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CEMENT STABILISATION WORKSHOP

8 July 2009

CLIENT'S OVERVIEW

D. ROSSMANN



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STABILISATION WORKSHOP

Current “Client” issues:

- “Pre-project” stabilisation designs
- Stabiliser type and availability
- ICL / ICC determination
- UCS issues
- ITS issues
- Time/strength behaviour
- Curing

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Pre-project stabilisation designs

- Appropriateness if gravel from borrowpit/quarry is to be crushed?
- Appropriateness if layer is to incorporate in-situ asphalt layers (influence of pre-milling!)

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STABILISATION WORKSHOP

Stabiliser Type and Availability

- What is the most appropriate stabiliser?
- Is cement the current “default” approach?
- What cement types are available in region of the project?
- CEM 32.5 vs CEM 42.5

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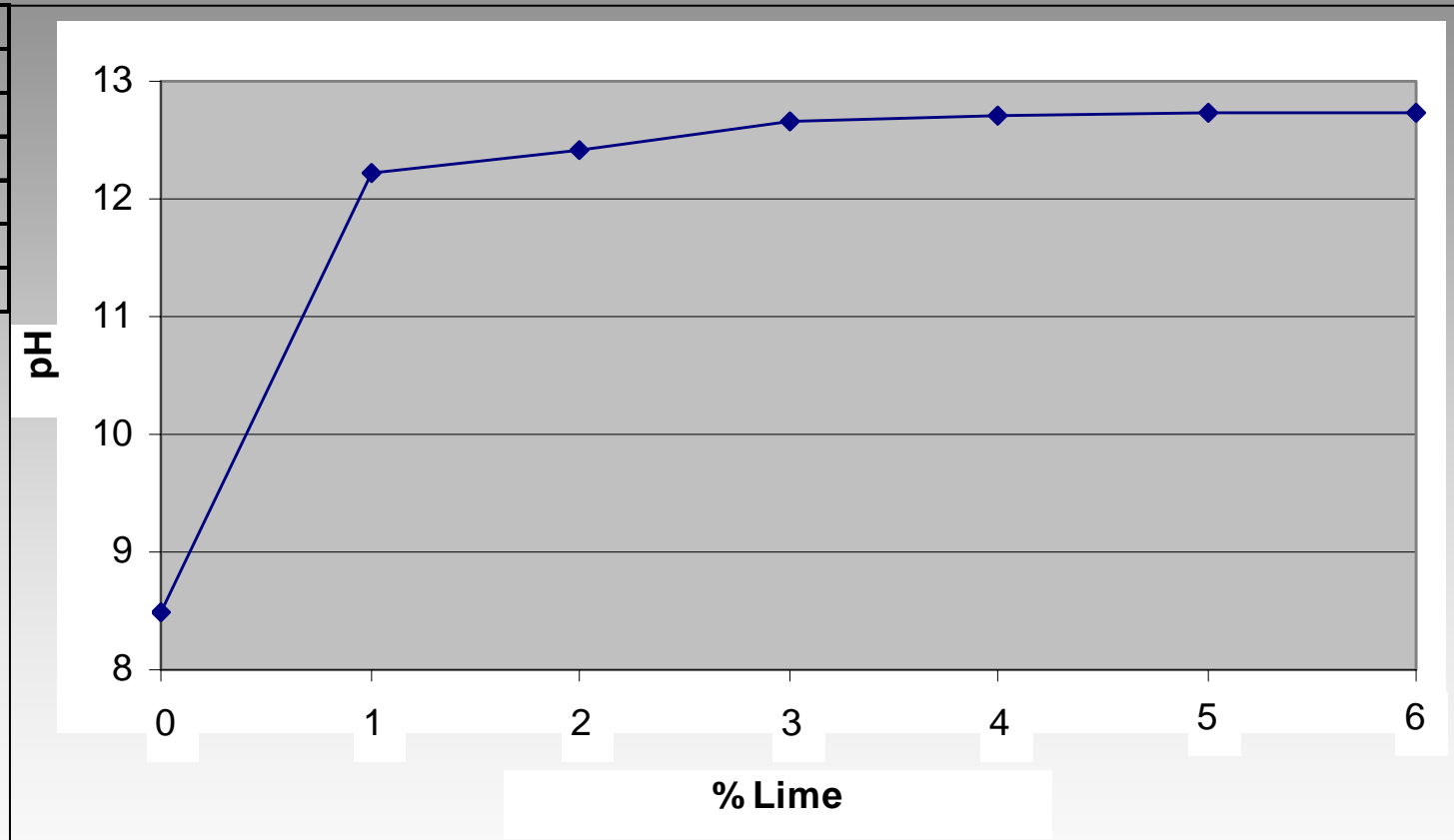
STABILISATION WORKSHOP

ICL / ICC Determination

- Different test methods
- Different interpretation of same test method.
- Risk of not satisfying ICL – carbonation?

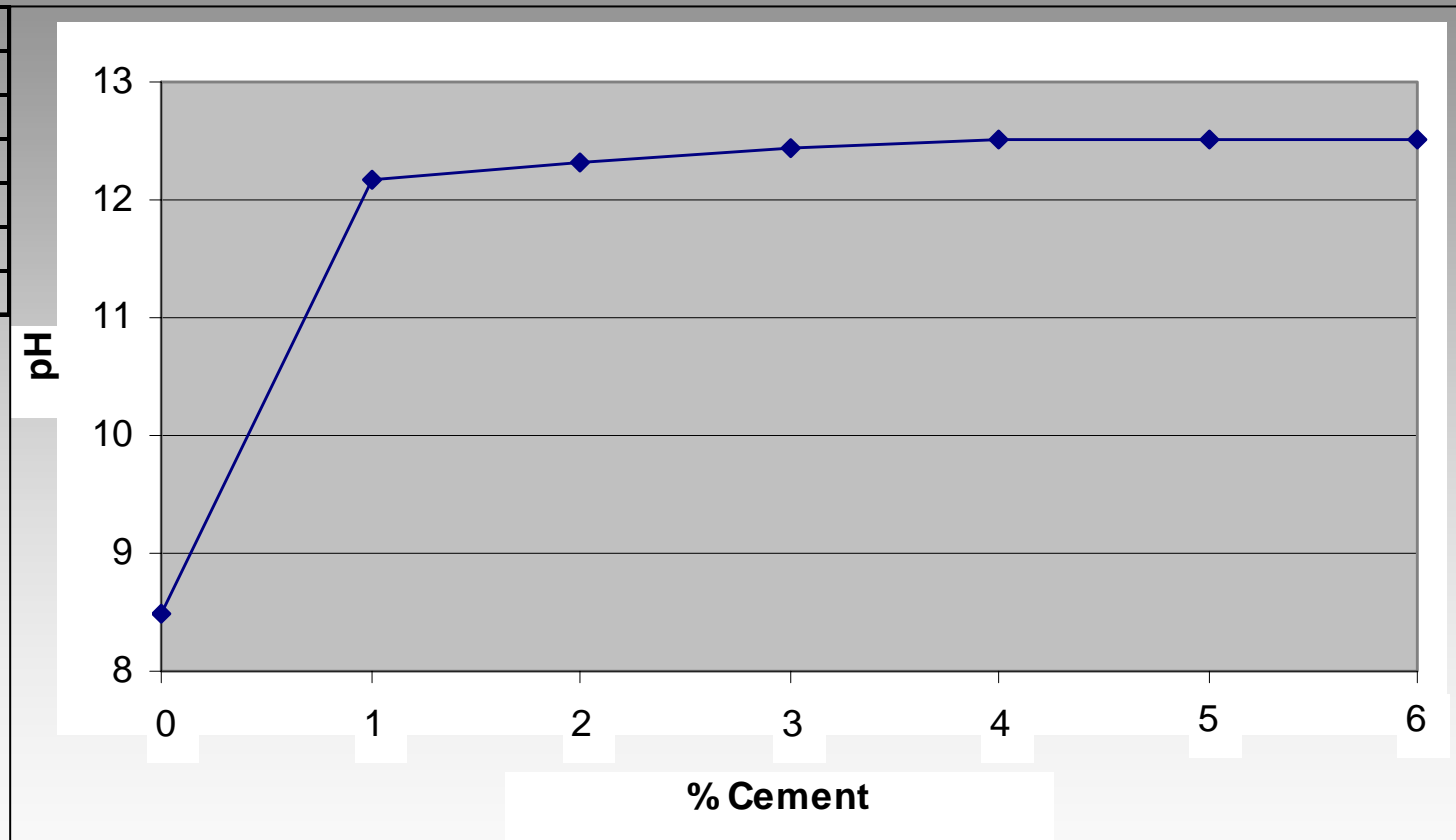
ICL GRAPH 9/482

0	8.5
1	12.23
2	12.41
3	12.66
4	12.7
5	12.72
6	12.72



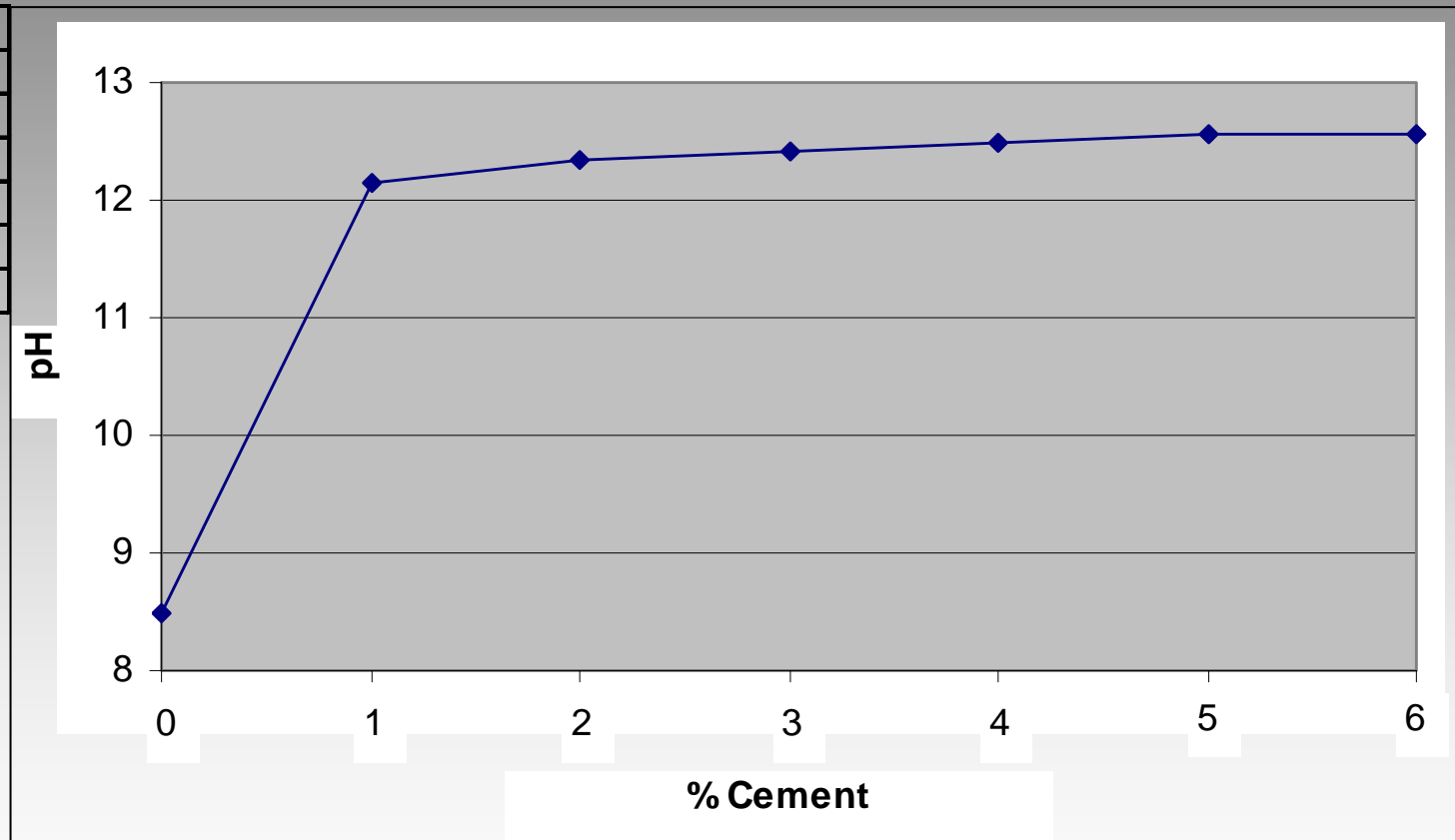
ICC GRAPH 9/482

0	8.5
1	12.18
2	12.32
3	12.45
4	12.51
5	12.52
6	12.52



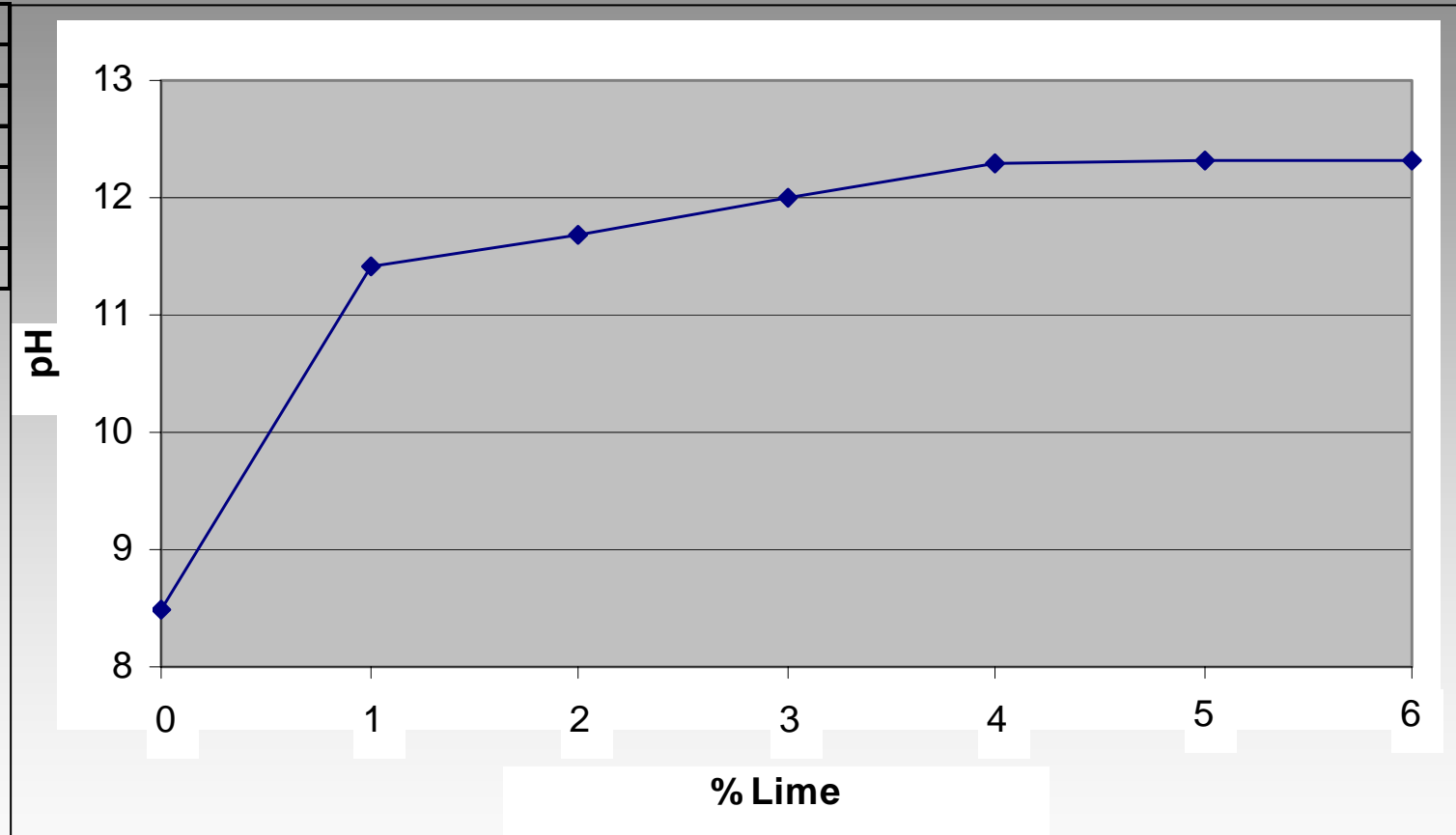
ICC GRAPH 9/481

0	8.5
1	12.15
2	12.33
3	12.41
4	12.5
5	12.55
6	12.55



ICL GRAPH 9/481

0	8.5
1	11.41
2	11.69
3	12.01
4	12.3
5	12.31
6	12.31



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UCS Issues

COLTO / TRH 14

Stabilised C4 layer UCS 0,75 – 1,5 MPa *

Stabilised C3 layer UCS 1,5 – 3,0 MPa *

* TRH 14 : Max value given as a guide only !!

TRUE LIFE STORY

Weathered dolerite

GM – 2,54

% passing 0,075mm – 6

PI – 5

CBR @ 100; 95; 90 - 114; 61; 47

ICC – 4,5%

TRUE LIFE STORY

Weathered dolerite

GM – 2,54

% passing 0,075mm – 6

PI – 5

CBR @ 100; 95; 90 - 114; 61; 47

ICC – 4,5%

UCS @ 2% - 2,3 MPa

3% - 3,9 MPa

4,5% - 6,6 MPa

6% - 7,0 MPa

MATERIALS TEST REPORT

Laboratory Number	9823				
Field Number					
Position in field					
Depth (mm)					
Sample Description	Du. Bl. Br. Crushed Concrete				
Stabilising Agent	None				

Sieve Analysis (Wet Preparation) TMH1 - Method A1 (a)

63.00 mm	Percentage Passing	100			
53.00 mm		95			
37.50 mm		91			
26.50 mm		83			
19.00 mm		71			
13.20 mm		64			
4.75 mm		48			
2.00 mm		26			
0.425 mm		11			
0.075 mm		6			
Grading Modulus		2.57			

Mechanical Analysis - TMH1 - Method A5

Coarse Sand (%)	57			
Coarse - Fine Sand (%)	6			
Medium - Fine Sand (%)	7			
Fine - Fine Sand (%)	9			
Silt and Clay (%)	22			

Atterberg Limits - TMH1 - Methods A2, A3, A4

Liquid Limit (%)	24			
Plasticity Index (%)	4			
Linear Shrinkage (%)	2.0			
Classification Group Index	A-1-a(0)			
TRH 14 Classification (1985)	#			

Maximum Dry Density and Optimum Moisture Content - TMH1 - Method A7

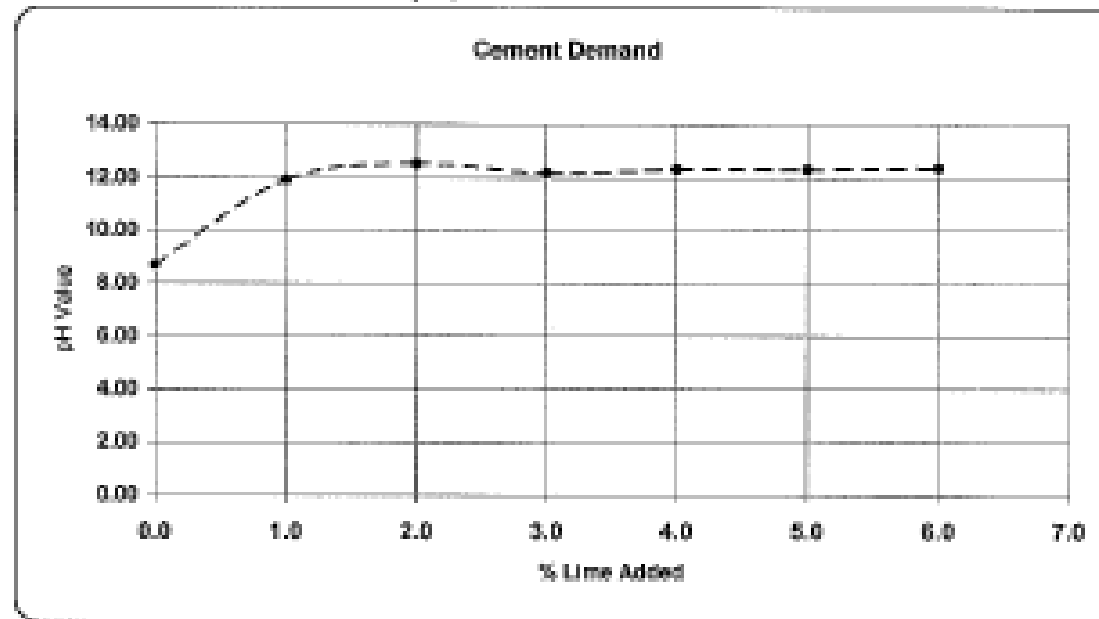
Optimum Moisture Content (%)				
Maximum Dry Density (kgm ³)				

Laboratory Number 9823
Field Number
Position
Depth (mm)
Material Description Du.BI.Br.Crushed Dolerite
Stabilising Agent Cement Eagle Pro NPC

INITIAL CONSUMPTION OF CEMENT 1 HOUR - Test Method A17T

% Cement Added	pH Value	% Cement Added	pH Value	% Cement Added	pH Value
0.0	8.70	5.0	12.35		
1.0	11.94	6.0	12.41		
2.0	12.54				
3.0	12.20				
4.0	12.35				

ONE HOUR LIME CONSUMPTION (X1) = 2.0

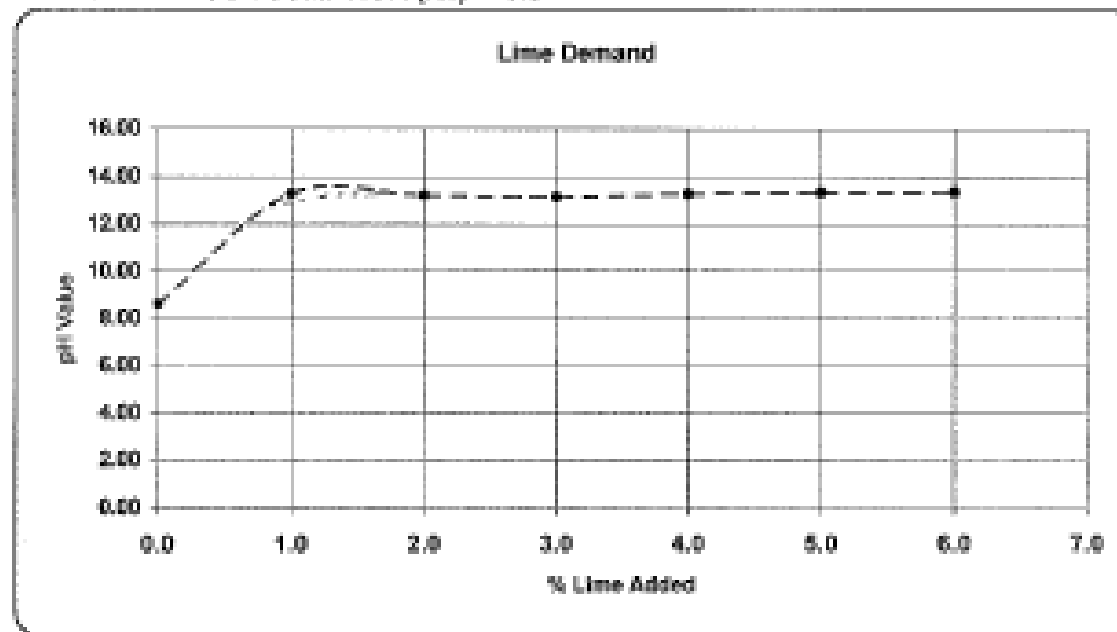


Laboratory Number 9823
Field Number
Position
Depth (mm)
Material Description Du.Bl.Br.Crushed Dolerite
Stabilising Agent Carlime

INITIAL CONSUMPTION OF LIME 1 HOUR - Test Method A17T

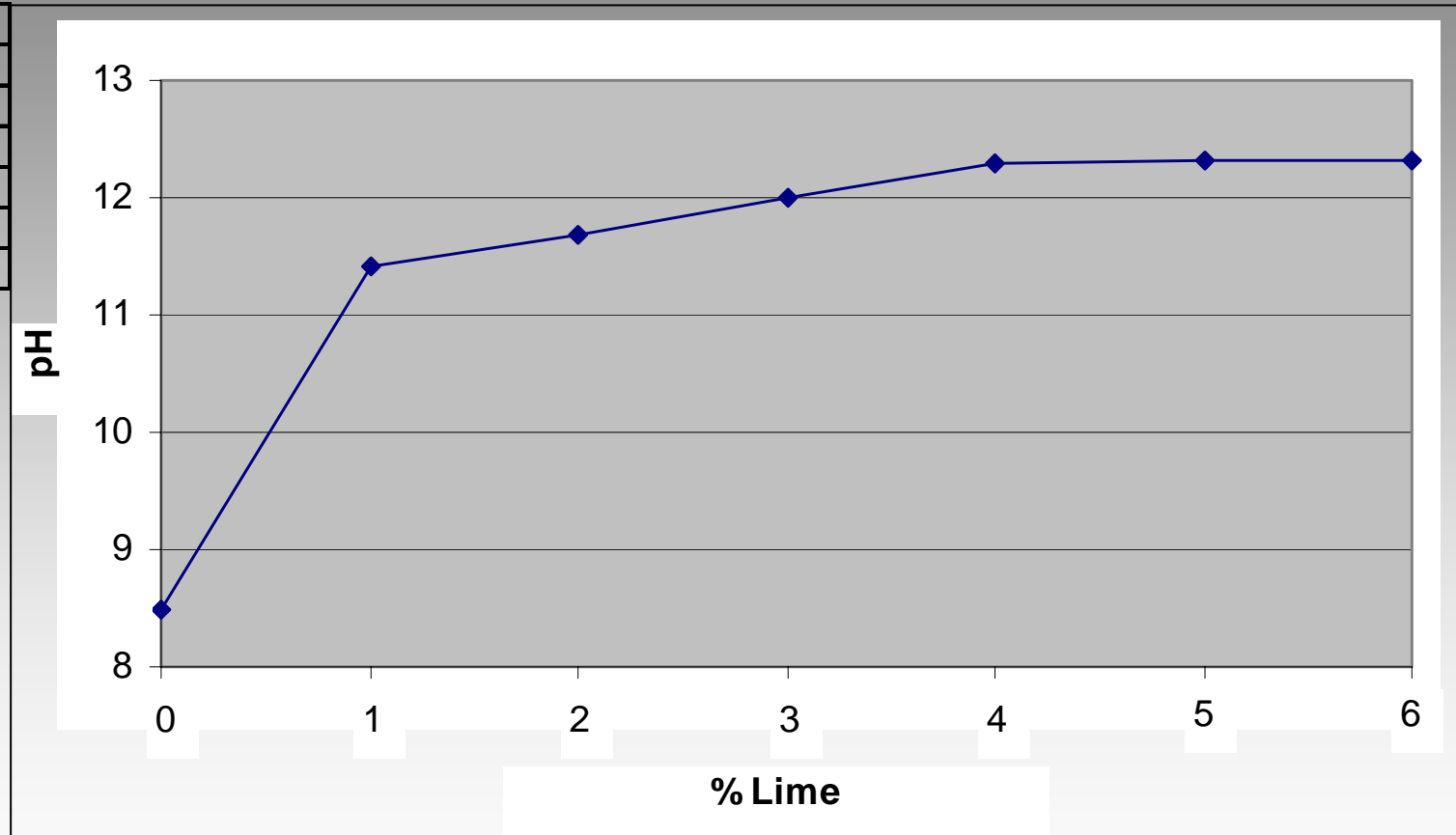
% Lime Added	pH Value	% Lime Added	pH Value	% Lime Added	pH Value
0.0	8.61	5.0	13.34	12.0	
1.0	13.28	6.0	13.38	14.0	
2.0	13.22				
3.0	13.15				
4.0	13.27				

ONE HOUR LIME CONSUMPTION (X1) = 0.8



ICL GRAPH 9/481

0	8.5
1	11.41
2	11.69
3	12.01
4	12.3
5	12.31
6	12.31



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ITS Issues

ITS > 250 kPa – Only SANRAL requirement.

Problems in achieving 250 kPa if

- GM > 2,3 !
- Well graded G1 – G4 material on coarse side of envelope
- relative high % < 37,5 > 26,5 mm fraction: compacted in 5 layers to give 127mm specimen
- Possible “delamination” of layers during test?
- Insufficient fines (mortar) to bind material = permeable layer?

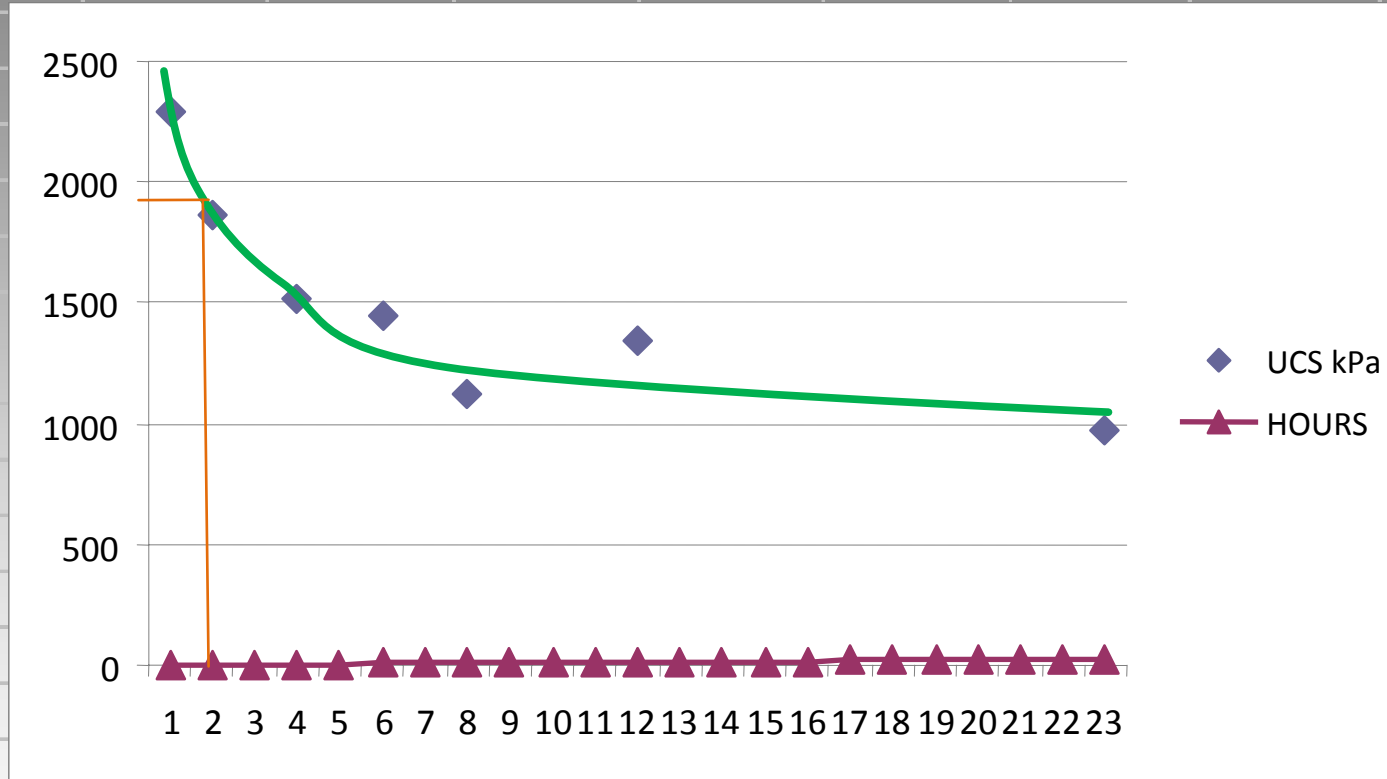
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Time / Strength Behaviour

Not all cements/gravel react the same?

UCS - STANDING TIME

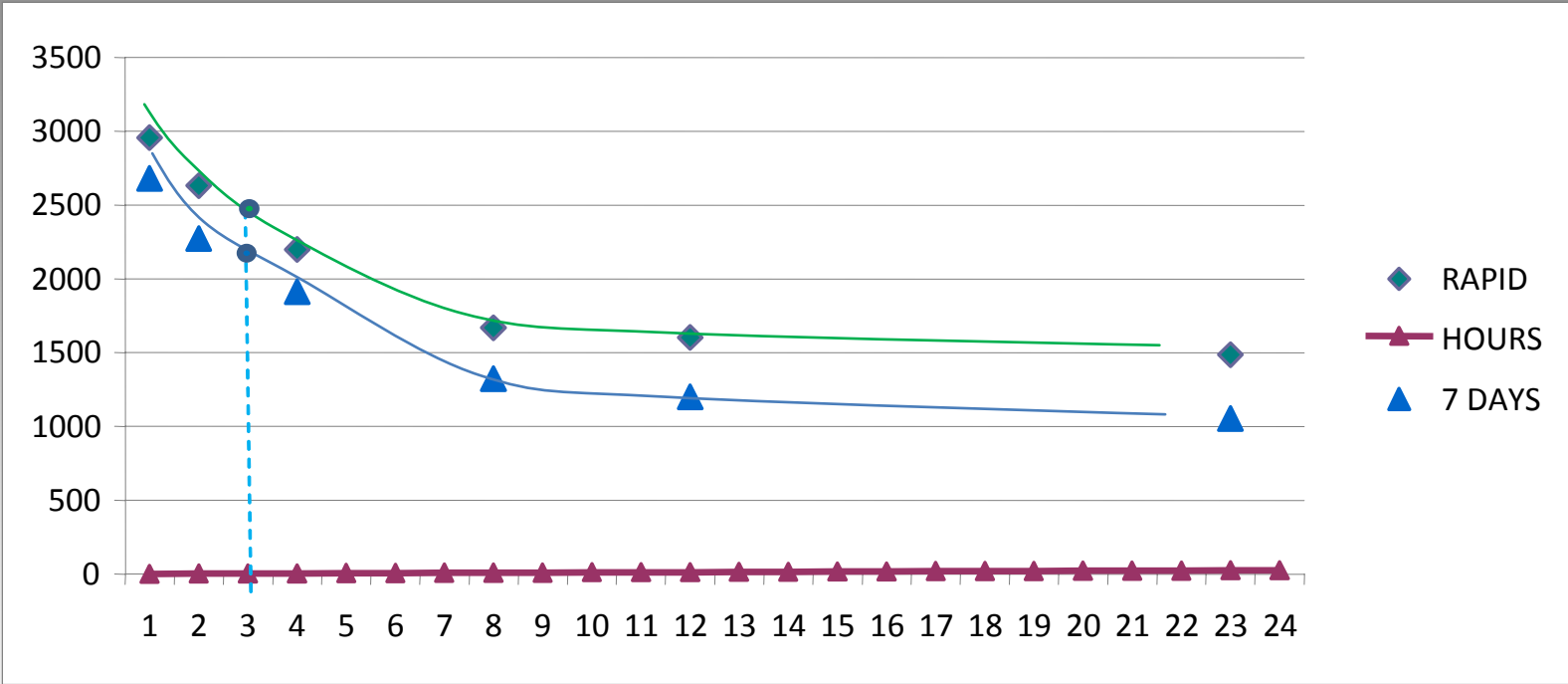


In 2,25 hours time the UCS value was only 80% of the original value.

09/07/2008



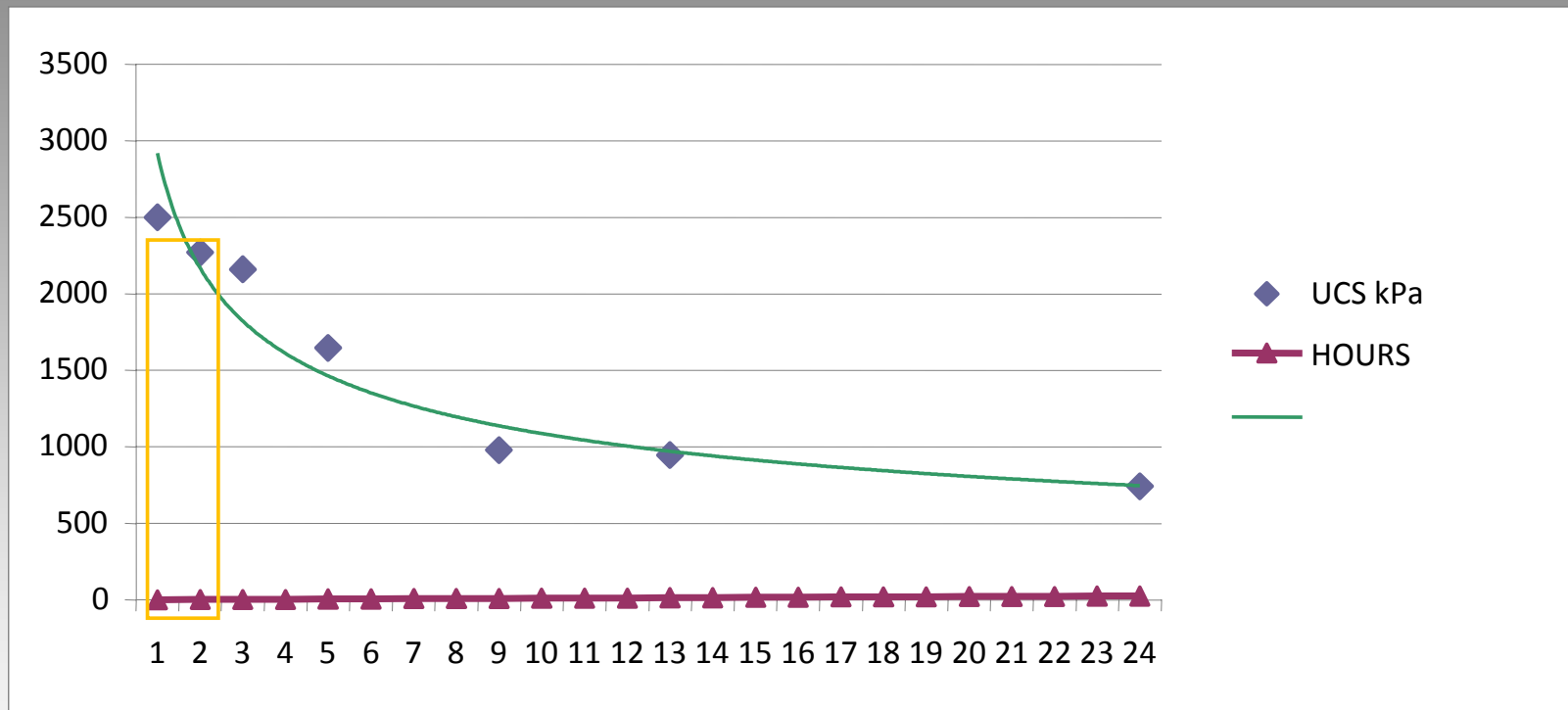
CEM I UCS - STANDING TIME - 28 January 2009



----- In **2.9** hours time the UCS value was only 80% of the original value.



UCS - STANDING TIME - 26 November 2008



In 2,25 hours time the UCS value was only 80% of the original value.

23/08/2008

Prepared by:
 Voorbereid door:
 HJ Schoonen
 Date / Datum:
 19-Mar-03

**STABILIZATION DESIGN
 PAVEMENTS
 STABILISASIE-ONTWERP
 PLAVEISIELS**

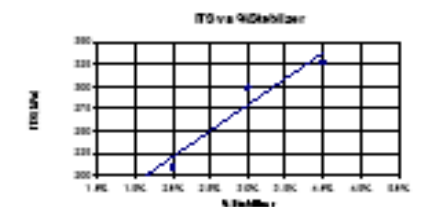
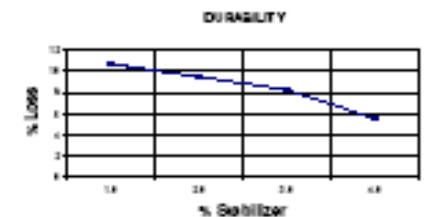
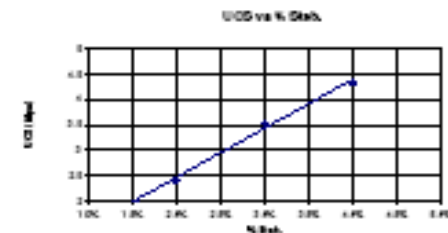
Contract / Kontrak: NPA N001-150-2007/1
 Route / Route: National Route 1
 Section / Gedeelte: Section 15/1E
 Layer / Laag: Subbase
 M: / Mengtel: 100% Main Gr Quarry

Form Van
D 5
 100/1992
 1 of 1
 van

Sources / Bronne		Material / Materiale Data											
Description / Beskrywing		1) Main Gr Quarry					2) Subgrade / Hoop (No. / No)						
Sub. / Type / Tipe		Dolomite / Gushed GG					1) 2)						
Sub. Source / Bronne (Patio/Veld)		General / Gemeng:					Ridolite Grs 032.5 A-L						
Line / Lijn:		Segment:					Ply / Afd. / Wegte:						
Before Treatment / Voor Bekendeling													
Properties / Eienskappe													
Source / Bron	Sample / Monster	7.5	63	53	27.5	20.5	19.0	13.2	4.75	2.0	0.425	0.075	GM
1) Main Gr Quarry	GG8	100	100	100	100	97	95	76	56	42	22	12	2.24
2) Main Gr Quarry	GG2.5	100	100	100	100	96	73	60	36	20	13	9	2.53
M: / Mengtel (Patio/Veld)													
Specification / Spesifikasie													
Source / Bron		3) Main Gr Quarry					12)					M: / Mengtel	
MDD	(kg/m ³)	225											
OMC / CVG	(%)	6.9											
ICGAVA		1.5%											
LLVG	PI	LSLR	SP	5	2								
CBR / MDV @ 100, 95, 90%		25	49		25								
After Treatment / Na Bekendeling													
Sub. / GRM @ 30.5 A-L (1%)		20			20				40				
MDD	(kg/m ³)	225					225						
OMC / CVG	(%)	7					6.6						
Comp. Moist / Verd. Vog. (%)		7.3					6.6						
LLVG	PI	LSLR	SP		2	SP			2				
400-NDM - UCS / SDS @ 40+60+100% Compaction/Verdigting*													
Do: After 24 Hours/Ur													
Do: After 3 Days/Dae													
Do: After 7 Days/Dae		2.4			3.52				4.53				
Do: After 28 Days/Dae													
Do: After 56 Days/Dae													
400-NDM - UCS / SDS ITS @ 40+60+100% Compaction/Verdigting													
Do: After 24 Hours/Ur													
Do: After 3 Days/Dae													
Do: After 7 Days/Dae													
Do: After 28 Days/Dae		210			299				327				
Do: After 56 Days/Dae													
CBR / MDV, UCS / SDS ITS @ 90 / 95 / 98% Compaction/Verdigting													
Do: After 24 Hours/Ur													
Do: After 3 Days/Dae													
Do: After 7 Days/Dae													
Do: After 28 Days/Dae													
Do: After 56 Days/Dae													
Durability / Duursaamheid	Loss/Verlies %	10.7			10.7				5.6			Loss/Verlies	
Wear Test (H-1 A19)	% (OS)											% (OS)	
Strength / Sterkte (Rsp.)	mm ()				mm ()				mm ()			mm ()	
Strength / Sterkte (MPa)													
Grad. + GM													
Target / Telling (Grad. + GM)													
Notes / Notas: - IC - Initial Consumption of Line / AFA - Aansienlike Kalkaanwag													

* Delete if not applicable / Heel deur indien nie van toepassing

Graphic Display / Grafiese Vertooning



Proposal / Aanbeveling		Ratio / Verhouding	100%
Source / Bronne:	Main Gr Quarry		
Material / Materiale:	Dolomite		
Stabilizer / Stabiliserend:	GRM 032.5 A-L	Ratio / Verhouding	
% Sub. per Mass/Mengtel:	2.5%	Total Total:	%
MDD of Treated Mixture / MDD van Behandelde Mengtel:			225 kg/m ³
OMC of Treated Mixture / OVG van Behandelde Mengtel:			6.6 %
Compaction Moisture / Verdichtingsvocht:			6.6 %
Target / Telling			
PI (Moisture/Moistuur):			6
CBR/MDV @	% Comp/Verdig. aferna	Hours/Ur / Days/Dae	% e
UCS/SDS @	100 % Comp/Verdig. aferna	7 Hours/Ur / Days/Dae	1.5-3 MPa ()
ITS @	100 % Comp/Verdig. aferna	7 Hours/Ur / Days/Dae	>250 MPa ()



Prepared by :

Designed by :

Date :
24/06/2009

Date :
20/04/2009

STABILIZATION DESIGN

Sources	(1) BP4	(2)	Stockpile (No./ Km)										
Description	CRUSHED WEATHERED DOLERITE										(1)	(2)	
Stab. (Type)	Cement	CEM 11 B-L 32.5	Lime	Slagment;					Fly AsH				
Stab. Sources (Ratio)	AFRISAM ALL PURPOSE										()	()	
BEFORE TREATMENT													
Properties													
Sources : PB 1	Sample No	75.0	63.0	53.0	37.5	26.5	19.0	13.2	4.75	2.00	0.425	0.075	GM
(1)	9/481(Geostrada)			100	90	72	65	60	47	28	12	6	2.54
(2)													
Mixture (Ratio.....)													
Specification (G 4)													
Source	(1)	BP 4					Mixture						
MODASHTO-MDD (kg / m ³)	2325												
OMC (%)	6.1												
ICC	4.5												
LL	PI	LS	21.0	8.0	3.5								
CBR / KDV @ 100, 95, 93 %	114	61	47										
AFTER TREATMENT													
Stab. () (%)	2% CEM			3 % CEM			4.5% CEM			6% CEM			
MAASHTO-MDD (kg / m ³)	2343			2343			2340			2312.0			
OMC (%)	7.4			7.4			7.4			7.9			
Comp. Moist (%)	7.6			7.4			7.4			8.1			
LL	PI	LS	27	5	2.5	27	3	1.5	SP	1	SP	1	
STRENGTH PARAMETERS													
CBR / KDV, UCS / EDS, ITS @ 100% Compaction													
Do : After / N 24 Hours	2331	/	181	3871	/	288	6633	/	595	6982	/	597	
Do : After 4 Days	/		/			/			/			/	
Do : After 7 Days	/		/			/			/			/	
Do : After 28 Days	/		/			/			/			/	
Do : After 56 Days	/		/			/			/			/	
CBR / KDV, UCS / EDS, ITS @ 97% Compaction / Verdigting													
Do : After / N 24 Hours	/		/			/			/			/	
Do : After 4 Days	/		/			/			/			/	
Do : After 7 Days	/		/			/			/			/	
Do : After 28 Days	/		/			/			/			/	
Do : After 56 Days	/		/			/			/			/	
CBR / KDV, UCS / EDS, ITS @ 93% Compaction / Verdigting													
Do : After / N 24 Hours	/		/			/			/			/	
Do : After 4 Days	/		/			/			/			/	
Do : After 7 Days	/		/			/			/			/	
Do : After 28 Days	/		/			/			/			/	
Do : After 56 Days	/		/			/			/			/	
Durability (wet/dry)	Loss %	60	Loss %	50	Loss %	17	Loss %						
Wet (TMH1 A19)	% (C / S)		% (C / S)		% (C / S)		% (C / S)						
Erosion (Rep.)	mm ()		mm ()		mm ()		mm ()						
Strength Mpa	UCS VALUES @ 100 %	2331	3871	6633	6982.0								
Grad. + GM													
Target (Grad. + GM)													
SWELL @ 100%													
NOTES													
Specify mixing method of stabilizer i.e bag / bulk:								BAG					
Specify mixing method of layer i.e insitu machine, by grader etc or batch plant:								GRADER					
Specify curing method:								WATERSPRAY					
Specify stabiliser determination method i.e Meth A15(d) TMH1 or canvas patch:								METH A15 (d)					
Indicate loaction of trial section:								KM 36.620 TO KM.36.820					
Other Notes:													
* Delete if not applicable													





Prepared by: Designed by:

Date : Date :
24/06/2009 17/05/2009

STABILIZATION DESIGN

Sources	(1) BP 1	(2)	Stockpile (No./Km)										
Description	CRUSHED WEATHERED DOLERITE										(1)	(2)	
Stab. (Type)	Cement	CEM 11B-L 32.5	Lime	Slagment;	Fly Ash								
Stab. Sources (Ratio)	AFRISAM ALLPURPOSE												
BEFORE TREATMENT													
Properties													
Sources : PB 1	Sample No	75.0	63.0	53.0	37.5	26.5	19.0	13.2	4.75	2.00	0.425	0.075	GM
(1)	9/1892(BP 1)			100	96	82	72	61	43	24	9	4	2.63
(2)													
Mixture (Ratio.....)													
Specification (G4)													
Source	(1)	BP 1										Mixture	
MODASHTO-MDD	(kg / m ³)	2346											
OMC	(%)	6.6											
ICC		2											
LL	PI	LS	22.0	5.0	2.5								
CBR / KDV @ 100, 95, 93 %		100	71	61									
AFTER TREATMENT													
Stab. ()	(%)	2%CEM			3%CEM			4%CEM					
MAASHTO-MDD	(kg / m ³)	2231			2238			2193					
OMC	(%)	6.1			7.2			7.3					
Comp. Moist.	(%)	6.4			7.0			7.4					
LL	PI	LS		NP		NP		NP					
STRENGTH PARAMETERS													
CBR / KDV, UCS / EDS, ITS @ 100% Compaction													
Do : After / N 24 Hours		3000	/	251	3380	/	370	4980	/	370			
Do : After 4 Days			/			/			/				
Do : After 7 Days			/			/			/				
Do : After 28 Days			/			/			/				
Do : After 56 Days			/			/			/				
CBR / KDV, UCS / EDS, ITS @ 97% Compaction / Verdigting													
Do : After / N 24 Hours		1800	/	205	2400	/	300	3510	/	370			
Do : After 4 Days			/			/			/				
Do : After 7 Days			/			/			/				
Do : After 28 Days			/			/			/				
Do : After 56 Days			/			/			/				
CBR / KDV, UCS / EDS, ITS @ 93% Compaction / Verdigting													
Do : After / N 24 Hours		999.0	/	169	1590	/	198	2490	/	230			
Do : After 4 Days			/			/			/				
Do : After 7 Days			/			/			/				
Do : After 28 Days			/			/			/				
Do : After 56 Days			/			/			/				
Durability (wet/dry)	Loss %			26	Loss %		13	Loss %		11	Loss %		
Wet (TMH1A 18)	% ()			C / S	% ()		C / S	% ()		C / S	% ()		C / S
Erosion (Rep.)	mm ()				mm ()			mm ()			mm ()		
Strength Mpa	UCS VALUES @ 100 %			3000			3380			4980			
Grad. +GM													
Target (Grad. +GM)													
SWELL @ 100%													
NOTES													
Specify mixing method of stabilizer i.e bag / bulk:											BAG		
Specify mixing method of layer i.e insitu machine, by grader etc or batch plant:											GRADER		
Specify curing method:											WATERSPRAY		
Specify stabiliser determination method i.e Meth A15(d) TMH1 or canvas patch:											METH A15 (d)		
Indicate loaction of trial section:											KM 8.620 TO KM.9.020		
Other Notes:													
* Delete if not applicable													



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STABILISATION WORKSHOP

Curing – COLTO

- i) Keep wet for 24 hours, then:
- ii) Cover with subsequent layer, or
- iii) Apply curing compound (emulsion / cut back bitumen) or
- iv) Apply prime coat, or
- v) Continuously moist – fog spray – for 7 days

SANRAL omit (iii) and (iv)!

Who does (v)?

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STABILISATION WORKSHOP

CONCLUSIONS

- There are a number of issues that need to be addressed

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STABILISATION WORKSHOP

CONCLUSIONS

- There are a number of issues that need to be addressed
- Have we taken our “eye off the ball”?

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STABILISATION WORKSHOP

CONCLUSIONS

- There are a number of issues that need to be addressed
- Have we taken our “eye off the ball”?
- Will SAPEM solve our problems?