Analysis Software to Verify Mix Designs

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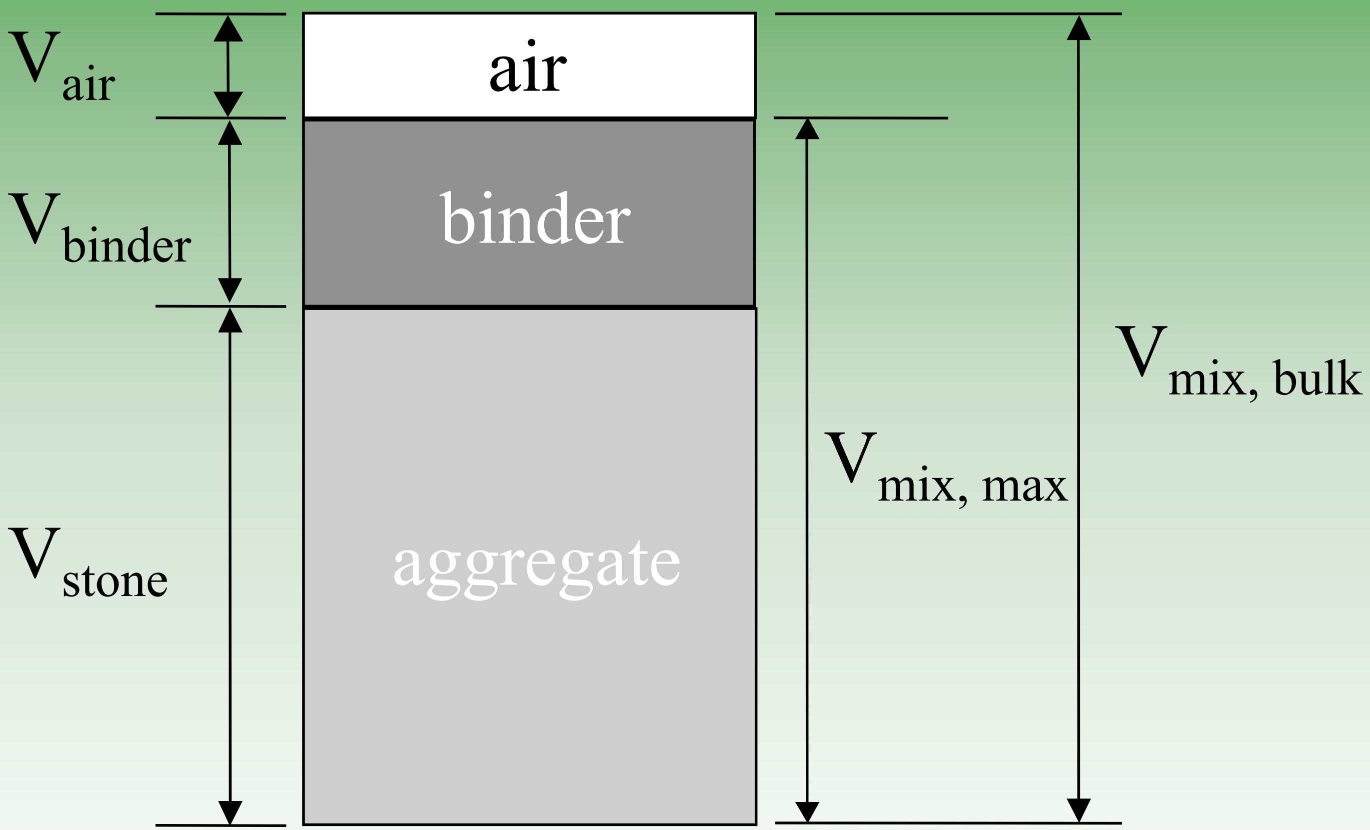
Mix Design Information

- Is the design information reasonable?

Gyratory Data						
% Asphalt Binder	3.85	4.35	4.85	4.87	5.35	
Corrected Gmb @ N-Des.	2.347	2.370	2.389	2.390	2.415	Number of Gyrations
Max. Sp.Gr. (Gmm)	2.532	2.509	2.490	2.490	2.476	N-Initial
% Gmm @ N- Initial	84.8	86.3	87.4	87.5	88.5	8
%Gmm @ N-Max	93.7	95.5	97.1	97.2	98.8	N-Design
% Air Voids	7.3	5.5	4.1	4.0	2.5	109
% VMA	14.6	14.2	13.9	13.9	13.5	N-Max
% VFA	49.8	60.9	70.9	71.2	81.7	174
Film Thickness	7.27	8.56	9.70	9.74	10.69	
Filler Bit. Ratio	1.26	1.07	0.95	0.94	0.86	Gsb for Angularity
Gsb	2.641	2.641	2.641	2.641	2.641	Method A
Gse	2.687	2.682	2.682	2.685	2.687	2.647
Pbe	3.20	3.78	4.28	4.29	4.71	
Pba	0.67	0.60	0.60	0.64	0.67	Pba / %Abs Ratio
% New Asphalt Binder	100.0	100.0	100.0	100.0	100.0	0.49
Asphalt Binder Sp.Gr. @ 25c	1.036	1.036	1.036	1.036	1.036	
% Water Abs	1.30	1.30	1.30	1.30	1.30	Slope of Compaction
S.A. m^2 / Kg.	4.41	4.41	4.41	4.41	4.41	Curve
% + 4 Type 4 Agg. Or Better	100.0	100.0	100.0	100.0	100.0	13.8
% + 4 Type 2 or 3 Agg.	25.4	25.4	25.4	25.4	25.4	
Angularity-method A	45	45	45	45	45	Mix Check
% Flat & Elongated	0.0	0.0	0.0	0.0	0.0	Excellent
Sand Equivalent	82	82	82	82	82	

Basic HMA mixture volumetrics



Volumetric Relationship of G_{mm}

$$y = Sx + b$$

$$\frac{100}{G_{mm}} = \left(\frac{(G_{se} - G_b)}{(G_{se})(G_b)} \right) P_b + \frac{100}{G_{se}}$$

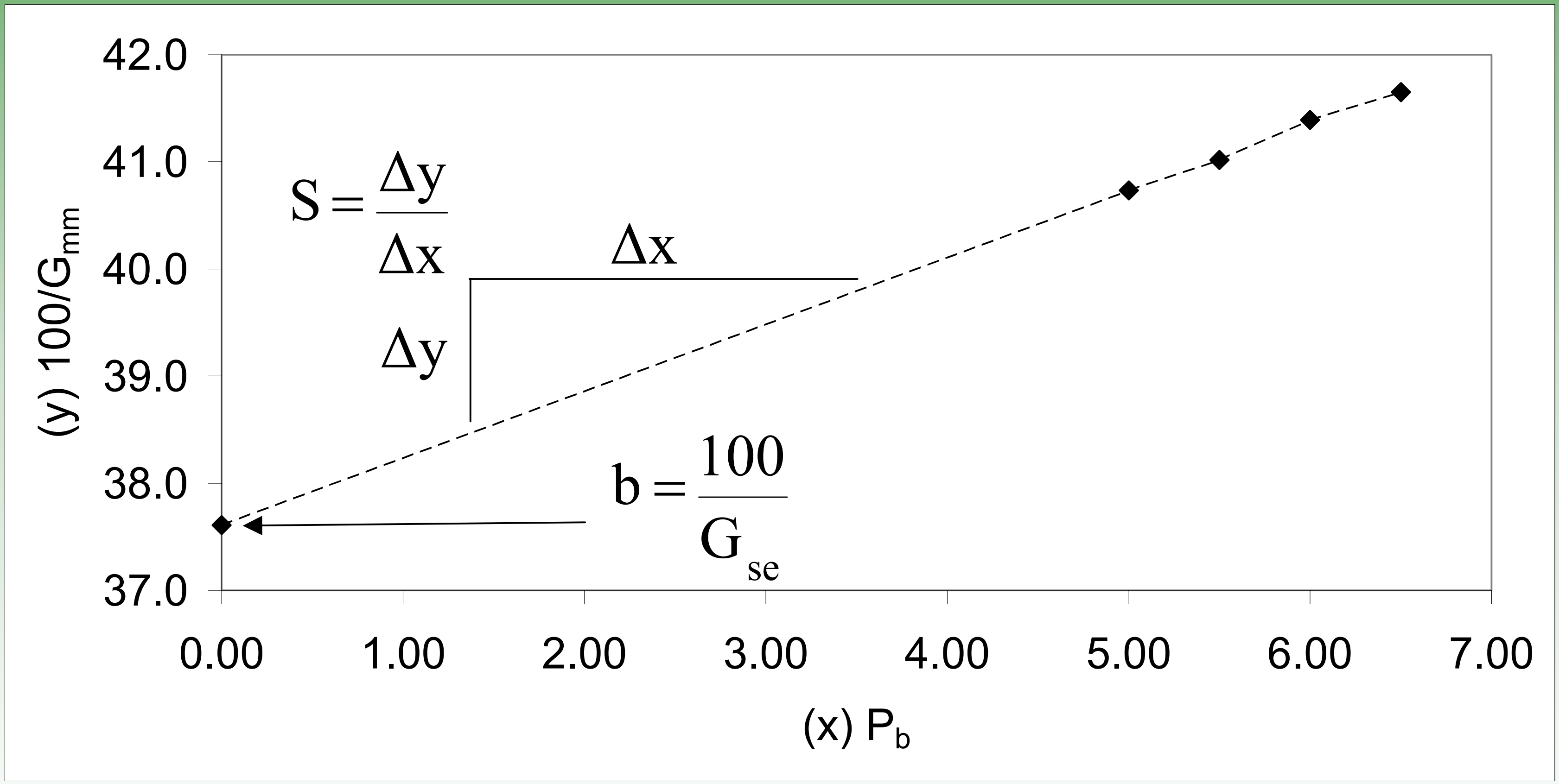
Relationship of G_{se} & G_b

- The resultant value for the slope, S, varies very little within the normal range of the specific gravity of the binder and the effective specific gravity of the aggregate.

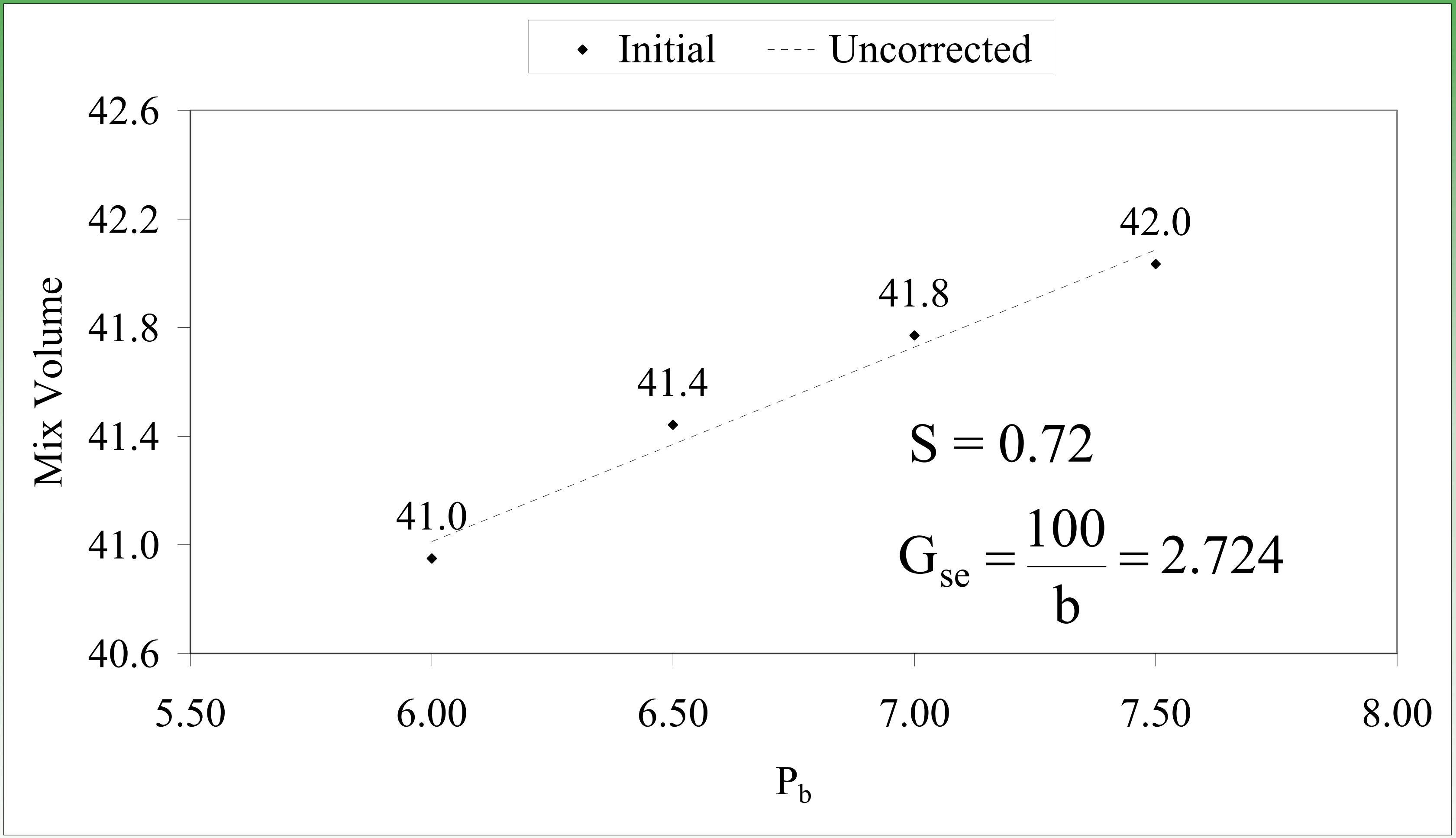
$$S = \left(\frac{(G_{se} - G_b)}{(G_{se})(G_b)} \right) = \text{slope} \approx 0.60$$

- Typical slope range from 0.58 to 0.62.

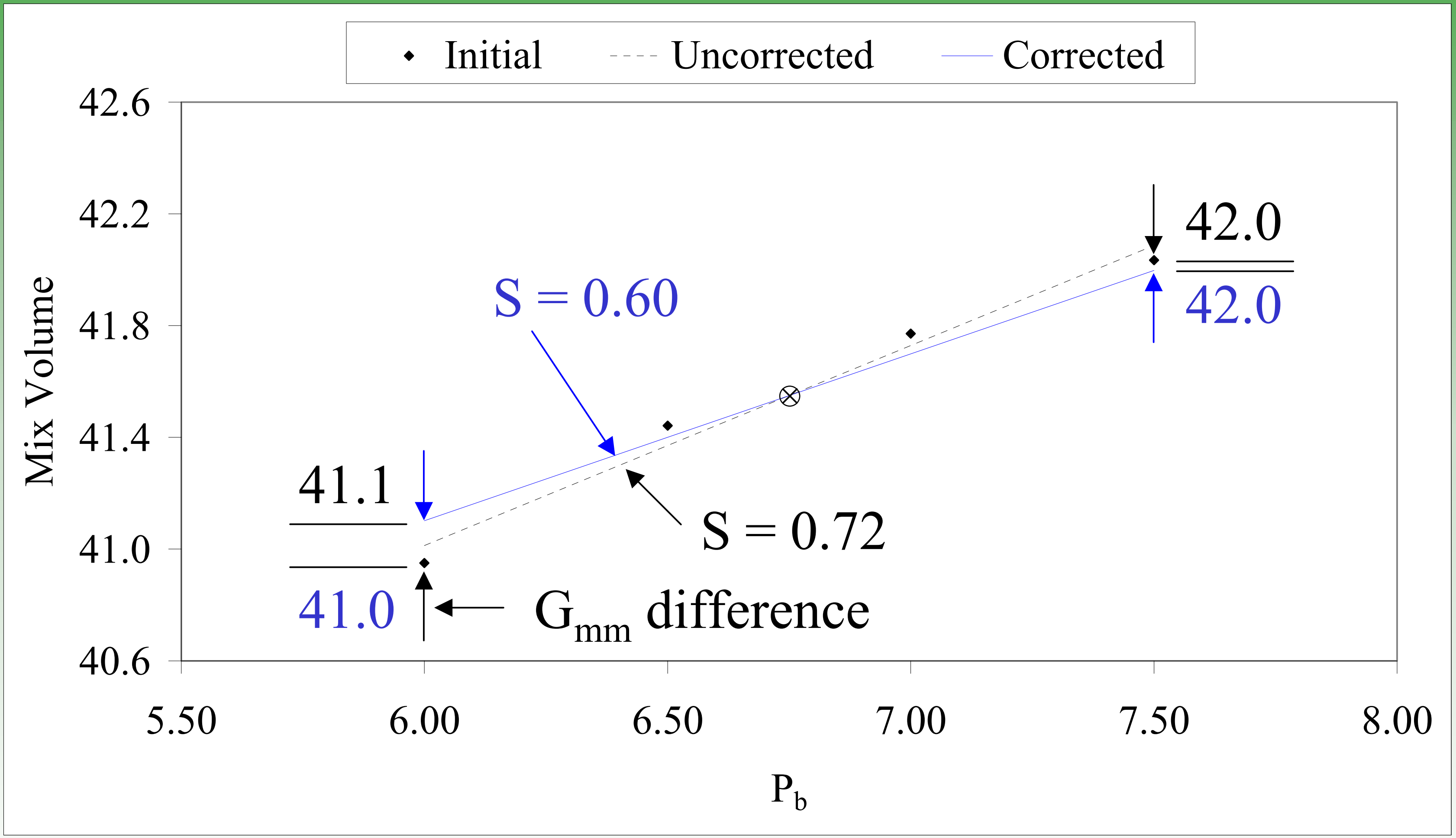
Generic Graphical Relationship



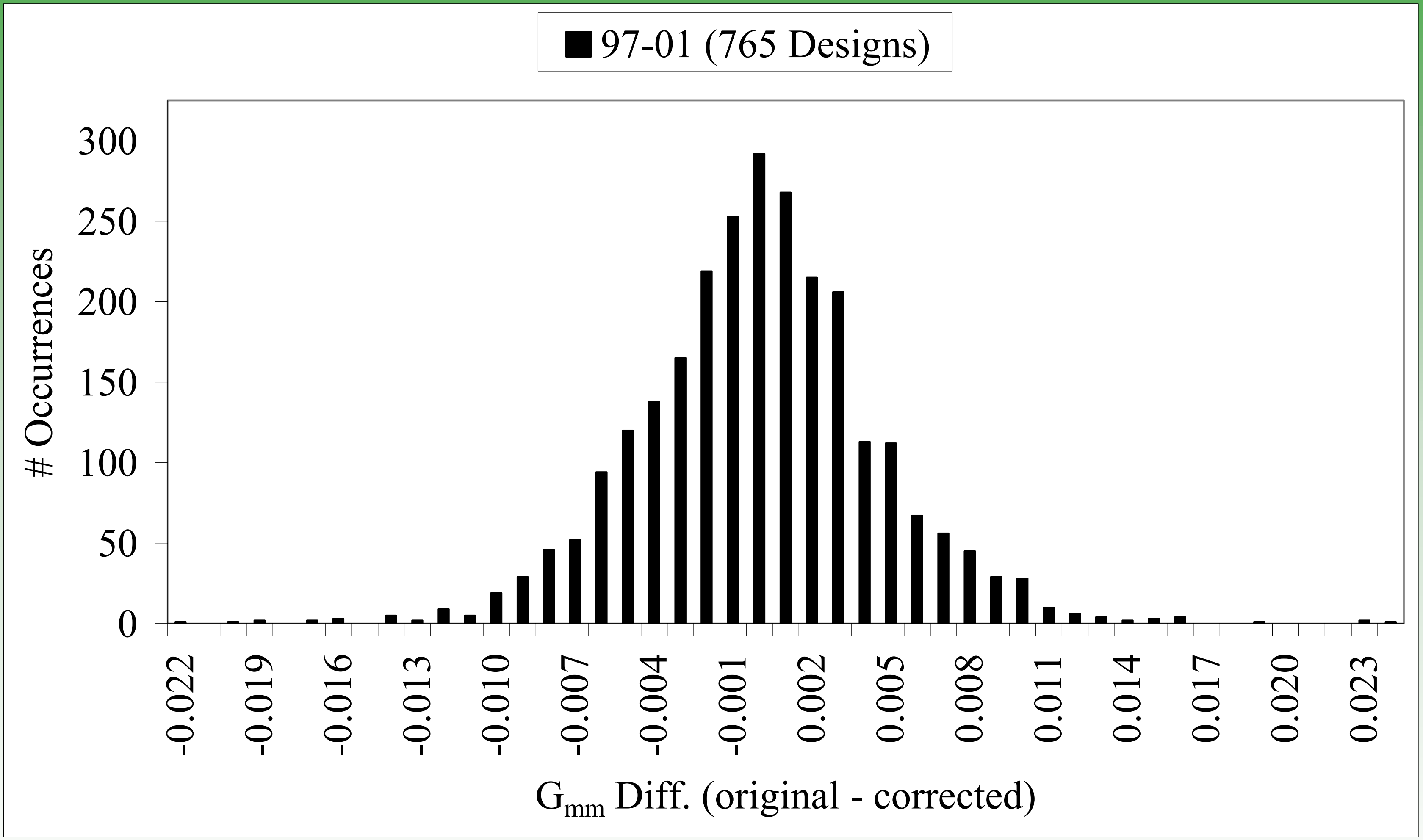
Typical 4-pt. mix design



Adjusted 4-pt. mix design



G_{mm} Diff. Distribution

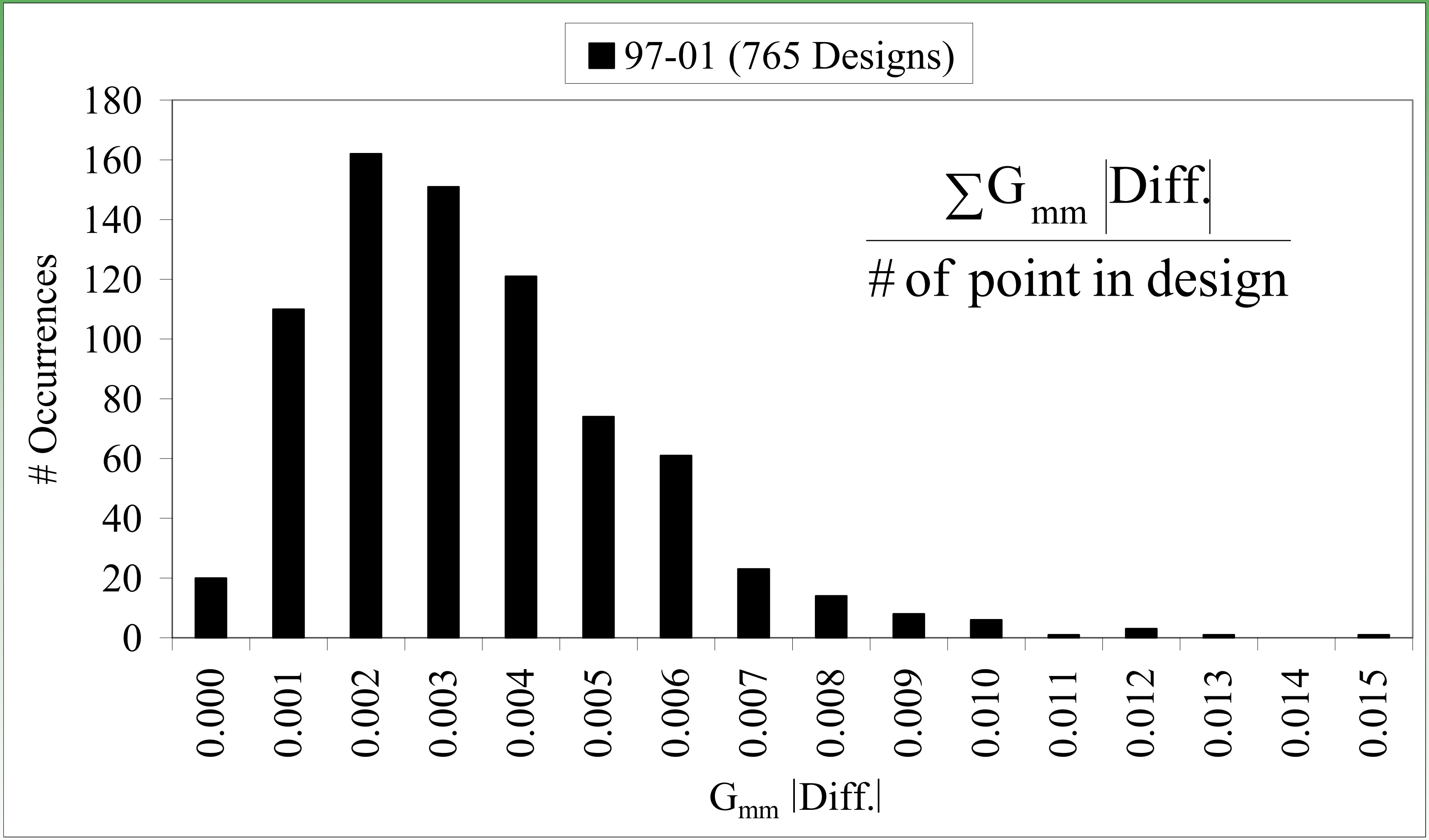


Statistical Analysis of G_{mm} Diff.

- The average and standard deviation are based on the individual comparisons of each design point.

G_{mm} Difference		1 Stdev		2 Stdev		3 Stdev	
Average	**Stdev**	**Low**	**High**	**Low**	**High**	**Low**	**High**
0.000	0.005	-0.005	0.005	-0.009	0.009	-0.014	0.014

Mix G_{mm} |Diff.| Distribution

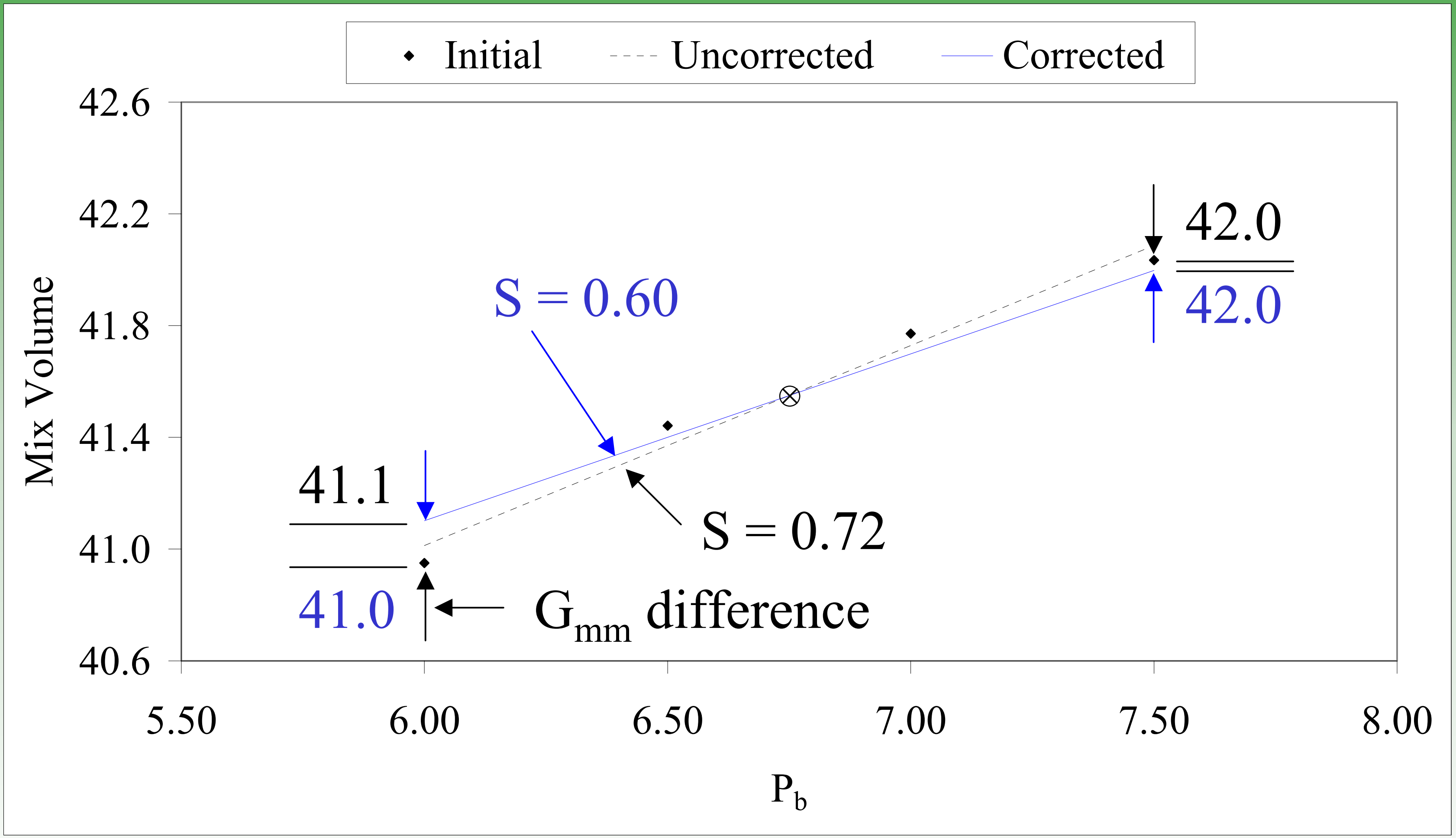


Statistical Analysis of Mix G_{mm} |Diff.| Distribution

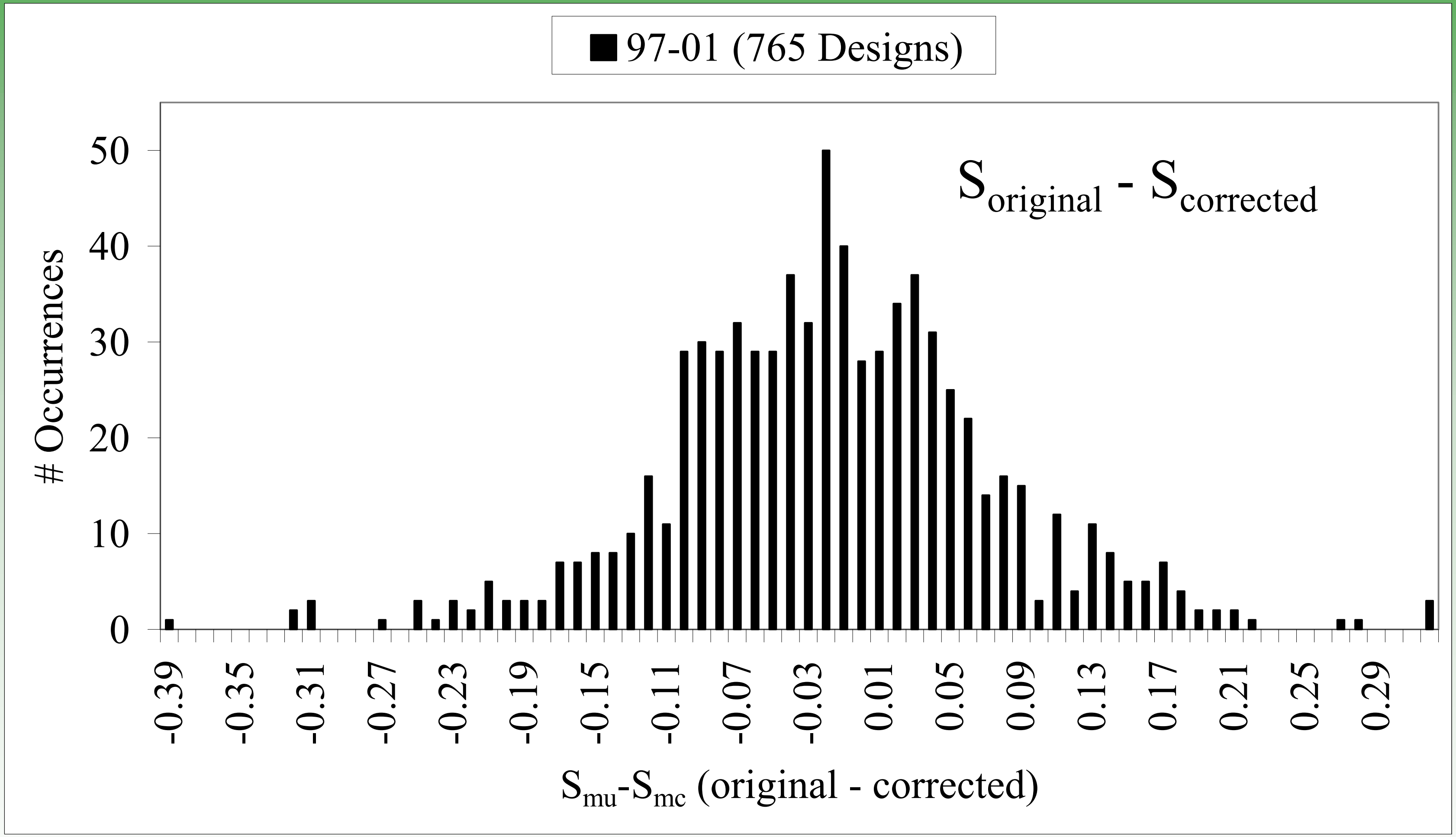
- The average and standard deviation are based on the average G_{mm} difference of each design on an absolute basis.

G_{mm} Difference		1 Stdev	2 Stdev	3 Stdev
Average	**Stdev**			
0.003	0.002	0.006	0.008	0.010

Adjusted 4-pt. mix design



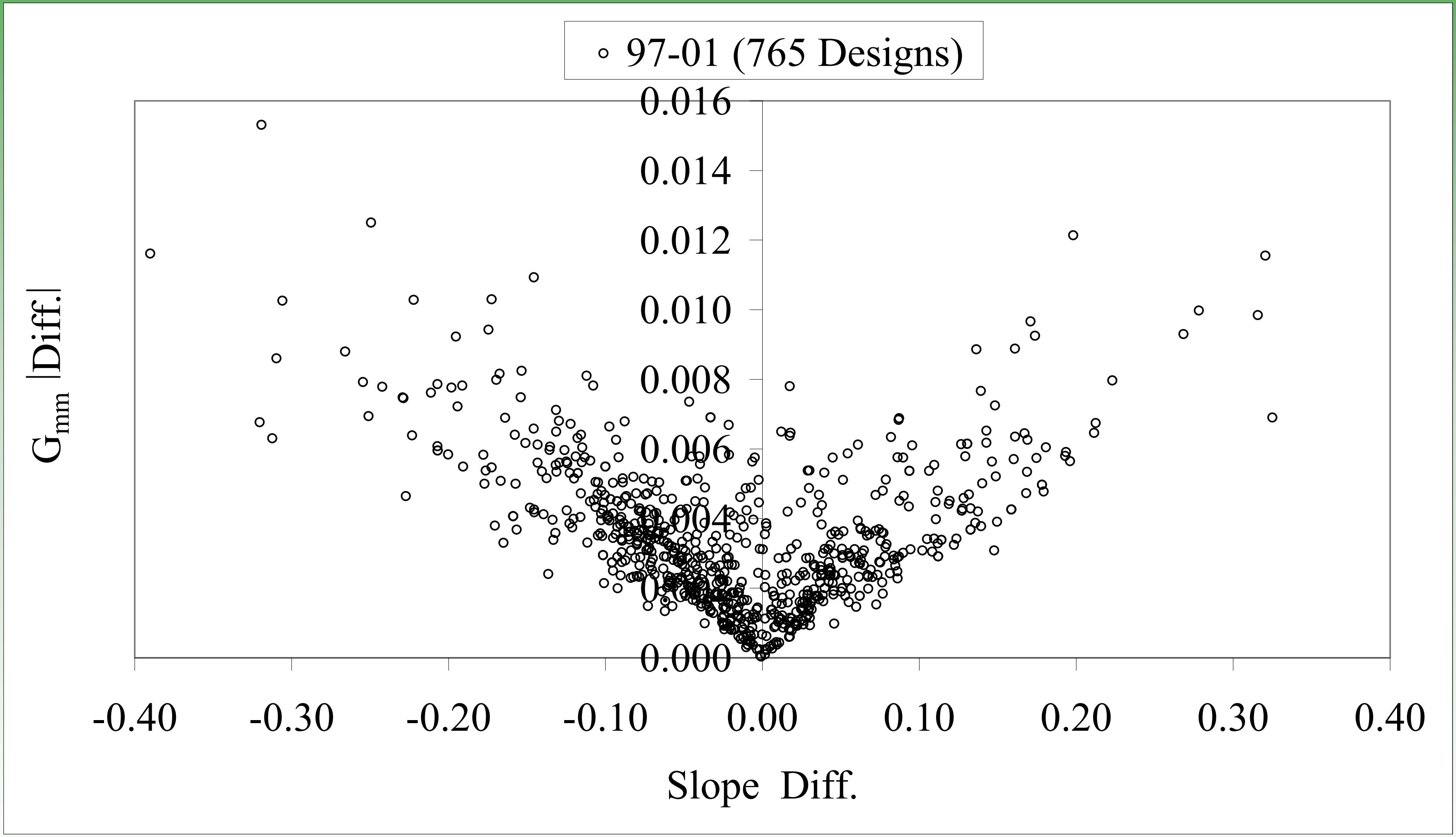
Mix G_{mm} Slope (S) Diff. Distribution



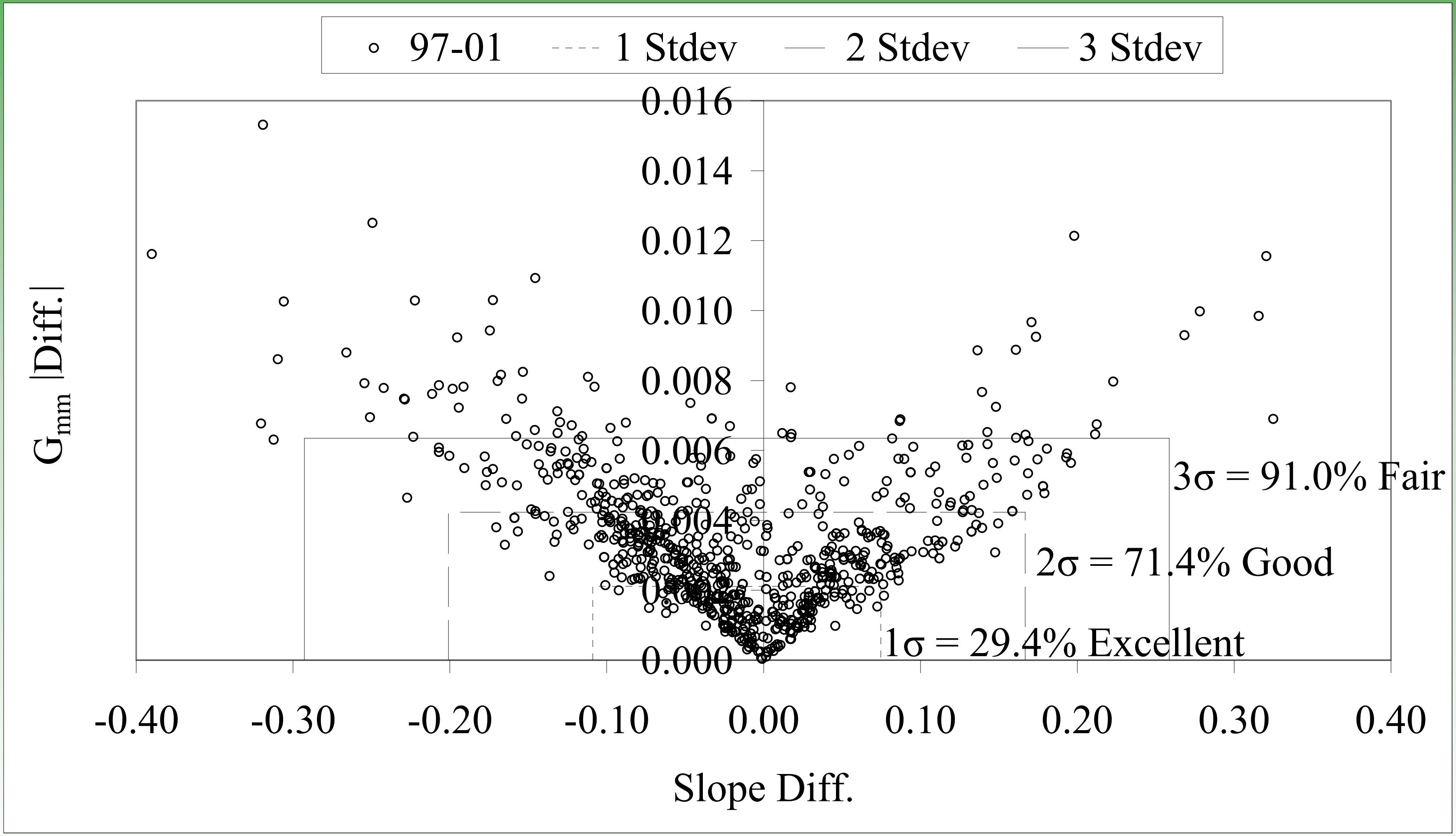
Statistical Analysis of the Mix G_{mm} Slope Diff.

S_{mu}-S_{mc} Avg.	S_{mu}-S_{mc} Stdev	1 Stdev		2 Stdev		3 Stdev	
		Low	High	Low	High	Low	High
-0.02	0.092	-0.11	0.07	-0.20	0.17	-0.29	0.26

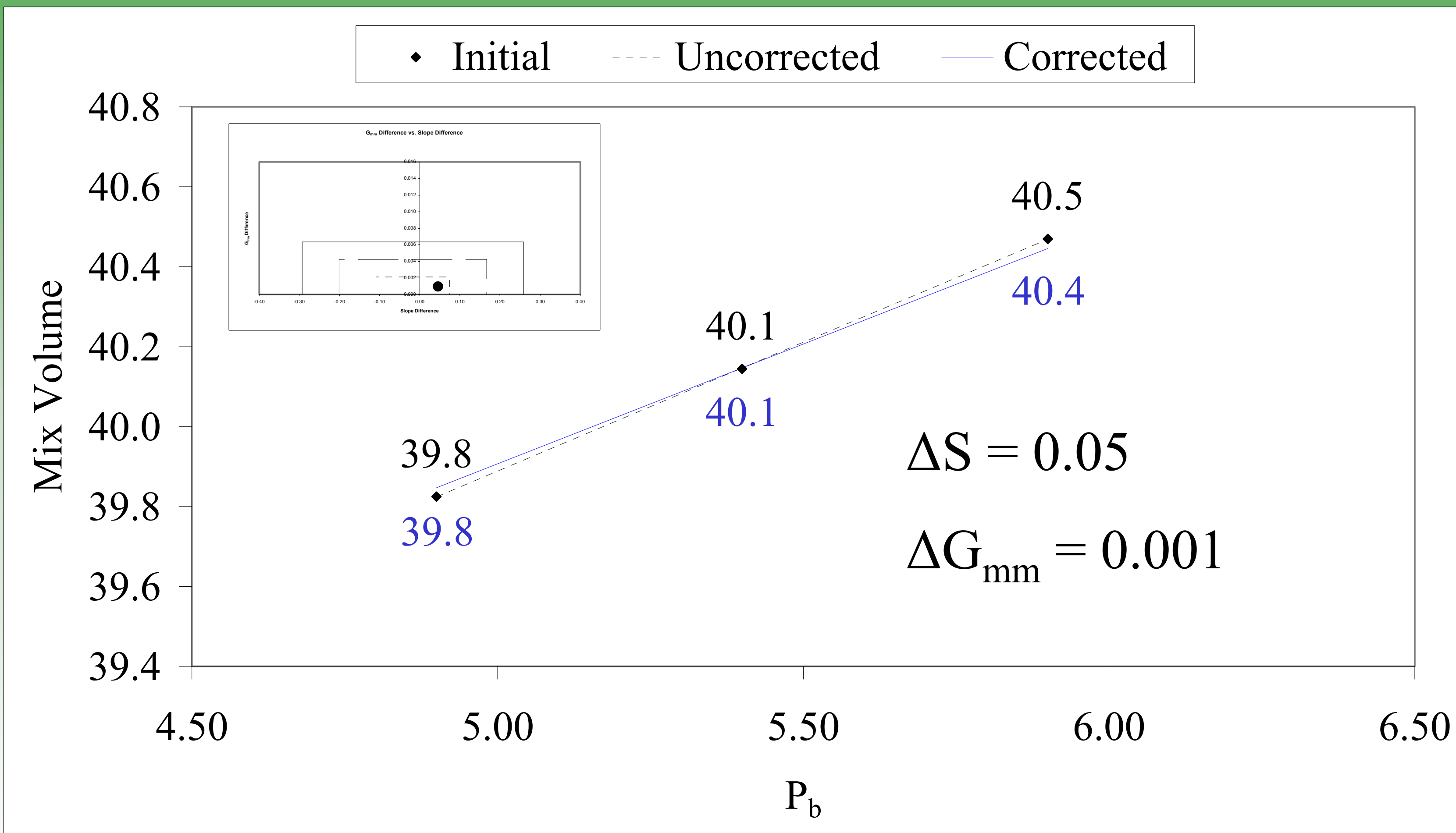
Mix G_{mm} |Diff.| vs. Mix G_{mm} Slope Diff.



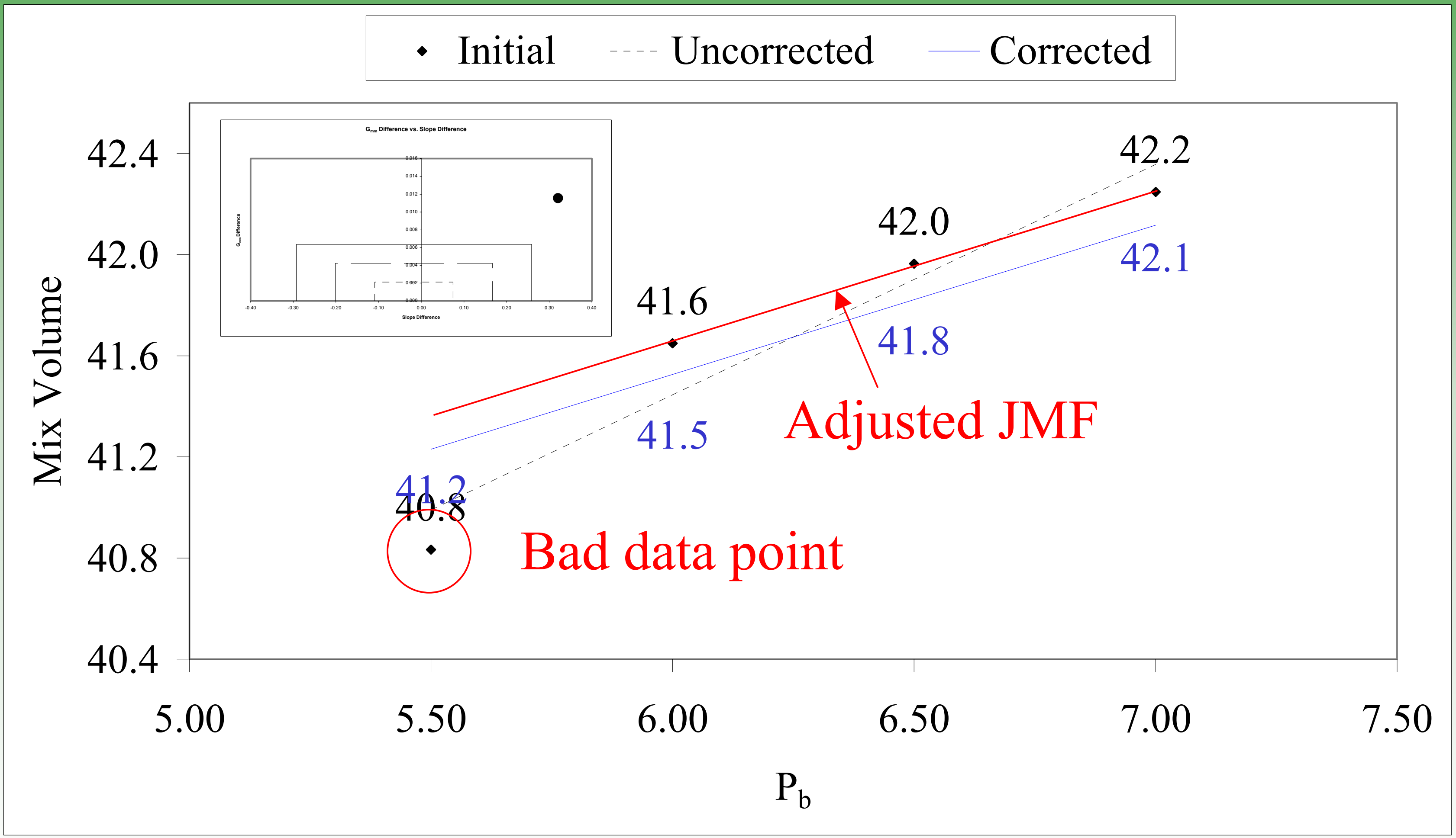
Mix G_{mm} |Diff.| vs. Mix G_{mm} Slope Diff.



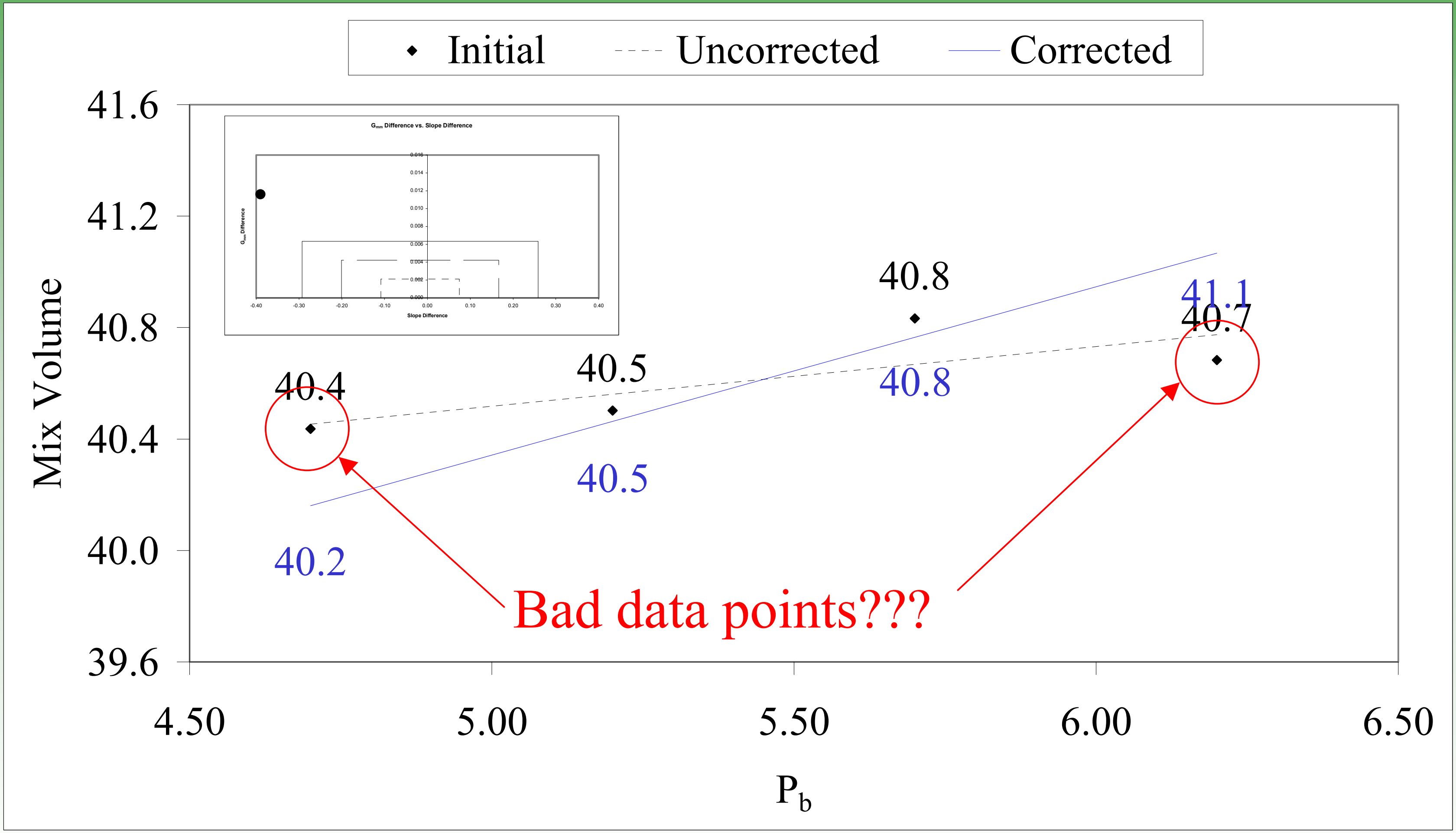
Case Study No. 1
Excellent Mix Design



Case Study No. 2
Poor Mix Design

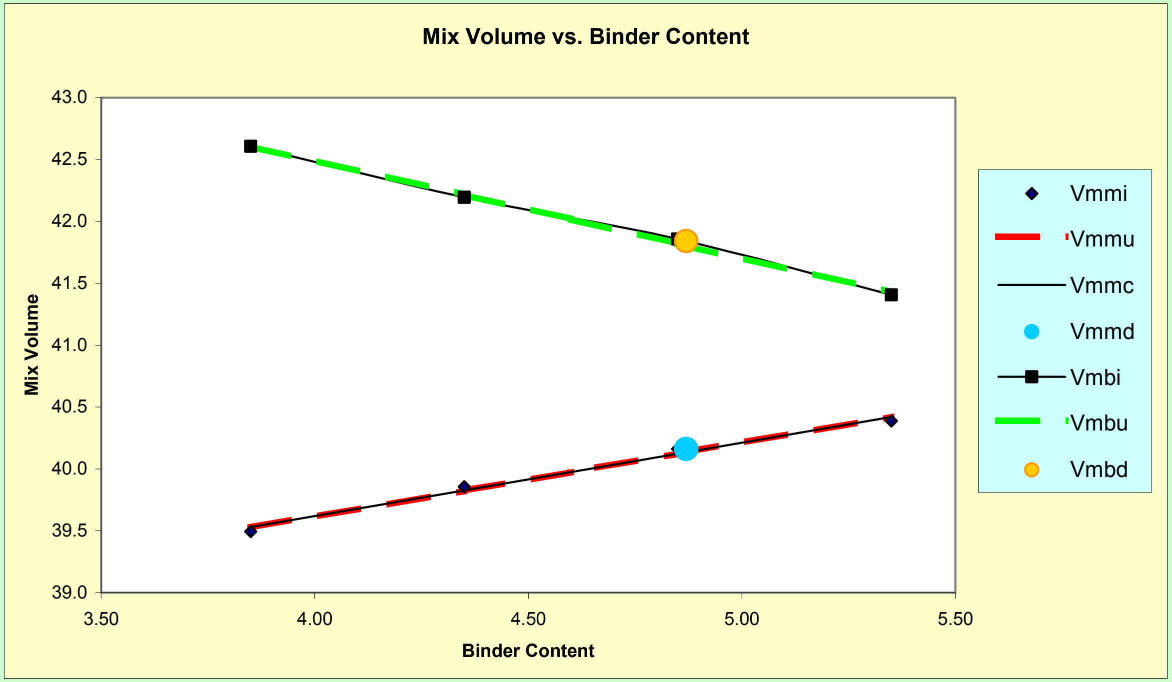


Case Study No. 3
Poor Mix Design



SHADES Mix Design Software (Excel) Mix Check Tab

Mix Check



Check
Excellent

S_{mbu}	S_{mmc}	S_{mmu}
-0.79	0.59	0.60

G_{se}	V_{mb} r^2	V_{mm} r^2
2.685	1.00	0.99

Summary of 2003 JMF Mix Check

	Excellent	Good	Fair	Poor
Designs Received	36.0%	54.0%	10.0%	0.0%

Summary of JMF Mix Check

1997-2001

	Excellent	Good	Fair	Poor
765 Designs Received	29.4%	42.0%	19.6%	9.0%

2003

	Excellent	Good	Fair	Poor
81 Designs Received	39.5%	50.6%	9.9%	0.0%