Session_12

Insitu Stabilisation

Queensland Government

Department of Main Roads

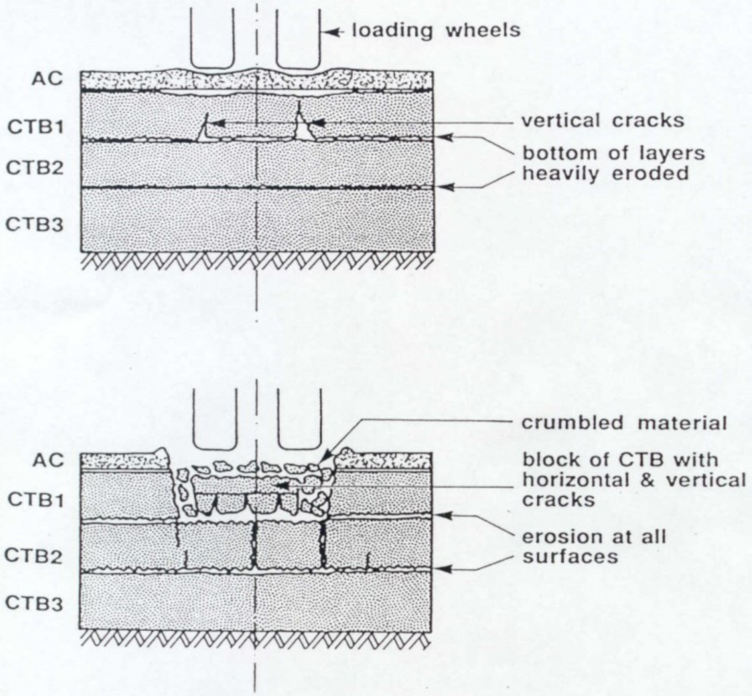
RECYCLING OPPORTUNITY

- Stage of development of the pavement
- Structural depth
- Width deficiency
- Quality of pavement material & subgrade

Insitu Recycling
Previous Problems

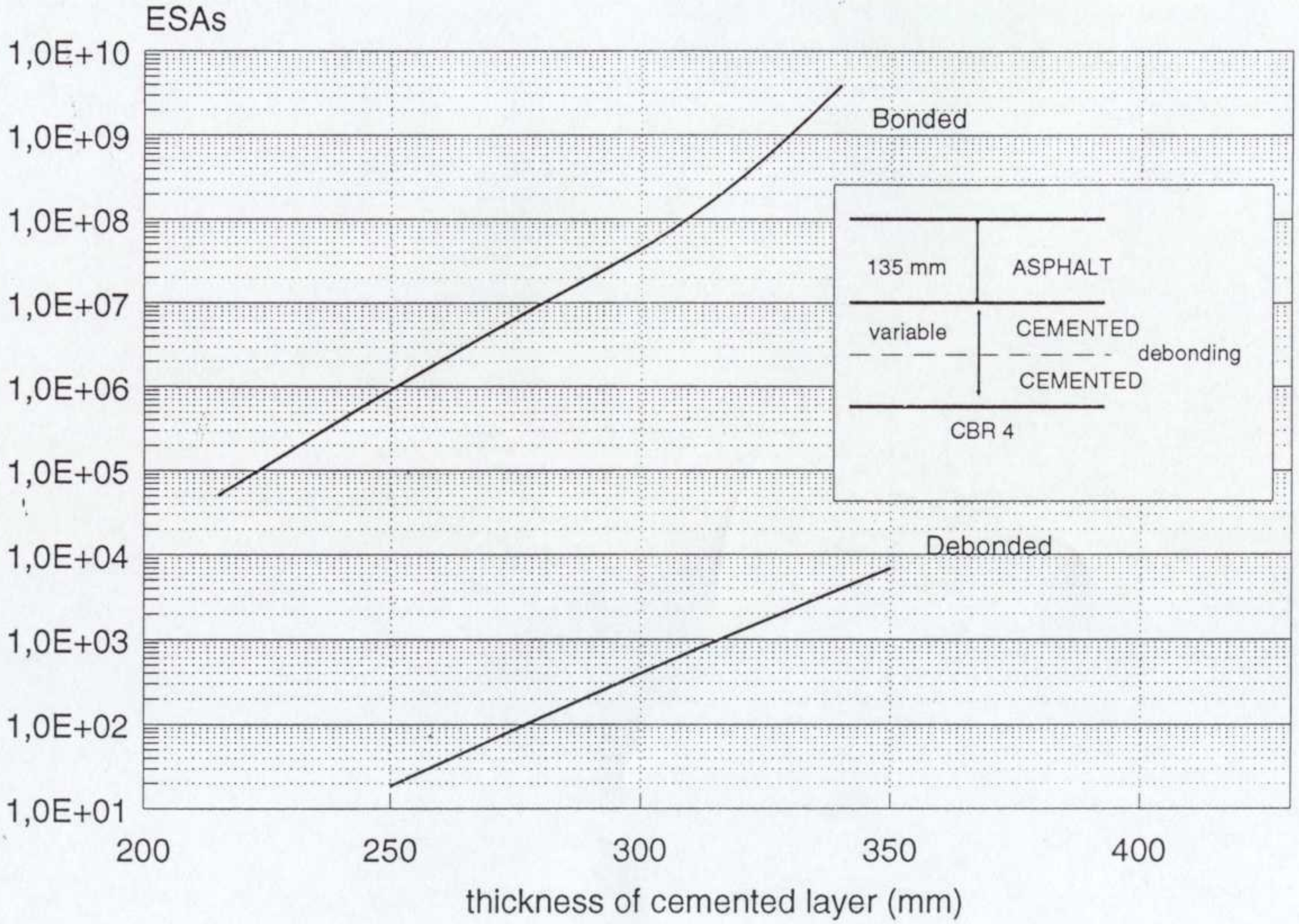
- Variability of the quality and depth of existing pavement material
- Short working times less than 2 hours
- High initial roughness >110 count k/m
- Extensive cracking

Erosion

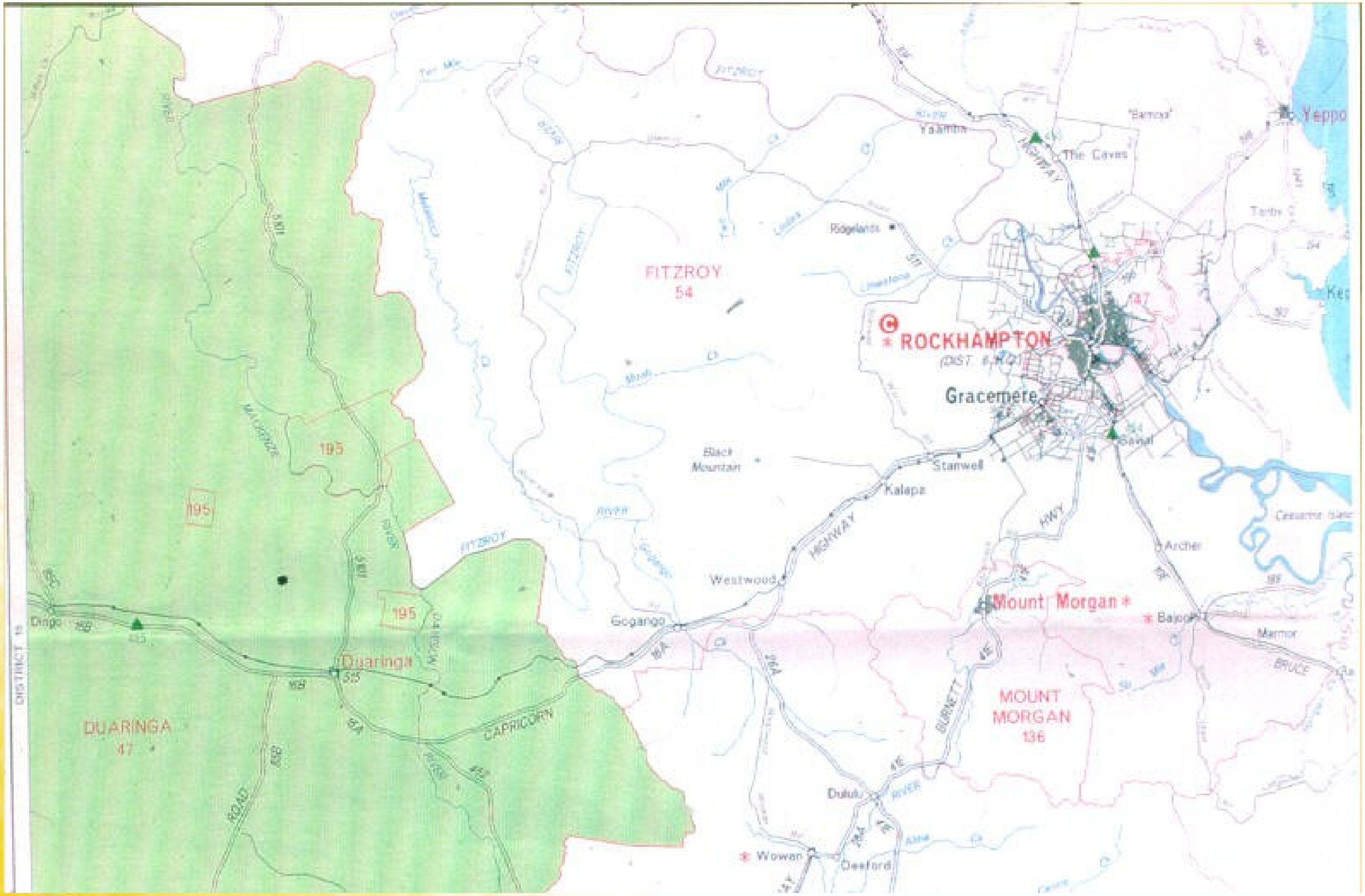


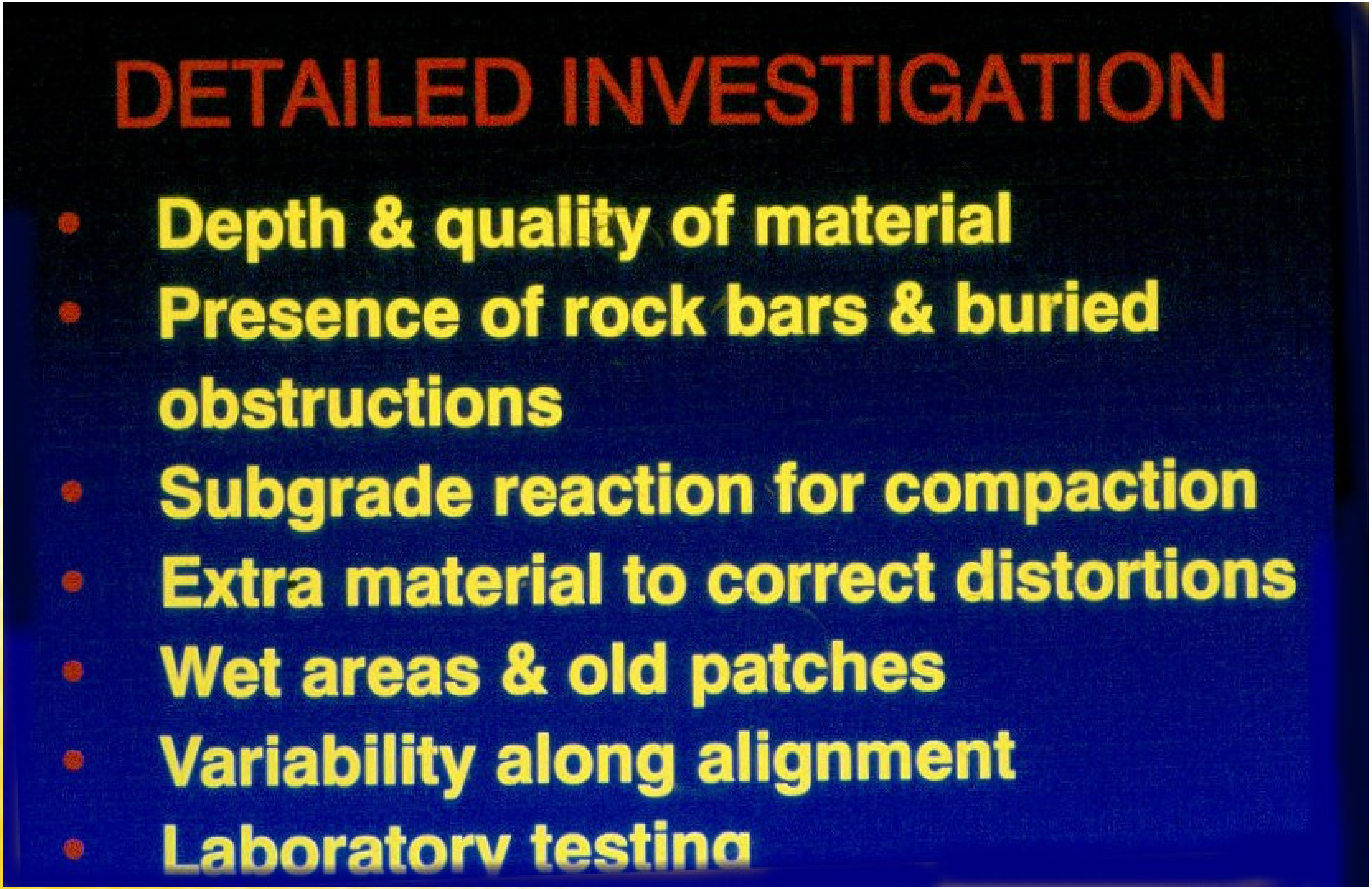
FAILURE MODE DUE TO DEBONDING
IN LAYERED CEMENTED PAVEMENT

PAVEMENT LIFE VS THICKNESS AND DEBONDING



OHP 12.5


ROCKHAMPTON
(DIST. 6, R.O.)
Gracemere
FITZROY
54
DUARINGA
47
MOUNT
MORGAN
136
Mount Morgan
Duaringa
Dingo
Gogango
Westwood
Kalapa
Stanwell
Black
Mountain
Ridgelands
Yaamba
The Caves
Archer
Bajool
Marmor
Dululu
Wowan
Deeford
195
195
195
FITZROY
RIVER
MACKENZIE
CAPRICORN
HIGHWAY
HWY
BRUCE
DISTRICT 15

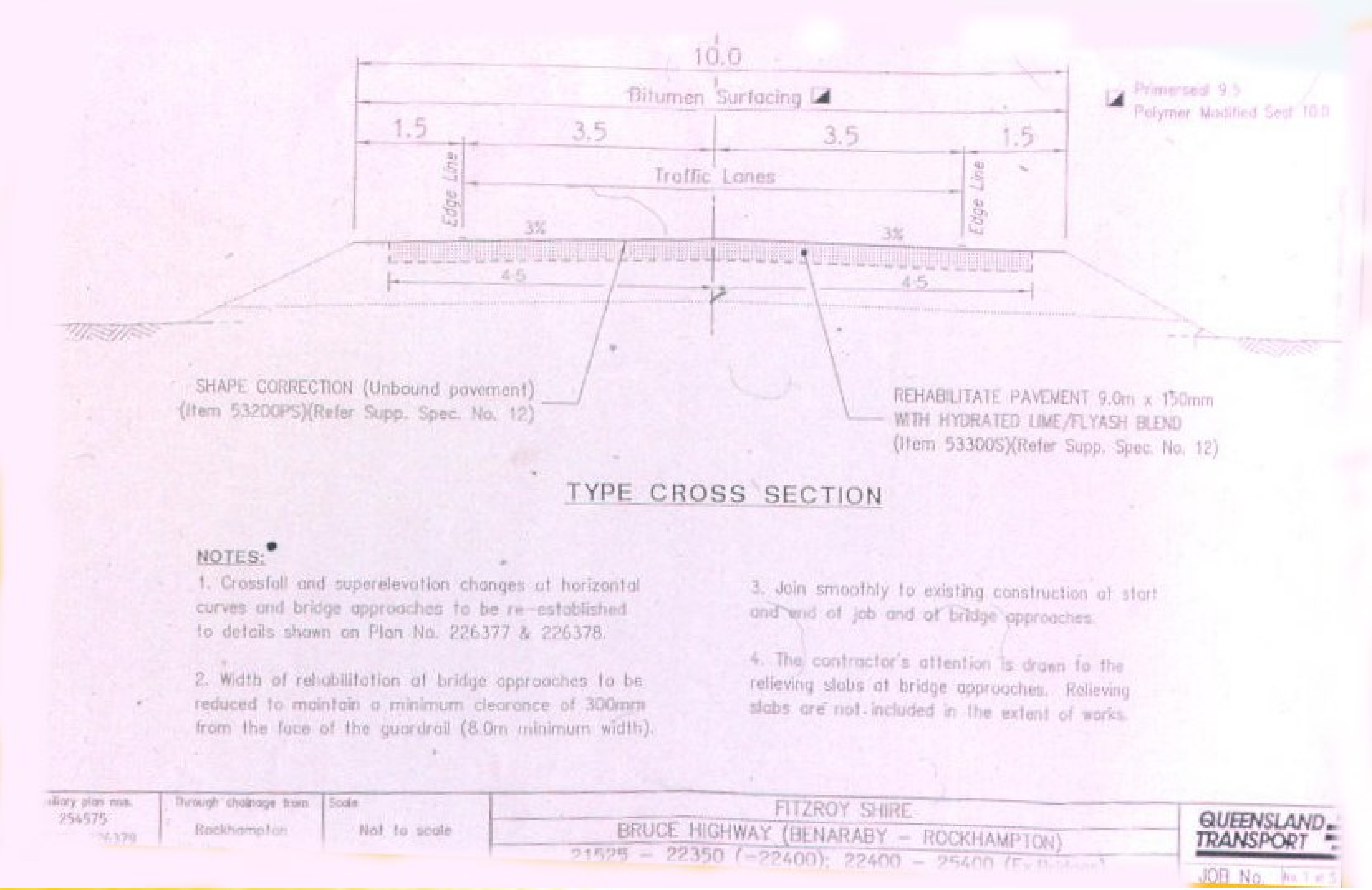


DETAILED INVESTIGATION

- Depth & quality of material
- Presence of rock bars & buried obstructions
- Subgrade reaction for compaction
- Extra material to correct distortions
- Wet areas & old patches
- Variability along alignment
- Laboratory testing

Range of Additives for Laboratory Trial

- Hydrated Lime/Flyash
- Second Grade Lime/Flyash
- Lean Lime/Flyash
- Hydrated Lime/Slag



TYPE CROSS SECTION

NOTES:

1. Crossfall and superelevation changes at horizontal curves and bridge approaches to be re-established to details shown on Plan No. 226377 & 226378.

2. Width of rehabilitation at bridge approaches to be reduced to maintain a minimum clearance of 300mm from the face of the guardrail (8.0m minimum width).

3. Join smoothly to existing construction at start and end of job and at bridge approaches.

4. The contractor's attention is drawn to the relieving slabs at bridge approaches. Relieving slabs are not included in the extent of works.

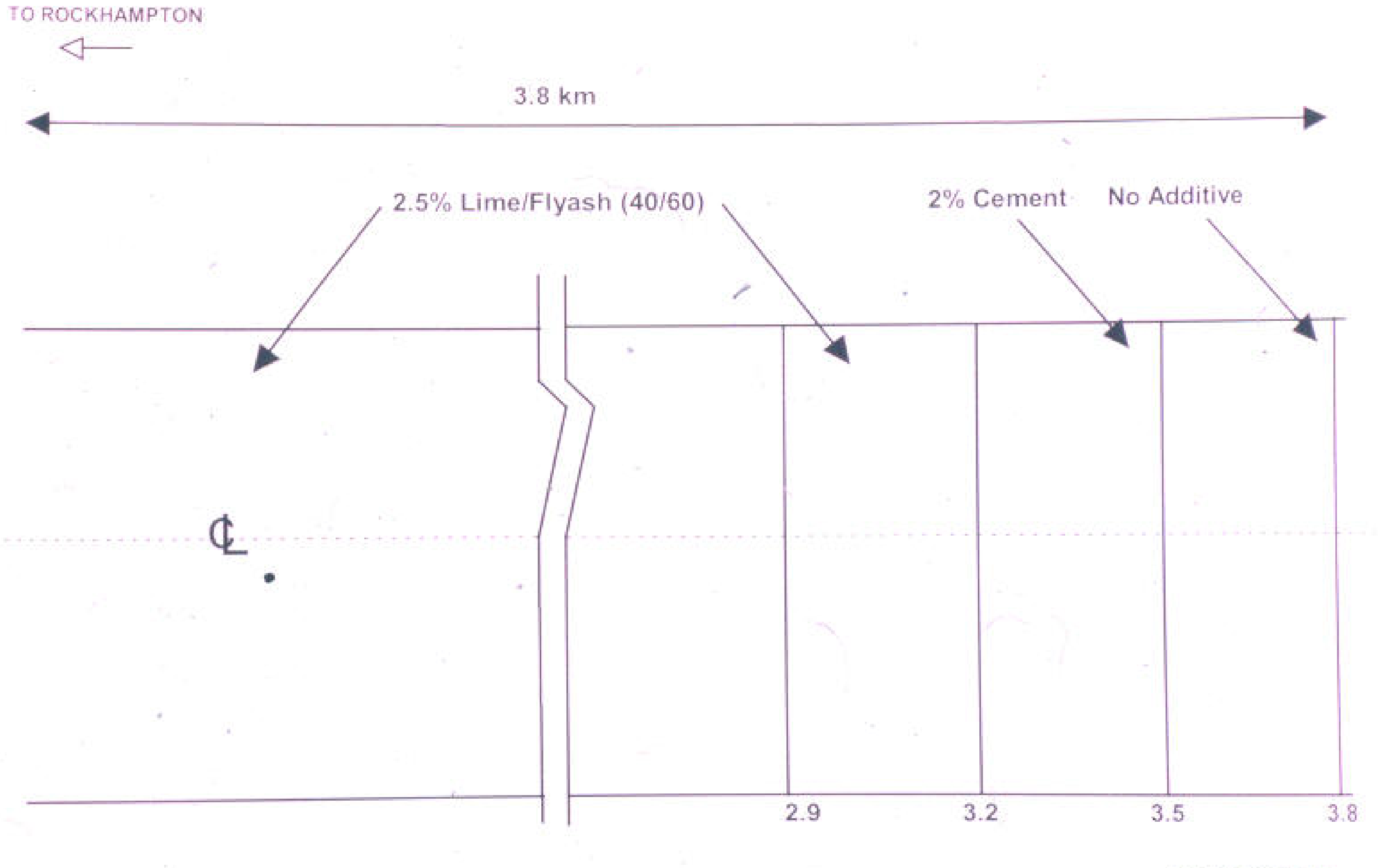
iliary plan nos.
254575
6379

Through chainage from
Rockhampton

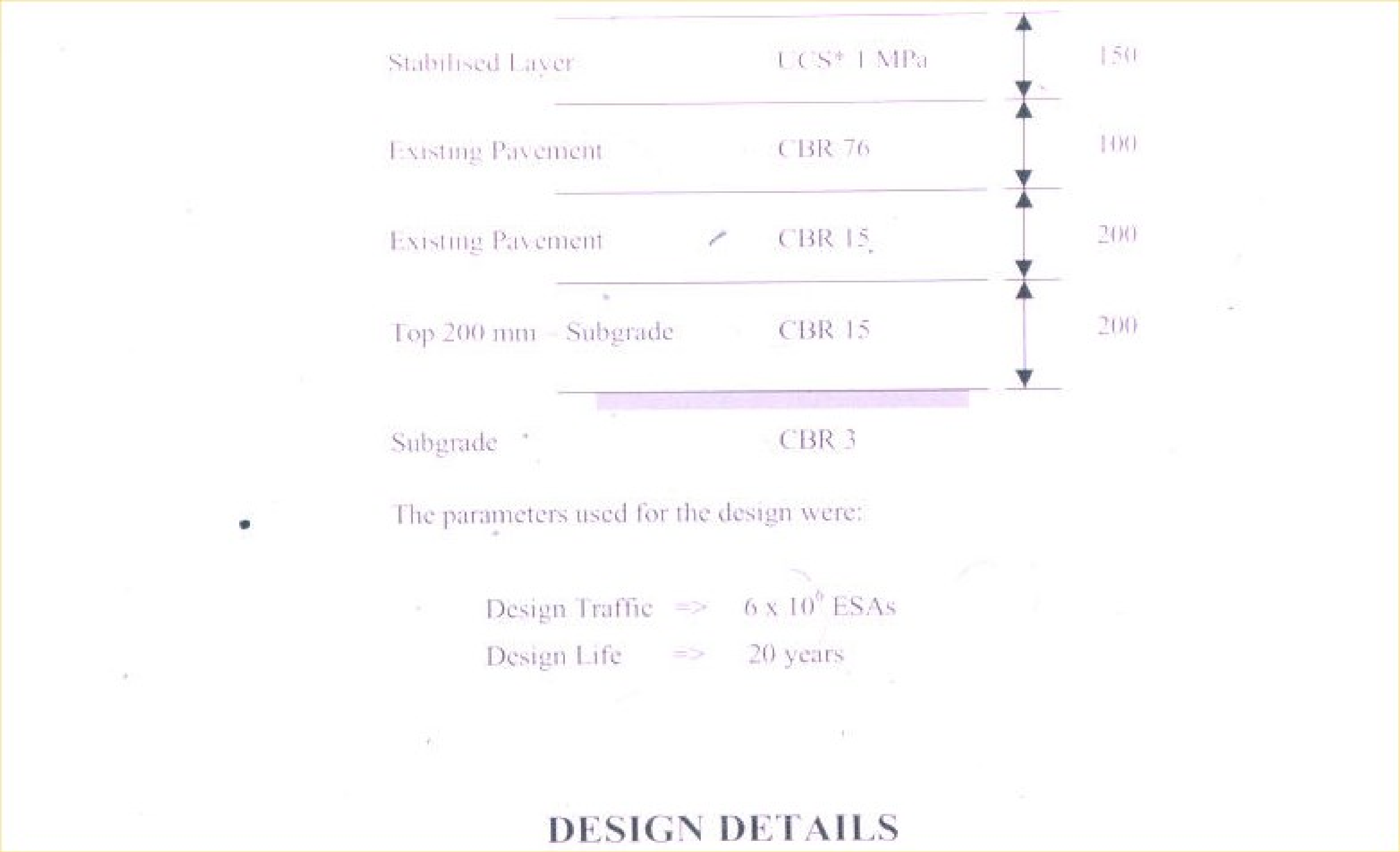
Scale
Not to scale

FITZROY SHIRE
BRUCE HIGHWAY (BENARABY – ROCKHAMPTON)
21525 – 22350 (–22400); 22400 – 25400

QUEENSLAND TRANSPORT
JOB No.



CONTROL SECTIONS - BRUCE HIGHWAY



Stabilised Layer	UCS* 1 MPa	150
Existing Pavement	CBR 76	100
Existing Pavement	CBR 15	200
Top 200 mm – Subgrade	CBR 15	200
Subgrade	CBR 3	

- The parameters used for the design were:

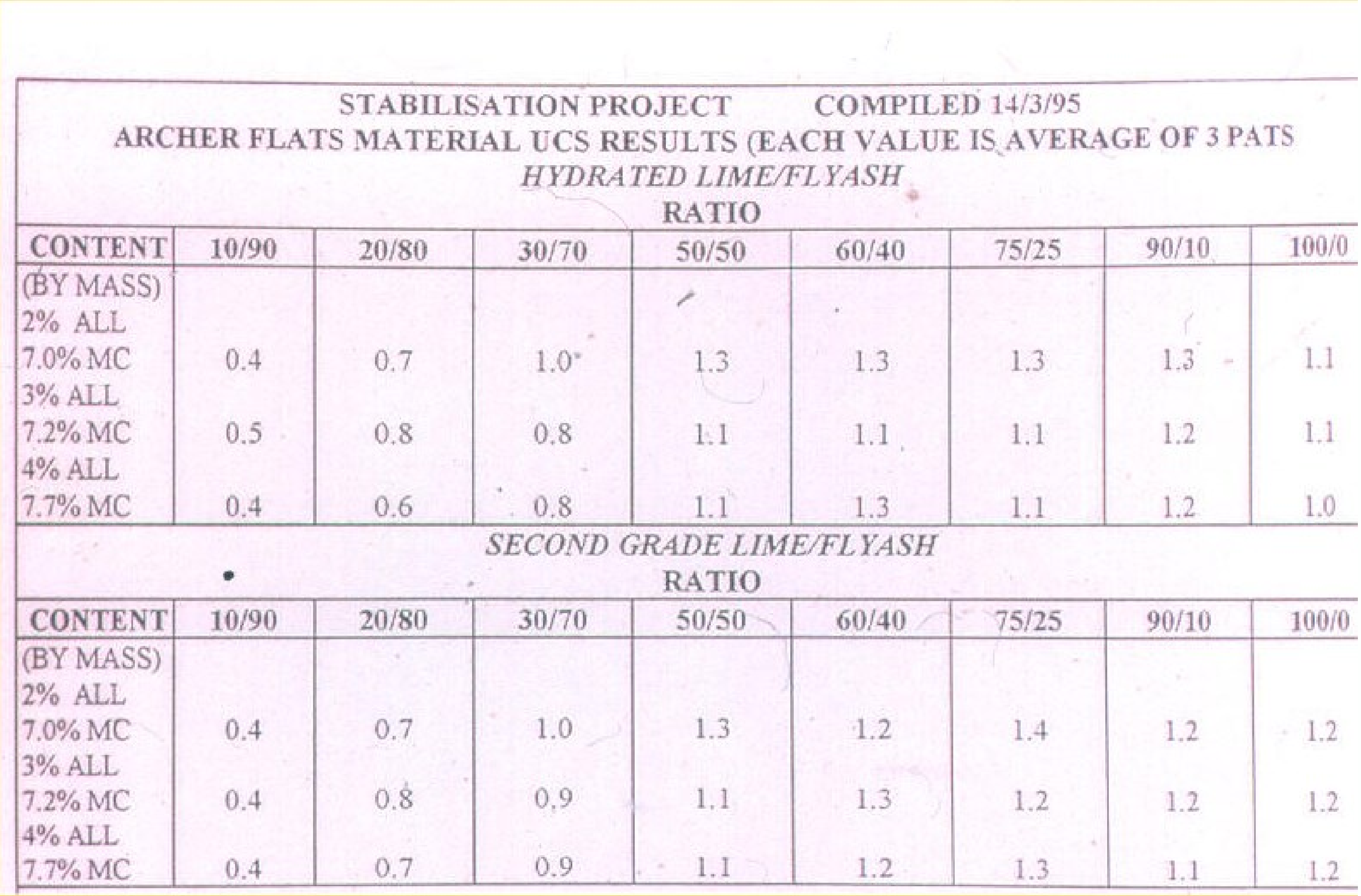
Design Traffic => 6×10^6 ESAs

Design Life => 20 years

DESIGN DETAILS


'94 4 20


BITELLI
1 9 24



STABILISATION PROJECT COMPILED 14/3/95

ARCHER FLATS MATERIAL UCS RESULTS (EACH VALUE IS AVERAGE OF 3 PATS

HYDRATED LIME/FLYASH

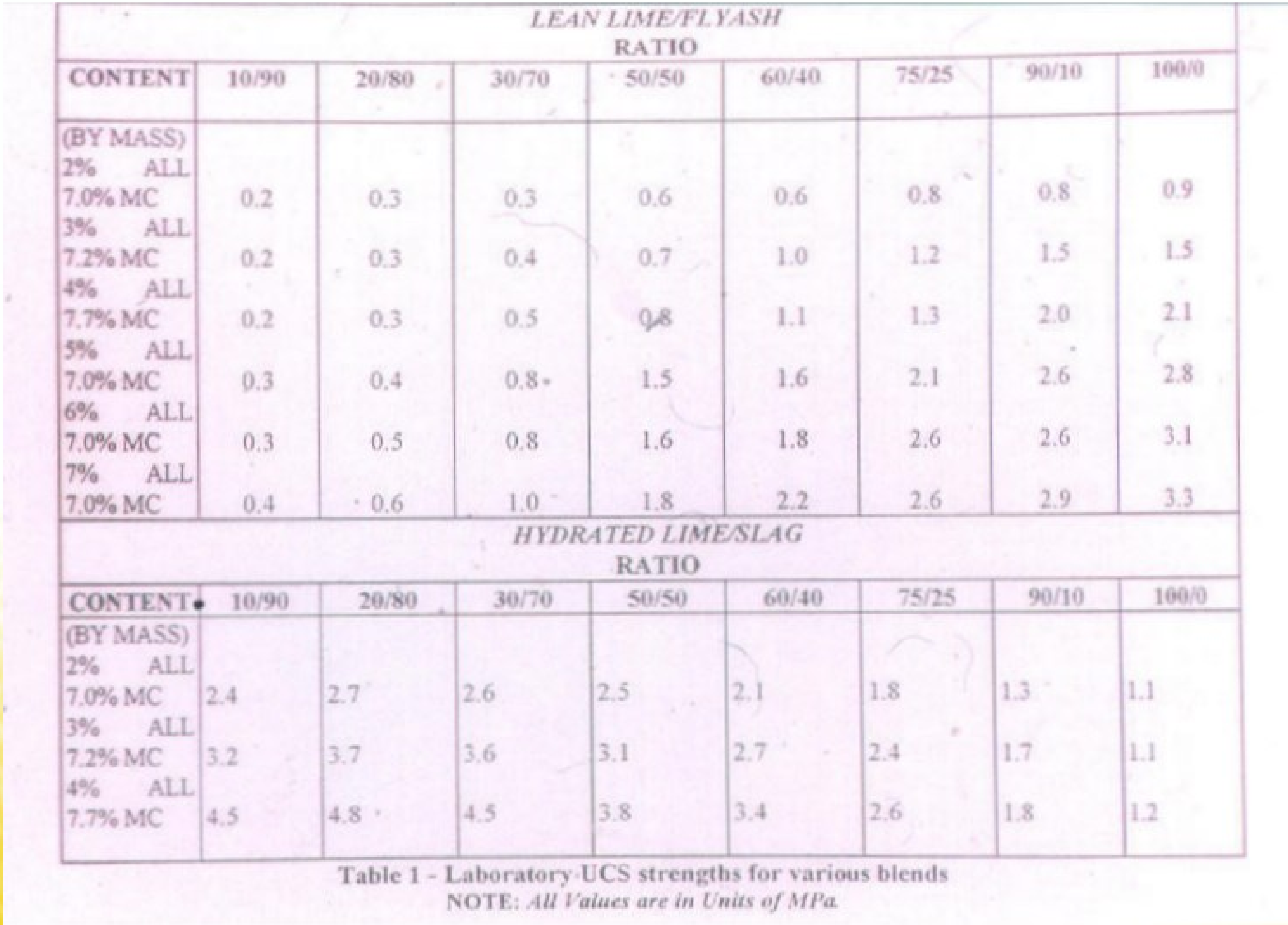
RATIO

CONTENT	10/90	20/80	30/70	50/50	60/40	75/25	90/10	100/0
(BY MASS) 2% ALL 7.0% MC	0.4	0.7	1.0	1.3	1.3	1.3	1.3	1.1
3% ALL 7.2% MC	0.5	0.8	0.8	1.1	1.1	1.1	1.2	1.1
4% ALL 7.7% MC	0.4	0.6	0.8	1.1	1.3	1.1	1.2	1.0

SECOND GRADE LIME/FLYASH

RATIO

CONTENT	10/90	20/80	30/70	50/50	60/40	75/25	90/10	100/0
(BY MASS) 2% ALL 7.0% MC	0.4	0.7	1.0	1.3	1.2	1.4	1.2	1.2
3% ALL 7.2% MC	0.4	0.8	0.9	1.1	1.3	1.2	1.2	1.2
4% ALL 7.7% MC	0.4	0.7	0.9	1.1	1.2	1.3	1.1	1.2



LEAN LIME/FLYASH

RATIO

CONTENT (BY MASS)	10/90	20/80	30/70	50/50	60/40	75/25	90/10	100/0
2% ALL 7.0% MC	0.2	0.3	0.3	0.6	0.6	0.8	0.8	0.9
3% ALL 7.2% MC	0.2	0.3	0.4	0.7	1.0	1.2	1.5	1.5
4% ALL 7.7% MC	0.2	0.3	0.5	0.8	1.1	1.3	2.0	2.1
5% ALL 7.0% MC	0.3	0.4	0.8	1.5	1.6	2.1	2.6	2.8
6% ALL 7.0% MC	0.3	0.5	0.8	1.6	1.8	2.6	2.6	3.1
7% ALL 7.0% MC	0.4	0.6	1.0	1.8	2.2	2.6	2.9	3.3

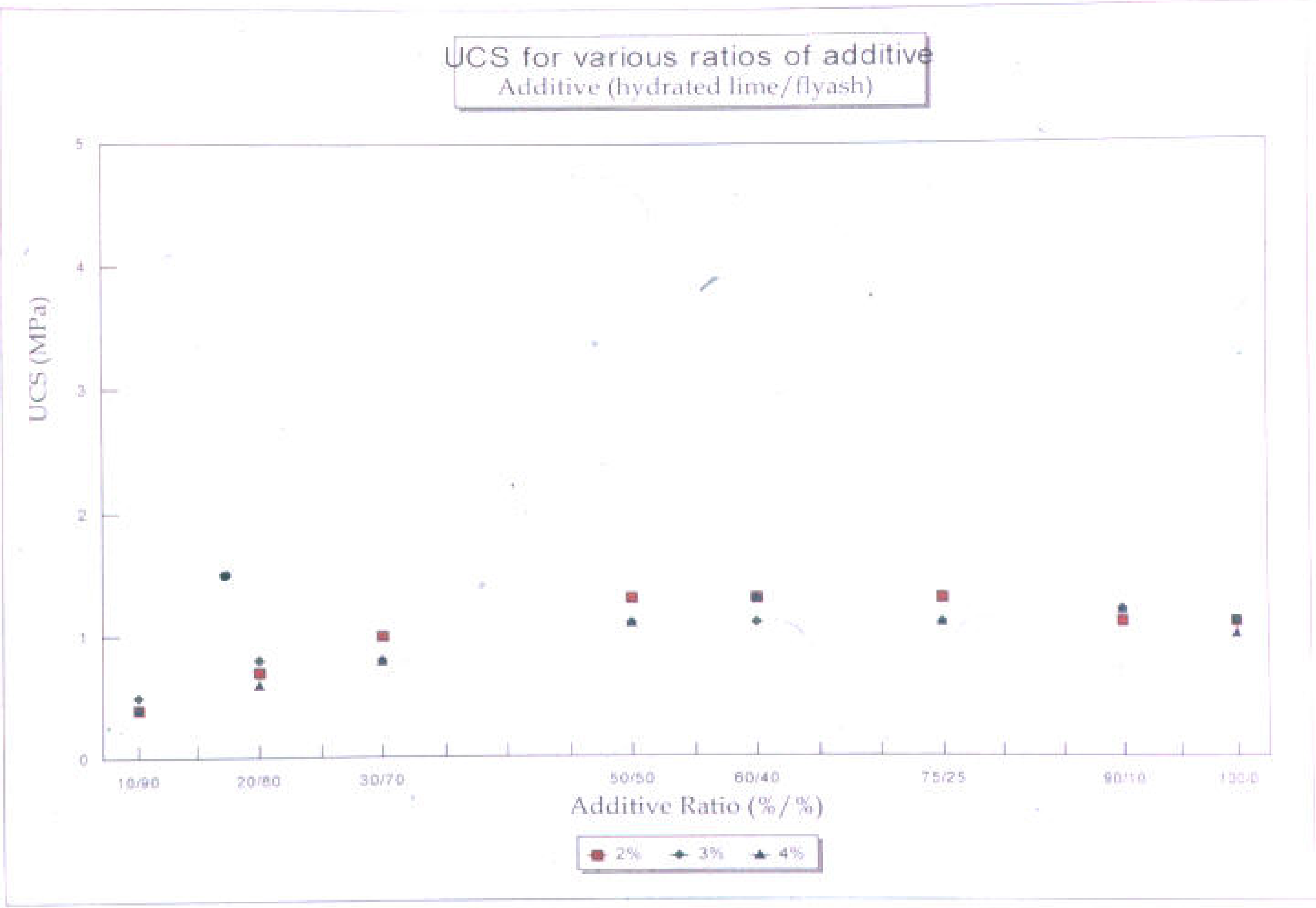
HYDRATED LIME/SLAG

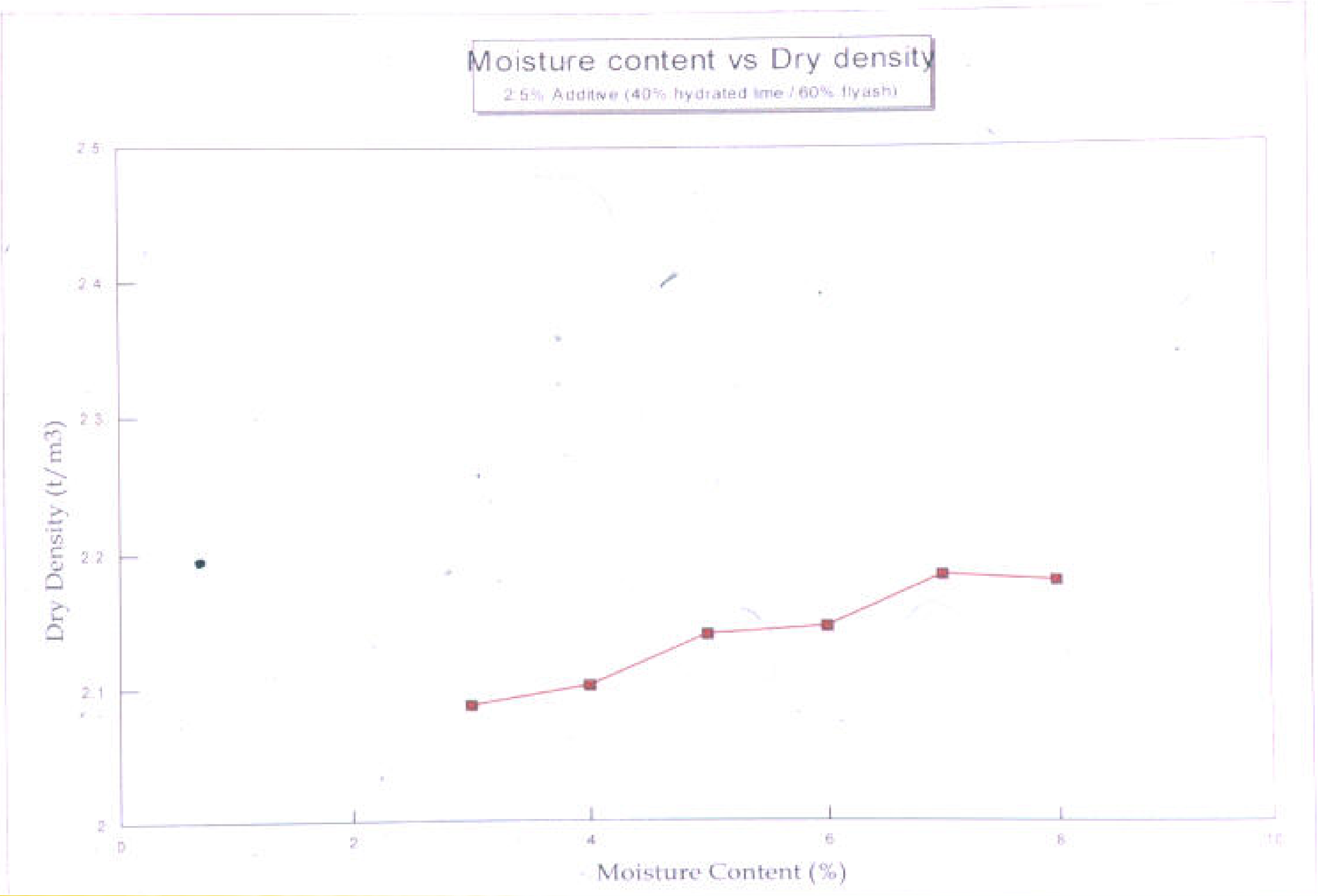
RATIO

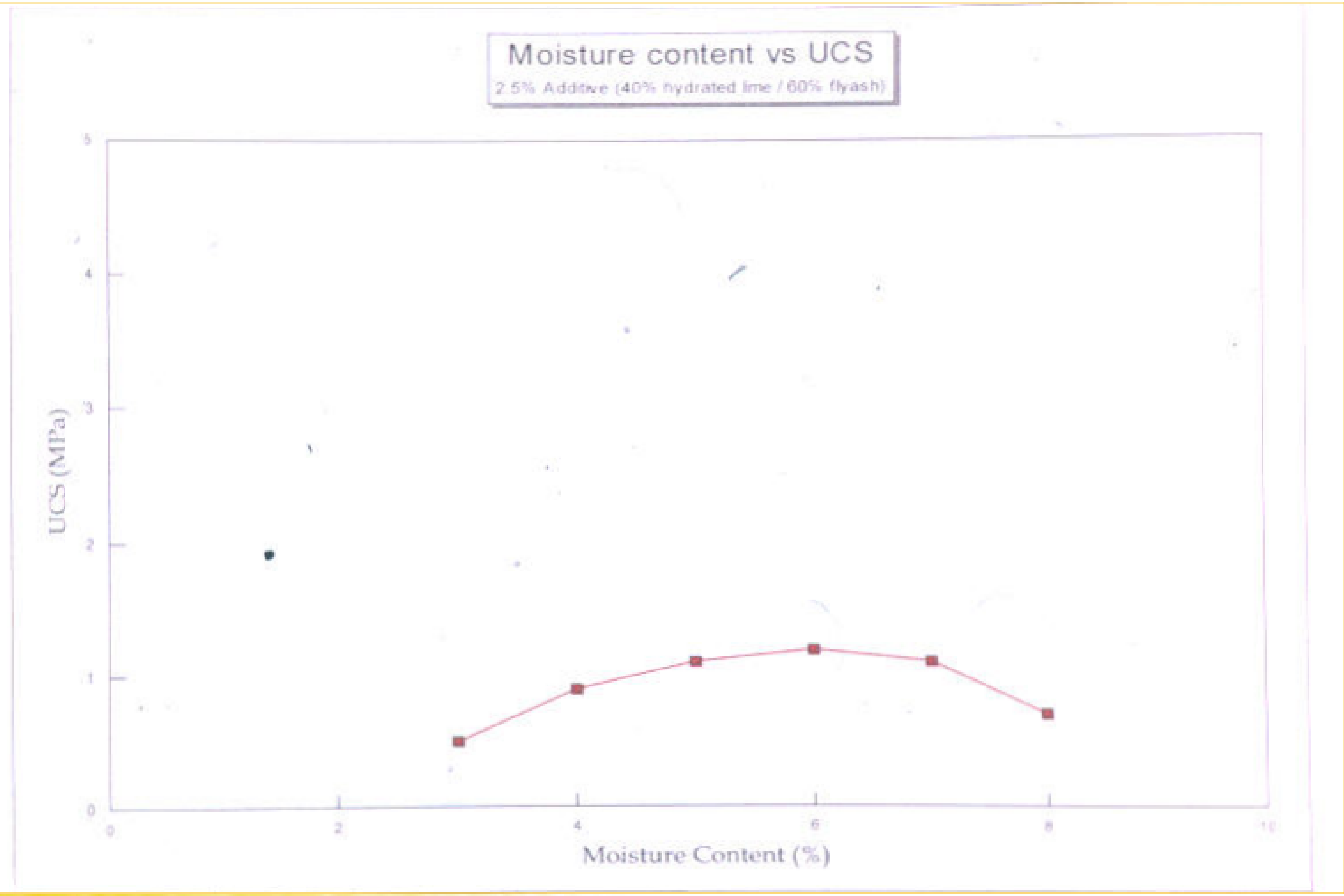
CONTENT (BY MASS)	10/90	20/80	30/70	50/50	60/40	75/25	90/10	100/0
2% ALL 7.0% MC	2.4	2.7	2.6	2.5	2.1	1.8	1.3	1.1
3% ALL 7.2% MC	3.2	3.7	3.6	3.1	2.7	2.4	1.7	1.1
4% ALL 7.7% MC	4.5	4.8	4.5	3.8	3.4	2.6	1.8	1.2

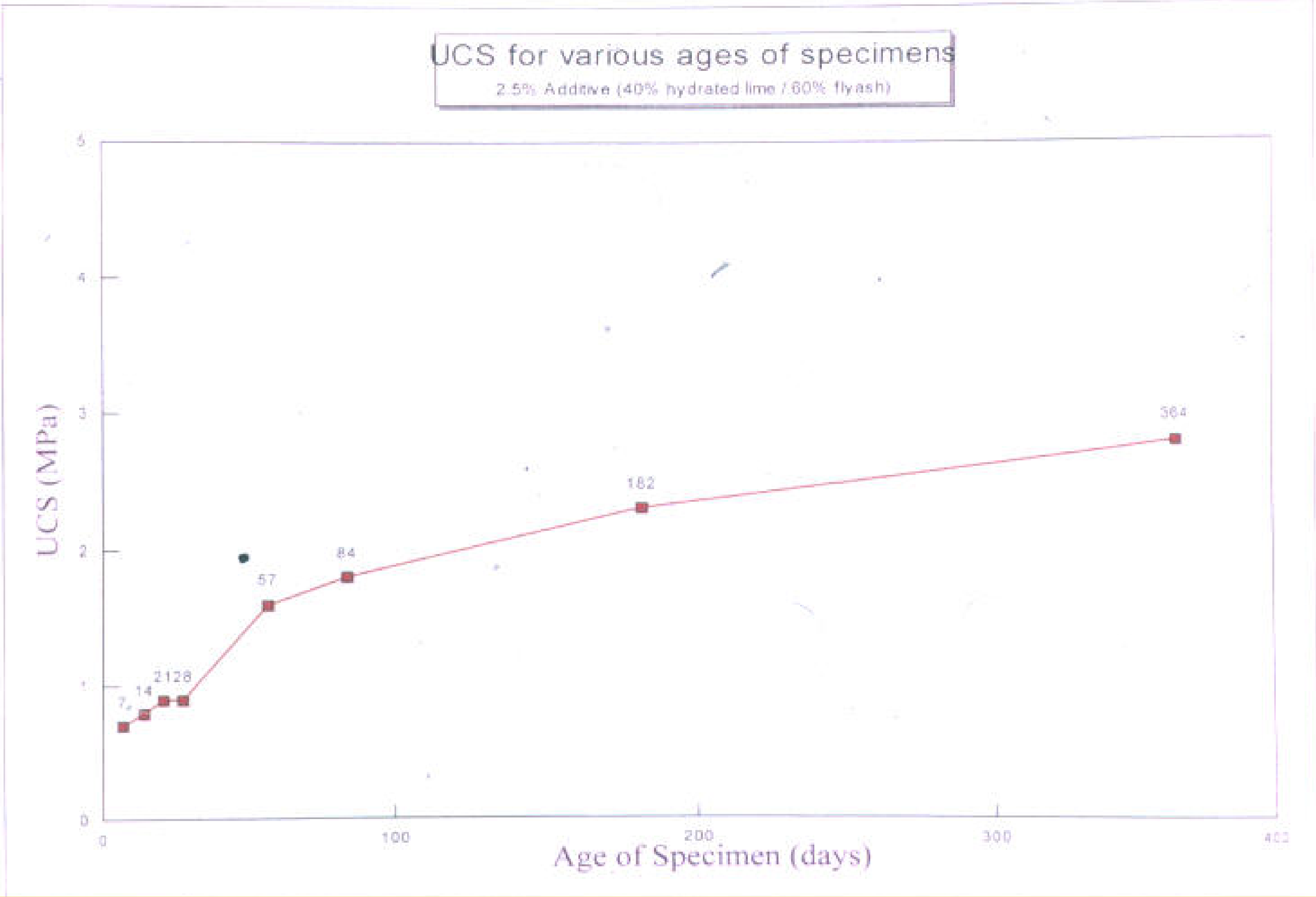
Table 1 - Laboratory UCS strengths for various blends

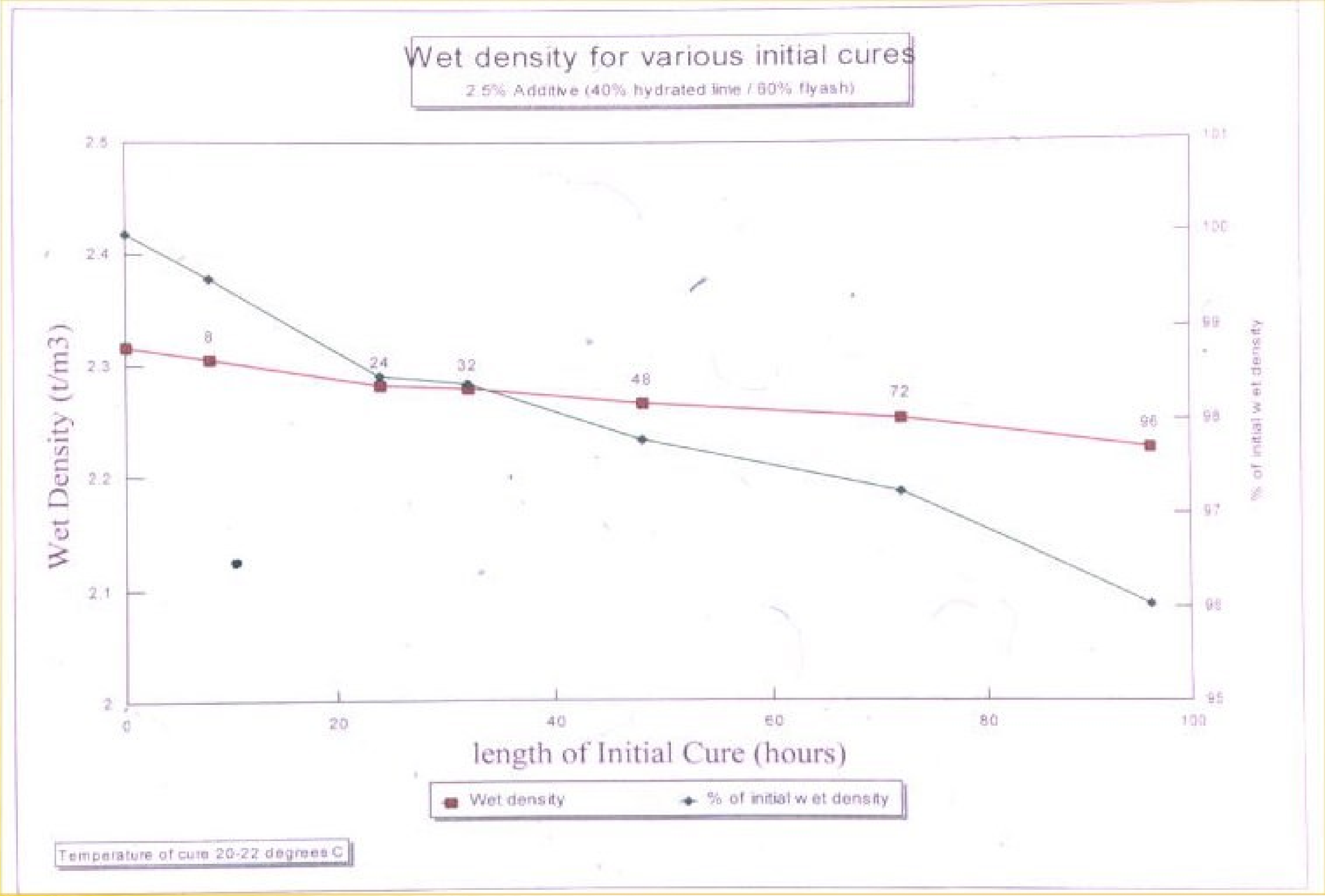
NOTE: *All Values are in Units of MPa*

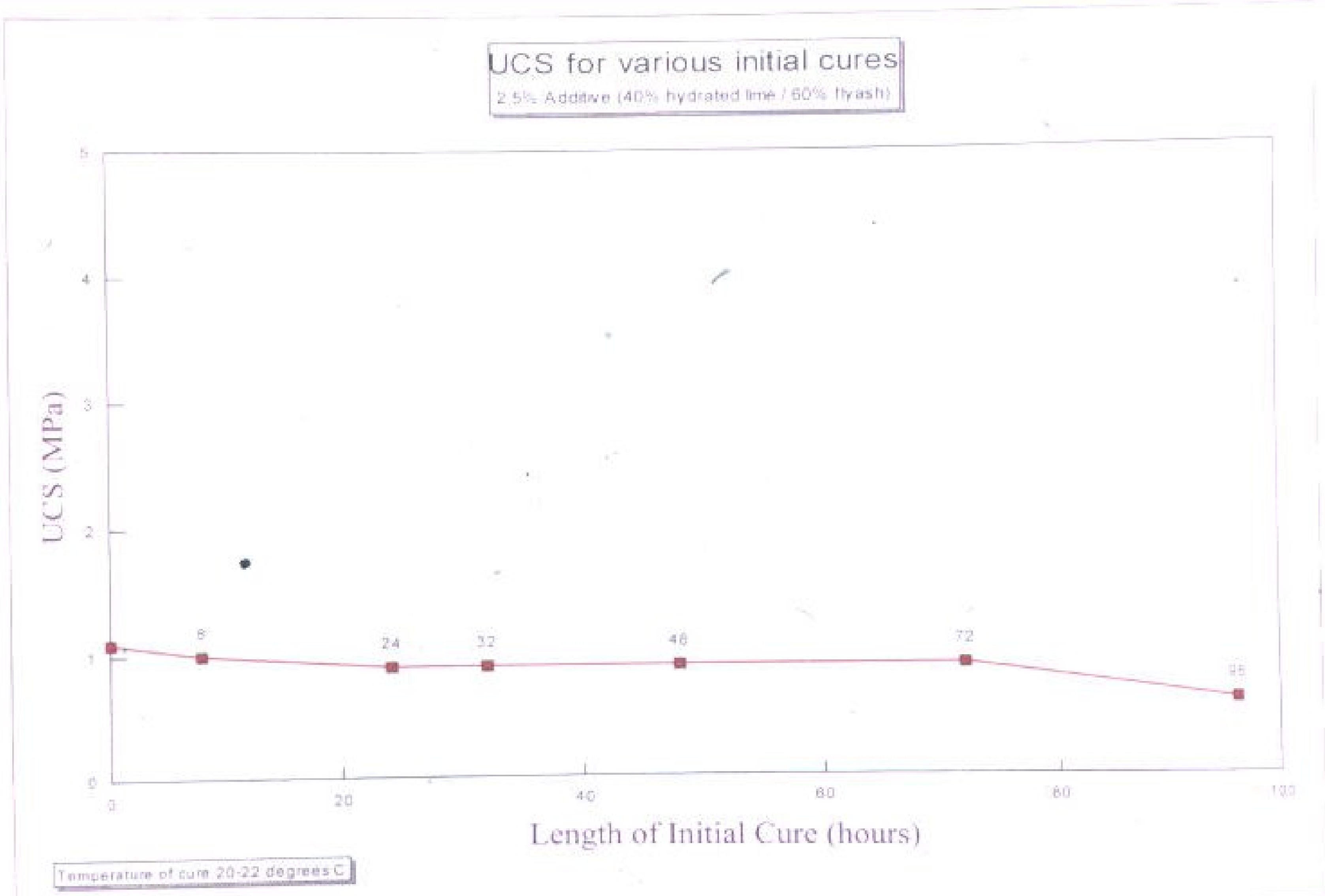

UCS for various ratios of additive
Additive (hydrated lime/flyash)
UCS (MPa)
0
1
2
3
4
5
10/90
20/80
30/70
50/50
60/40
75/25
90/10
100/0
Additive Ratio (%/%)
2%
3%
4%

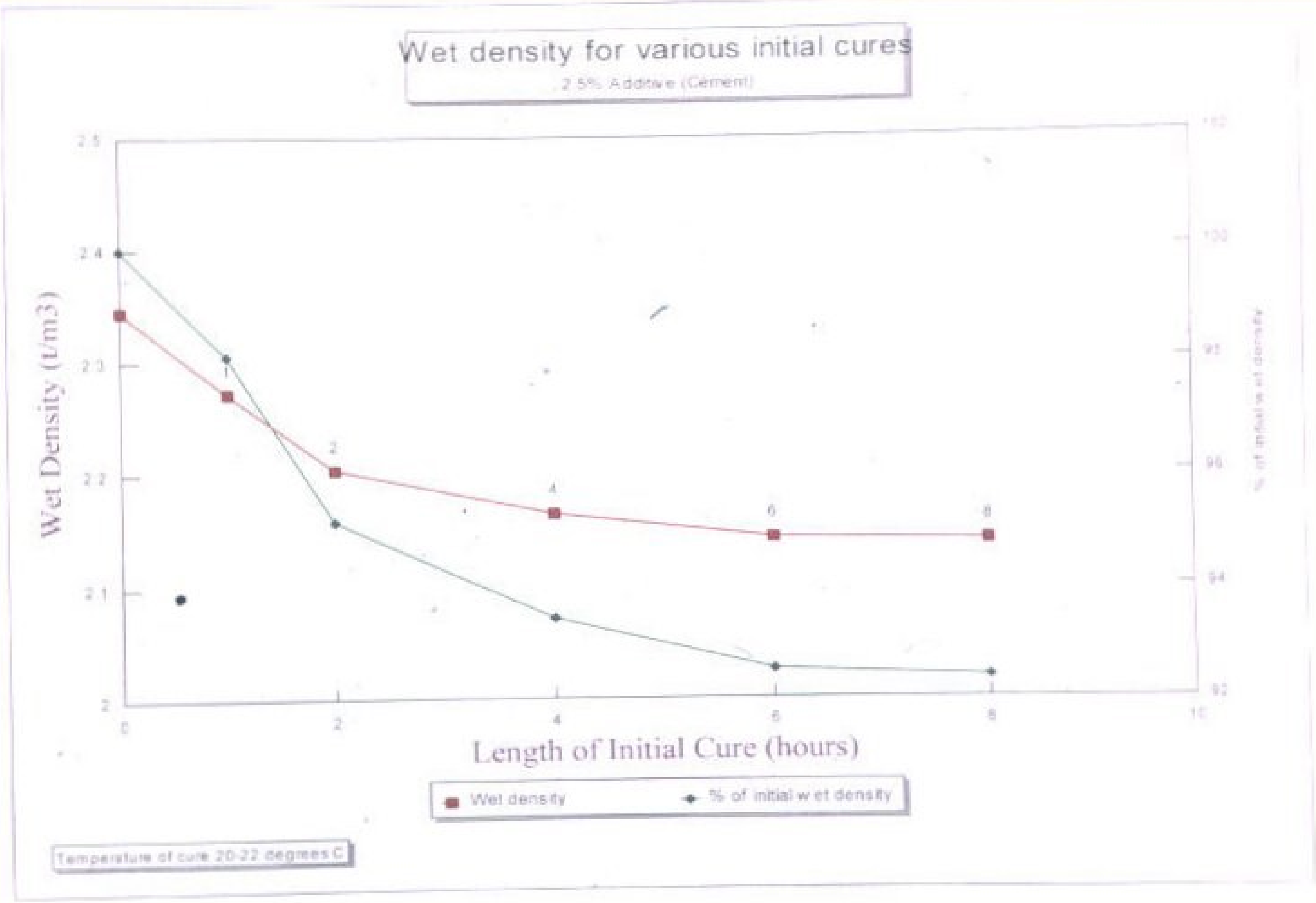

Moisture content vs Dry density
2.5% Additive (40% hydrated lime / 60% flyash)
Dry Density (t/m3)
2.5
2.4
2.3
2.2
2.1
2
Moisture Content (%)
0
2
4
6
8
10

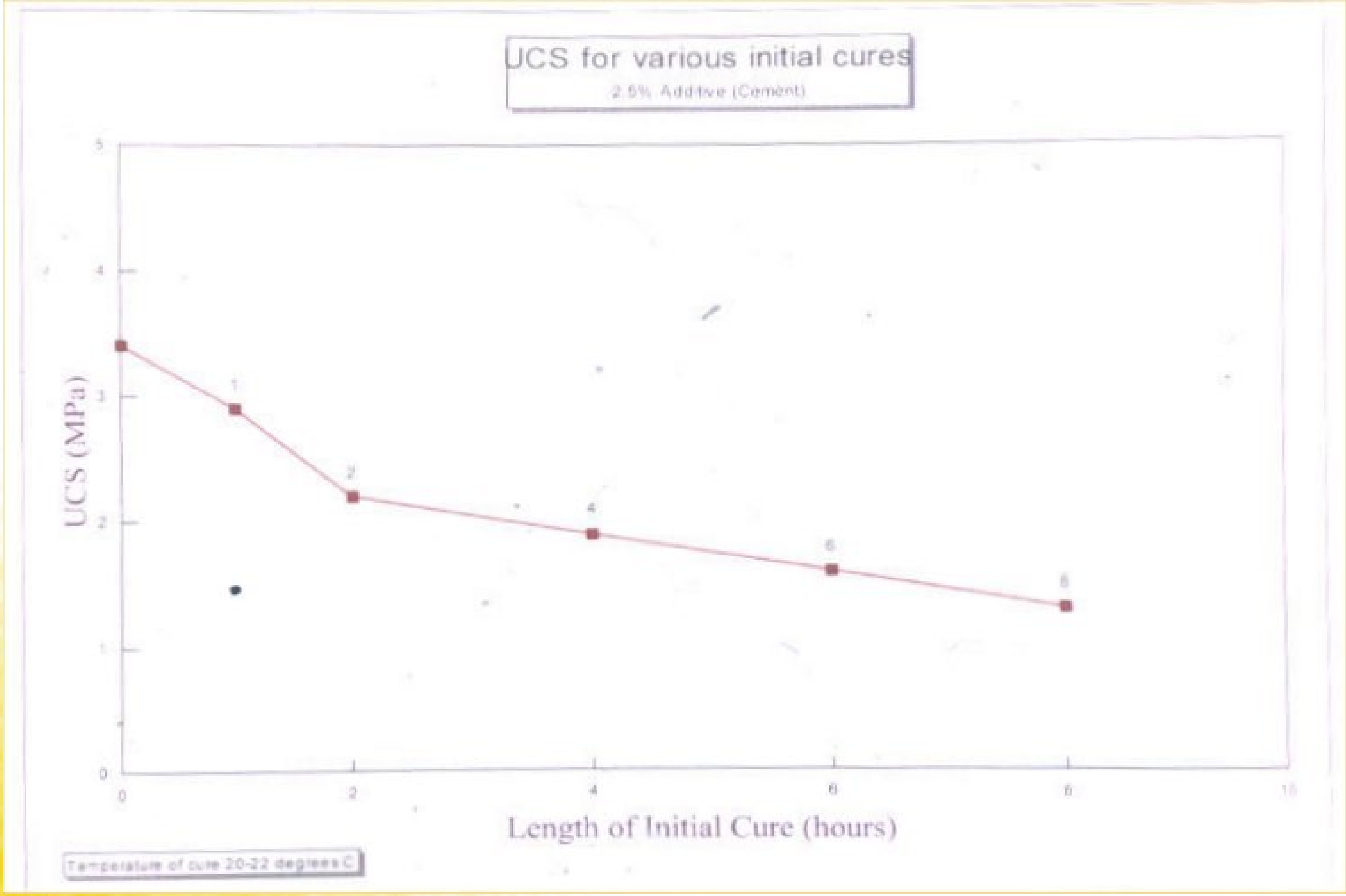

Moisture content vs UCS
2.5% Additive (40% hydrated lime / 60% flyash)
UCS (MPa)
0
1
2
3
4
5
Moisture Content (%)
0
2
4
6
8
10

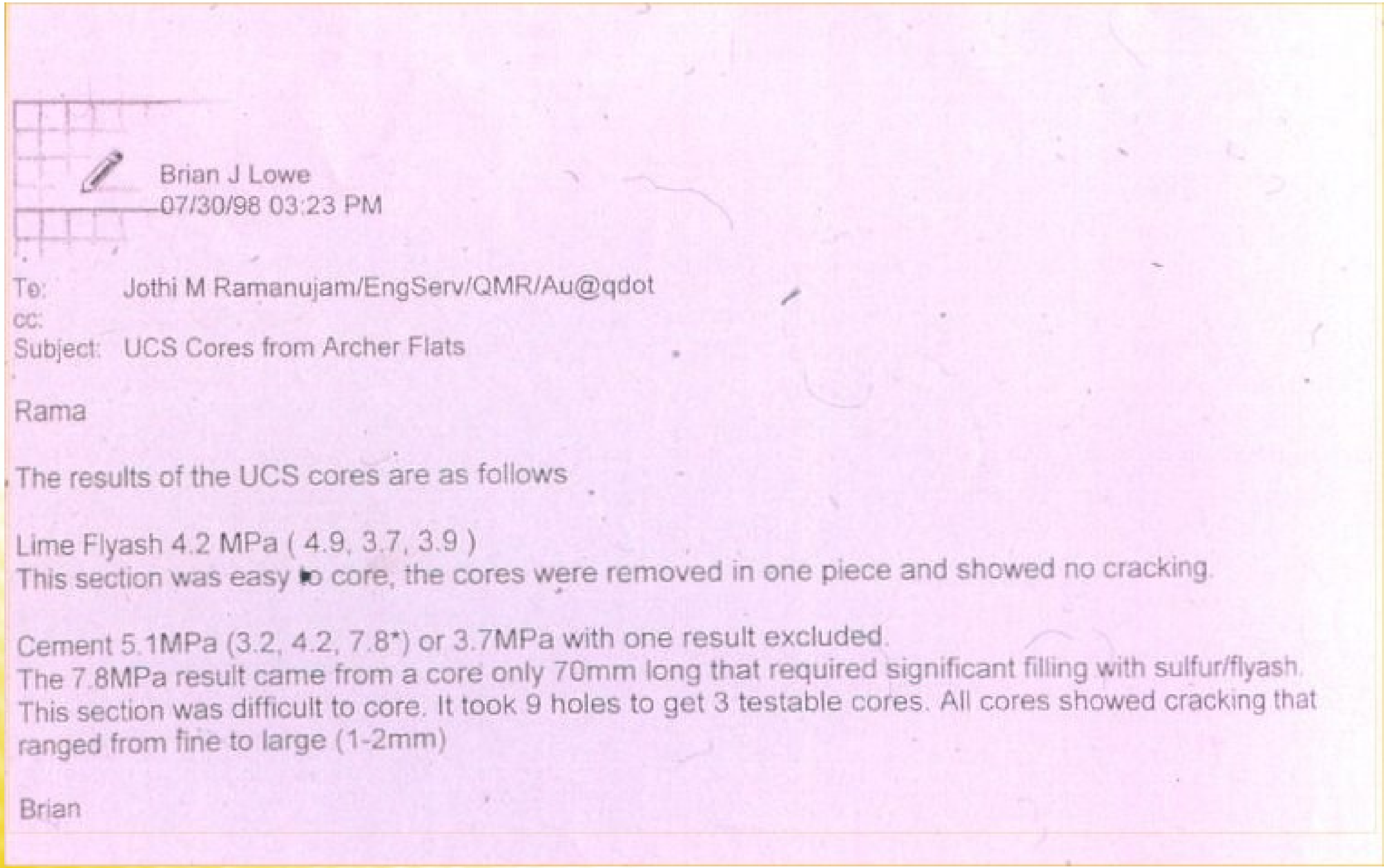

UCS for various ages of specimens
2.5% Additive (40% hydrated lime / 60% flyash)
UCS (MPa)
0
1
2
3
4
5
Age of Specimen (days)
0
100
200
300
400
7
14
21
28
57
84
182
364


Wet density for various initial cures
2.5% Additive (40% hydrated lime / 60% flyash)
Wet Density (t/m3)
2.5
2.4
2.3
2.2
2.1
2
% of initial wet density
101
100
99
98
97
96
95
0
20
40
60
80
100
length of Initial Cure (hours)
8
24
32
48
72
96
Wet density
% of initial wet density
Temperature of cure 20-22 degrees C


UCS for various initial cures
2.5% Additive (40% hydrated lime / 60% flyash)
UCS (MPa)
0
1
2
3
4
5
8
24
32
48
72
96
0
20
40
60
80
100
Length of Initial Cure (hours)
Temperature of cure 20-22 degrees C


Wet density for various initial cures
2.5% Additive (Cement)
Wet Density (t/m3)
2.5
2.4
2.3
2.2
2.1
2
% of initial wet density
102
100
98
96
94
92
0
2
4
6
8
10
1
2
4
6
8
Length of Initial Cure (hours)
Wet density
% of initial w et density
Temperature of cure 20-22 degrees C


UCS for various initial cures
2.5% Additive (Cement)
UCS (MPa)
5
4
3
2
1
0
0
2
4
6
8
10
Length of Initial Cure (hours)
1
2
4
6
8
Temperature of cure 20-22 degrees C



Brian J Lowe
07/30/98 03:23 PM

To: Jothi M Ramanujam/EngServ/QMR/Au@qdot
cc:
Subject: UCS Cores from Archer Flats

Rama

The results of the UCS cores are as follows

Lime Flyash 4.2 MPa (4.9, 3.7, 3.9)
This section was easy to core, the cores were removed in one piece and showed no cracking.

Cement 5.1MPa (3.2, 4.2, 7.8*) or 3.7MPa with one result excluded.
The 7.8MPa result came from a core only 70mm long that required significant filling with sulfur/flyash.
This section was difficult to core. It took 9 holes to get 3 testable cores. All cores showed cracking that ranged from fine to large (1-2mm)

Brian

Definitions - working time (RTA)

(a) Working time for maximum dry density

The working time for maximum density is defined as the time measured from the commencement of the addition of the stabilising agent to the compaction of the stabilised material, which corresponds to 97.0% of the mean value of three determinations of maximum dry density in accordance with RTA T130, for samples compacted one hour after incorporation of the stabilising agent. All samples shall be cured in a loose condition in airtight containers at 23°C ±2°C.

Definitions - working time (cont.)

(b) Working time for unconfined compressive strength (UCS)

The working time for UCS is defined as the time measured from the commencement of the addition of the stabilising agent to the compaction of the stabilised material, which corresponds to 80% of the mean value of three determinations of UCS in accordance with RTA T131, for samples compacted one hour after incorporation of the stabilising agent. All samples shall be cured in a loose condition in airtight containers at 23°C ± 2°C.

Definitions - working time (cont.)

(c) Nominated working time

The nominated working time is the lesser of the working time determined for either the maximum dry density or the unconfined compressive strength.

Typical binder types

- cement

  General purpose, Types GP or GB
  Special purpose, Types LH, SR, etc
  Complying with AS3972

- lime

  Hydrate (MRS 11.23)
  Quicklime (MRS 11.23)

Typical binder types (cont.)

- Ground granulated iron blast furnace slag

  (AS 3582.2)

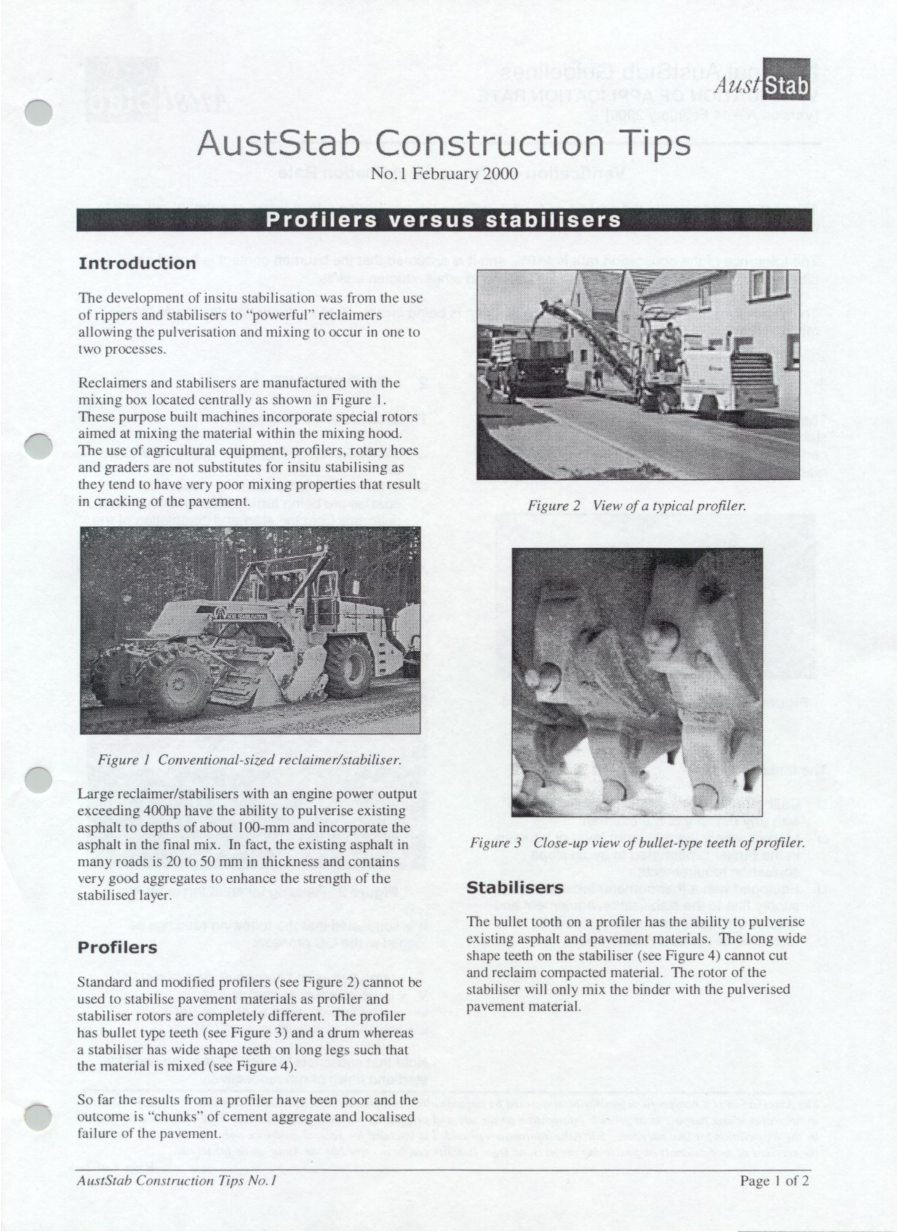
- Flyash

  (AS 3582.1 - fine grade)

Typical blends

“Slagment”	75 cement : 25 slag cement
“Pozzoment”	75 cement : 25 flyash
“Stabilment”	85 granulated : 15 lime slag
“Triple blends”	lime/slag/flyash 30/50/20 or 33/33/33 etc.

Reclaimer/stabiliser



AustStab Construction Tips

No.1 February 2000

Profilers versus stabilisers

Introduction

The development of insitu stabilisation was from the use of rippers and stabilisers to "powerful" reclaimers allowing the pulverisation and mixing to occur in one to two processes.

Reclaimers and stabilisers are manufactured with the mixing box located centrally as shown in Figure 1. These purpose built machines incorporate special rotors aimed at mixing the material within the mixing hood. The use of agricultural equipment, profilers, rotary hoes and graders are not substitutes for insitu stabilising as they tend to have very poor mixing properties that result in cracking of the pavement.

Figure 1 Conventional-sized reclaimer/stabiliser.

Large reclaimer/stabilisers with an engine power output exceeding 400hp have the ability to pulverise existing asphalt to depths of about 100-mm and incorporate the asphalt in the final mix. In fact, the existing asphalt in many roads is 20 to 50 mm in thickness and contains very good aggregates to enhance the strength of the stabilised layer.

Profilers

Standard and modified profilers (see Figure 2) cannot be used to stabilise pavement materials as profiler and stabiliser rotors are completely different. The profiler has bullet type teeth (see Figure 3) and a drum whereas a stabiliser has wide shape teeth on long legs such that the material is mixed (see Figure 4).

So far the results from a profiler have been poor and the outcome is "chunks" of cement aggregate and localised failure of the pavement.

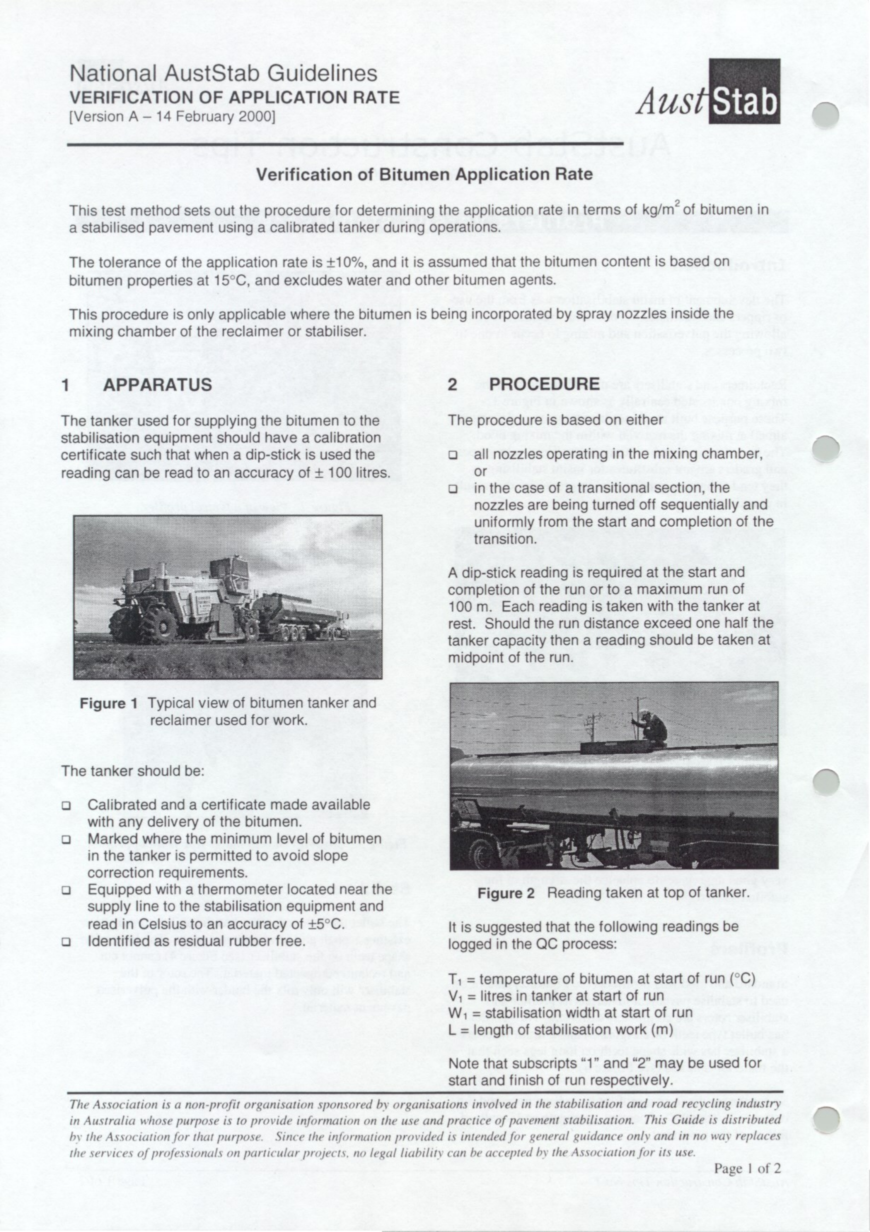
Figure 2 View of a typical profiler.

Figure 3 Close-up view of bullet-type teeth of profiler.

Stabilisers

The bullet tooth on a profiler has the ability to pulverise existing asphalt and pavement materials. The long wide shape teeth on the stabiliser (see Figure 4) cannot cut and reclaim compacted material. The rotor of the stabiliser will only mix the binder with the pulverised pavement material.

AustStab Construction Tips No.1 Page 1 of 2



National AustStab Guidelines
VERIFICATION OF APPLICATION RATE
[Version A – 14 February 2000]

Verification of Bitumen Application Rate

This test method sets out the procedure for determining the application rate in terms of kg/m^2 of bitumen in a stabilised pavement using a calibrated tanker during operations.

The tolerance of the application rate is ±10%, and it is assumed that the bitumen content is based on bitumen properties at 15°C, and excludes water and other bitumen agents.

This procedure is only applicable where the bitumen is being incorporated by spray nozzles inside the mixing chamber of the reclaimer or stabiliser.

1 APPARATUS

The tanker used for supplying the bitumen to the stabilisation equipment should have a calibration certificate such that when a dip-stick is used the reading can be read to an accuracy of ± 100 litres.

Figure 1 Typical view of bitumen tanker and reclaimer used for work.

The tanker should be:

- ☐ Calibrated and a certificate made available with any delivery of the bitumen.
- ☐ Marked where the minimum level of bitumen in the tanker is permitted to avoid slope correction requirements.
- ☐ Equipped with a thermometer located near the supply line to the stabilisation equipment and read in Celsius to an accuracy of ±5°C.
- ☐ Identified as residual rubber free.

2 PROCEDURE

The procedure is based on either

- ☐ all nozzles operating in the mixing chamber, or
- ☐ in the case of a transitional section, the nozzles are being turned off sequentially and uniformly from the start and completion of the transition.

A dip-stick reading is required at the start and completion of the run or to a maximum run of 100 m. Each reading is taken with the tanker at rest. Should the run distance exceed one half the tanker capacity then a reading should be taken at midpoint of the run.

Figure 2 Reading taken at top of tanker.

It is suggested that the following readings be logged in the QC process:

T_1 = temperature of bitumen at start of run (°C)
V_1 = litres in tanker at start of run
W_1 = stabilisation width at start of run
L = length of stabilisation work (m)

Note that subscripts "1" and "2" may be used for start and finish of run respectively.

The Association is a non-profit organisation sponsored by organisations involved in the stabilisation and road recycling industry in Australia whose purpose is to provide information on the use and practice of pavement stabilisation. This Guide is distributed by the Association for that purpose. Since the information provided is intended for general guidance only and in no way replaces the services of professionals on particular projects, no legal liability can be accepted by the Association for its use.

Page 1 of 2

WIRTGEN 2500


94 4 6


94 4

29 6 '00

Block cracking

Cracks directing surface water “V”

Punching of stabilised layer

Delaminations

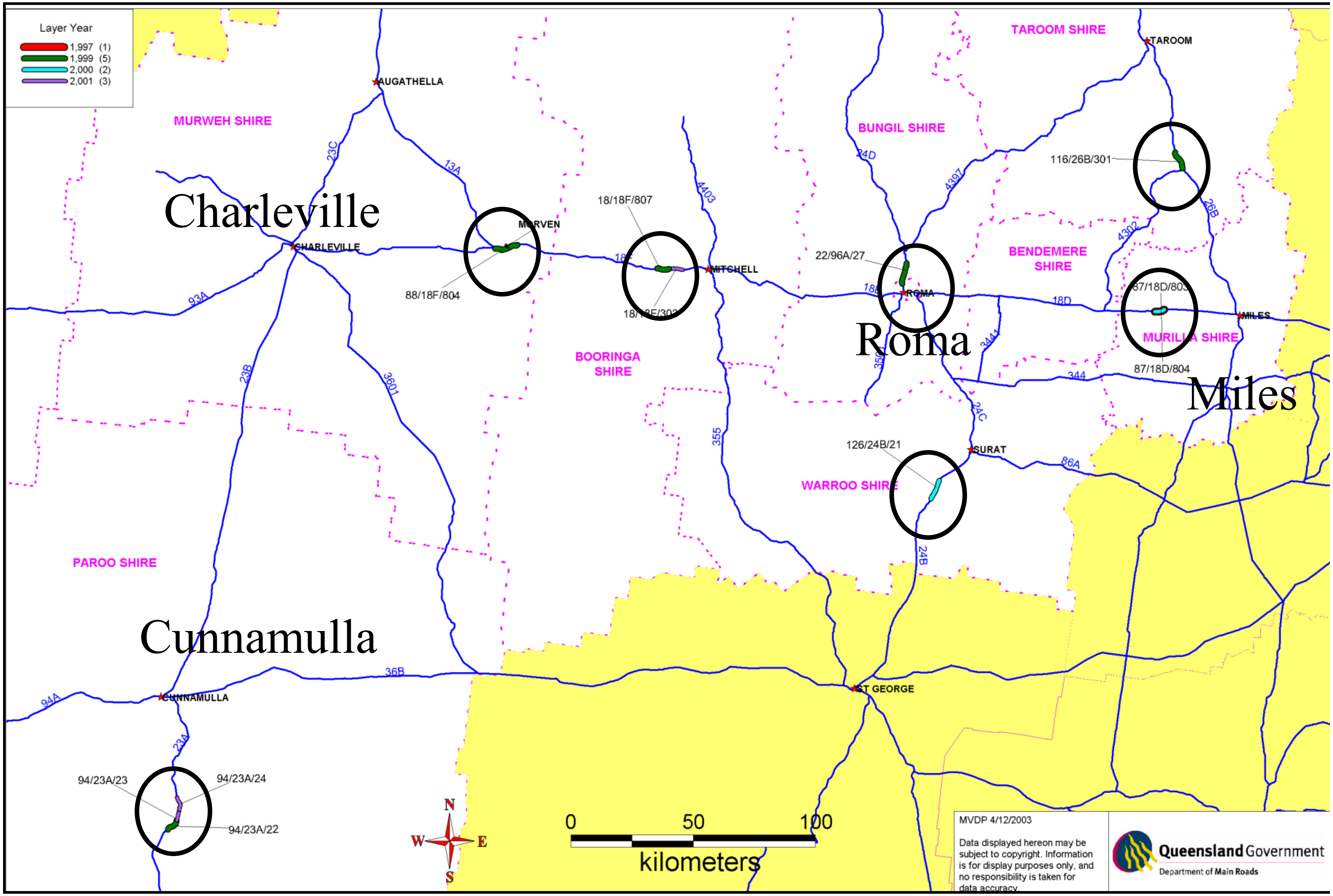

95 1 20

Roma : Insitu Stabilisation

- **12 projects** amounting to 63km of varying construction between June 1997 – Oct 2001
- **Construction** : 3 Full Width; 9 OWPs
- **Subgrade :** 4 NonReactive; 8 Reactive
- **Additive Type** : 6 Cem/Fly; 3 Lime/Fly;

  2 Lime/Cem/Fly; 1 Hydrated Lime
- **Depth of stabilisation** : 6 x 250mm; 6 x 300mm

Where abouts ?



Type of Materials Stabilised

- 25% Added Gravel + 25% Exist Gravel + 50% Loam : 4% C/F
- 50% Ridge Gravel + 50% Sandstone : 5% L/C/F (30/30/40)
- 50% Ridge Gravel + 50% Loam : 5% C/F (75/25)
- 50% Ridge Gravel + 50% White Rock : 5% C/F (75/25)
- 40% Ridge Gravel + 60% Loam to Clay Loam : 2% C/F
- 50% Loam + 50% Clay : 2.5% C/F
- 83% Loam + 17% Clay : 6.5% Hyd Lime

Assessing Performance

- **Structural Performance** :
  - Rutting
  - Shoving
  - Block/Fatigue Cracking
  - Pavement Repairs
- **Functional Performance :**
  - Longitudinal Cracking
  - Vertical Depression at Joint
  - Roughness
  - Surfacing Defects

Early Performance (2 – 7 yrs) by Design Lab UCS

- Poor Performers : UCS < 0.7MPa
- Fair Performers : UCS 0.7MPa – 1.2 MPa
- Good Performers : UCS 1.2MPa – 1.5MPa

Early Performance (2 – 7 yrs) by Stabilisation Depth

- 300mm Depth (6 Projects):
  - Good Structural = 1 Good Functional = 0
  - Fair Structural = 3 Fair Functional = 5
  - Poor Structural = 2 Poor Functional = 1
- 250mm Depth (6 Projects) :
  - Good Structural = 5 Good Functional = 4
  - Fair Structural = 1 Fair Functional = 2
  - Poor Structural = 0 Poor Functional = 0

Early Performance : Conclusions

- Target 1.0 MPa to 1.5MPa Design Lab UCS
- Plan a Geotextile Seal for stabilised Pavements on Reactive subgrades
- Lime/Flyash (40/60), in economic proportions, struggles to provide UCS
- Depth of 250mm
- Better construction practices to avoid depressed joint

South of Surat
Structural = Good
Functional = Fair

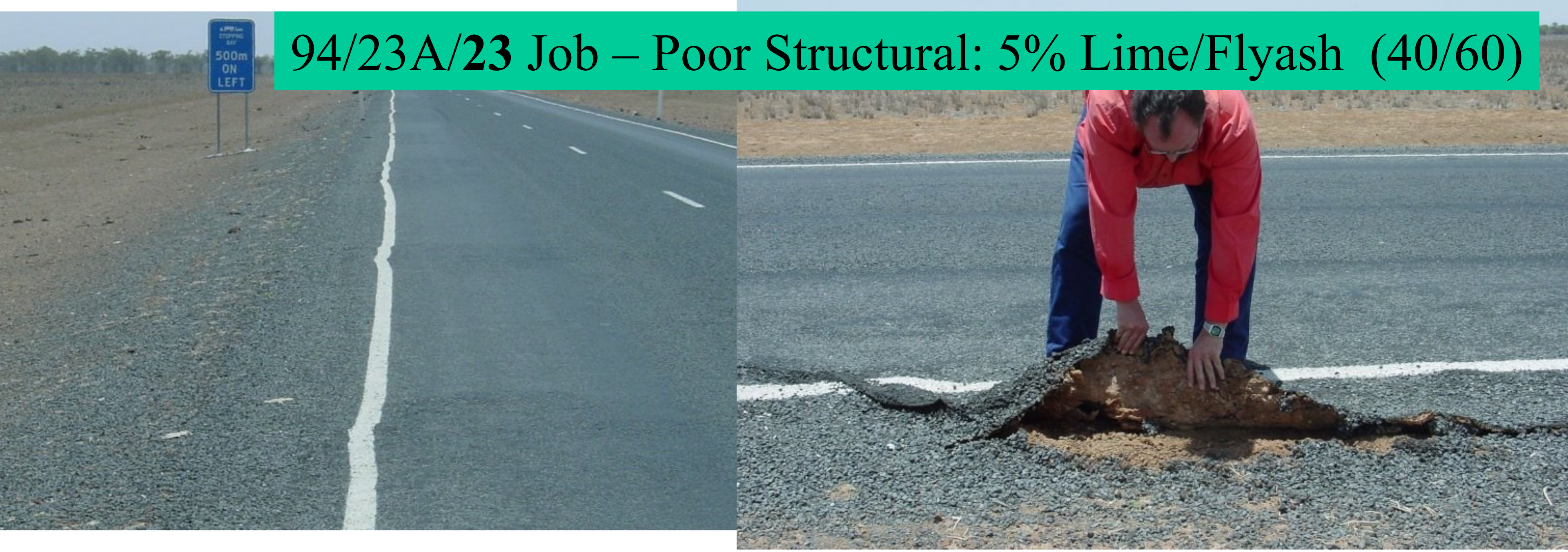
Block Cracking : North of Roma

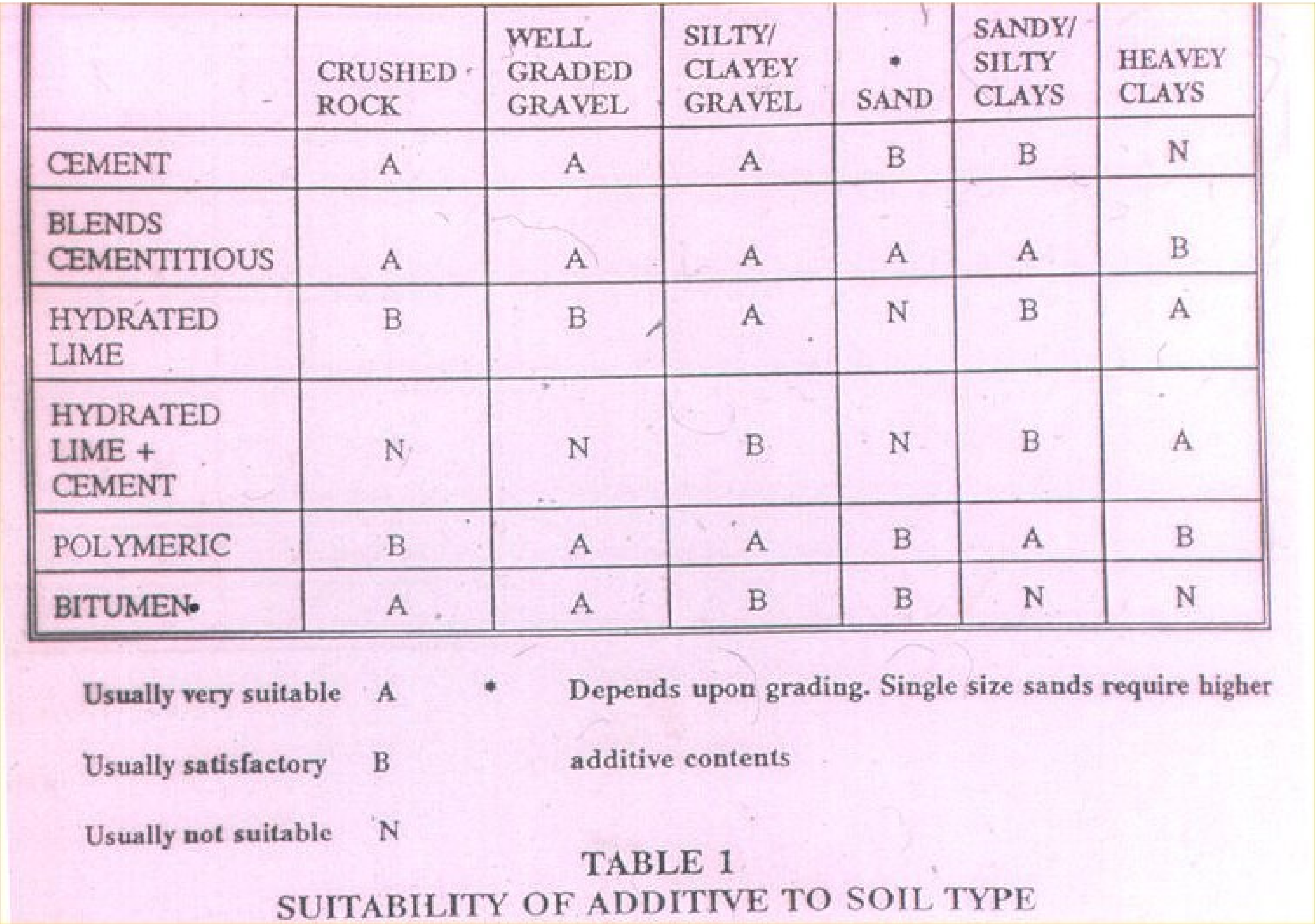
Structural = Fair

Functional = Fair

94/23A/**22** Job – Good Structural: 6.5% Hyd Lime

94/23A/**23** Job – Poor Structural: 5% Lime/Flyash (40/60)





	CRUSHED ROCK	WELL GRADED GRAVEL	SILTY/ CLAYEY GRAVEL	• SAND	SANDY/ SILTY CLAYS	HEAVEY CLAYS
CEMENT	A	A	A	B	B	N
BLENDS CEMENTITIOUS	A	A	A	A	A	B
HYDRATED LIME	B	B	A	N	B	A
HYDRATED LIME + CEMENT	N	N	B	N	B	A
POLYMERIC	B	A	A	B	A	B
BITUMEN•	A	A	B	B	N	N

Usually very suitable	**A**	•	**Depends upon grading. Single size sands require higher additive contents**
Usually satisfactory	**B**		
Usually not suitable	**N**		

TABLE 1
SUITABILITY OF ADDITIVE TO SOIL TYPE

Guide to selecting method of stabilisation

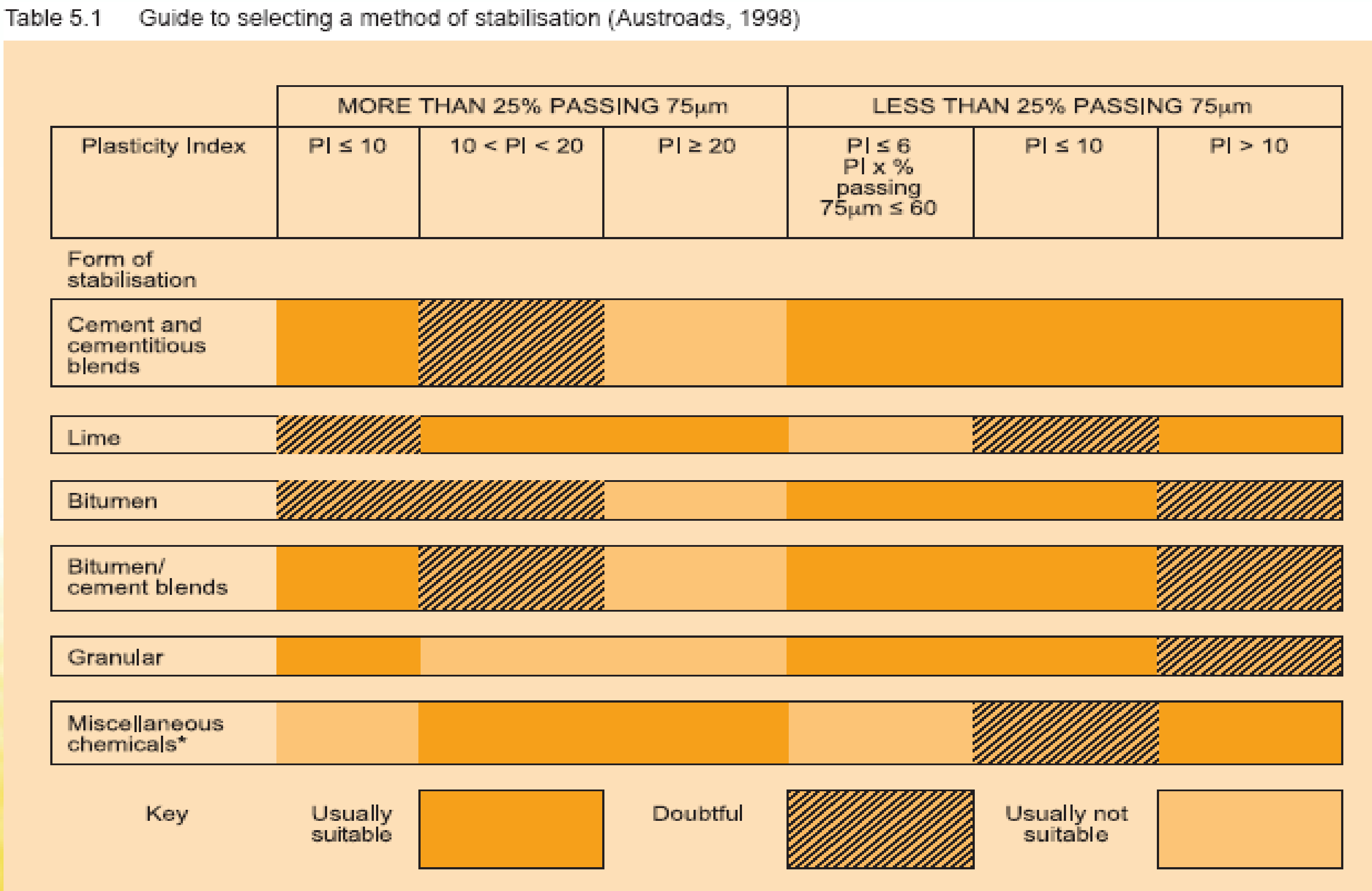


Table 5.1 Guide to selecting a method of stabilisation (Austroads, 1998)

	MORE THAN 25% PASSING 75μm			LESS THAN 25% PASSING 75μm		
Plasticity Index	PI ≤ 10	10 < PI < 20	PI ≥ 20	PI ≤ 6 PI x % passing 75μm ≤ 60	PI ≤ 10	PI > 10
Form of stabilisation						
Cement and cementitious blends	🟧	▨	□	🟧	🟧	🟧
Lime	▨	🟧	🟧	□	▨	🟧
Bitumen	▨	▨	□	🟧	🟧	▨
Bitumen/ cement blends	🟧	▨	□	🟧	🟧	▨
Granular	🟧	□	□	🟧	🟧	▨
Miscellaneous chemicals*	□	🟧	🟧	□	▨	🟧

Key: Usually suitable 🟧 Doubtful ▨ Usually not suitable □

The in situ foamed bitumen stabilisation process

A brief overview of the process

Pulverising prior to stabilisation

- Breaks up wearing course (seal or thin asphalt) and any patches

Trimming after pulverising

- Remove irregularities before stabilisation and compaction

Apply Lime

- Quicklime depicted here
- Dust is a hazard to construction personnel and public

Tray tests 1

- To check application rate
- Should be done regularly
- Usually 3 trays, each a third of a square metre

Tray tests 2

- Tare scales with trays before laying out trays
- Stop applicator very soon after passing over trays

Lime applied

- Multiple tests in series if necessary
- Reapply lime in trays
- Rate must be correct before allowing the run/s to be completed

Slake Lime 1

- Necessary for quicklime only
- Multiple passes may be necessary to ensure full slaking

Slake Lime 2

- Slaking generates steam clouds
- Environmental and perhaps safety concerns

Slake Lime 3

- Temperature may indicate if hydration is complete

Foamed bitumen stabilisation 1

- Foamed bitumen stabilise ASAP after slaking is complete

Foamed bitumen stabilisation 2

- Stabiliser pushes bitumen tanker
- Check foaming of bitumen at start of run (halt if necessary)

Compaction

- Follow stabilising run with compaction equipment
- Be aware if padfoot allowed too close to surface its pattern will reflect through to the seal.

Testing

- Sample ASAP after stabilising for tests such as bitumen content
- Sample ASAP after compaction to obtained reference density
- Complete reference density test ASAP (within 2 hours) after stabilising (binders affect compaction).


12 9:27

Foamed Bitumen Stabilised Pavements - SEQ

- Gladfield – Cunningham Highway
- Rainbow Beach – Rainbow Beach Road
- Inglewood – Cunningham Highway
- Allora – New England Highway
- Beenleight – Beenleigh Connection Road
- Beaudesert – Beaudesert – Boonah Road
- Redland Shire – Various Roads

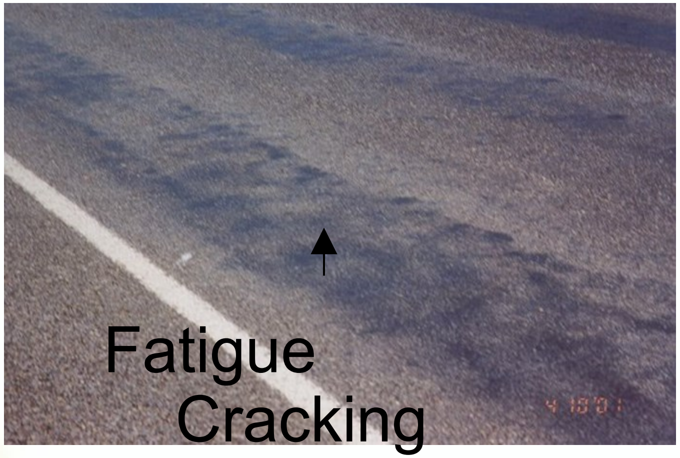
Gladfield – Built 1997

- 250mm OWP + 200mm IWP stabilised with 4% bitumen & 1.5% cement
- CBR 3 (expansive) subgrade
- Pavement life (prior to fatigue) ~ 2.5 years
- Approx. traffic to failure ~ 2.5 x 10^6 ESA
- Site has been overlaid with 160mm granular material.

Inglewood – Built 1998

- 200mm stabilised layer with 4% bitumen & 1.5% quicklime.
- Insitu subgrade strength CBR 5 – 20
- 3 year prior to the onset of fatigue cracking (only in areas with insitu CBR 5 - 8)
- Calculated fatigue life similar to that achieved in the field

Inglewood – 2001



Fatigue Cracking

Possible CTB Patch?

Fatigue Cracking

Fatigue Cracking

Rainbow Beach – Built 1998

- Trial to assess foamed bitumen against bitumen emulsion stabilisation
- 3 x 200m sections of foamed bitumen stabilisation constructed using 3, 4 & 5% bitumen + 1.5% quicklime
- Still performing adequately and showing few signs of distress

Rainbow Beach – 2003

Allora– Built 1999

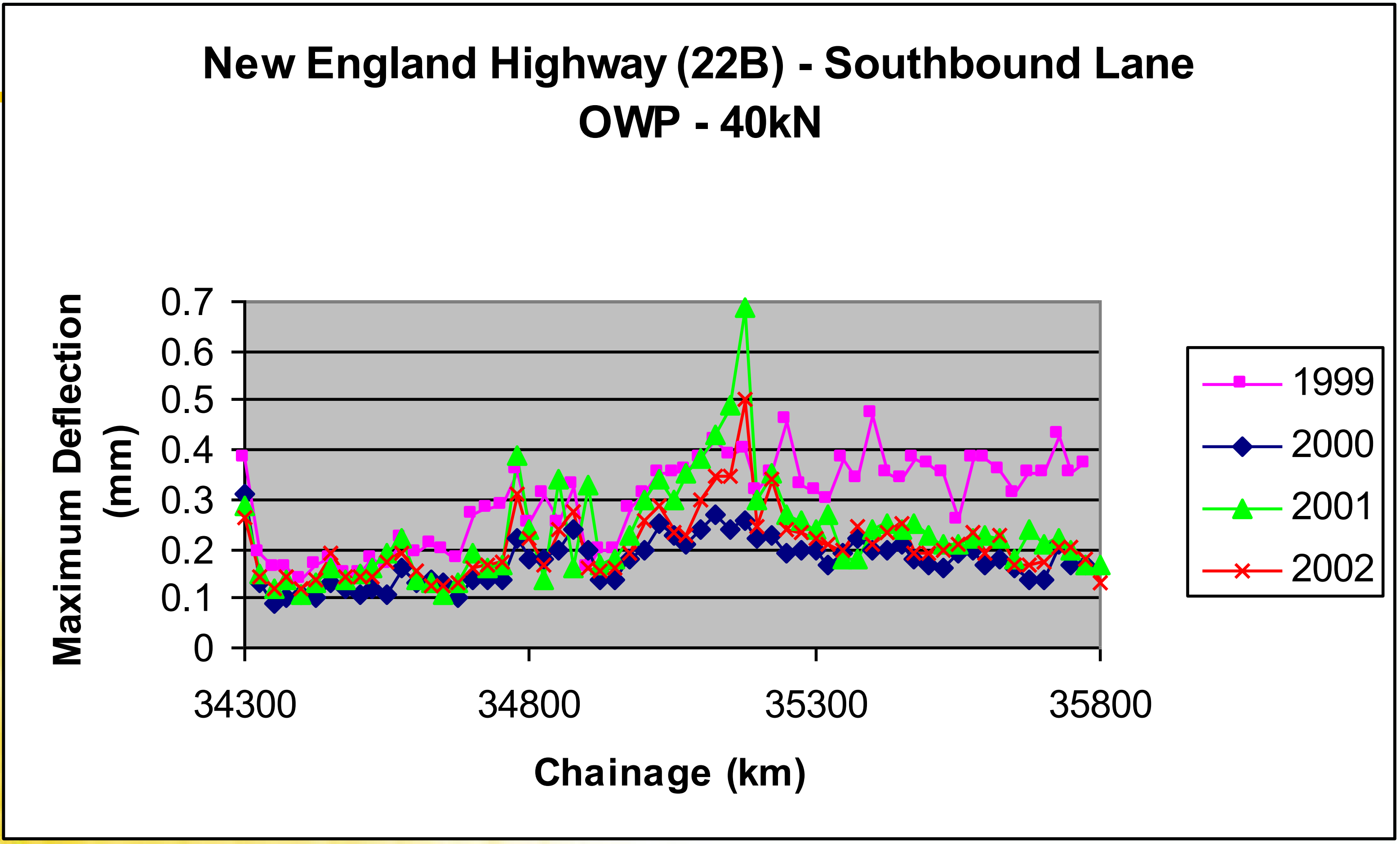
- 17km section stabilised 250mm OWP + 200mm IWP with 3.5% bitumen + 1.5% quicklime
- Originally design with a 50 – 120mm asphalt overlay (not constructed)
- Subgrade – expansive black soil
- 1.5km section tested for deflection at regular intervals

Allora - 2002

- Isolated signs of distress
  - – Two minor rut / shove failures
    - Possibly material related
  - – Longitudinal cracking
    - Subgrade movement
    - IWP fatigue cracking (insufficient depth?)
  - – Seal Flushing

Allora - 2002

Allora Deflection Data



Queensland Government

Department of Main Roads

Pavement Design – Cemented Pavements

- Items required:
  - – Accurate traffic data to calculate design ESAs
  - – Existing Pavement Structure
  - – Insitu subgrade strength
  - – Depth of suitable material for stabilisation
  - – Applied load (full standard axle 750kPa tyre pressure)
  - – Stabilised pavement stiffness – Resilient Modulus (MPa)
  - – Performance criteria???

Performance Criteria

- Pre-cracking Criteria
  - CAT I CTB - $(310/\mu\varepsilon)^{12}$, Modulus 5,000MPa
    - UCS 3 – 4MPa Type 1.1, 1.2, 2.1, 3.1 material
  - CAT II CTB - $(440/\mu\varepsilon)^{12}$ Modulus 2,000MPa
    - UCS 2 – 3MPa Type 1.1, 1.2, 2.1, 3.1 material
    - UCS 3 – 4MPa other materials (if appropriate for use)
  - CAT I and Cat II CTB generally provide insufficient fatigue life in most situations without going to deep lift stabilisation ($300mm^+$) or inclusion of post cracking life in the design calculations.

Post-Cracking Life

- Should only be assumed where there is:
  - 150mm of cover material (asphalt or granular)
  - Geotextile seal or interlayer
  - PMB Interlayer (S9S @ 2.5L/m^2)
- Post cracking life - 500MPa anisotropic layer (no sublayering)

Cementitiously Modified Pavements

- UCS 1.0 – 1.5MPa at 28 days
- Performance criteria – ???
- Generally modeled as a granular layer or Cat II CTB
- Extracted field cores indicate that stiffening over time (fatigue problem?)

Model Comparison

- DTL = 3.0 x 10^6 ESA
- Subgrade CBR 4
- To be designed with 50mm DG Asphalt
- Stabilisation thickness required:
    - Cat II CTB (with post cracking life) = 285mm
    - 500MPa Granular (anisotropic) = 285mm
    - 500MPa Granular (isotropic) = 230mm
    - 1,000MPa Granular (anisotropic) = 215mm

Safeguards for Insitu Pavement Modification

- Minimum stabilisation depth 200mm
- Design UCS 1 – 1.5MPa at 28 days
- Minimum additive content 1.5%
- Provision of a PMB interlayer, Geotextile interlayer or seal in the design or prior to the onset of fatigue cracking.

Pavement Design – Foamed Bitumen

- Performance Criteria???
  - – Assumed to fatigue and behave similar to asphalt
  - – Reduce V_b due to low bitumen content
- Resilient Modulus
  - – Based off laboratory test results
  - – Reduction factors are applied to laboratory test values to account for field moisture conditions, field compaction and material variability

Foamed Bitumen Stabilised Pavements

- Post-cracking life assumed where a geotextile seal is placed prior to the onset of fatigue
- Example: Stabilisation depth of 240mm is required compared to 285mm for cement modification.

Pavement Design - Lime Modified Subgrades

- Lime Demand Test – Minimum lime content to avoid strength loss during the design life
- Recommended Design UCS: 1.0 – 1.5MPa at 28 days (unsoaked)
- Capillary Rise
- Amelioration process essential in the mix design stage where PI > 20

Pavement Design – Lime Stabilised Subgrades

- Maximum design subgrade CBR 7 – 20MPa
- Dependant on:
  - Stabilisation thickness (200 – 300mm)
  - Achieved UCS
  - Underlying support
  - Compaction standard applied
- Subgrade rutting checked at the following locations:
  - Top of the treated layer
  - Top of the untreated material.

Performance Warning

- It is essential that the following items are adequately controlled to achieved the desired outcomes:
  - Design
    - UCS testing and calculation of design thickness
    - Determination of the allowable working time
    - Incorporation of a geotextile seal and PMB interlayer
  - Construction
    - Additive content, moisture content, stabilisation depth and compaction

Capillary Rise Test

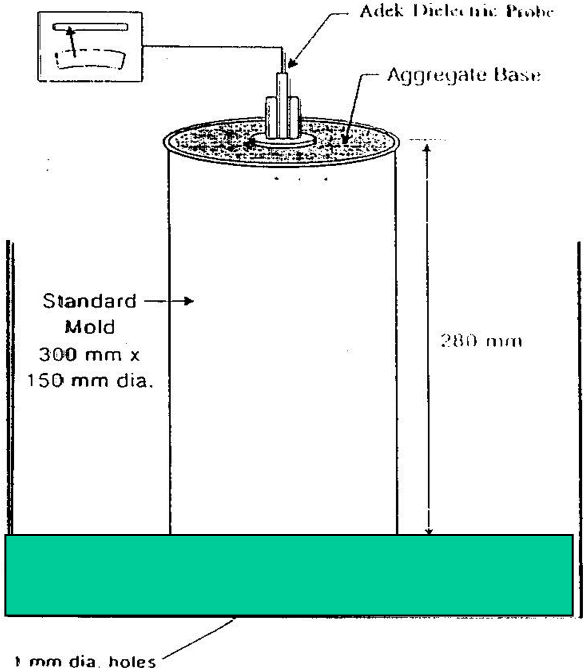
- Measures the ability of material to draw in water and become saturated.

Capillary Rise Over Time

Capillary Rise of Various Base Materials

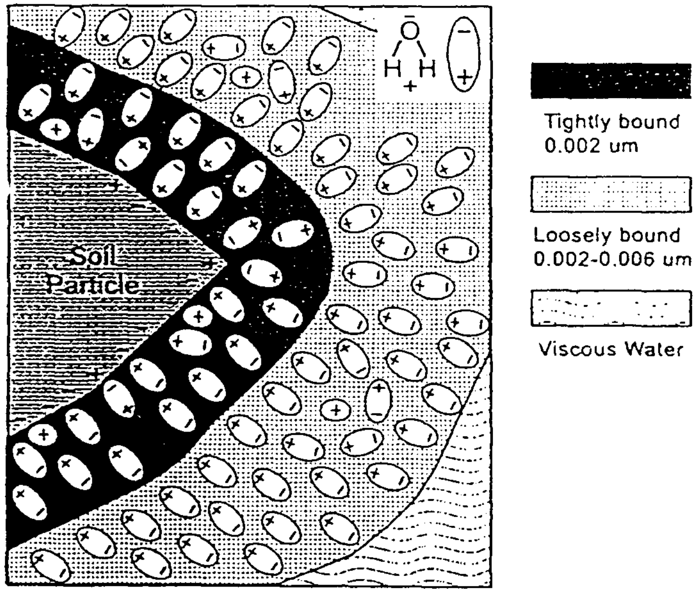
Suction Test

- Measures the change in electrostatic capacity of the material during a Capillary Rise Test.



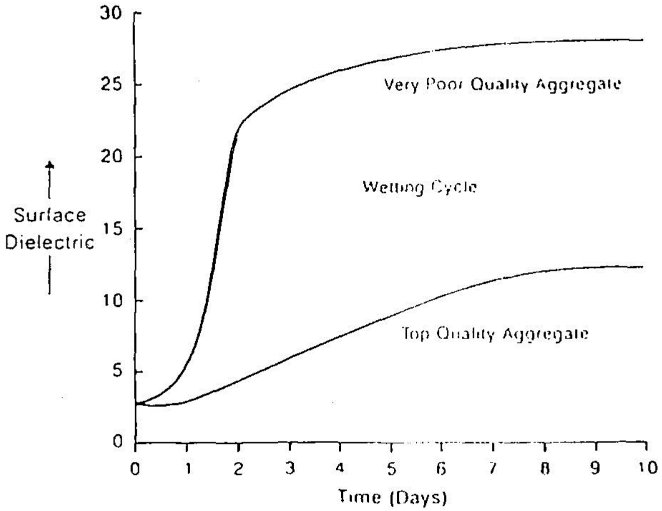
Dielectric Constant

- The Dielectric Constant is a measure of the “free” or unbound water within an aggregate sample.



Material Performance

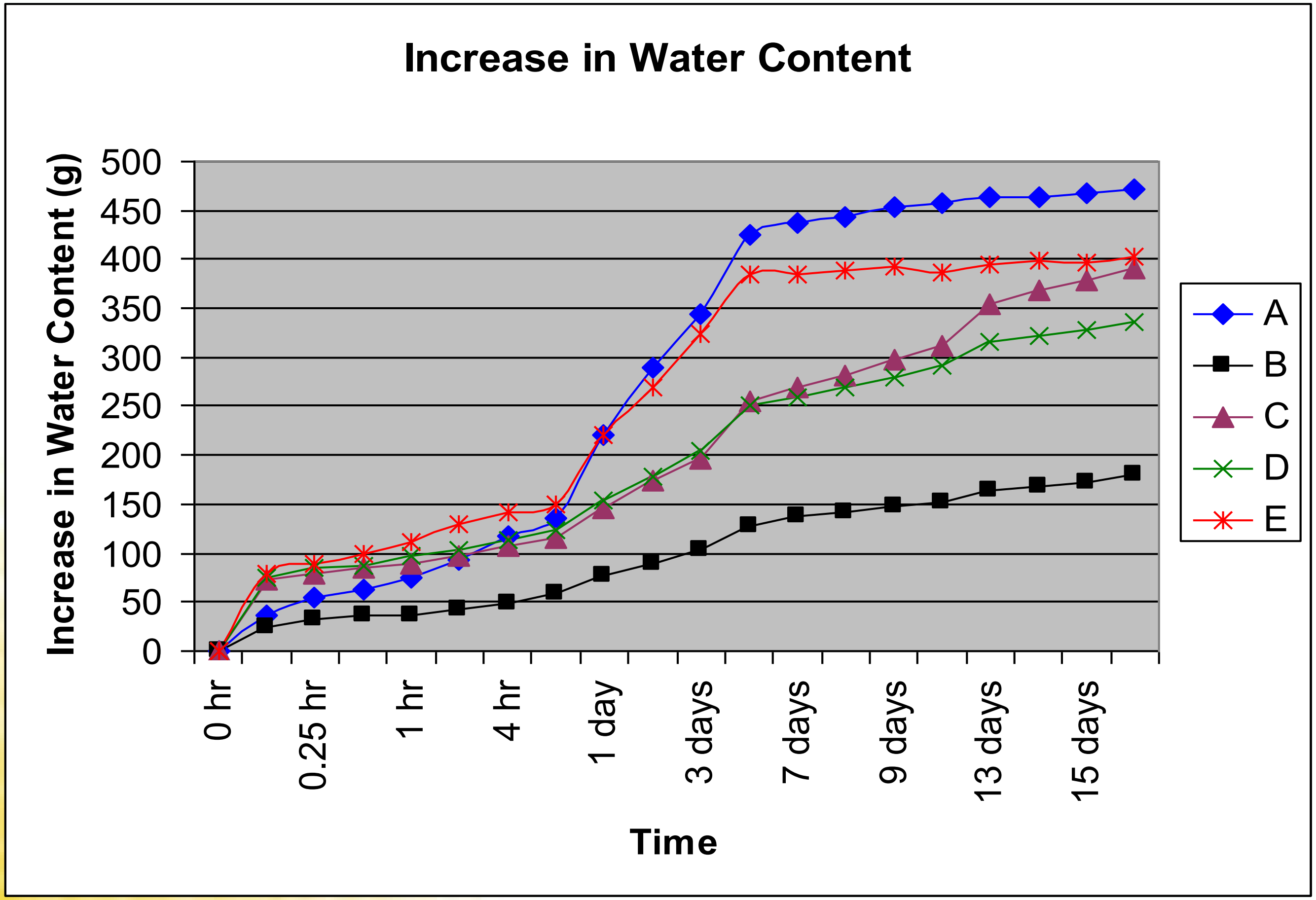
- Poor performing aggregates are those that reach saturation rapidly and that also result in a large increase in the dielectric value



Applications for the Suction Test

- Detect moisture sensitive pavement materials.
- Selection of pavement materials.
- Rehabilitation treatment selection.
  - Stabilisation additive content.

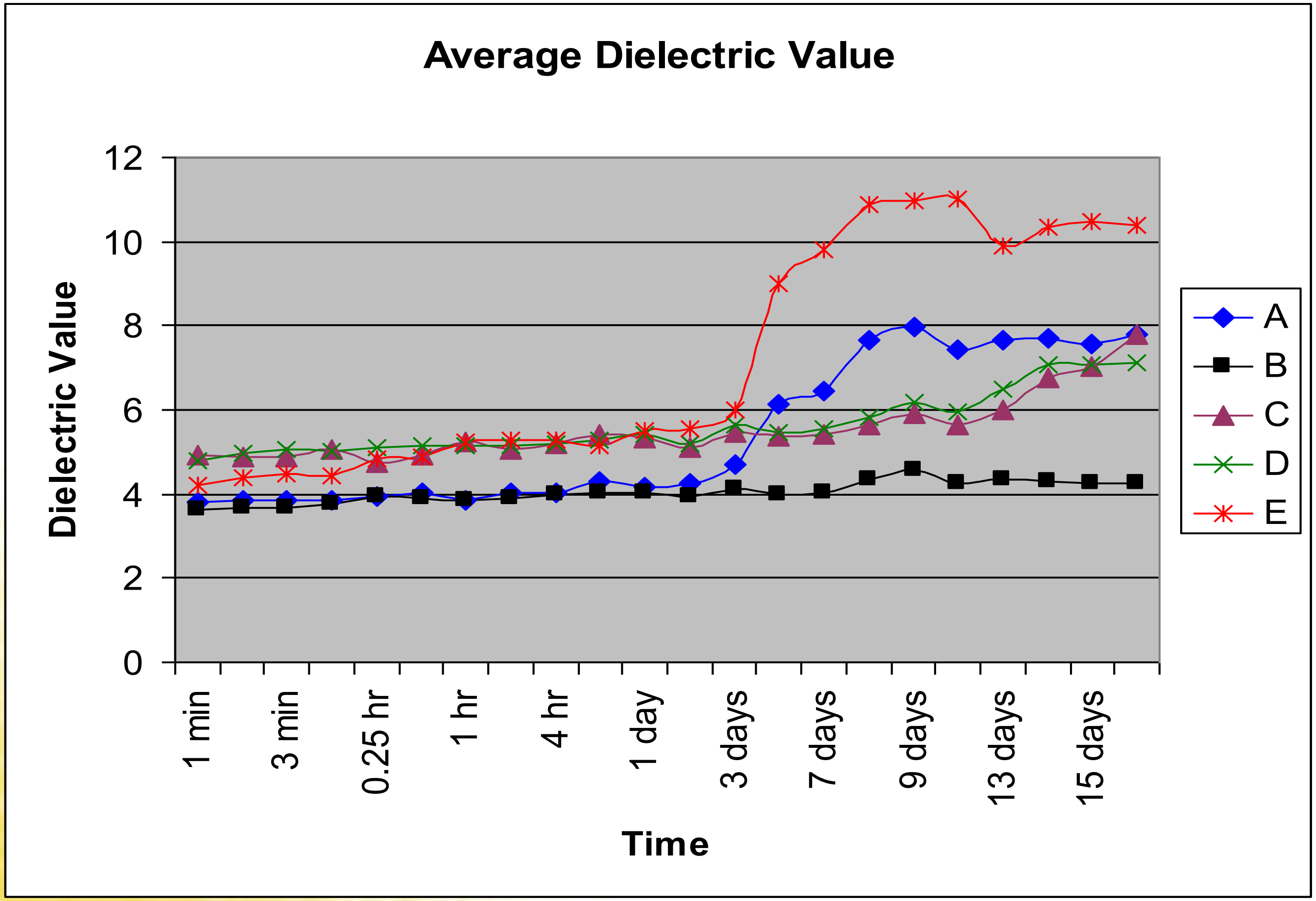
Granular Materials



Queensland Government

Department of Main Roads

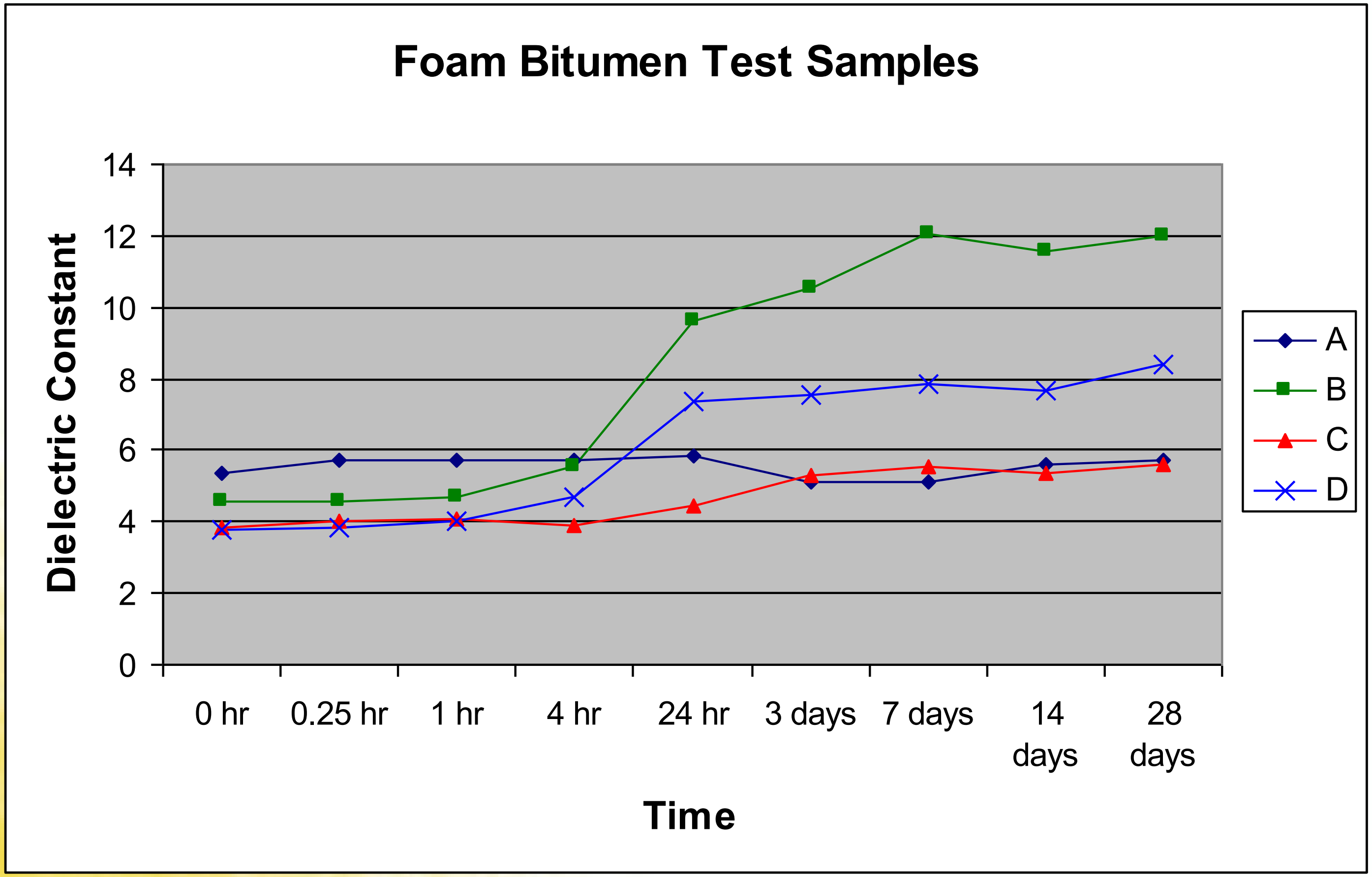
Granular Materials 2



Queensland Government

Department of Main Roads

Stabilised Materials



Specification for lime stabilising subgrades

Discussion of issues relating to the current specification

Queensland Government

Department of Main Roads

What does it do?

- Used for:
  - Modification, usually for ease of construction
  - Long term strength gain, modifies and also achieves long term strength retention
- Improves constructability by:
  - Improving plastic properties
  - flocculating particles
  - drying material

What is amelioration?

- Common to lime stabilise subgrades in 2 passes
  - apply 50% of the dosage in first pass
  - wait 24 hours
  - apply remaining 50% in last pass

Why ameliorate?

- Heavy clays are difficult to stabilise in one pass
  - adequate mixing is difficult
  - heavy clay tends to clump together
- Allows 24 hours for the lime to start working
  - flocculate clay particles
  - “break down” clays
  - improve workability
- Results in:
  - better mixing in the second run
  - Construction (and compaction?) is easier

Amelioration issues 1

- Longer time to finish construction
  - Delays Contractor
    - Contractor has to bring machine back a second day
    - Contractor can't continue construction until after second run
  - Delays construction
  - Delays trafficking
  - Open to weather longer
    - Rain

Amelioration issues 2

- Machine breakdown
  - If only one machine is in the area a second will need to be sourced within 24 hours of first pass
    - In remote areas this could be difficult
  - Extended delays
    - Subgrade should not be left too long before the second run is completed
      - for example
        - » becomes open and porous (water infiltration is a problem)
        - » can be difficult to compact
    - Open to weather (that is rain) for extended period
    - Construction delayed as subgrade must be completed first

Other issues 1

- Quicklime 1
  - – Costs less to cart
  - – Requires slaking
  - – Generates steam clouds
    - Environment
    - Residents
    - Property
  - – Must ensure completely hydrated which can be difficult in the field
  - – More reactive and therefore more dangerous

Other issues 2

- Quicklime
  - If not completely hydrated water infiltrating will hydrate remaining quicklime which can cause pavement failure????
- Hydrated Lime
  - Costs more to cart
  - Doesn't require slaking as already hydrated
  - Can blow around more due to low density
    - Environment
    - Residents
    - Property
  - Safer

Other issues 3

- Source of quicklime
  - Equivalent calcium oxide content may vary with source.
  - Adjust spread rate according to specification
- Trimming time limit?
- Testing times
  - Binders added affect compaction
  - Reference density compaction should be done ASAP after stabilising, max 2 hours