OVERVIEW OF RECYCLING PROJECTS INCORPORATING BSM LAYERS

CLIMATIC CONSIDERATIONS

ISAP Working Group WG2
Champagne Sports Resort
Sunday 11 September 2011

Dave Collings
LOUDON INTERNATIONAL

TOPICS

CLIMATE CONCERNS

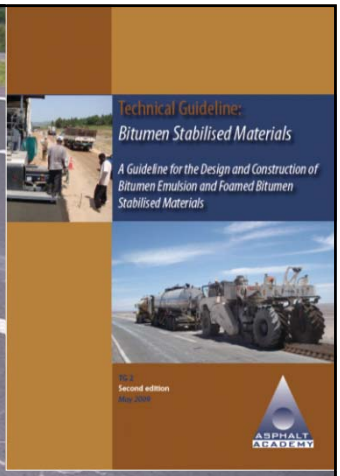
- Moisture
- Temperature

MOISTURE CONDITIONS

- During construction
- After finishing / before surfacing

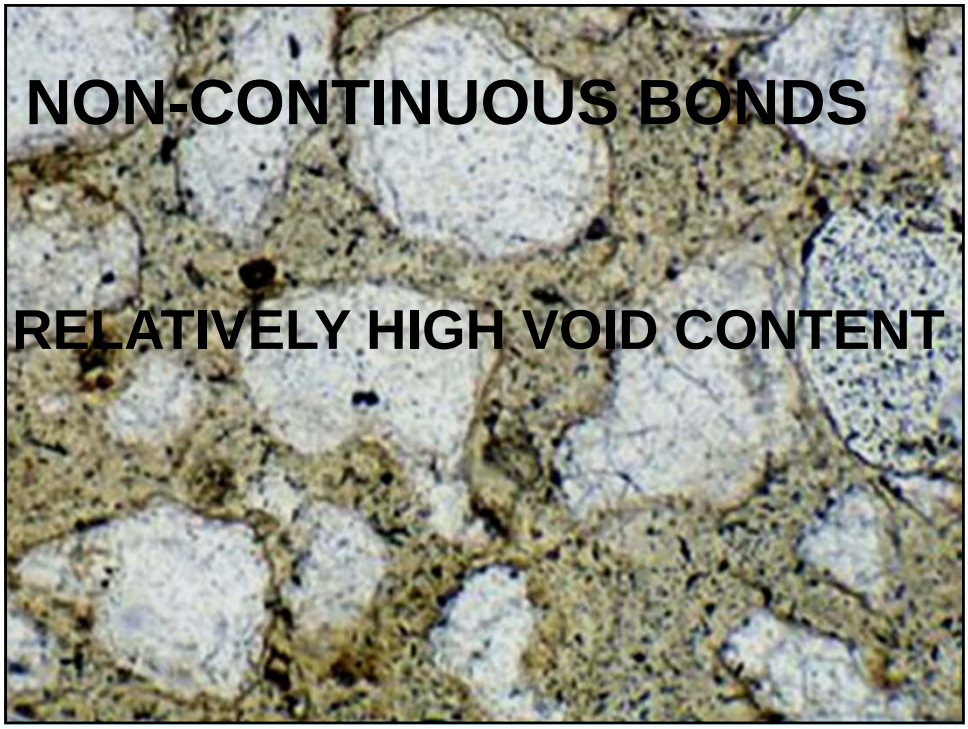
TEMPERATURES

- During construction
- Operating conditions



"BSM"

TG2 (2009)

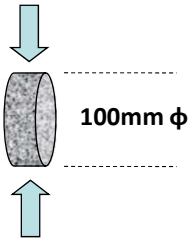

NON-CONTINUOUS BONDS
RELATIVELY HIGH VOID CONTENT


MOISTURE SUSCEPTIBILITY
sappi usutu

DETERMINATION OF THE EFFECT OF ACTIVE FILLER

MATERIAL TO BE STABILISED		Aggregates		Bitumen	Active Filler
Description		Pa.R.Br.Qtz.Pebbles + Gravel + RA		80/100 Pen	As shown
Location / Source:		**km 1+000**		SAPREF	Contractor
Mod AASHTO	(kg/m3)	2075	Optimum moisture content (%):		8.0
FOAMED BITUMEN STABILISED MATERIAL SPECIMENS					
Compactive effort		Vibratory Hammer : TG2(2009) Method 8(2)		**100mm**	diameter
Date moulded		06 January 2011			
Foamed Bitumen added	(%)	2.5	2.5	2.5	
Bitumen foaming conditions:		Water added (%)	2.3	Temperature (°C)	175
Type and percent filler added	(%)	**No filler**	**1% Lime**	**1% Cement**	
Moulding moisture content	(%)	6.1	6.2	6.2	
TEST RESULTS					
ITS dry	(kPa)	**316**	**466**	**325**	
Moisture content at break	(%)	1.0	1.3	1.2	
Dry Density	kg/m^3	2078	2080	2088	
Temperature at break	(oC)	24.9	25.0	25.4	
ITS wet	(kPa)	**68**	**303**	**186**	
Moisture content at break	(%)	6.3	5.9	5.8	
Dry Density	kg/m^3	2080	2079	2086	
Temperature at break	(oC)	25.3	25.5	25.4	

LEVEL 1

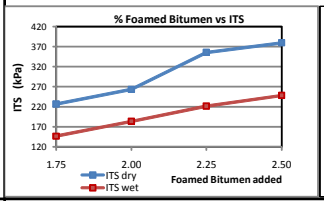


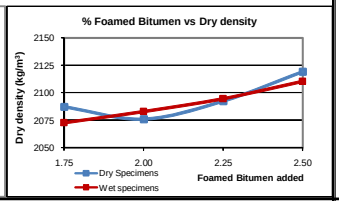
FOAMED BITUMEN MIX DESIGN REPORT - LEVEL 1

MATERIAL TO BE STABILISED		Aggregates		Bitumen	Active Filler
Description		Pa R Br Qtz Pebbles + Gravel + RA		80/100	Lime
Location / Source:		**km 1+000**		SAPREF	Northern Lime
Maximum Dry Density	(kg/m3)	2075	Optimum moisture content (%):		8.0

FOAMED BITUMEN STABILISED MATERIAL SPECIMENS

Compactive effort		Vibratory Hammer : TG2(2009) Method 8(2)		**100mm** diameter	
Date moulded		10 January 2011			
Foamed Bitumen added	(%)	**1.75**	**2.00**	**2.25**	**2.50**
Bitumen foaming conditions:		Water added (%)	2.3	Temperature (°C)	175
Type and percent filler added	(%)	1% Lime	1% Lime	1% Lime	1% Lime
Moulding moisture content	(%)	6.6	7.6	6.2	6.7
TEST RESULTS					
ITS dry	(kPa)	**227**	**263**	**355**	**379**
Moisture content at break	(%)	1.1	1.0	0.9	1.2
Dry Density	kg/m^3	2087	2076	2093	2119
Temperature at break	(oC)	24.6	24.7	24.6	24.7
ITS wet	(kPa)	**147**	**183**	**221**	**248**
Moisture content at break	(%)	7.9	7.5	7.4	6.8
Dry Density	kg/m^3	2073	2083	2094	2110
Temperature at break	(oC)	25.3	25.2	25.2	25.3
Tensile Strength Retained	(%)	65	69	62	65
TG2 (2009) Material Classification **BASED ON ITS$_{DRY}$ AND ITS$_{WET}$**		**BSM 1**	**BSM 1**	**BSM 1**	**BSM 1**





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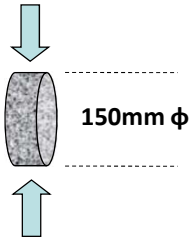
TG2 CLASSIFICATION

(kPa)

BSM-1	BSM-2	BSM-3
> 225	> 175	> 125
> 100	> 75	> 50

LEVEL 2



FOAMED BITUMEN MIX DESIGN REPORT - LEVEL 2

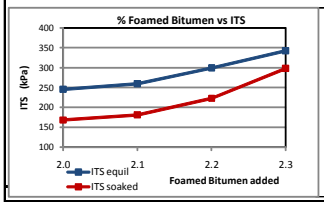
MATERIAL TO BE STABILISED	Aggregates		Bitumen	Active Filler
Description	Pa R Br Qtz Pebbles + Gravel + RA		80/100	Lime
Location / Source:	**km 1+000**		SAPREF	Northern Lime
Maximum Dry Density (kg/m3)	2075	Optimum moisture content (%):		8.0

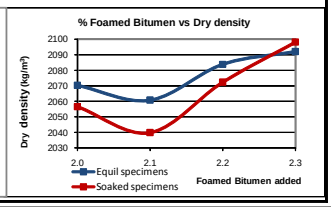
FOAMED BITUMEN STABILISED MATERIAL SPECIMENS

Compactive effort	Mod AASHTO TMH 1 A7		**150mm** diameter	
Date moulded	17 January 2011			
Foamed Bitumen added (%)	**2.0**	**2.1**	**2.2**	**2.3**
Bitumen foaming conditions:	Water added (%)	2.3	Temperature (°C)	175
Type and percent filler added (%)	1% Lime	1% Lime	1% Lime	1% Lime
Moulding moisture content (%)	7.9	8.4	7.8	7.9

TEST RESULTS

ITS equilibruim	(kPa)	**245**	**259**	**299**	**342**
Moisture content at break	(%)	3.8	4.2	3.9	3.8
Dry density	kg/m^3	2070	2061	2084	2092
Temperature at break	(oC)	24.6	25.0	24.9	24.8
ITS soaked	(kPa)	**169**	**181**	**223**	**298**
Moisture content at break	(%)	6.8	7.0	6.5	6.6
Dry density	kg/m^3	2057	2040	2072	2098
Temperature at break	(oC)	24.3	24.3	24.9	24.8
Tensile Strength Retained	(%)	69	70	75	87
TG 2 (2009) Material Classification **BASED ON ITS$_{EQUIL}$ VALUES ONLY**		**BSM 1**	**BSM 1**	**BSM 1**	**BSM 1**





FOAMED BITUMEN MIX DESIGN REPORT - LEVEL 2

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Description	Pa R Br Qtz Pebbles + Gravel + RA		80/100	Lime
Location / Source:	**km 1+000**		SAPREF	Northern Lime
Maximum Dry Density (kg/m3)	2075	Optimum moisture content (%):		8.0

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Bitumen foaming conditions:	Water added (%)	2.3	Temperature (°C)	175
Type and percent filler added (%)	1% Lime	1% Lime	1% Lime	1% Lime
Moulding moisture content (%)	7.9	8.4	7.8	7.9

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TG2 CLASSIFICATION

(kPa)

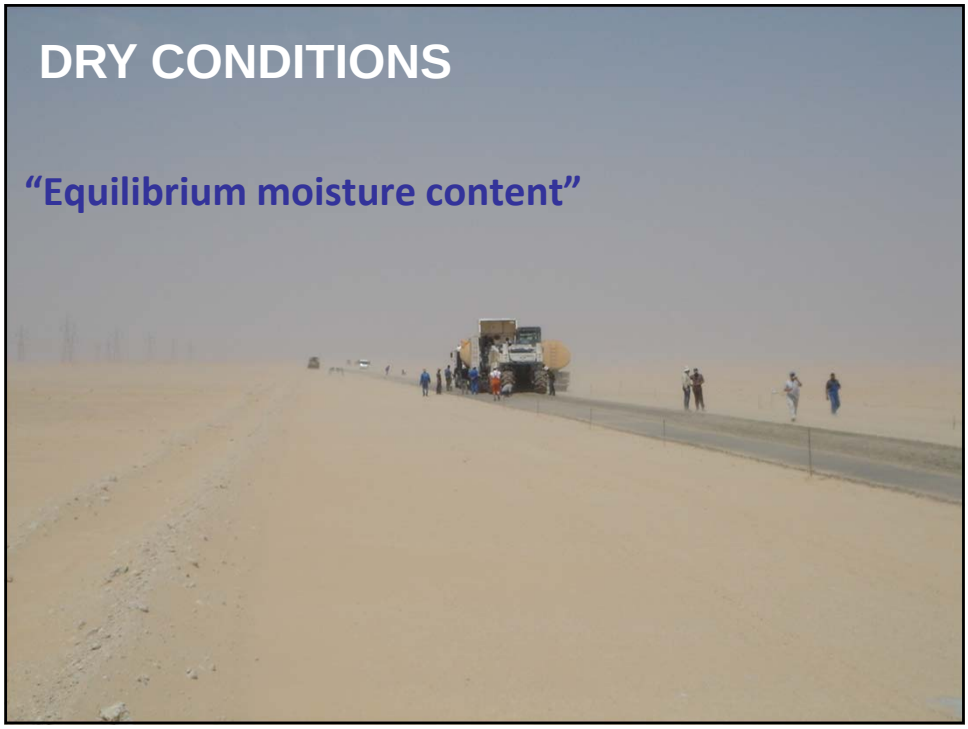
BSM-1	**BSM-2**	**BSM-3**
> 175	**> 135**	**> 75**
> 150	**> 100**	**> 60**
(> 100)	**(> 75)**	**(> 50)**


Moisture Induction Sensitivity Test (MIST)
2007/09/01 03:46 am


MOISTURE CONTENT
Mixing moisture content / compaction

DRY CONDITIONS

"Equilibrium moisture content"

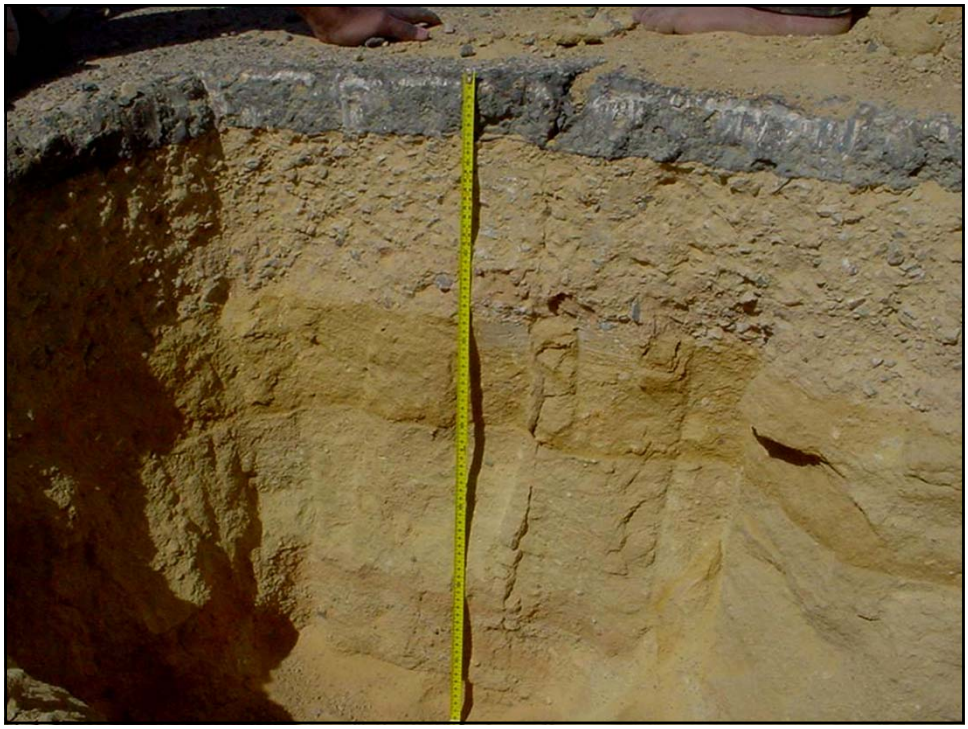


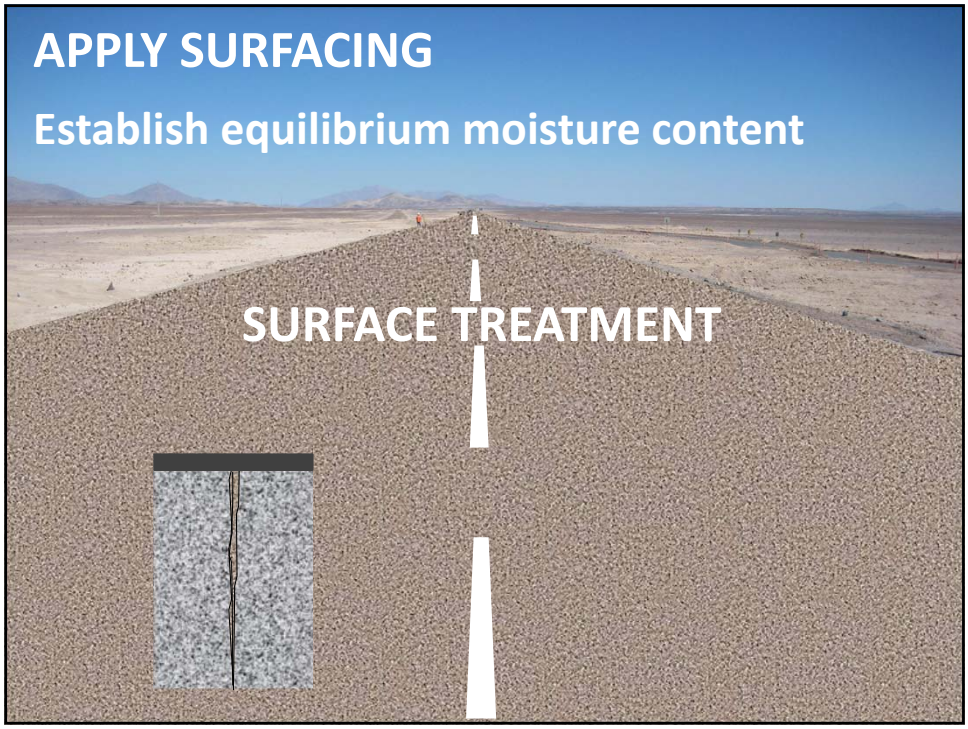
Effect of altitude

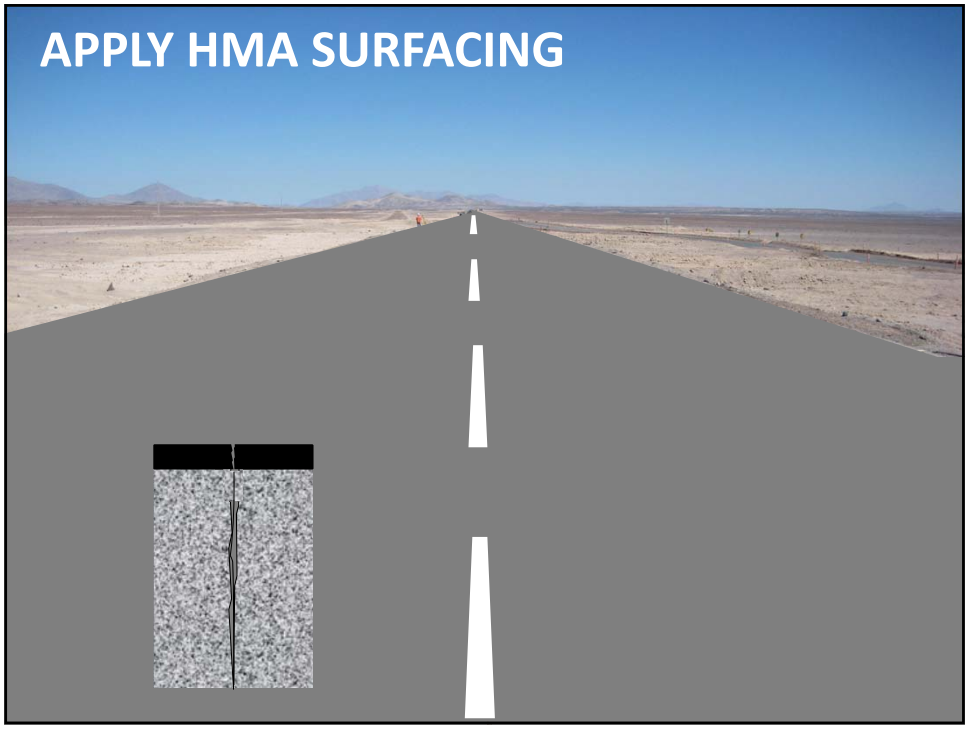
Working at + 4 000m

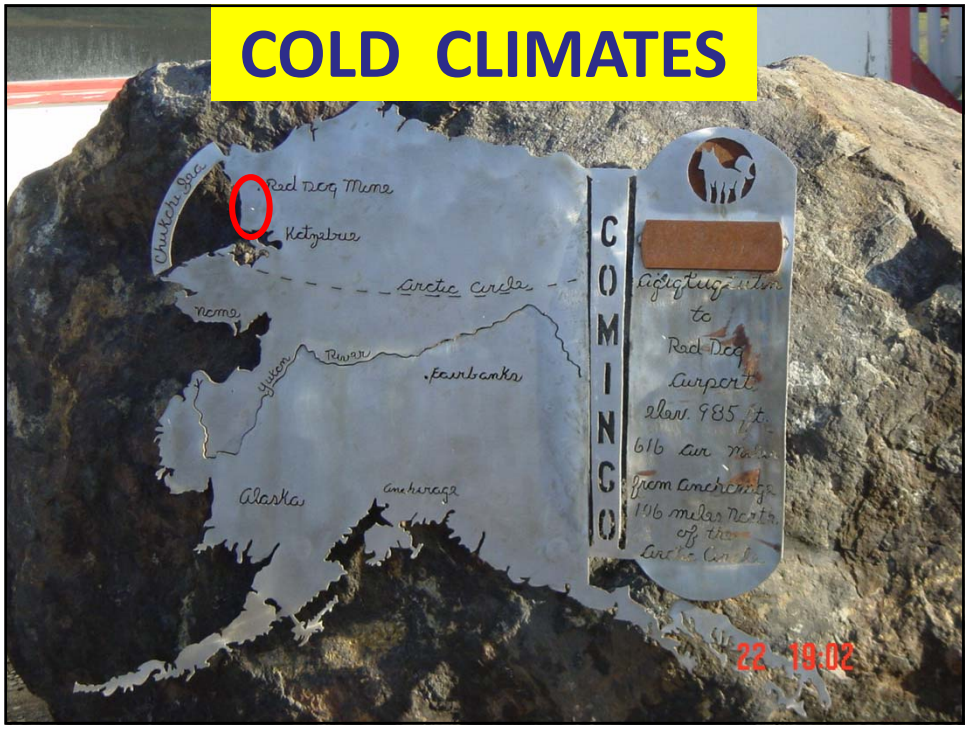
Drying to hygroscopic moisture content

"Pore fluid suction pressure"




APPLY SURFACING
Establish equilibrium moisture content
SURFACE TREATMENT


APPLY HMA SURFACING


COLD CLIMATES
Red Dog Mine
Kotzebue
Arctic Circle
Nome
Yukon River
Fairbanks
Alaska
Anchorage
COMING
to
Red Dog
Airport
from Anchorage
196 miles North
of the
Arctic Circle
22 19:02

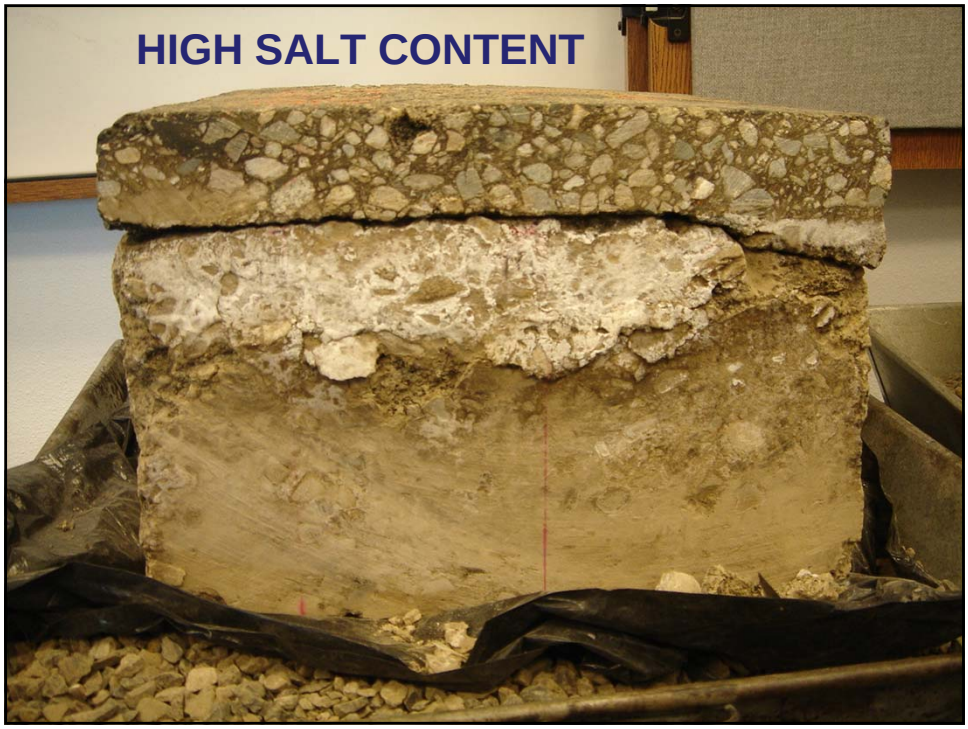

STABILISE FRESH CRUSHED STONE MATERIAL: 200mm
16 17:34

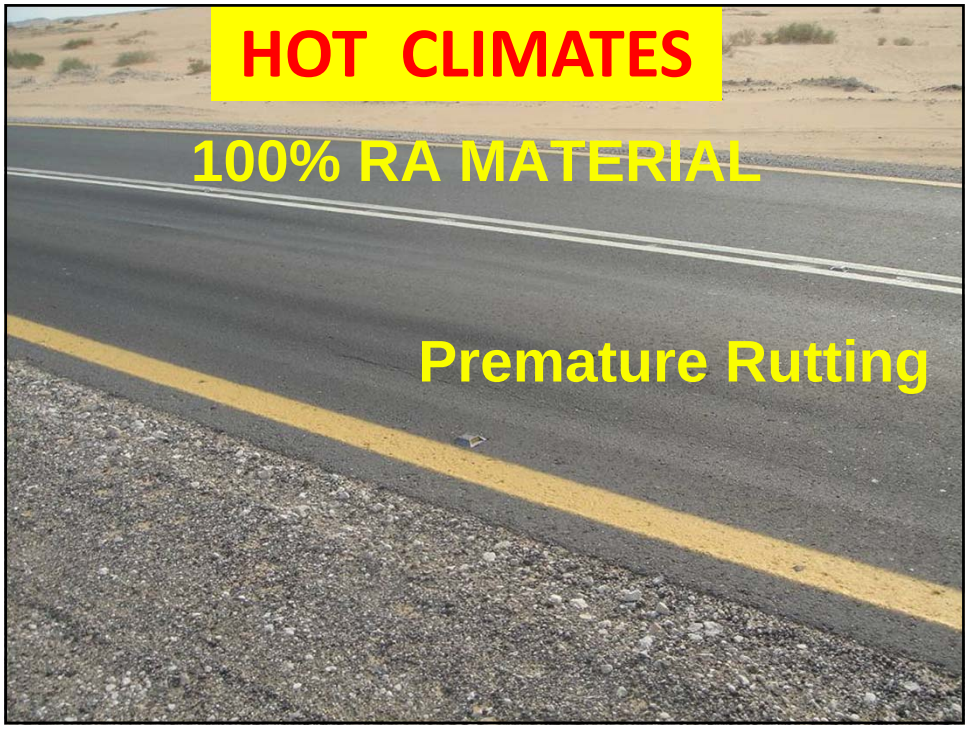

19mm CHIP SEAL
22 6:35

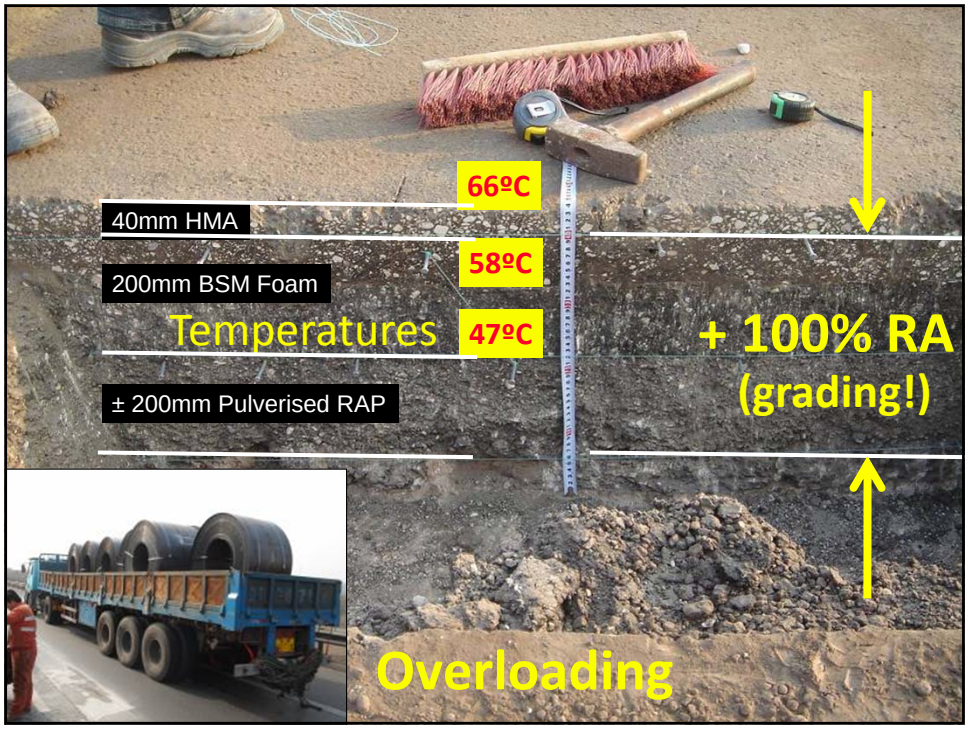

Anchorage – Fairbanks, Alaska
September 2005

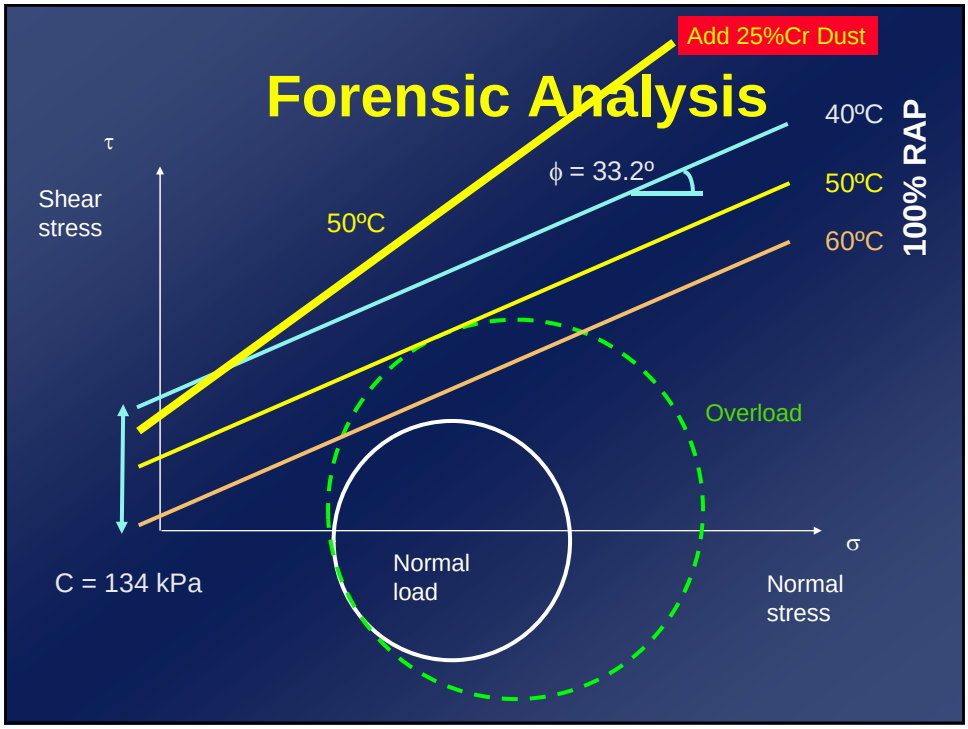

February 2006
- 45°C

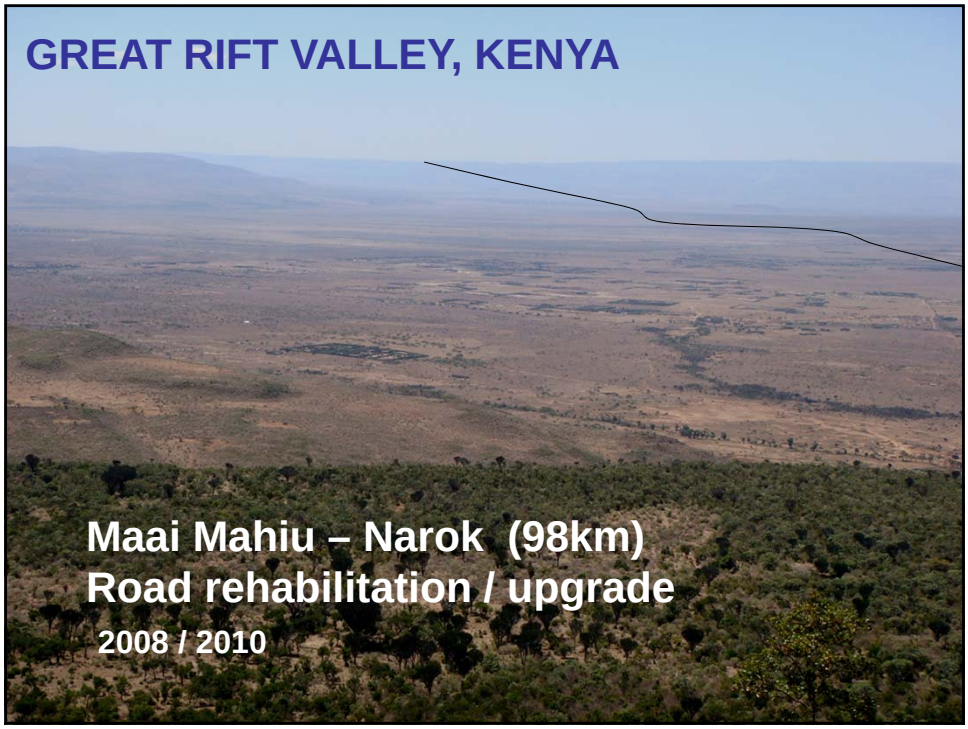

"BLISTERS"

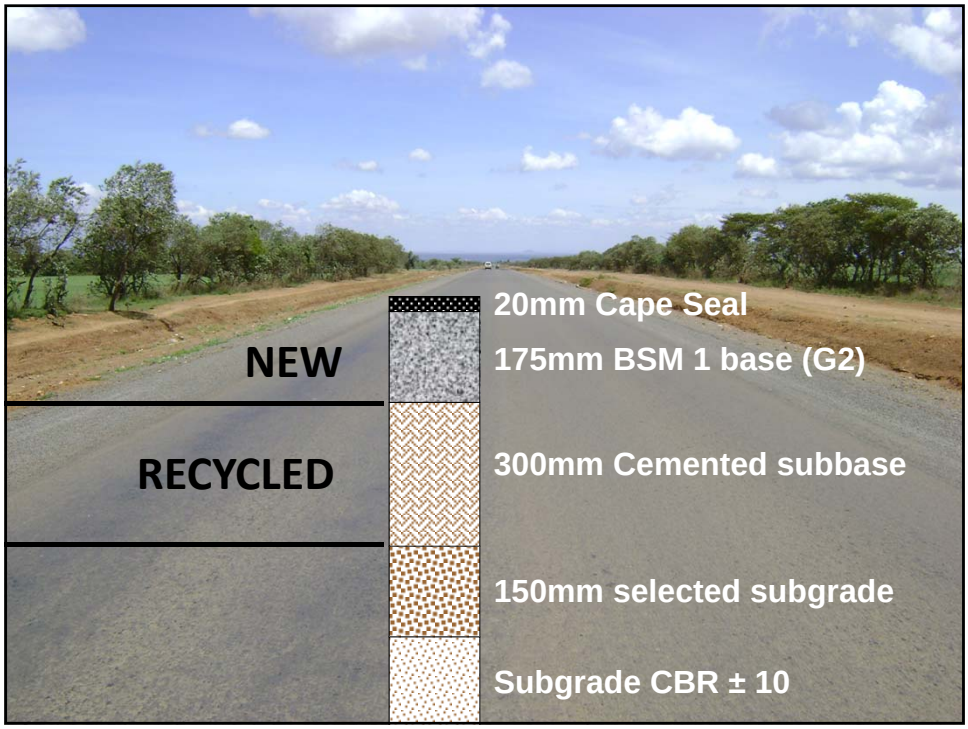

HIGH SALT CONTENT


HOT CLIMATES
100% RA MATERIAL
Premature Rutting

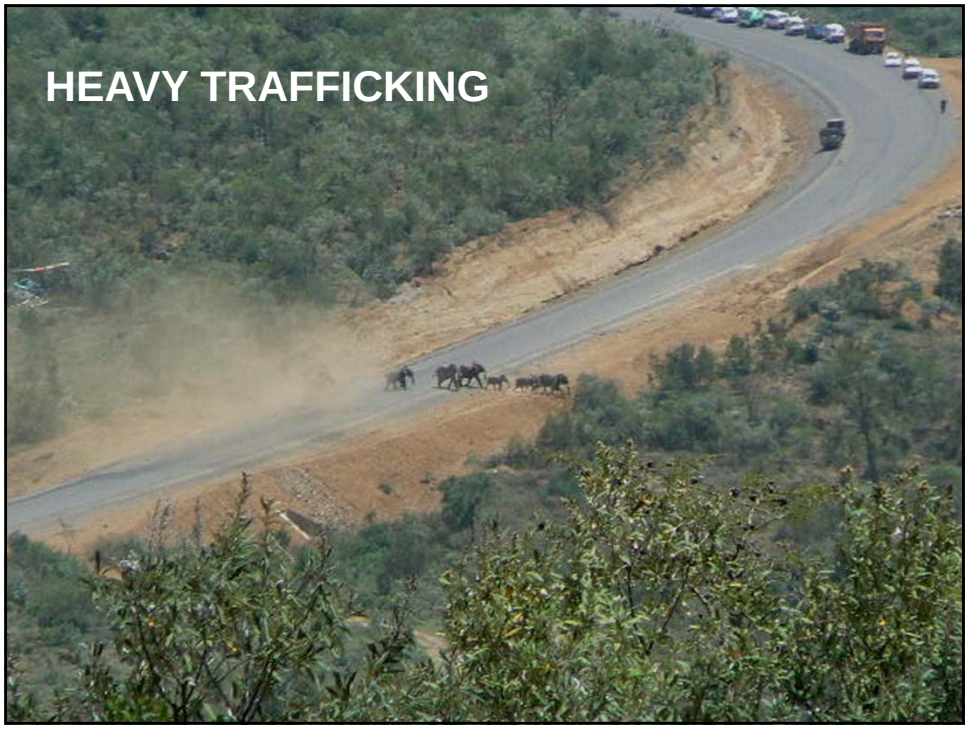

66ºC
40mm HMA
58ºC
200mm BSM Foam
Temperatures
47ºC
+ 100% RA
(grading!)
± 200mm Pulverised RAP
Overloading


Add 25%Cr Dust
Forensic Analysis
40ºC
50ºC
60ºC
100% RAP
τ
Shear stress
ϕ = 33.2º
50ºC
Overload
σ
C = 134 kPa
Normal load
Normal stress


GREAT RIFT VALLEY, KENYA
Maai Mahiu – Narok (98km)
Road rehabilitation / upgrade
2008 / 2010


NEW
RECYCLED
20mm Cape Seal
175mm BSM 1 base (G2)
300mm Cemented subbase
150mm selected subgrade
Subgrade CBR ± 10


Completed Cape Seal


HEAVY TRAFFICKING


THANK YOU !!