower limit to allow room for initial densification due to traffic
4. Sufficient workability



Design Steps:

1. Select and test: aggregate & bitumen
2. Select gradation
3. Develop trial blends
4. Calculate blended specific gravity – SG_{agg} blend
5. Establish mixing and compaction temperatures
6. Heat and mix bitumen and aggregates
7. Compact specimen (100 mm diameter)
8. Stability and flow test (Marshall test)
9. Calculate volumetric properties of compacted samples
10. Determination of optimum bitumen content

Lab Mix - Material



- Aggregate and bitumen test
- Aggregate blend

Gradation

TABLE 4.3.3 GRADATION LIMITS FOR ASPHALTIC CONCRETE

Mix Type	Wearing Course	Wearing Course	Binder Course
Mix Designation	AC 10	AC 14	AC 28
BS Sieve Size (mm)	Percentage Passing by Weight		
28.0			100
20.0		100	72 - 90
14.0	100	90 - 100	58 - 76
10.0	90 - 100	76 - 86	48 - 64
5.0	58 - 72	50 - 62	30 - 46
3.35	48 - 64	40 - 54	24 - 40
1.18	22 - 40	18 - 34	14 - 28
0.425	12 - 26	12 - 24	8 - 20
0.150	6 - 14	6 - 14	4 - 10
0.075	4 - 8	4 - 8	3 - 7

Lab Mix - compaction

- Sample preparation
- 4 samples at each bitumen content
- 75 blows/face

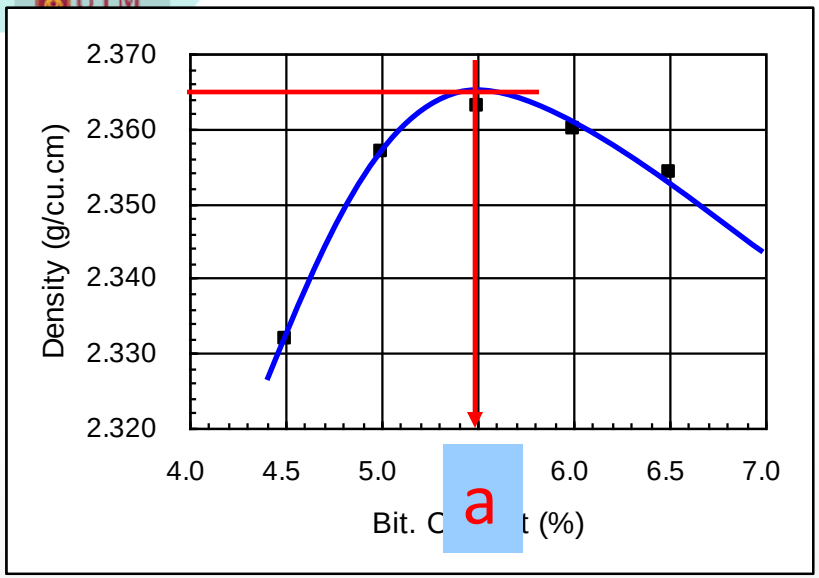
Lab Mix - density

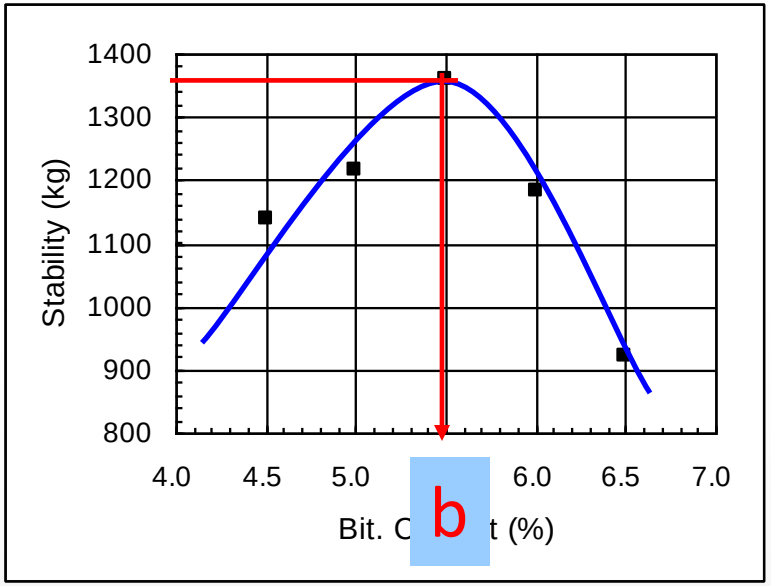
Lab Mix - Marshall Test

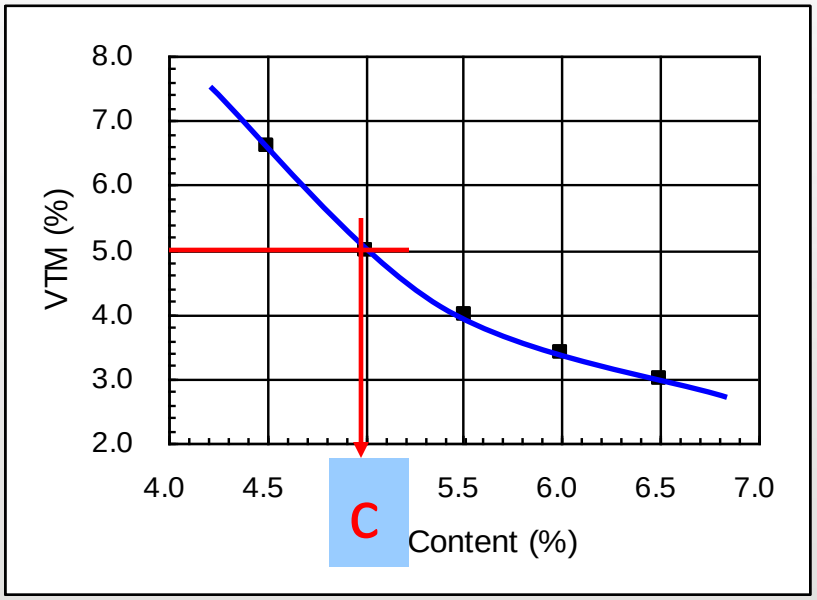
Lab Mix - Marshall Form

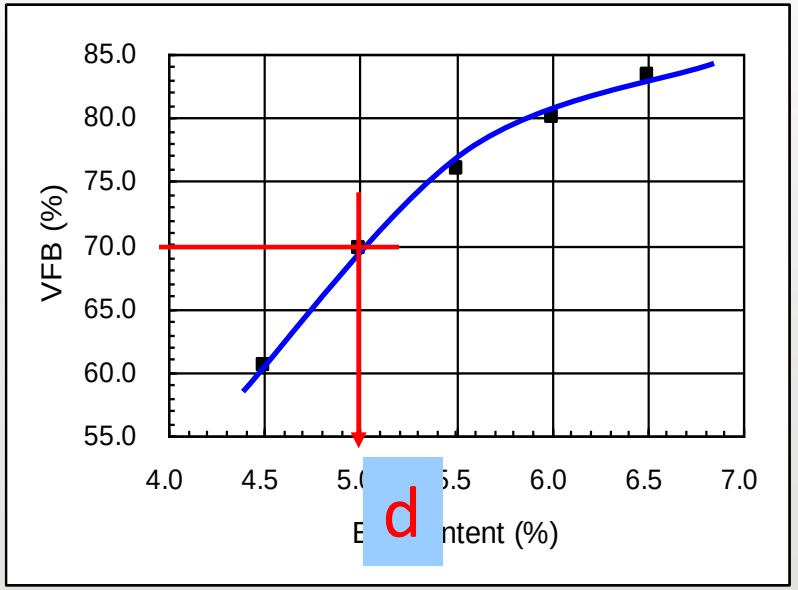
%BIT SPEC. NO.	%BIT. SPEC. NO.	WEIGHT-gm			BULK VOL. cc.	SPEC. GRAV.	VOLUME-%TOTAL			VOIDS-%				STABILITY-kg			FLOW	STIFFNESS
		Saturated surface dry	IN AIR	IN WATER		BULK	MAX. THEOR.	BIT	AGG.	VOIDS	AGG.	FILLED (BIT)	TOTAL MIX		MEAS.	CORR.	mm	
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
%Bit. by wt. of Agg.	%Bit. by wt. of MIX.				c-e	d / f		b x g / SGbit	(100-k)g / SGag	100-i-j	100-j	100(i/l)	100-(100g/h)	CORR FACTOR		p x o		d / r
	4.50	1200.8	1195.3	685.9	514.9	2.321								1.00	1161	1161	3.27	
		1196.4	1193.7	685.9	510.5	2.338								1.00	1100	1100	3.17	
		1195.7	1192.7	685.4	510.3	2.337								1.00	1150	1150	3.33	
AVG						**2.332**	**2.498**	**10.2**	**83.2**	**6.6**	**16.8**	**60.6**	**6.6**			**1137**	**3.26**	**349.1**
	5.00	1197.9	1194.7	690.7	507.2	2.355								1.04	1191	1239	3.70	
		1195.8	1192.7	690.2	505.6	2.359								1.04	1163	1210	3.71	
		1200.5	1197.1	692.4	508.1	2.356								1.04	1151	1197	3.83	
AVG						**2.357**	**2.480**	**11.4**	**83.6**	**5.0**	**16.4**	**69.8**	**5.0**			**1215**	**3.75**	**324.3**
	5.50	1202.8	1199.9	695.2	507.6	2.364								1.04	1321	1374	4.30	
		1180.3	1176.4	682.7	497.6	2.364								1.04	1298	1350	4.29	
		1178.6	1174.8	681.2	497.4	2.362								1.09	1239	1351	3.93	
AVG						**2.363**	**2.461**	**12.6**	**83.4**	**4.0**	**16.6**	**76.0**	**4.0**			**1358**	**4.17**	**325.4**
	6.00	1185.0	1182.3	685.8	499.2	2.368								1.04	1163	1210	4.63	
		1196.0	1191.5	690.6	505.4	2.358								1.04	1135	1180	4.72	
		1188.8	1184.0	685.6	503.2	2.353								1.04	1111	1155	4.69	
AVG						**2.360**	**2.443**	**13.7**	**82.8**	**3.4**	**17.2**	**80.0**	**3.4**			**1182**	**4.68**	**252.5**
	6.50	1172.7	1168.2	675.9	496.8	2.351								1.04	870	905	5.31	
		1185.6	1180.8	685.6	500.0	2.362								1.04	870	905	5.48	
		1178.9	1172.4	679.6	499.3	2.348								1.04	919	956	5.69	
AVG						**2.354**	**2.426**	**14.9**	**82.2**	**3.0**	**17.8**	**83.3**	**3.0**			**922**	**5.49**	**167.8**

Lab Mix – OBC Determination









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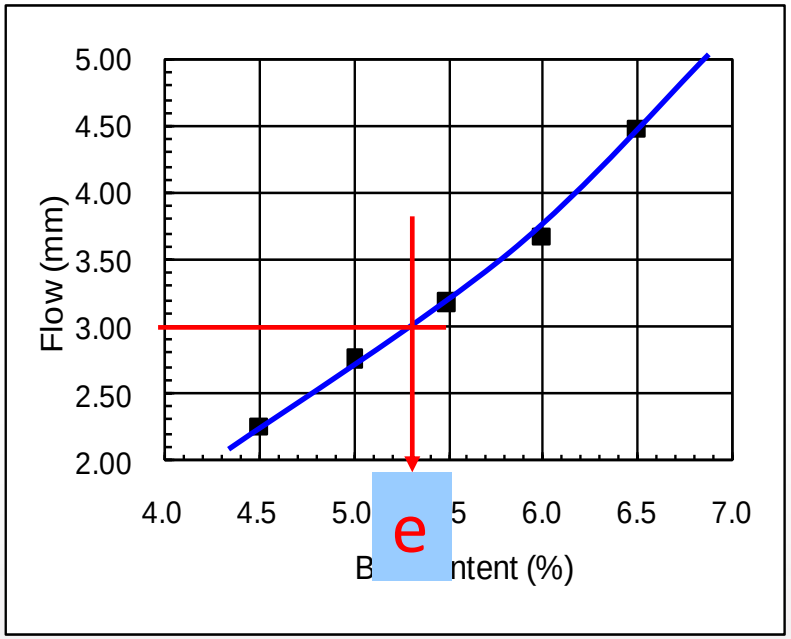
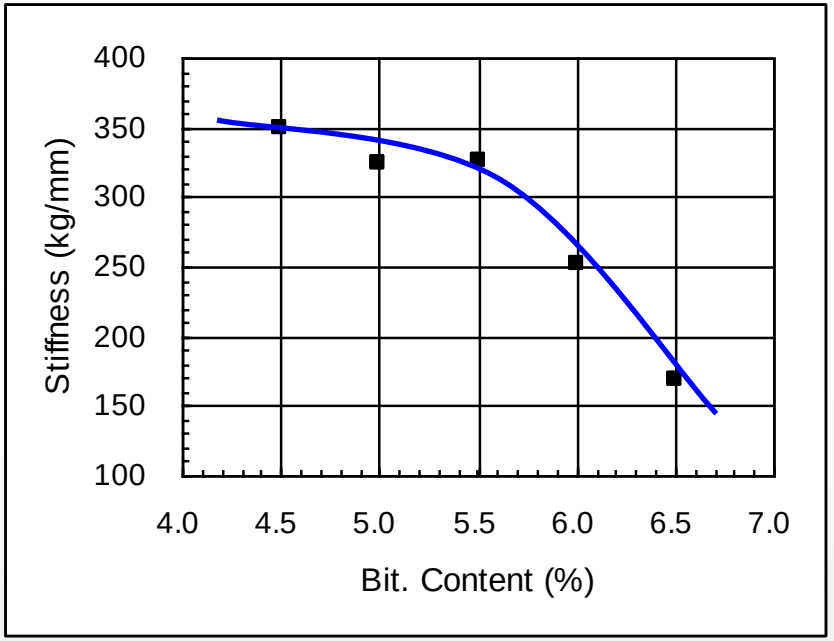
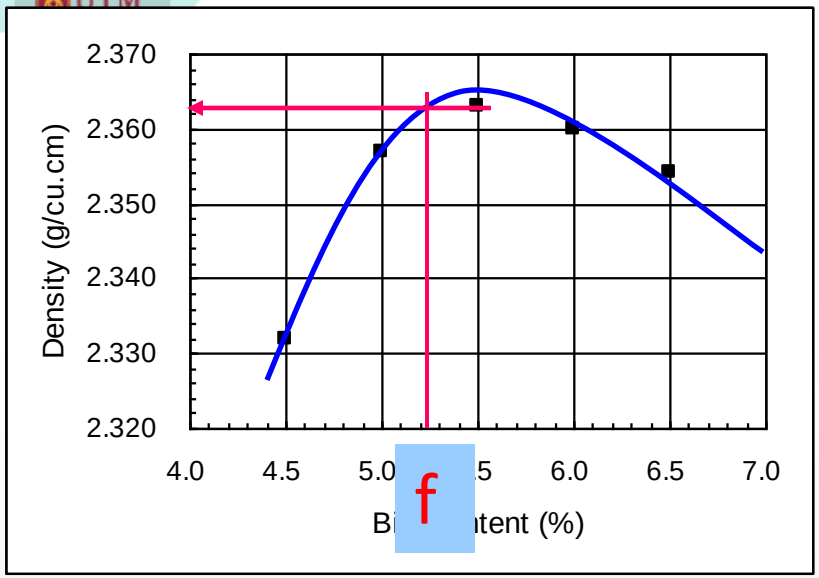


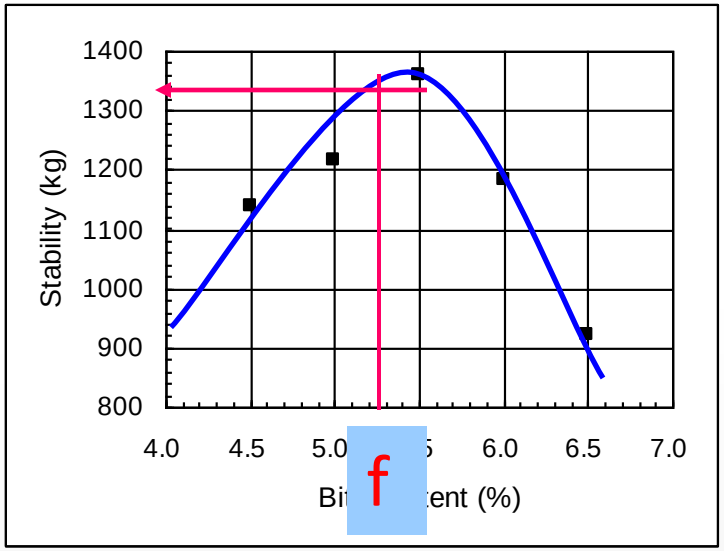


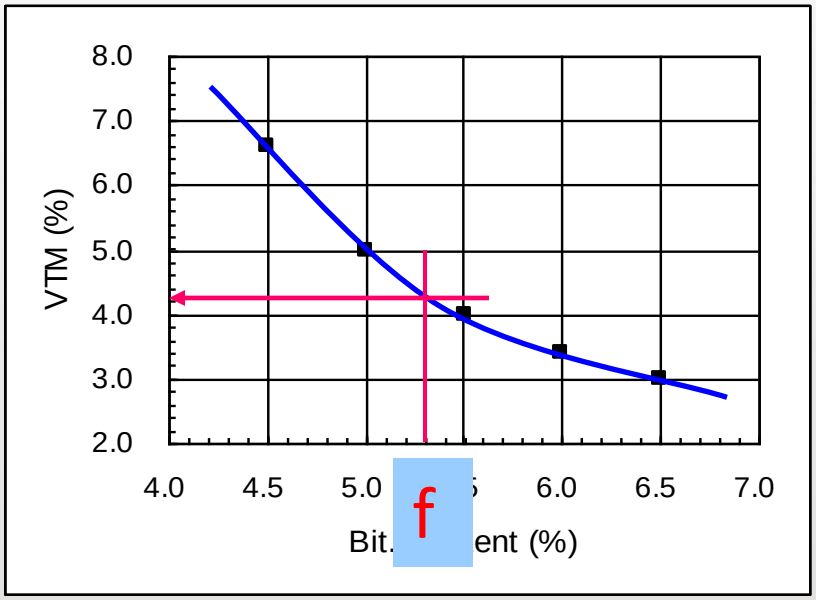
OBC =(a + b + c + d + e)/5 = f

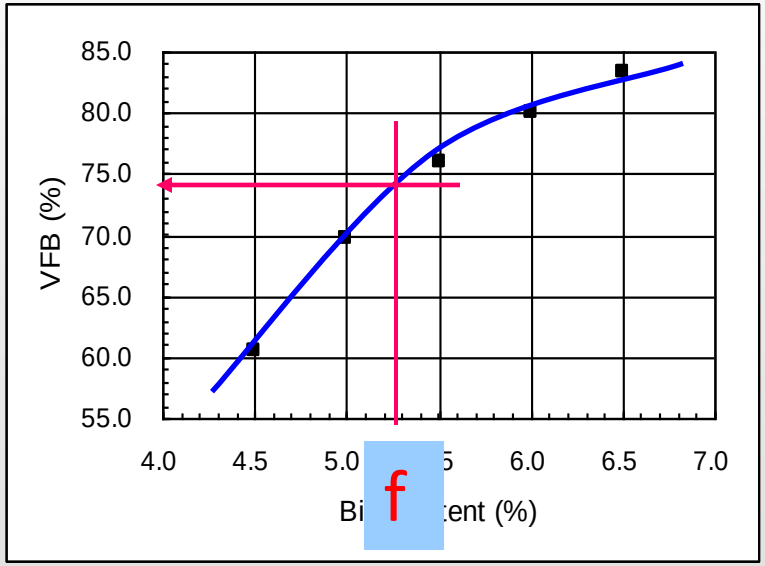
Check parameters @ OBC

Lab Mix – Value @ OBC

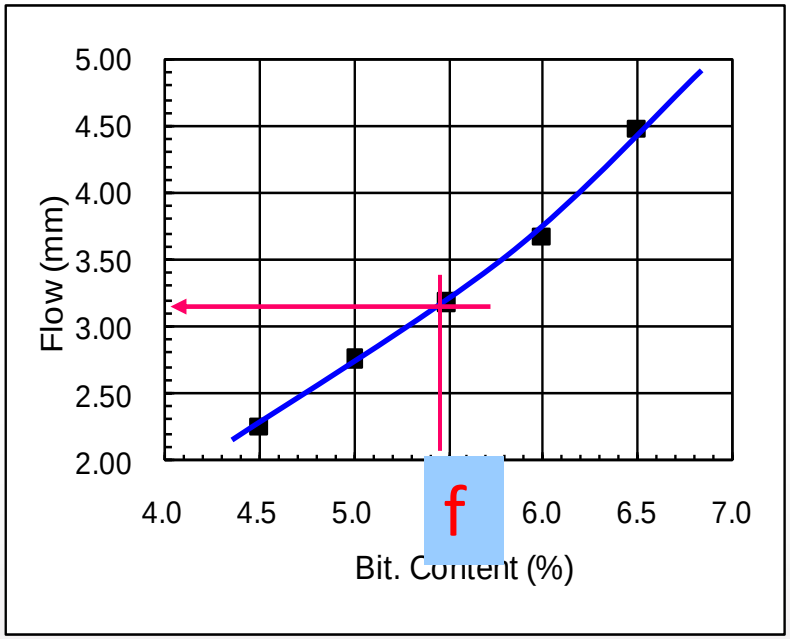


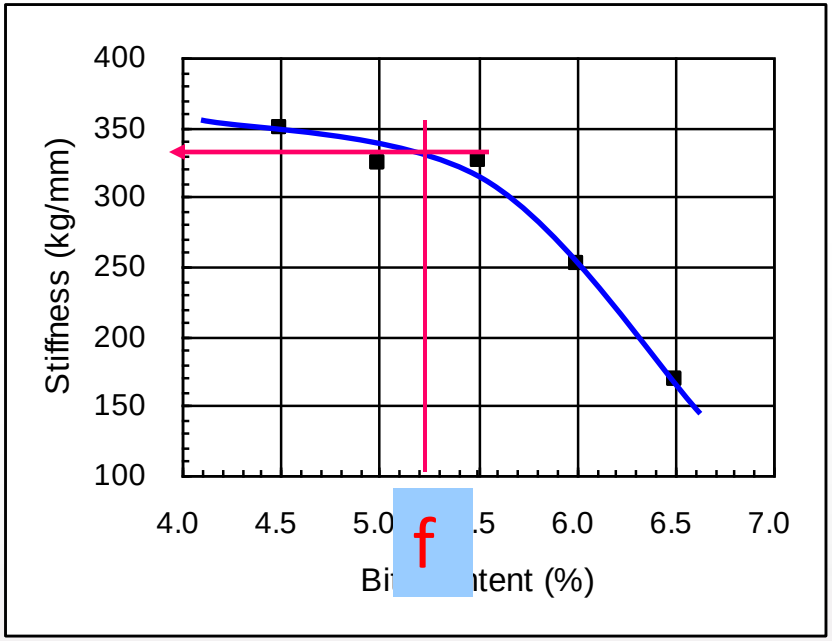






Lab Mix - Value @ OBC





Compare parameters with specification

Pass? >> OBC = f

Fail? >> redesign

Specification

Parameter	WC	BC
Stability (S)	> 8000 N	> 8000 N
Flow (F)	2.0 - 4.0 mm	2.0 – 4.0 mm
Stiffness (S/F)	> 2000N/mm	> 2000 N/mm
Air Voids in Mix (VTM)	3.0 – 5.0 %	3.0 – 7.0 %
Voids filled with Bitumen (VFB)	70 – 80 %	65 –75 %

Thank you for your attention

e-mail your questions to:

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or

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