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ROAD SECTOR DEVELOPMENT PROGRAMME PACKAGE 3

PAVEMENT DESIGN SUPPLEMENTS

TRAINING MATERIALS




INDONESIA
INFRASTRUCTURE
INITIATIVE

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ROAD SECTOR DEVELOPMENT PROGRAMME
PACKAGE 3

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TRAINING MATERIALS

INDONESIA INFRASTRUCTURE INITIATIVE

May 2011

INDONESIA INFRASTRUCTURE INITIATIVE

This document has been published by the Indonesia Infrastructure Initiative (IndII), an Australian Government funded project designed to promote economic growth in Indonesia by enhancing the relevance, quality and quantum of infrastructure investment.

ACKNOWLEDGEMENTS

This report has been prepared by Edward James on behalf of Cardno Emerging Markets in association with the Australian Road Research Board who were engaged under the Indonesia Infrastructure Initiative (IndII), funded by AusAID, as part of the Directorate General of Highways (DGH) Programme Development Activity.

The products of this Activity draw from numerous sources, particularly the following guidelines and technical papers:

Pavement Design Guide, AASHTO, 1993

Austroads Pavement Design "A Guide to the Structural Design of Road Pavements" 2008

Overseas Road Note 31, Transport Research Laboratory (TRL), UK, 1993

LR 1132, Transport Research Laboratory, 1986

TRL611, Transport Research Laboratory, 1986

The debt owed to the authors of these documents must be acknowledged.

Any errors of fact or interpretation of previous studies under the IndII Road Sector Development Programme are solely those of the author.Any errors of fact or interpretation of previous studies under the IndII Road Sector Development Programme are solely those of the author.

Ed Vowles, Team Leader

Jakarta, May 2011

Document Control: IndII RSDP3 – Activity 201 Deliverable 6C Training Materials					
Version	**Date**	**Author**	**Initials**	**Reviewer**	**Initials**
HIS edit corrections	August 2011	Edward James		Ed Vowles	

TABLE OF CONTENTS

ABBREVIATIONS

AASHTO	Association of American State Highway and Transportation Officials
AC	Asphaltic concrete
AC BC	Asphaltic concrete binder course
AC WC	Asphaltic concrete wearing course
AMP	Asphalt mixing plant
Austroads	Association of Australian and New Zealand road transport and traffic authorities
BB	Benkelman Beam
CBR	Californian bearing ratio
CESA	Cumulative equivalent standard axles
CIRCLY	Australian mechanistic design software program used by Austroads 2004
CTB	Cement treated base
DCP	Dynamic cone penetrometer
DG	Director General
DGH	Directorate General of Highways (Bina Marga)
DGH 2002	DGH Flexible Pavement Design Guide
DGH 2003	DGH Rigid Pavement Design Guide
EA	Executing Agency
ESA4	Equivalent Standard Axle – 4th power
ESAasphalt	Equivalent Standard Axle for asphalt (5th power)
FWD	Falling weight deflectometer
FY	Fiscal year
GoI	Government of Indonesia
Hr	Hour
IndII	Indonesia Infrastructure Initiative
IRI	International Roughness Index
IRMS	Indonesian Road Management System
K	Constant
Km	Kilometer
LMC	Lean mix concrete
MDD	Maximum dry density
OMC	Optimum moisture content
ORN	Overseas Road Note
PI	Plasticity Index
PPK	Pejabat Pembuat Komitment (Sub Project Manager)
RF	Reliability factor
SG2	Subgrade with CBR 2 percent
TMasphalt	Traffic multiplier for design of asphalt layers
TRL	Transport Road Laboratory (UK)
VDF	Vehicle damage factor
Yr	Year
$\mu\varepsilon$	Microstrain

EXECUTIVE SUMMARY

Training materials prepared for workshops conducted throughout the Activity delivery period are provided. The audience for workshops that have been conducted to date has been limited to Indonesian Road Research Institute (Pusjatan) and Technical Directorate of Directorate General of Highways (DGH-Bintek) staff. A final workshop is planned to present the Design Supplements and Activity #201 findings to a wider audience. Materials for the upcoming workshop are under preparation and have not been included in this document set.

Table 1.1 summarises the main workshop activities, papers presented and authors.

Table 1.1: IndII RSDP3, Activity 201, Training Workshops

Activity	Venue	Title	Presenter(s)	Date
1	Bintek, Jakarta	Activity 201 Road Design Standards	Nigel Rockliffe, Ted James	22 Nov, 2011
2	Pusjatan, Bandung	First Pusjatan Presentation: Pavement Design Module	Edward James	14 Dec, 2010
3	Pusjatan, Bandung	Second Pusjatan Presentation: Pavement Design Module	Edward James	18 Jan, 2011
4	Bintek, Jakarta	Pavement Design Supplement: Part I: New Pavements	Edward James	8 Feb, 2011
5	Bintek, Jakarta	Pavement Design Supplement Part II: Rehabilitation and Recycling	Geoff Jameson	21 May, 2011
6	Bintek, Jakarta	Rehabilitation Treatment Selection, Warrants and Triggers	Edward James	20 May, 2011

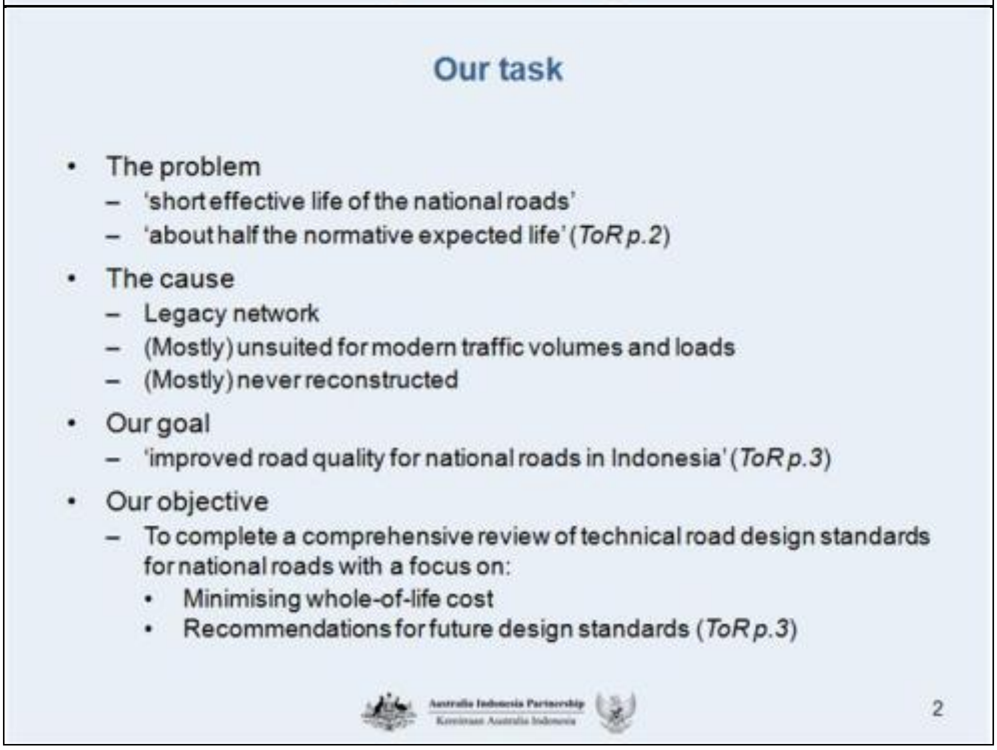
Copies of presentations are provided in Annexes 1 to 6.

Translations of Supplements I and II to Bahasa Indonesia are included as Annexes 7 and 8. These translations will be an essential component of any future training programme. They require review before final issue.

Every effort has been made to ensure that the Supplements are self explanatory. Training during the course of the Activity was directed towards Bintek and Pusjatan staff who will support future training activities. A further training programme will clearly be required to introduce Supplements I and II to a wider audience including provincial and local level pavement and drainage designers. This training should be delivered during Phase II of the Activity.

Deliverable 7 describes further training and other Activities required to support full implementation of Supplements I and II.

ANNEXE 1: ACTIVITY 201 ROAD DESIGN STANDARDS



Two main outputs

- 3a - LCC model, data preparation and key policy issues on new or fully reconstructed pavements
  - evaluation of the design catologue
  - pavement construction quality
  - Overloading

- 3b – Final LCC evaluation including
  - rehabilitation and maintenance treatments
  - consequences for budget planning
  - a strategy to address budget limitations
  - sensitivity to traffic levels loading and maintenance practices

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3

Component tasks

1. Review current DGH design standards
2. Develop rehabilitation and new design options
3. Conduct life-cycle cost analysis
   - Select and configure life-cycle cost (LCC) tool
   - Create LCC case studies
     - New (flexible) pavements and major policy drivers
     - Rehabilitation and maintenance
   - Conduct and interpret LCC analysis
4. Devise road design standards / warrants
5. Write pavement and drainage design and maintenance manual and...
6. Conduct training
7. Scope services for potential future activity

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4

Results – new pavement designs

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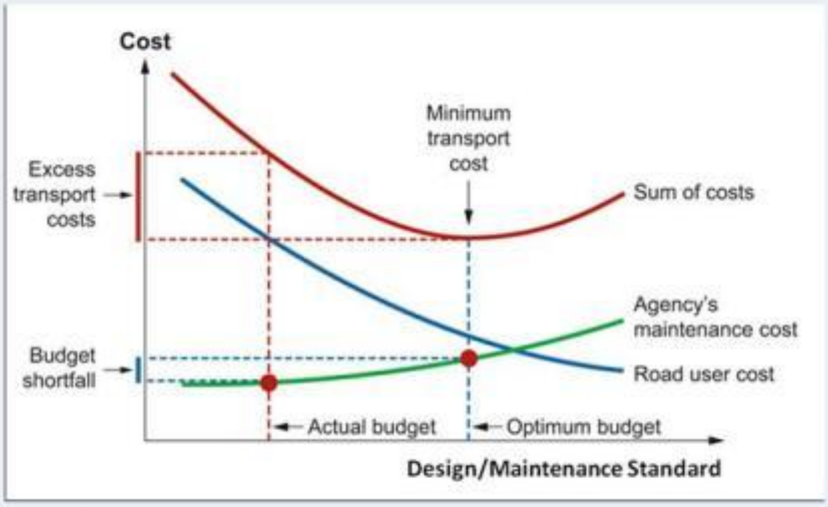
5

Minimising costs



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Design traffic and pavement catalog

- Current rate of loading 3 times higher than legal loading
  - 30% less trips than legal loading
  - 'Actual' scenario: 40% of representative sections fall within catalog
  - 'Compliant' scenario: 60% fall within catalog
  - Need for rigid pavements?
- Capacity constraint for high traffic (>25,000 AADT) and very high traffic (>50,000 AADT)
  - Need for 4 lane and 6 lane solutions

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Road deterioration rates & treatment lives & Road Agency Costs

- Treatment lives (surfacings/overlays etc **with Multiple Triggers**)
  - Wide variation (based on research studies)
  - < 5 years 'Actual' scenario
  - 12 – 20 years 'Compliant' scenario
- Road Agency Costs (RAC) for flexible pavements
  - Low traffic (<5,000 AADT)
    - Whole of Life Costs 30% lower for 'Compliant' scenario
    - 8% construction cost saving
  - High traffic (>15,000 AADT)
    - Whole of Life Costs 22% lower for 'Compliant' scenario
    - Minimal construction cost saving
    - Need for rigid pavements?
- Both cost minimisation rules give similar optima, i.e. TTC and RAC

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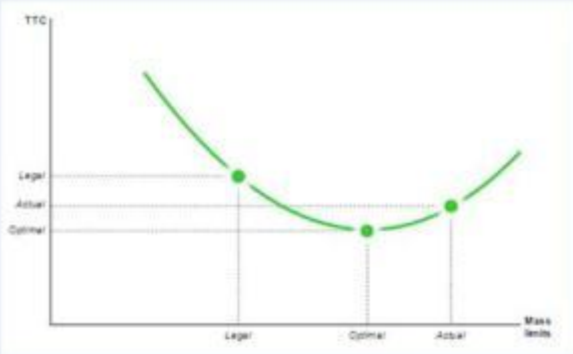
Compliance is costly

- Compliance delivers lower RAC
- However, RUCs rise
- Why
  - too many extra trips (39%)
  - RUCs very high
  - legally sanctioned limits too low
  - a balance is needed
- but, need to ensure loading spectrums & compositions reasonable



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Catalog of structures which minimise life cycle costs (1)

- Different structures apply for 'Actual' and 'Compliant' scenarios for the same transport task (tonne.km)
- Solutions for 10, 20 and 40 year initial design lives
- Significant strengthening &/or heavier pavements required for 'Actual' scenario
- Optimums assume sufficient lane capacity exists
  - Addressed through lane-by-lane analysis of multi lane roads for > 25,000 initial AADT

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10

Catalog of structures which minimise life cycle costs (2)
Compliant Scenario

LEGAL LOADING (7b - Condition responsive with reconstruction)

COMPLIANT SCENARIO		AADT	CESA 10 YEARS	CESA 20 YEARS	CESA 40 YEARS	AMGBT1	AMGBT2	AMGBT3	AMGBT4	AMGBT5	AMCBT5	AMCBT6	AMCBT7	AMCBT8	AMCBT9
Rac [$ * 10^6]	Extremely	200	0.4	1	4	0.10	0.10	0.17	0.23	0.30	0.27	0.27	0.32	0.35	0.43
	Very low	500	1	3	9	**0.10**	0.10	**0.17**	0.23	0.30	0.27	0.27	0.32	0.35	0.43
	Below low	1,500	3	9	27	0.12	0.11	0.17	0.23	**0.31**	0.27	0.27	0.32	0.36	0.43
	Low	2,500	5	14	44	0.13	0.12	0.18	**0.23**	0.31	**0.28**	0.28	**0.32**	0.36	0.43
	Medium	7,500	16	43	133	[illegible]	0.17	[illegible]	[illegible]	0.35	**0.31**	0.31	**0.35**	0.39	0.46
	High	25,000	55	103	250	0.72	[illegible]	0.49	[illegible]	0.96	0.60	**0.61**	0.64	**0.70**	0.83
	Very high	50,000	48	121	298	[illegible]	[illegible]	0.49	[illegible]	[illegible]	[illegible]	[illegible]	0.81	0.88	**1.05**

(white box)	- solution acceptable by all methods
(orange box)	- Rejected on basis of reconstruction treatment lives too short based on LCC analysis
(hatched box)	- Rejected on basis of short structural lives from design analysis (<10 years)
Bold	- structural design solutions subject to checking, with left most solution with > 10 - 15 years structural life
Solid line	- boundary of solutions with > < 10 years life
Dashed	- boundary of solutions with > < 20 years life

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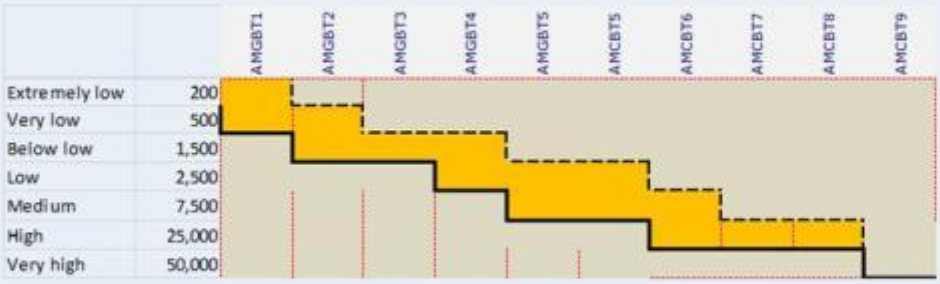
11

Pavement designs for 'Compliant' & 'Actual' scenarios
> 10 year initial structural design life



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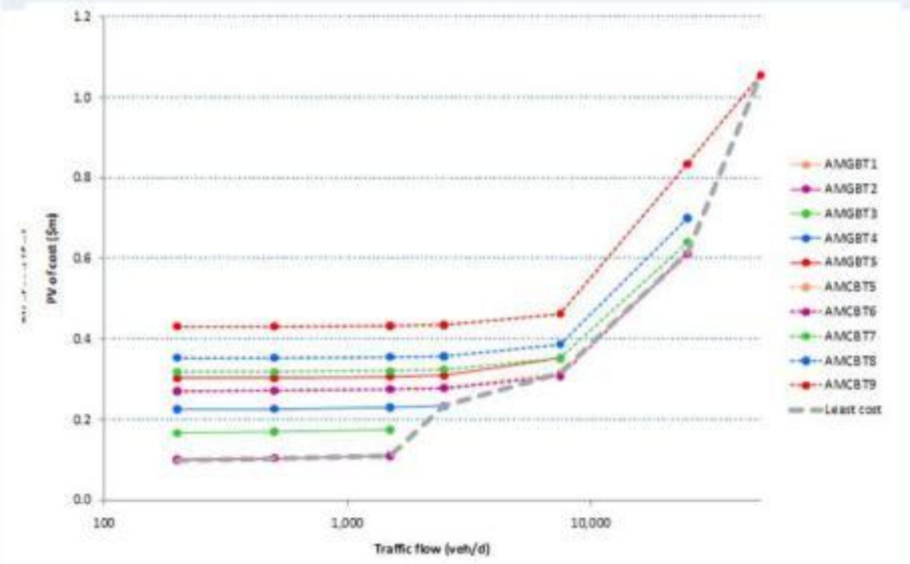
12

RAC v Initial traffic level



Traffic flow (veh/d)

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Key assumptions

Key assumptions

- Extent of overloading and applicability to low-medium volume roads
- Are road deterioration rates are typical of today
- VOCs adequately represent fleet

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Results – rehabilitation and maintenance treatments

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Process

- Initial optimisation
  - Multiple analyses using a wide range of possible solutions
  - Decision criteria – minimise TTC
  - Triggers
    - Cracking, rutting, roughness
  - Intervention levels
    - Fair, Poor, Very Poor, Ex Poor
  - Treatments
    - Overlays: 50mm – 250mm, Full reconstruction
    - Routine maintenance

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16

Condition as a function of surface distress

Condition	Condition				
	Area of cracking (%)	Area of ravelling (%)	Standard potholes	Edge break (m^3)	Mean rut depth (mm)
Good	1	1	0	0	2
Fair	5	5	0	5	5
Poor	15	15	5	50	15
Very Poor	25	20	50	250	25

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17

Condition as a function of roughness (m/km IRI)

Condition	Traffic				
	Very low	Low	Medium	High	Very high
New	1.8	1.8	1.8	1.8	1.8
Good	3	2.75	2.5	2.25	2
Fair	4.25	4	3.75	3.5	3.25
Poor	5.5	5.25	5	4.75	4.5
Very Poor	6.75	6.25	6	5.75	5.5

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18

Trial 1 - Optimal treatment – 50 mm to 100 mm overlays
The overlay solution

Start condition	EL	VL	BL	L	M	H	VH
GOOD	MPRE50VP	MPRE50P	MRUF50F	MPRE50F	MPRE75F	MPRE100F	MRUF100F
FAIR	MPRE50P	MPRE50P	MRUF50F	MRUF75F	MPRE75F	MPRE100F	MRUF100F
POOR	MPRE50P	MPRE50P	MPRE50P	MPRE75F	MPRE75F	MPRE100F	MRUF100F
VERY POOR	MPRE50P	MPRE50P	MRUF50F	MRUF75F	MPRE75F	MRUF75F	MRUF100F

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19

Trial 2 - Optimal treatment – 50 mm to 250 mm overlays
The rehabilitation solution

Start condition	EL	VL	BL	L	M	H	VH
GOOD	MPRE5OF	MPRE5OF	MPRE5OF	MPRE5OF	MPRE75F	MPRE100F	MPRE125F
FAIR	MPRE50P	MPRE50P	MPRE100F	MPRE100F	MPRE125F	MPRE125F	MPRE125F
POOR	MPRE75F	MPRE100F	MPRE100F	MPRE100F	MPRE125F	MPRE125F	MPRE125F
VERY POOR	MPRE100F	MPRE100F	MPRE100F	MPRE100F	150	200	250
Typical structural requirement (mm) for very poor conditions	**50**	**50**	**100**	**100**			
Extremely poor	**Recon**	**Recon**	**Recon**	**Recon**	**Recon**	**Recon**	**Recon**

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20

Trial 3 - Optimal treatment – 50 mm overlays to Reconstruction
The reconstruction solution

Start condition	EL	VL	BL	L	M	H	VH
GOOD	MPRE50F	MPRE50F	MPRE50F	MPRE50F	MPRE75F	MPRE100F	MPRE125F
FAIR	MPRE50P	MPRE50P	MPRE100F	MPRE100F	MPRE125F	MPRE125F	MPRE125F
POOR	MPRE75F	MPRE100F	MPRE100F	MPRE100F	MPRE125F	MPRE125F	MPRE125F
VERY POOR	MPRE100F	MPRE100F	MPRE100F	MPRE100F			
Typical structural requirement (mm) for very poor conditions	**50**	**50**	**100**	**100**	**Recon**	**Recon**	**Recon**
Extremely poor	**Recon**	**Recon**	**Recon**	**Recon**			

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21

Modelling the road network

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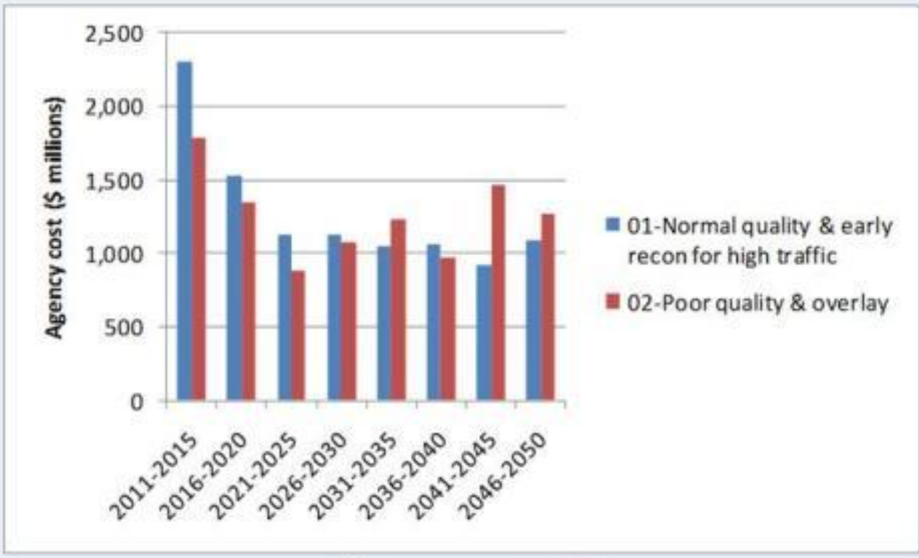
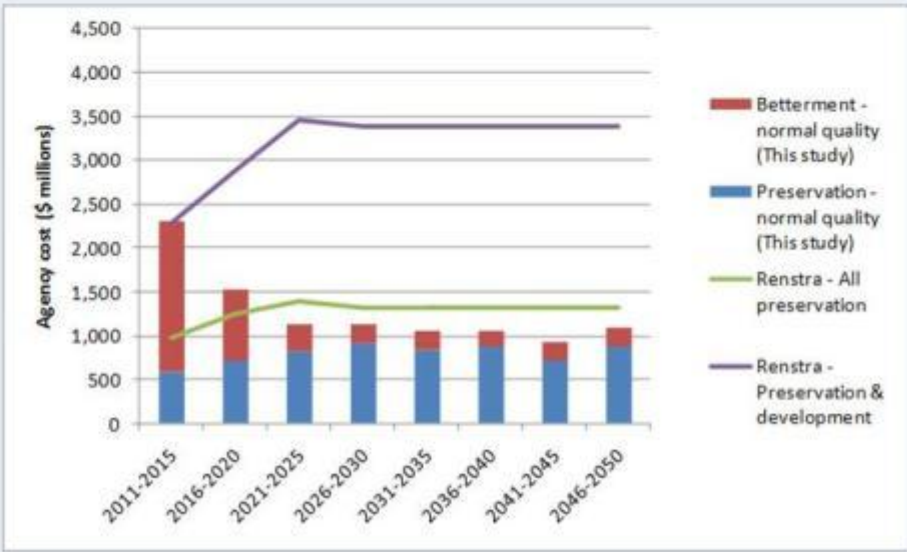
Analysis conditions

- Treatment strategy – use of two options comprising:
  - Normal quality and early reconstruction for high traffic with a full suite of preservation and renewal treatments.
  - Poor quality and overlays, with a full suite of preservation and renewal treatments.
- Treatment selection
  - predominantly condition based triggers
  - practical constraints
- Unconstrained budget.
- Constrained budget – 50% and 75% of the unconstrained Year 1 need, with the former representing the preservation budget in the RENSTRA.
- Axle loading regime
  - the current actual axle loading regime
- Construction quality
  - existing network (with deterioration factors set at poor)
  - either poor or normal (good) quality applied post reconstruction.

Unconstrained: Annual budget needs (in 5 year periods)



Unconstrained: Comparison with RENSTRA & forward estimates



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25

Annual treatment length for two options

Option	Works type	2011-2015	2016-2020	Long term
01-Normal quality and early reconstruction for high traffic	Periodic & Rehabilitation (%)	10%	14%	12%
	Reconstruction (%)	13%	5%	2%
02-Poor quality and overlays	Periodic & Rehabilitation (%)	24%	31%	22%
	Reconstruction (%)	9%	3%	1%

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26

Annual average preservation and renewal costs ($ millions)

Treatment strategy/scenario	Very Low (AADT < 1000)	Low (AADT 1000 – 4999)	Medium (AADT 5000 – 14999)	High (AADT >15000)	ALL
01-Normal quality and early reconstruction for high traffic with unconstrained funding	10,488	20,744	26,208	80,654	26,780

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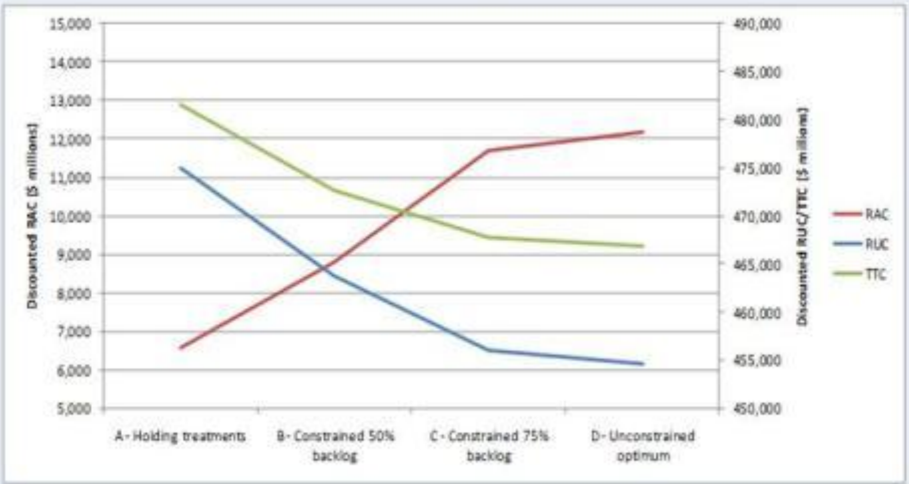
27

Trend in RAC, RUC and TTC by treatment strategy/funding constraint



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28

Summary of economic costs ($ billions)

Treatment strategy/budget constraint	PV of RAC	PV of RUC	PV of TTC	PV of RUC savings	Increase in RAC	Marginal BCR	
						Base = A	Base = B
A - Holding treatments	6.5	475.0	481.6	0	0	0	NA
B - Constrained 50% backlog	8.8	463.8	472.6	11.2	2.2	5.0	0
C - Constrained 75% backlog	11.7	456.0	467.7	19.0	5.1	3.7	2.7
D - Unconstrained optimum	12.2	454.6	466.8	20.4	5.6	3.6	1.7

Key:

TTC - Total transport costs (the sum of RAC and RUC)

RAC - Road agency costs

RUC - Road user costs

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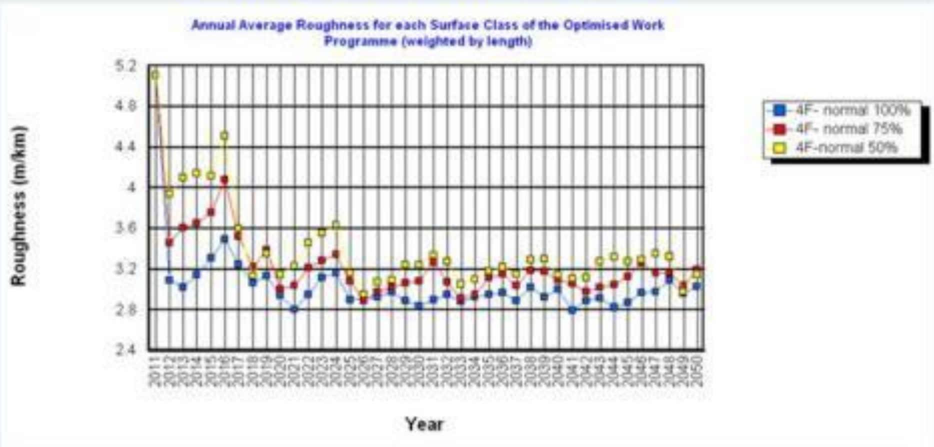
29

Trend in road roughness in relation to treatment strategy/funding constraint



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30

Summary of network budget analysis

- Unconstrained optimum (D) is best
- Holding treatments option (A) are worst
- Constrained options with reconstruction provide large savings:
  - Marginal BCRs between 3.7 (C) and 5 (B) where the base case is Option A
- If base case is changed to Option B, (equivalent to the current RENSTRA asset preservation budget)
  - BCRs between 1.7 and 2.7
- Net savings between 5 and 11 times annual preservation budget.

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31

Network analysis

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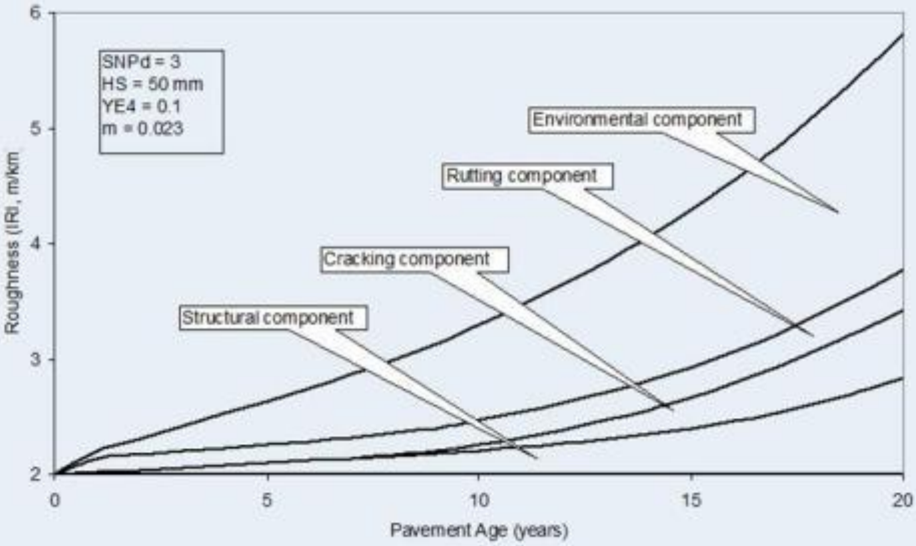
32

Roughness progression



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33

Deterioration factors

Construction Quality	Traffic (MESA/yr)		Kgm	Kgs
Well constructed roads with average to good asphalt surfacings in flat to rolling terrain and free flowing traffic conditions.	Heavy	> 0.75	1.3	1.0
	Light-Medium	< 0.75	2.6	1.2
Poorly designed/constructed road, exhibiting failures due to poor road widening and reinstatement prior to overlay and poor mix design, in flat to rolling terrain and free flow traffic conditions.	Heavy	> 0.75	5.3	1.0
	Light-Medium	< 0.75	5.5	1.4
Well constructed roads located in mountainous regions with average to good asphalt surfacings	All	All	2.6	1.5
Well constructed roads in mountainous regions with poor asphalt surfacings	All	All	7.0	1.5

Kgm – environment and design standard modifying factor (affected by location, X-section, drainage, etc)
Kgs – structural deterioration progression factor (function of strength adequacy/variability relative to design traffic)

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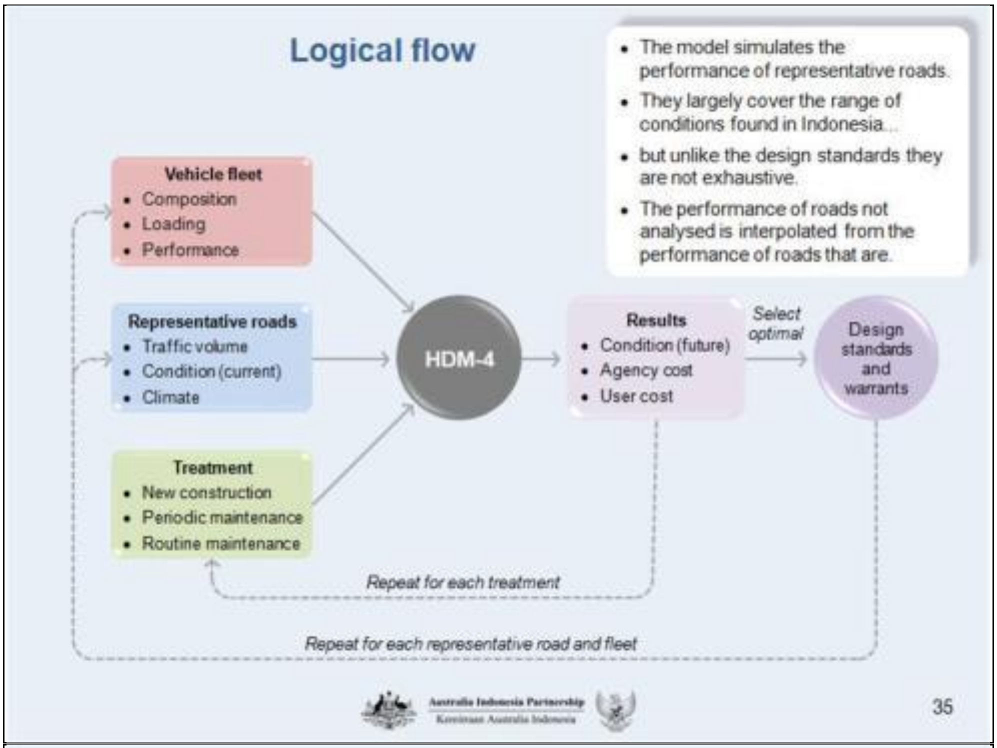
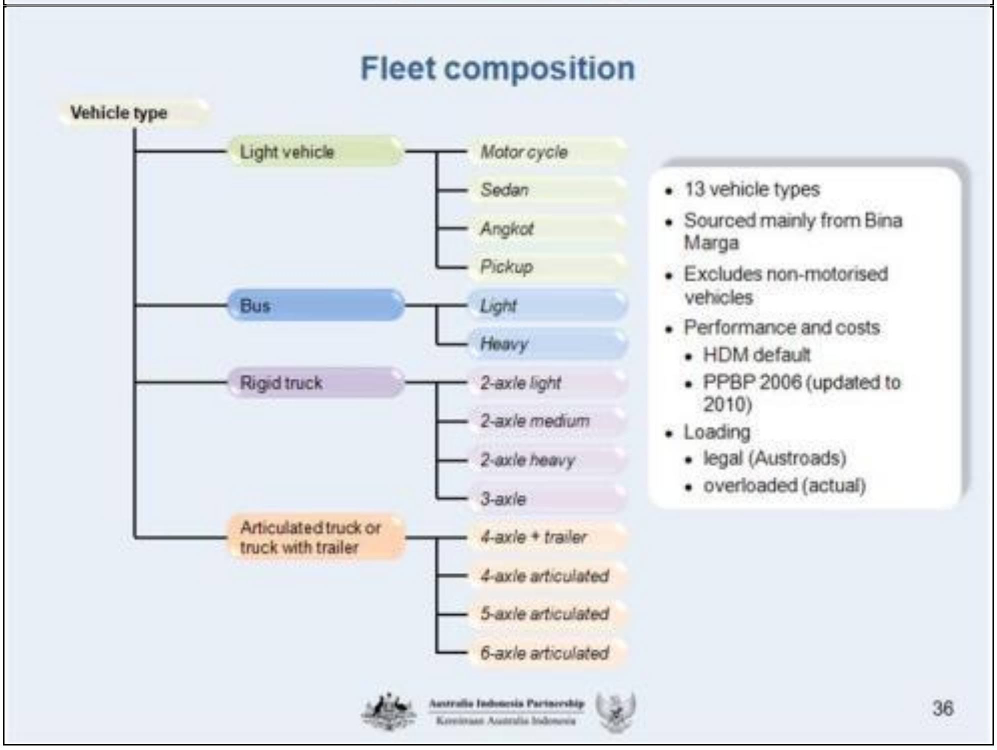
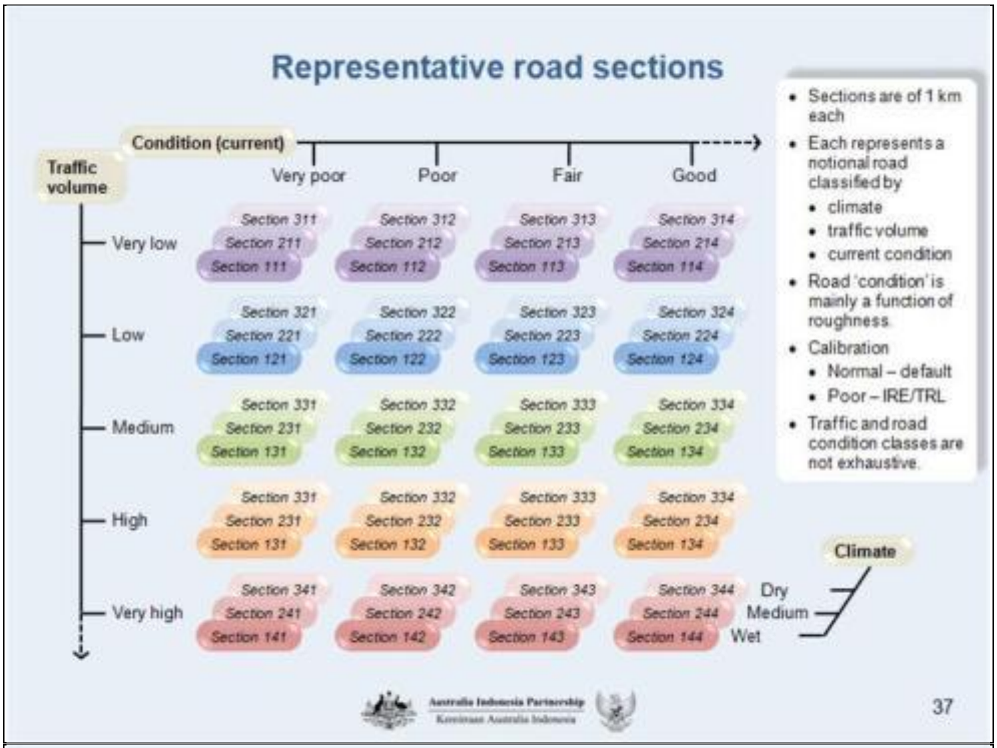
34


Logical flow
The model simulates the performance of representative roads.
They largely cover the range of conditions found in Indonesia...
but unlike the design standards they are not exhaustive.
The performance of roads not analysed is interpolated from the performance of roads that are.
Vehicle fleet
Composition
Loading
Performance
Representative roads
Traffic volume
Condition (current)
Climate
Treatment
New construction
Periodic maintenance
Routine maintenance
HDM-4
Results
Condition (future)
Agency cost
User cost
Select optimal
Design standards and warrants
Repeat for each treatment
Repeat for each representative road and fleet
35


Fleet composition
Vehicle type
Light vehicle
Motor cycle
Sedan
Angkot
Pickup
Bus
Light
Heavy
Rigid truck
2-axle light
2-axle medium
2-axle heavy
3-axle
Articulated truck or truck with trailer
4-axle + trailer
4-axle articulated
5-axle articulated
6-axle articulated
13 vehicle types
Sourced mainly from Bina Marga
Excludes non-motorised vehicles
Performance and costs
HDM default
PPBP 2006 (updated to 2010)
Loading
legal (Austroads)
overloaded (actual)
36


Representative road sections
Condition (current)
Traffic volume
Very poor
Poor
Fair
Good
Very low
Low
Medium
High
Very high
Section 311
Section 211
Section 111
Section 312
Section 212
Section 112
Section 313
Section 213
Section 113
Section 314
Section 214
Section 114
Section 321
Section 221
Section 121
Section 322
Section 222
Section 122
Section 323
Section 223
Section 123
Section 324
Section 224
Section 124
Section 331
Section 231
Section 131
Section 332
Section 232
Section 132
Section 333
Section 233
Section 133
Section 334
Section 234
Section 134
Section 341
Section 241
Section 141
Section 342
Section 242
Section 142
Section 343
Section 243
Section 143
Section 344
Section 244
Section 144
Climate
Dry
Medium
Wet
• Sections are of 1 km each
• Each represents a notional road classified by
• climate
• traffic volume
• current condition
• Road 'condition' is mainly a function of roughness
• Calibration
• Normal – default
• Poor – IRE/TRL
• Traffic and road condition classes are not exhaustive
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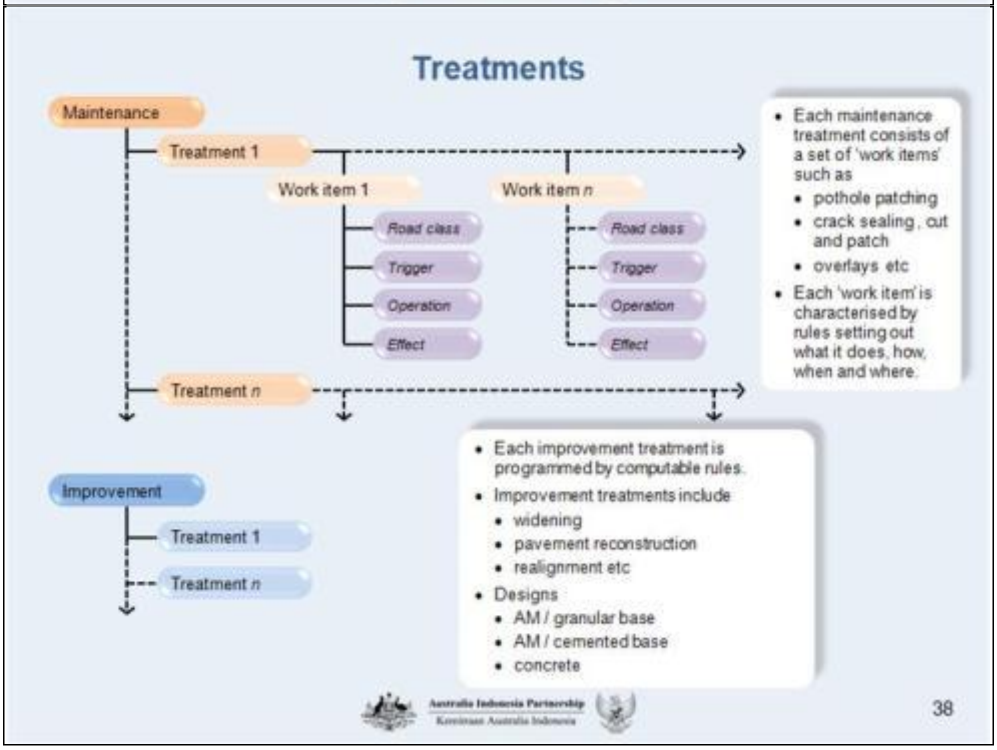
37


Treatments
Maintenance
Treatment 1
Work item 1
Work item n
Road class
Trigger
Operation
Effect
Treatment n
• Each maintenance treatment consists of a set of 'work items' such as
• pothole patching
• crack sealing, cut and patch
• overlays etc
• Each 'work item' is characterised by rules setting out what it does, how, when and where
Improvement
Treatment 1
Treatment n
• Each improvement treatment is programmed by computable rules
• Improvement treatments include
• widening
• pavement reconstruction
• realignment etc
• Designs
• AM / granular base
• AM / cemented base
• concrete
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38

Dimensions for classification

Dimension	Category 1	2	3	4	5
Traffic volume	Very low	Low	Medium	High	Very high
Current condition	Very poor	Poor	Medium	Good	Very good
Climate	Dry	Seasonal	Wet	–	–
Structural adequacy	Weak	Moderate	Strong	–	–
Construction quality	Poor	Normal	–	–	–

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39

The challenges

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40


Past and future composition of Indonesia's roads
Area of road base
Betterment and new construction commence in mid 70s
Projections in this study
New constructed base
Bettered base
Original base
Year
1950
1980
2010
2040
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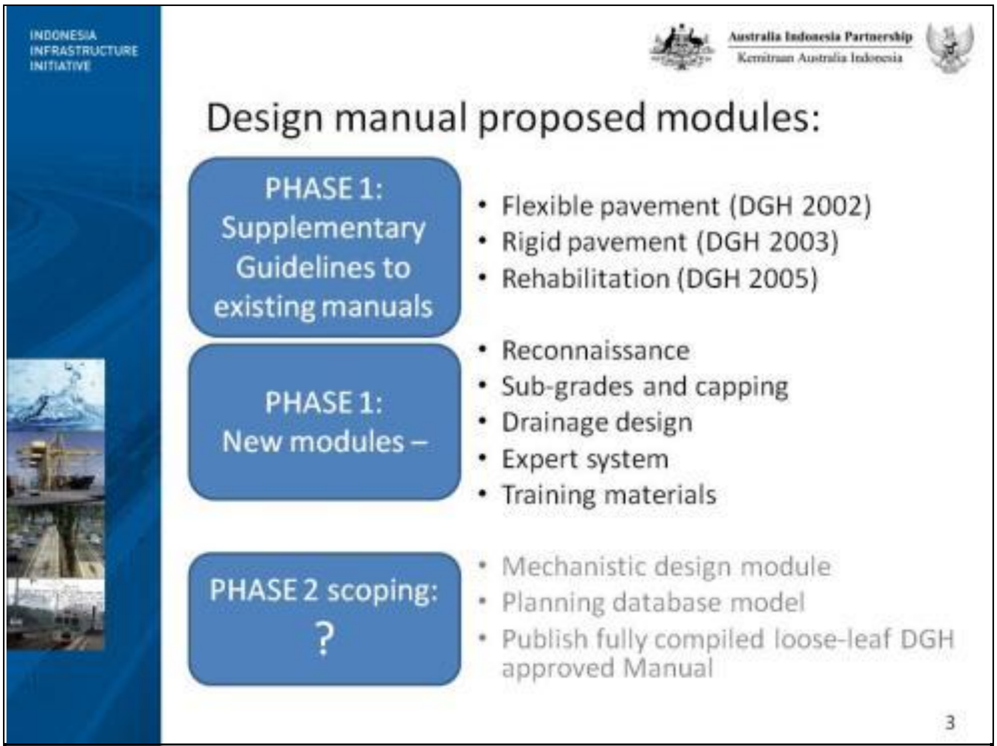
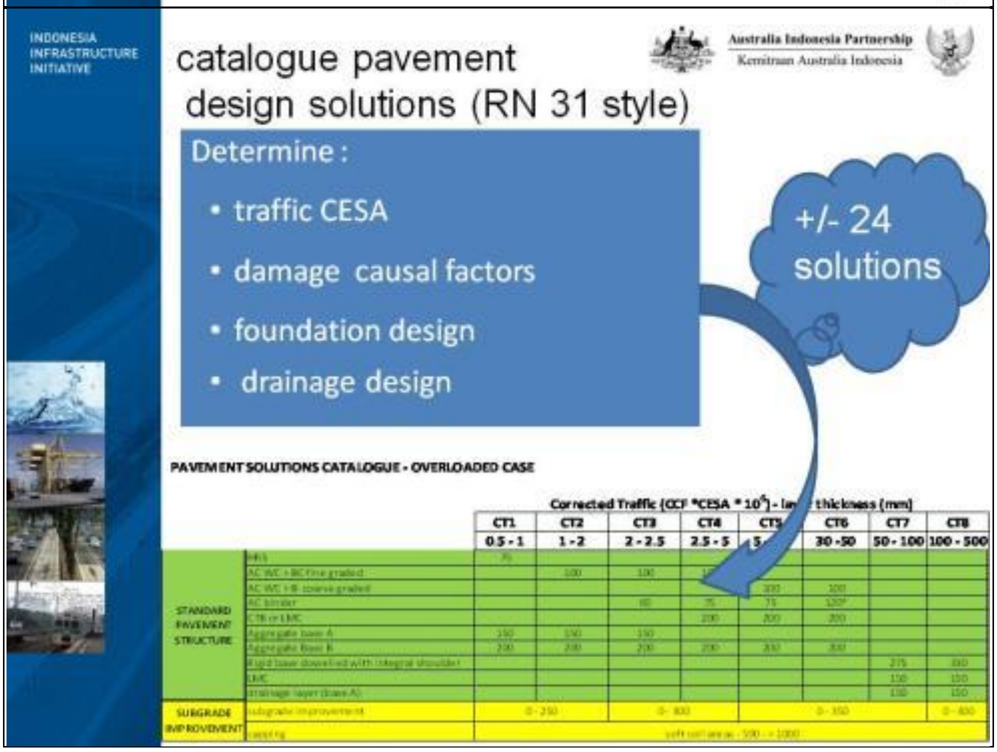
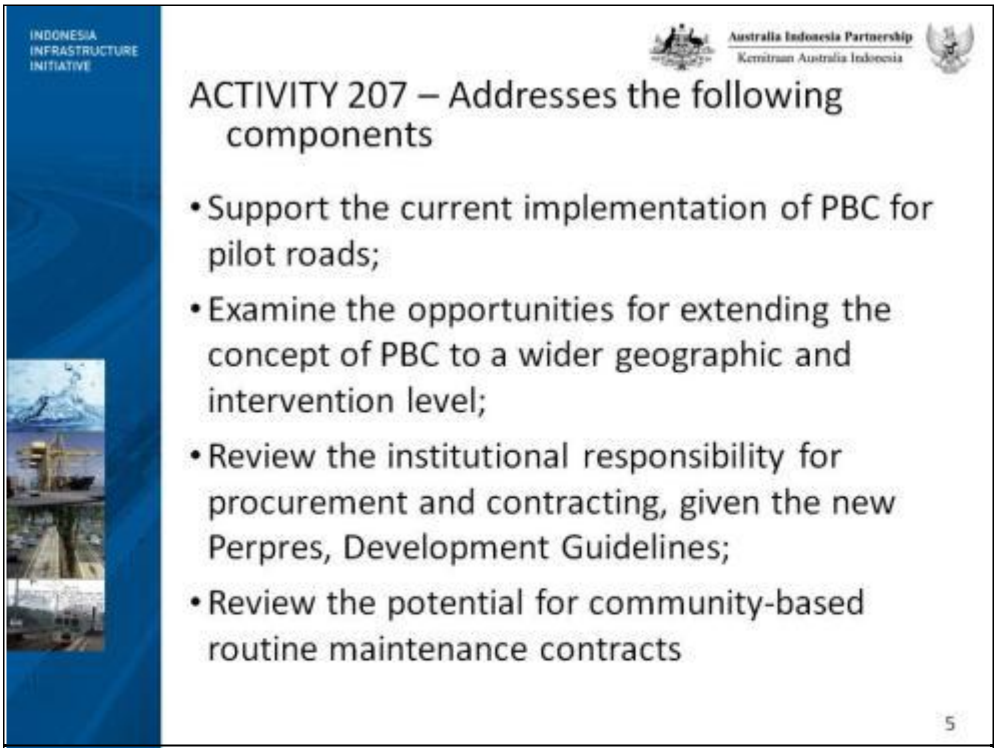
41

ANNEXE 2: FIRST PUSJATAN PRESENTATION


INDONESIA INFRASTRUCTURE INITIATIVE
Australia Indonesia Partnership
Kemitraan Australia Indonesia
Design manual proposed modules:
PHASE 1: Supplementary Guidelines to existing manuals
• Flexible pavement (DGH 2002)
• Rigid pavement (DGH 2003)
• Rehabilitation (DGH 2005)
PHASE 1: New modules –
• Reconnaissance
• Sub-grades and capping
• Drainage design
• Expert system
• Training materials
PHASE 2 scoping: ?
• Mechanistic design module
• Planning database model
• Publish fully compiled loose-leaf DGH approved Manual
3


INDONESIA INFRASTRUCTURE INITIATIVE
Australia Indonesia Partnership
Kemitraan Australia Indonesia
catalogue pavement design solutions (RN 31 style)
Determine :
• traffic CESA
• damage causal factors
• foundation design
• drainage design
+/- 24 solutions
PAVEMENT SOLUTIONS CATALOGUE - OVERLOADED CASE
CT1 0.5 - 1
CT2 1 - 2
CT3 2 - 2.5
CT4 2.5 - 5
CT6 30 - 50
CT7 50 - 100
CT8 100 - 500
STANDARD PAVEMENT STRUCTURE
SUBGRADE IMPROVEMENT


INDONESIA INFRASTRUCTURE INITIATIVE
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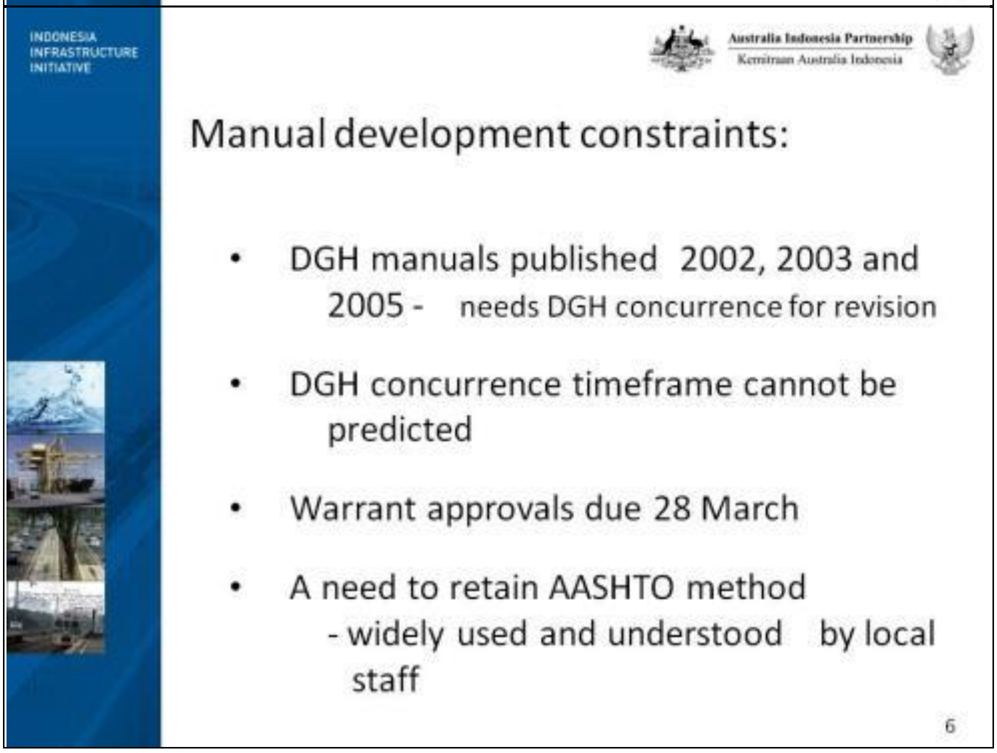
ACTIVITY 207 – Addresses the following components
• Support the current implementation of PBC for pilot roads;
• Examine the opportunities for extending the concept of PBC to a wider geographic and intervention level;
• Review the institutional responsibility for procurement and contracting, given the new Perpres, Development Guidelines;
• Review the potential for community-based routine maintenance contracts
5


INDONESIA INFRASTRUCTURE INITIATIVE
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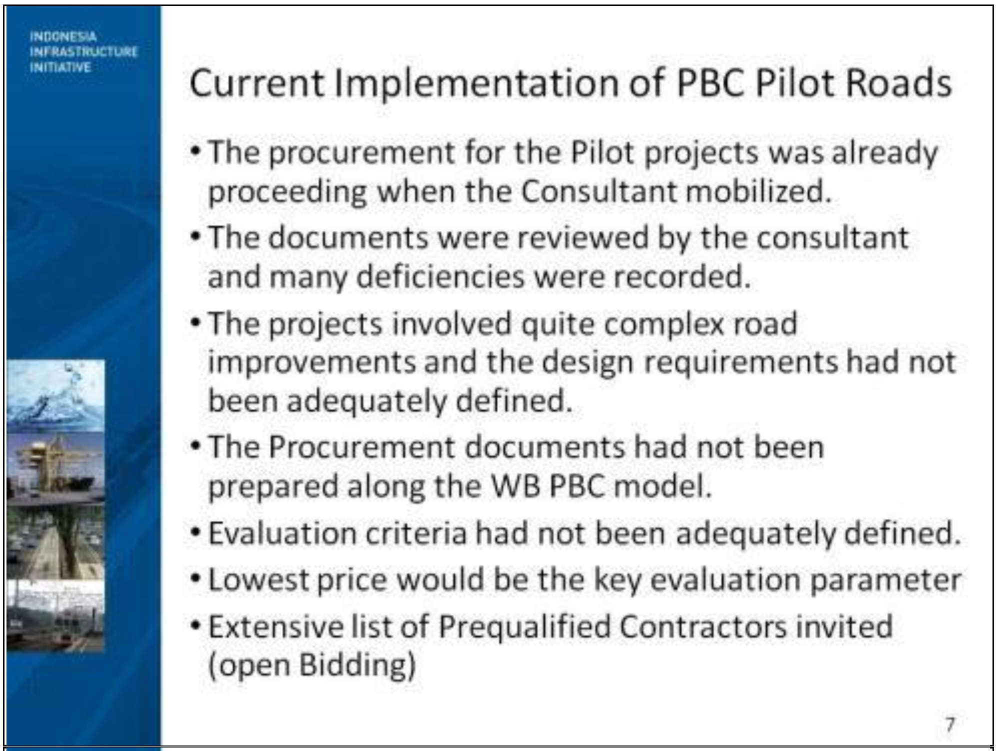
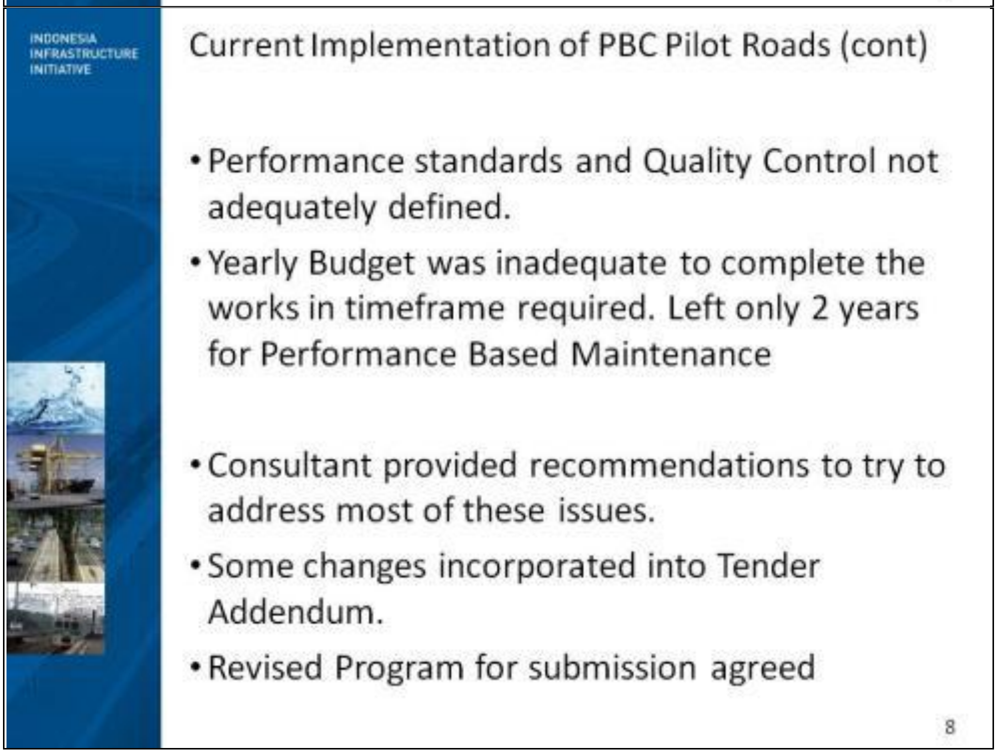
Manual development constraints:
• DGH manuals published 2002, 2003 and 2005 - needs DGH concurrence for revision
• DGH concurrence timeframe cannot be predicted
• Warrant approvals due 28 March
• A need to retain AASHTO method - widely used and understood by local staff
6


INDONESIA INFRASTRUCTURE INITIATIVE
Current Implementation of PBC Pilot Roads
• The procurement for the Pilot projects was already proceeding when the Consultant mobilized.
• The documents were reviewed by the consultant and many deficiencies were recorded.
• The projects involved quite complex road improvements and the design requirements had not been adequately defined.
• The Procurement documents had not been prepared along the WB PBC model.
• Evaluation criteria had not been adequately defined.
• Lowest price would be the key evaluation parameter
• Extensive list of Prequalified Contractors invited (open Bidding)
7


INDONESIA INFRASTRUCTURE INITIATIVE
Current Implementation of PBC Pilot Roads (cont)
• Performance standards and Quality Control not adequately defined.
• Yearly Budget was inadequate to complete the works in timeframe required. Left only 2 years for Performance Based Maintenance
• Consultant provided recommendations to try to address most of these issues.
• Some changes incorporated into Tender Addendum.
• Revised Program for submission agreed
8

INDONESIA INFRASTRUCTURE INITIATIVE

Extending the Concept of PBC to a wider geographic and intervention level

- Bintec keen for the consultant to identify suitable project for which more appropriate PBC documentation can be prepared.
- Consultant has prepared some guidelines for selecting appropriate road section. Focus should be on Routine and Periodic Maintenance
- Awaiting on review of revised Renstra to consider possible projects.
- Need to identify Government Regulations that hinder or conflict with PBC concept.

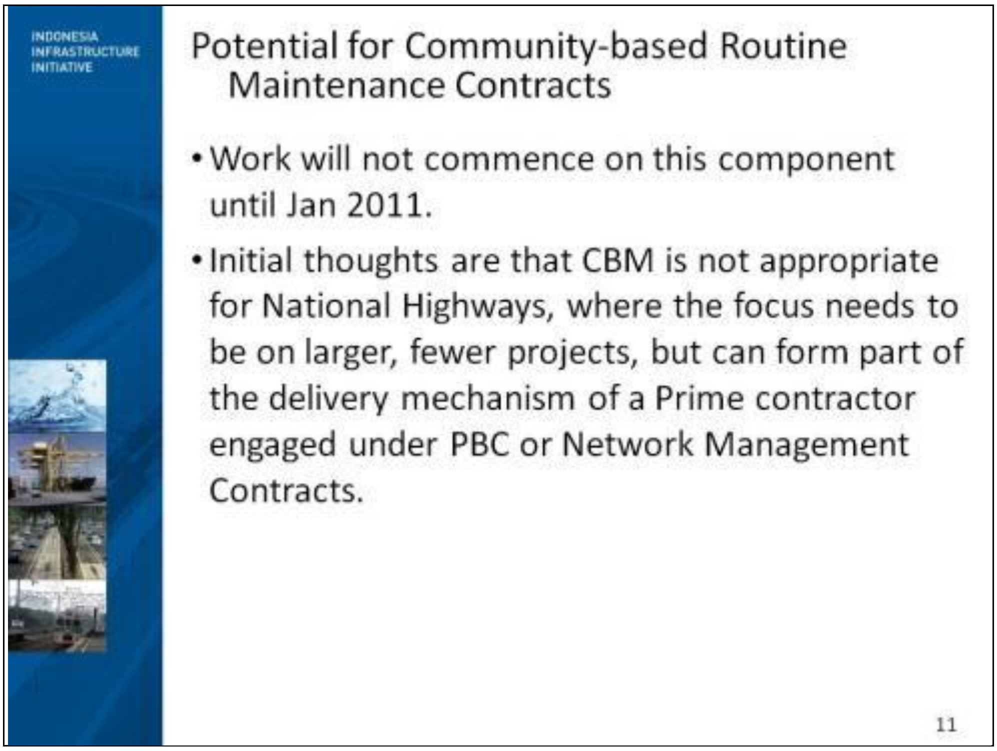
9

INDONESIA INFRASTRUCTURE INITIATIVE

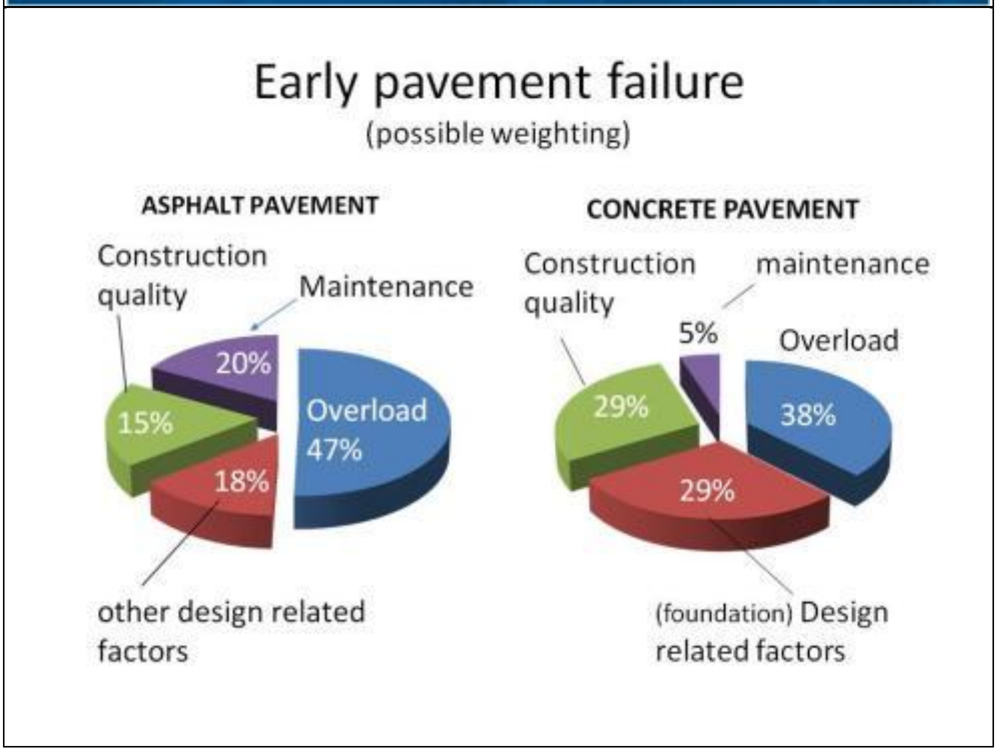
Institutional Responsibility for Procurement and Contracting,

- Review completed on the difference between KEPPRES 80/2003, and PERPRES 54/2010
- Identifying Procurement Process and role of Satker both before and after the introduction of Balai.
- Currently interviewed Balai IV and Balai VIII to review their role and the changed role of Satkers after Balai level introduced in 2008. Both are working differently. Will meet with more to learn of discrepancies.
- Initial findings indicate that there has not been significant changes or gains from Balai introduction.
- The reviews conducted thus far show that introduction of Balai is not addressing fragmented packaging.
- Should consider institutional review and direct assistance to say 2-3 Balai's, and select candidate road for PBC

10


INDONESIA INFRASTRUCTURE INITIATIVE
Potential for Community-based Routine Maintenance Contracts
• Work will not commence on this component until Jan 2011.
• Initial thoughts are that CBM is not appropriate for National Highways, where the focus needs to be on larger, fewer projects, but can form part of the delivery mechanism of a Prime contractor engaged under PBC or Network Management Contracts.
11

ANNEXE 3: SECOND PUSJATAN PRESENTATION



Provisional design life (subject to life cycle cost model results):

pavement	years
Flexible	20
rigid	40
Overlay non structural	10
Overlay structural	10 - 20
recycling	20

Pavement Design Supplement

Section 7

Foundation Design

Foundation Design Supplement

- Characteristic sub-grade
- Homogeneous sections
- Sub-grade edge dimensions
- Expansive soil
- Capping for soft soil
- Combined modulus

Foundation Design: responsibility for sub-grade improvement

As far as is possible, all sub-grade improvement requirements, shall be clearly described in contract documents. However the contractor shall remain responsible for providing sub-grade support in accordance with pavement design requirements even if not specifically described in the contract documents.

(reason: full extent of improvement required often only clear during grade preparation)

The design bearing capacity for normal and expansive sub-grades shall be the 4 day soaked, 95% MDD value provided field compaction is possible (ie not applicable to saturated alluvial soils or peat)

If the sub-grade is saturated and cannot be compacted:

a) the laboratory CBR value shall not be used in design;

b) a geo-textile separator and capping layer shall be provided and other sub-grade improvement measures shall also be required as described in section... .

c) The top of the capping layer shall be deemed to have a characteristic CBR of 3%,

Characteristic CBR

The design road length shall be divided into homogeneous sections such that:

a) When there is sufficient unbiased CBR data available (> 8 tests per homogeneous section), the CBR data set for each homogeneous section shall have a coefficient of variation not exceeding 25% (standard deviation / mean).

The characteristic sub-grade value shall be determined from the following formula:

Characteristic CBR = mean – 1.3 x standard deviation

b) When only limited data is available, homogeneous sections shall be determined visually (example: alluvial secton, hill section) .

DCP readings shall not be used to calculate sub-grade-bearing capacity unless the sub-grade is at its wettest condition when tested. DCP values may be used to determine homogeneous sections

Bearing capacity values back calculated from deflection data (FWD or BB) shall not be used to determine sub-grade bearing capacities but may be used to determine homogeneous sections

Sub-grade improvement

sub-grade improvement shall be in accordance with Figure 1

Foundation – fig 1

capping

- A geo-textile shall be used beneath capping placed directly on saturated ground,
- A geo-grid layer may also be used if cost reduction or other benefit can be demonstrated

CAPPING LAYER DESIGN RULES – CONCRETE PAVEMENT

1 Minimum for working platform
2 Minimum for cover over expansive soil
3 Minimum for cover over flood level and/or ground water
4 Minimum to limit concrete pavement curvature due to differential settlement !!
5 Minimum for CBR = $\{\{\Sigma h CBR^{0.3}\}/\Sigma h\}^3$

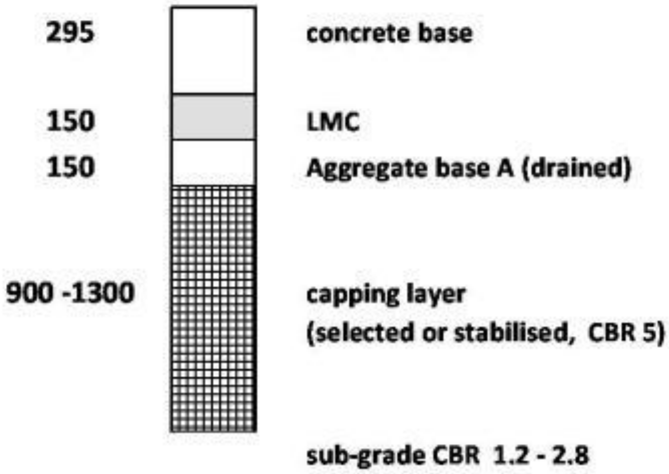
Foundations: capping layer design for rigid pavement

- Giroud / Hau working platform
- RTA deflection curvature > 800 m
- Permanent deformation of soft soil sub-grade under dynamic loading

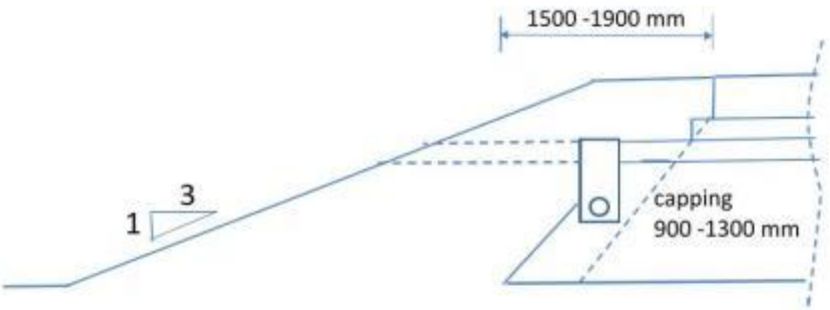
Capping on expansive soil

- Capping on expansive soil having an activity value exceeding 125 ... shall be as provided in Table ...
- The capping should include a low permeability layer or a stabilised layer
- Moisture variation in the sub-grade shall be minimised by shoulder sealing, lining of surface drains, provision of cut off drains or moisture barriers as appropriate, and positive drainage of the sub-base
- Subsoil drains shall only be used if free draining

possible rigid pavement structure for soft soil sub-grades

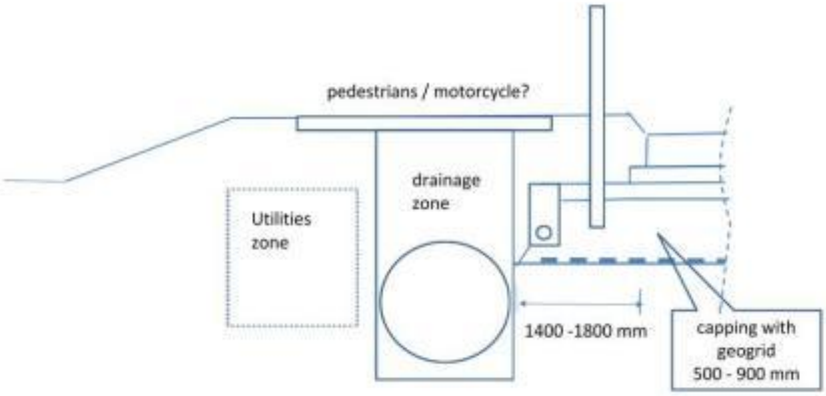


Suggested minimum rigid pavement capping edge support for alluvial soft soil sub-grade eg Merak Toll, Pantura, W Java, K



NB: same edge dimension rules apply to median – therefore cap continuous across narrow median

Rigid pavement soft soil edge detail – capping 2.8 to 3.6 m wider than pavement



Pavement Design Supplement

Section 10

Flexible Pavement Design

Flexible Pavement Guideline Supplement issues:

- Overloading — year 0-10: allow in design; > year 11: assume legal load in design
- Construction quality — there is no alternative to design for specified construction quality
- Other design deficiencies — next slide

Design deficiencies:

- Optimum drainage 'm' factor adjustment
- Climate (wet season)
- Layered design analysis (AASHTO 3.1.5 Sub-layering design)
- Asphalt 5th power rule
- Axle group effects
- Pavement and cap edge dimensions
- layer thickness optimisation

INDONESIA INFRASTRUCTURE INITIATIVE

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Climate Zone proposal

Chart based system Traffic Multiplier (TM)

Zone	Description (consistent with HDM 4)	Example locations	Rainfall (mm/annum)	period sub grade wet (Rain >80mm/month (months))	Traffic Correction Factor
I	tropical, sub-humid with strongly seasonal rainfall	Kupang and islands further east except Irian Jaya	<1400	6	1
II	tropical, sub-humid with seasonal rainfall	Sumbawa, Bali	1400 - 1800	7	1.2
III	tropical humid with seasonal rainfall	Jakarta, Bandung	1900-2300	8	1.3
IV	tropical, per humid with year round rainfall and high humidity and/or moisture surplus	permanent high water table and irrigated areas, eg PANTURA, wet mountainous areas	>2300	12	2

23

Design cases: suggested 'm' values for general use

Field condition	Water removal within:	Drainage quality	Percent of time close to saturation	'm' value for design
Cuttings with sub soil drain, hilly area, free draining	2 hours	excellent	5 - 25%	1.2
embankments with day-lighting of sub base	2 hours	excellent	5 – 25%	1.2
At grade with subsoil drain, flat area, occasional flooding of subsoil drain	1 day	good	5 - 25%	1.0
Embankments with low permeability verge and boxed sub-base	1 week	fair	5 – 25%	0.9
No sub soil drain in cut or at grade	1 month	poor	5 – 25%	0.7
Sub-grade permanently saturated during wet season and undrainable – no discharge point for sub-soil drains eg Pamanukan – NB: capping layer rules may also apply	Will not drain	Very poor	> 25%	0.4

Traffic multipliers (TM)

Traffic multipliers are proposed to account for a number of key factors that contribute to pavement service life reduction in Indonesia factors included in the standard values provided in Table .. are:

a) wet season duration
b) Asphalt fatigue (5th power rule)
c) Axle group effect on soft sub-grades

Table .. Traffic Multipliers

FAILURE MODE	pavement structure including capping	CLIMATE ZONE			
		I	II	III	IV
asphalt fatigue	all	1.80	2.12	2.39	3.60
permanent deformation	less than 1 metre	1.00	1.18	1.33	2.00
	more than 1 metre	1.10	1.30	1.46	2.20

Pavement Design Supplement

Section 5

Construction Considerations

Construction considerations – add to specification:

all sub-grades that can be dried to a condition that permits compaction, shall be compacted as specified: including cuttings, embankment, at-grade areas and ground beneath sub-grade improvement

all existing asphalt or rigid pavement at or beneath grade shall be scarified or removed as instructed by the Engineer

a pad-foot roller shall be used for compaction of clay and silty clay sub-grades

Compaction equipment shall have drum widths not exceeding the width to be compacted. Excavation or embankment necessary solely to provide access or operating width for compaction equipment shall not be measured for payment

INDONESIA INFRASTRUCTURE INITIATIVE

Australia Indonesia Partnership
Kemitraan Australia Indonesia

Climate Zone proposal

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IV	tropical, per humid with year round rainfall and high humidity and/or moisture surplus	permanent high water table and irrigated areas, eg PANTURA, wet mountainous areas	>2300	12	2

29

Provisional Traffic Multipliers for general use

FAILURE MODE	pavement structure including capping	CLIMATE ZONE			
		I	II	III	IV
asphalt fatigue	all	1.80	2.12	2.39	3.60
permanent [illegible]	less than 1 me[illegible]	1.00	1.18	1.33	2.00
	[illegible]an 1 [illegible]	1.10	1.30	1.46	2.20

Without adjustment (new proposal) pavement may fail in 10 years instead of 20

DRAINAGE DESIGN ADJUSTMENT FACTORS

Field condition	Water removal within:	Drainage quality	Percent of time close to saturation	'm' value for design
Cuttings with sub soil drain, hilly area, free draining	2 hours	excellent	5 - 25%	1.2
embankments with day-lighting of sub base	2 hours	excellent	5 – 25%	1.2
At grade with subsoil drain, flat area, occasional flooding of subsoil drain	1 day	good	5 - 25%	1.0
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Sub-grade permanently saturated during wet season and undrainable – no discharge point for sub-soil drains eg Pamanukan – NB: capping layer rules may also apply	Will not drain	Very poor	> 25%	0.4

EXAMPLE – STANDARD DESIGN SOLUTIONS CATALOGUES FROM PAVEMENT DESIGN SUPPLIMENT

CHART 1: FOUNDATION DESIGN FOR FLEXIBLE AND RIGID PAVEMENT

		Subgrade strength class		TRAFFIC CLASS										
				T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11
				< 0.3	0.3 - 0.5	0.5 - 1	1 - 2	2 - 2.5	2.5 - 5	5 - 10	10 - 30	30 - 50	50 - 100	100 - 200
FOUNDATION	Subgrade improvement (lime stabilisation or selected embankment material)	SG6	≥6	no improvement required										
		SG5	5							100	100	100	100	100
		SG4	4	100	100	100	100	100	100	150	150	200	200	200
		SG3	3	200	150	150	150	200	200	250	250	250	300	300
		SG2.5	2.5	250	175	175	200	225	250	300	300	300	325	350
		SG2	2	300	200	200	250	250	300	350	350	350	350	400
	capping layer (granular)	SG1(5)	< 2 (6)	Provisional (2)(3) 900 - 1200 mm granular capping (or 500 -800 mm + geo-grid)										

Possible future distribution of treatment types – potential cost saving 30%

	NEAR FUTURE (% of National)	IDEAL 20 YEARS FROM NOW (% of National)	Design life Years TM x CESA
PERIODIC MAINTENANCE – Non structural overlay	10	5	10
BETTERMENT – structural overlay	10	2.5	10 - 20
NEW CONSTRUCTION OR RECONSTRUCTION	>2.5	2.5	20 - 40

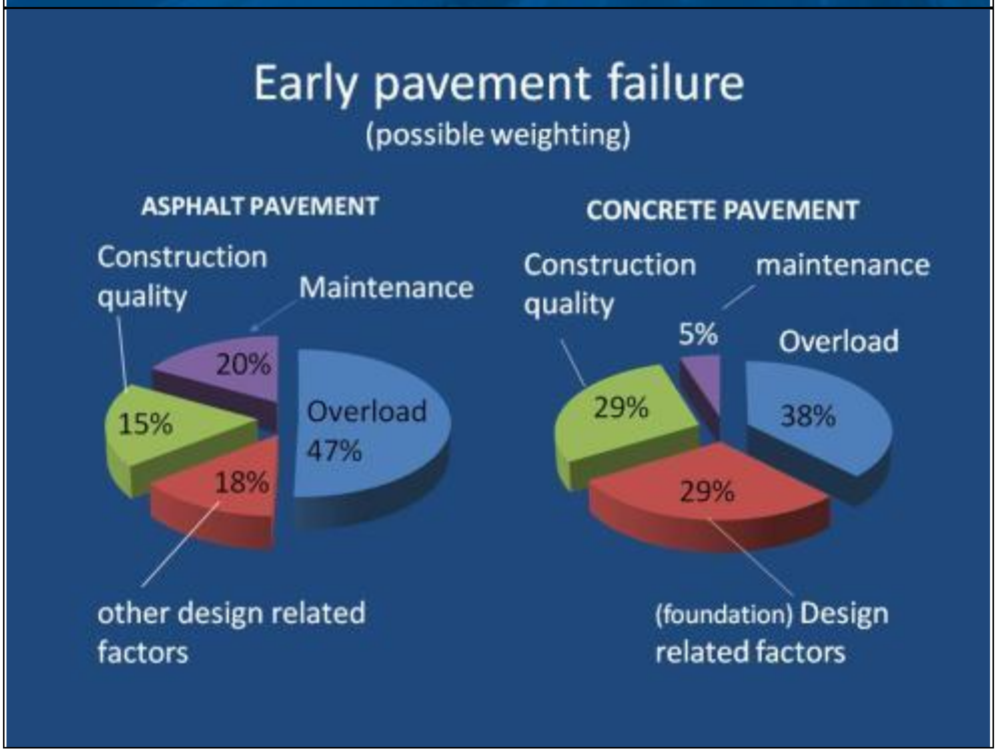
Possible warrants to initiate investigation for reconstruction or recycling vs maintenance by overlay

	< 10^6 TM x CESA	≥ 10^6 TM x CESA
Deflection (BB) (mm)	> 3	> 2.4
Structural overlay thickness (mm)	> 90	> 195
Percentage of pavement severely distressed (%)	> 15	> 10

Provisional pavement re-gravelling or recycle planning solutions

	TM x CESA (4th power)		
	0.5 - 2	2 - 50	> 50
Type	Granular overlay with HRS or AC	Recycled cement treated base	Case by case
Cost Rp/m2	135,000 – 185,000	328,500 – 373,750	
Provisional #201 Traffic Class	T2 – T4	T4 – T9	T10 – T11

ANNEXE 4: PAVEMENT DESIGN SUPPLEMENT: PART I



Pavement Design Supplement

Section 7
Foundation Design

Foundation Design Supplement

- Characteristic sub-grade
- Homogeneous sections
- Sub-grade edge dimensions
- Expansive soil
- Capping for soft soil
- Combined modulus

CAPPING LAYER DESIGN RULES – CONCRETE PAVEMENT

1. Minimum for working platform
2. Minimum for cover over expansive soil
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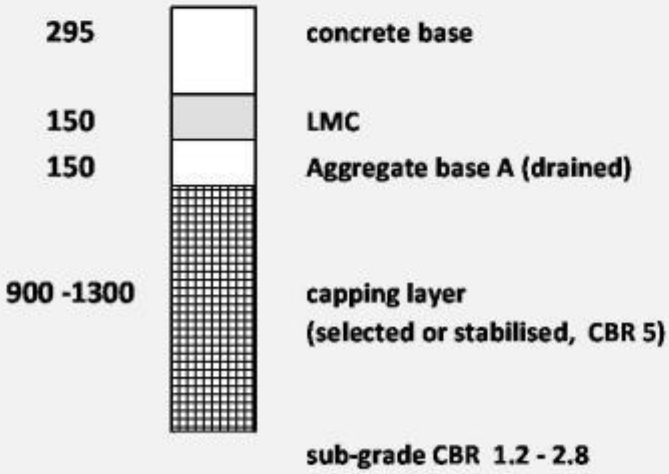
4. Minimum to limit concrete pavement curvature due to differential settlement to > 800 metres
5. Minimum for CBR = $\{\{\Sigma h CBR^{0.3}\}/\Sigma h\}^{3}$

possible rigid pavement structure for soft soil sub-grades



Pavement Design Supplement

Section 10

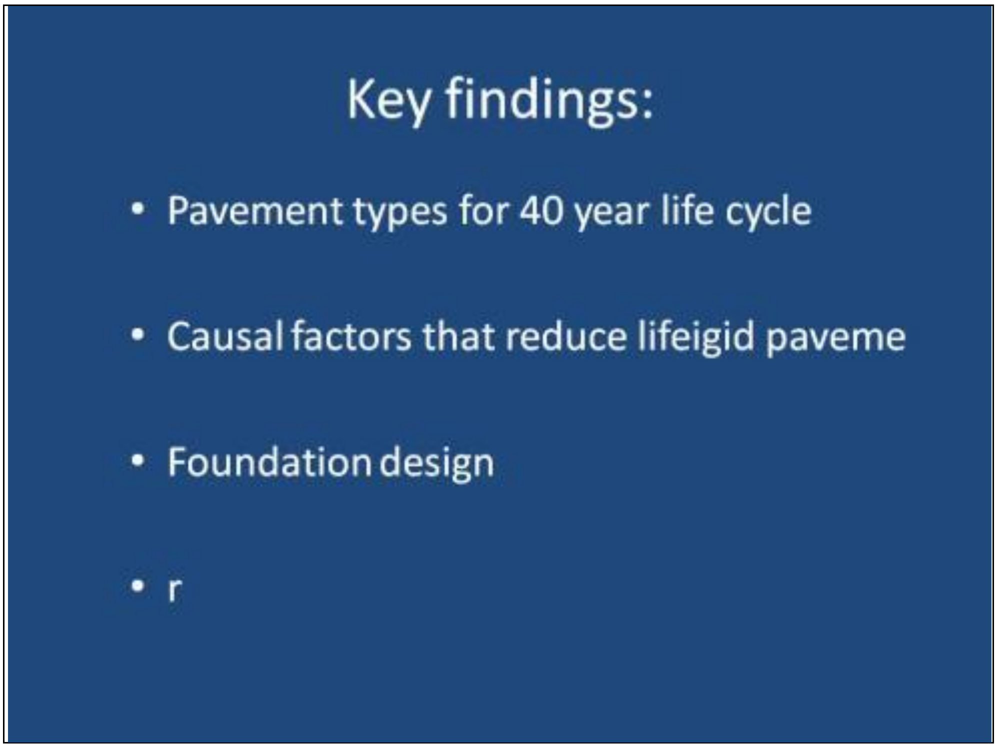
Flexible Pavement Design


Flexible Pavement
Guideline Supplement issues:
• Overloading
year 0-10
allow in design
> year 11
assume legal load in design
• Construction quality
there is no alternative to design for specified construction quality
• Other design deficiencies
next slide

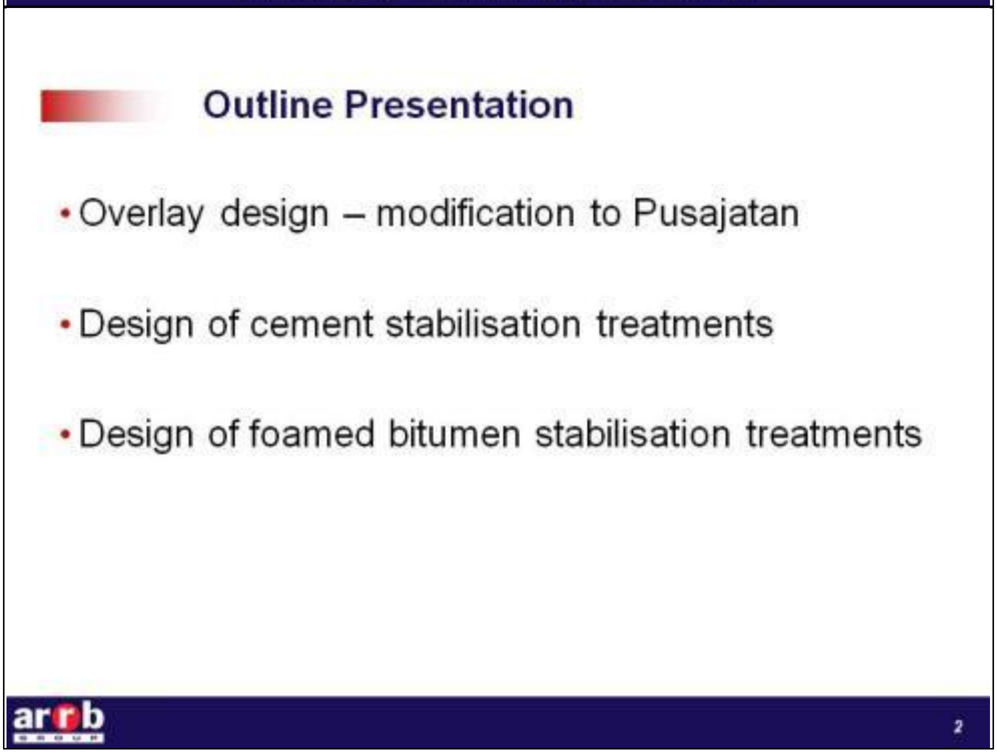

Design deficiencies:
➤ Optimum drainage 'm' factor adjustment
➤ Climate (wet season)
➤ Layered design analysis (AASHTO 3.1.5 Sub-layering design)
➤ Asphalt 5th power rule
➤ Axle group effects
➤ Pavement and cap edge dimensions
➤ layer thickness optimisation


Pavement Design Supplement
Section 5
Construction Considerations


TERIMAKASIH


Key findings:
• Pavement types for 40 year life cycle
• Causal factors that reduce lifeigid paveme
• Foundation design
• r

ANNEXE 5: PAVEMENT DESIGN SUPPLEMENT: PART II



The challenge

arrb GROUP 3

Soft subgrades

arrb GROUP 4

Design of asphalt overlays

arrb GROUP 5

Existing Pusjatan Method

- Deflection-based method
- utilises Austroads design defections
- does not enable an assessment of whether asphalt overlay will fatigue crack

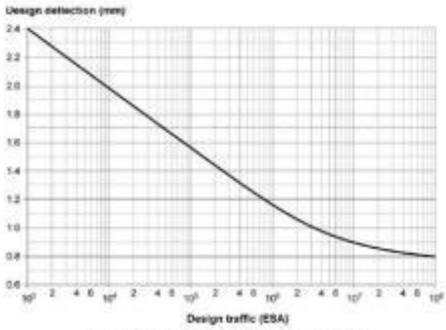


Figure E.5: Design deflections to limit permanent deformation

arrb GROUP 6

Deflection bowl curvature correlates with strain at bottom of asphalt layers

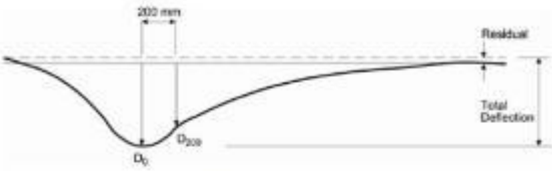


Figure B.4: Benkleman Beam bowl

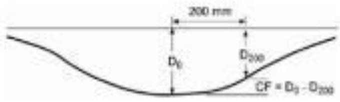
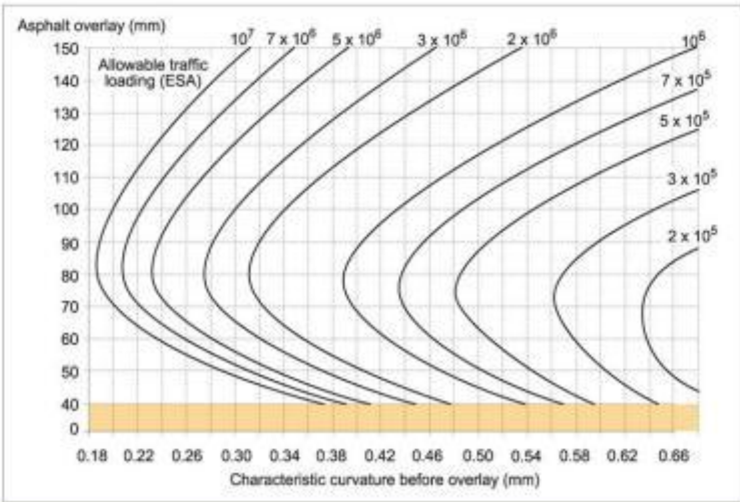


Figure B.5: Curvature function

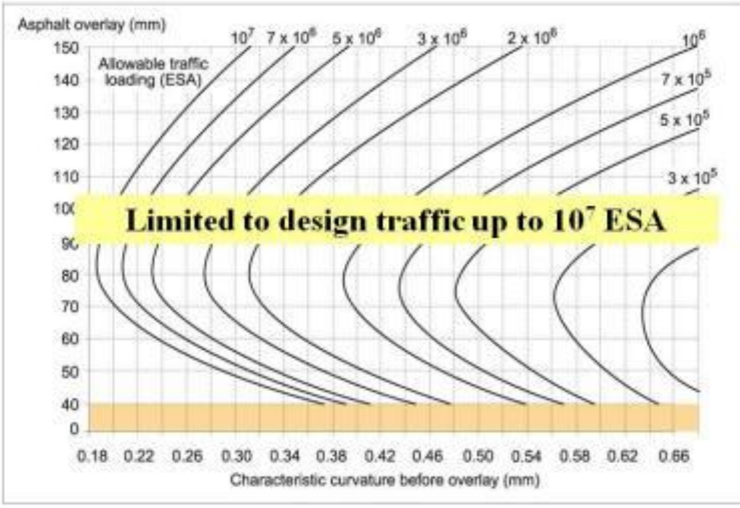
arrb GROUP 7

Addition requirement in Austroads to check the fatigue life of proposed overlay using the curvature



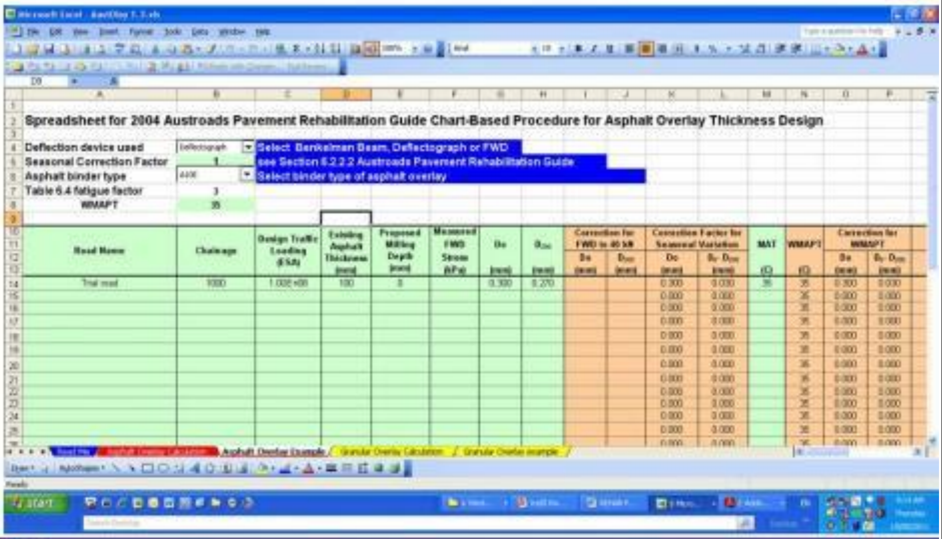
arrb GROUP 8

Addition requirement in Austroads to check the fatigue life of proposed overlay using the curvature



arrb GROUP 9

Spreadsheet available



arrb GROUP 10

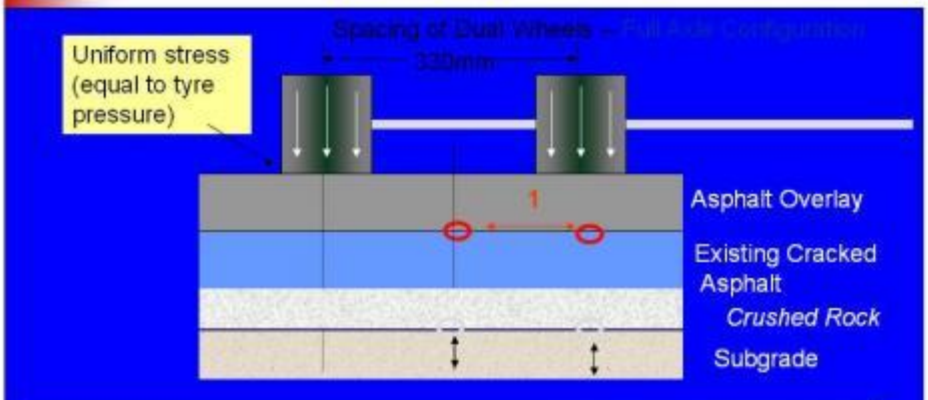
General Mechanistic Procedure (GMP

GMP is an iterative process with following steps:

- selecting homogeneous sections
- estimating moduli of existing materials
- selecting a trial overlay treatment
- calculating the critical strains in the overlaid pavement using CIRCLY
- using the strains to predict the allowable traffic loading
- if allowable traffic loading greater than design traffic loading, then accept
- otherwise select another trial overlay

11

Performance criteria of overlay treatments



1 Tensile strain at bottom of asphalt overlay - **asphalt fatigue of overlay**

2 Compressive strain at top of subgrade - **rutting & shape loss**
Denotes likely locations of critical strains due to applied loading

12

Move towards an Indonesian GMP

- Need first a mechanistic design procedure for new flexible pavements
- Then develop a complimentary procedure for overlay design
- GMP requires
  - the use of FWD, difficult to estimate moduli from BB deflection bowls
  - Linear elastic model like CIRCLY

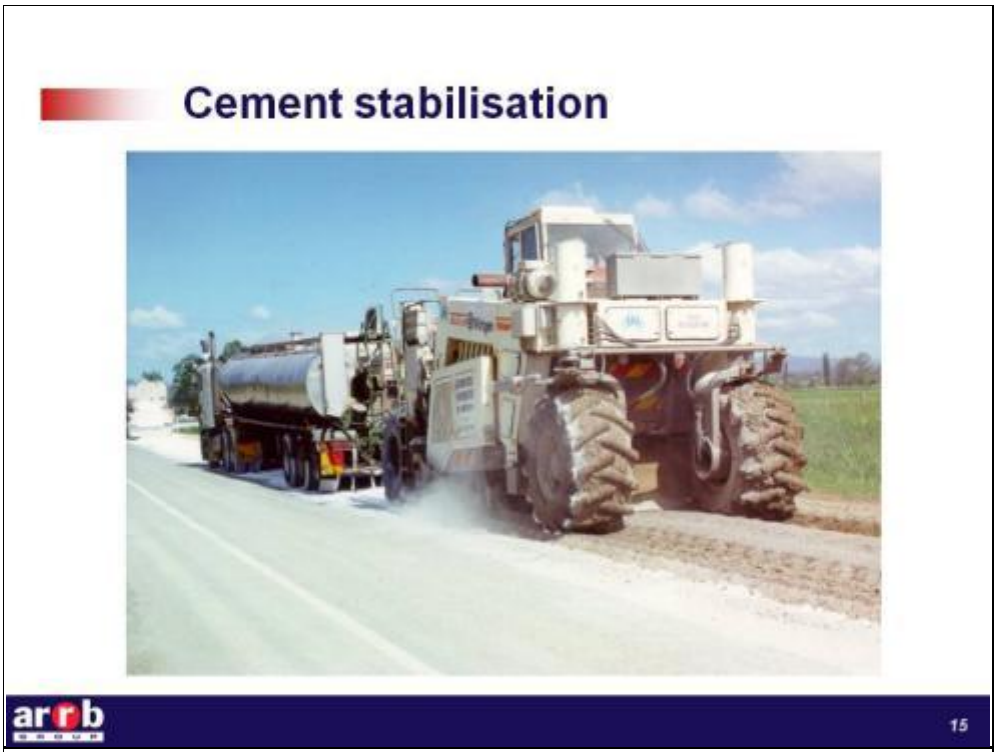
13

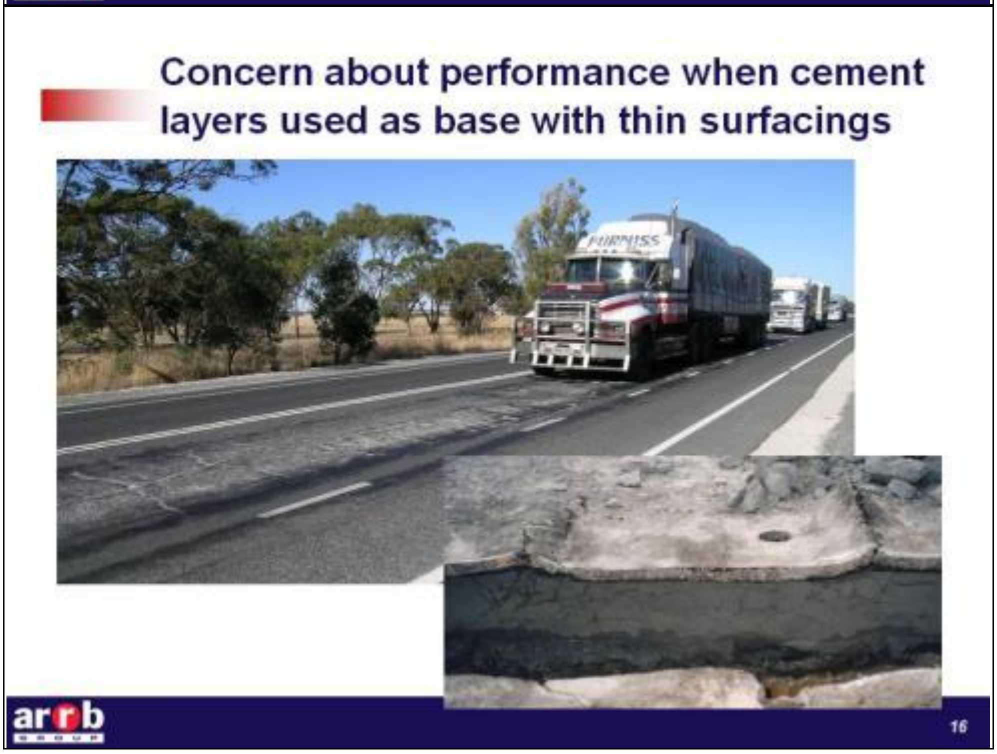
Interim Proposal for Overlay Design

Supplement Pusjatan deflection-based method

- For project where the design traffic loading less than or equal to 10^7 ESA,
  - Measure curvature and check that proposed overlay has adequate fatigue life
  - Not required if overlay is thin HRS
- For projects where the design traffic loading is greater than 10 10^7 ESA
  - Check structural adequacy using the AASHTO Structural Number approach as given in DGH Design of Flexible Pavements

14


Cement stabilisation
15


Concern about performance when cement layers used as base with thin surfacings
16

Cemented materials fatigue testing

arrb GROUP 17

Fatigue life highly sensitive to axle load, 20th power of axle load

Modulus, breaking strain and fatigue relationships for each material

Material	Fatigue equation	Strain damage exponent	Breaking strain (microstrain) 9 months curing	Mean modulus (MPa) 9 months curing
Weathered granite 3%	log(N) = -27 x log(strain ratio) -5.45	27	185	11,500
Weathered granite 5%	log(N) = -14 x log(strain ratio) -0.22	14	169	17,500
Calcrete limestone 3%	log(N) = -22 x log(strain ratio) -6.2	22	296	11,500
Calcrete limestone 5%	log(N) = -36 x log(strain ratio) -8.7	36	208	16,500
Basalt (Mt. Gambier) 3%	log(N) = -24 x log(strain ratio) -3.89	24	216	15,000
Prior stream gravel 5%	log(N) = -15 x log(strain ratio) -0.85	15	127	18,000
Modified prior stream gravel 3%	log(N) = -16 x log(strain ratio) -1.77	16	126	17,500
Lean mix concrete	log(N) = -21 x log(strain ratio) -2.93	21	227 (3 months curing)	36,500 (3 months curing)

Source: Gonzalez et al. 2010.

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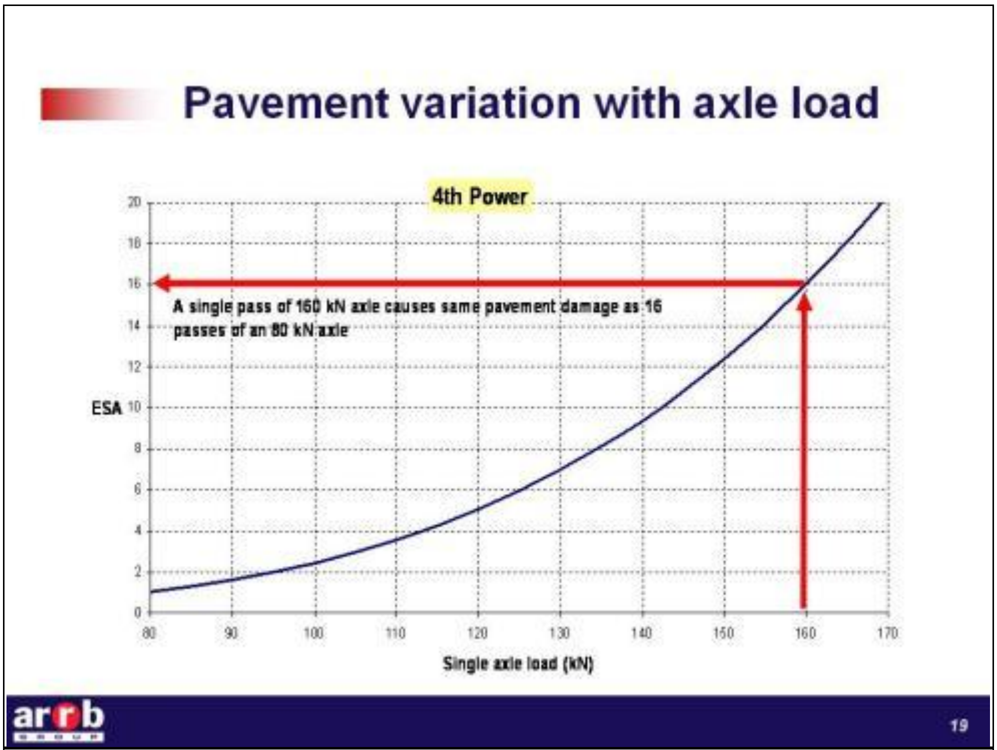
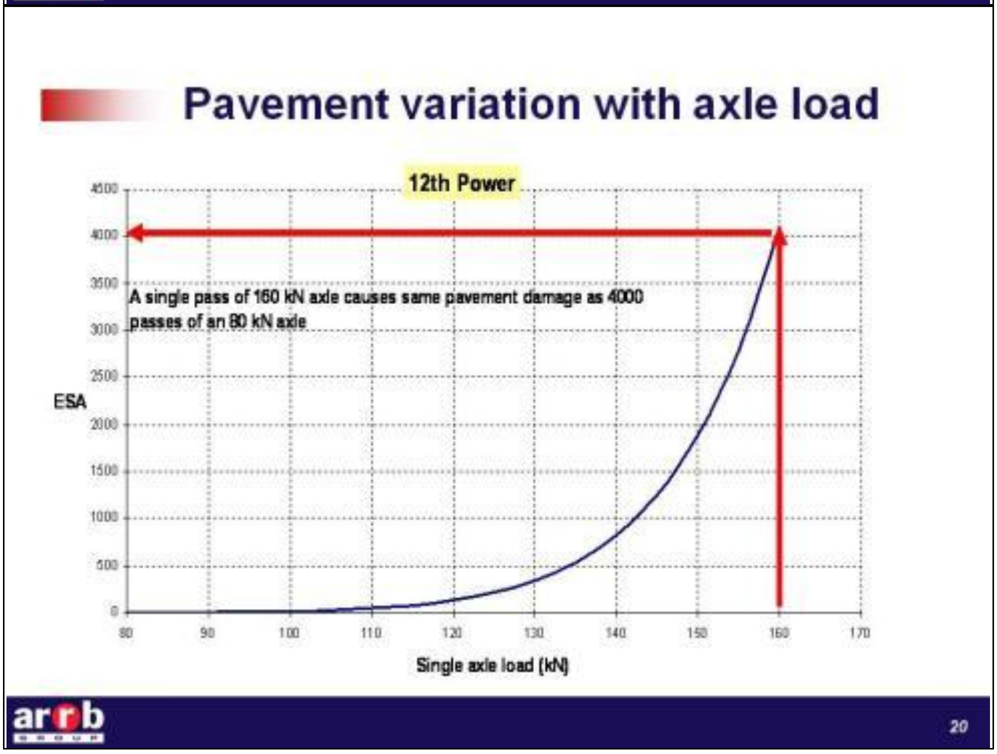

Pavement variation with axle load
4th Power
A single pass of 160 kN axle causes same pavement damage as 16 passes of an 80 kN axle
ESA
Single axle load (kN)
arrb
19

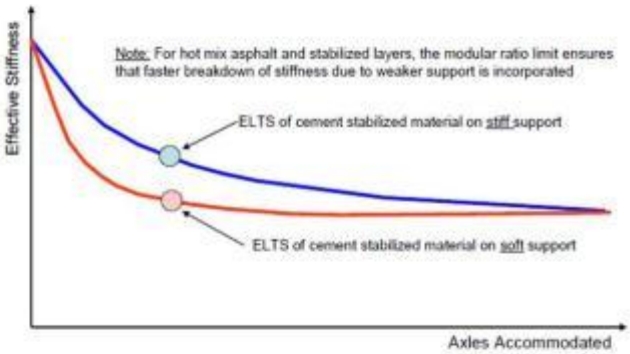

Pavement variation with axle load
12th Power
A single pass of 160 kN axle causes same pavement damage as 4000 passes of an 80 kN axle
ESA
Single axle load (kN)
arrb
20

Under high Indonesia axle loads, very high CTB thickness if design to inhibit fatigue cracking of CTB

21

Recommendation

- Unlikely to be economic to design for fatigue of CTB
- For practical construction thicknesses, assume cemented material will rapidly fatigue crack
- Reduce to a cracked modulus of 500 MPa



22

Proposed minimum surfacing when using Portland cement

- the cemented material will fatigue crack into blocks
- with thin surfacings moisture ingress
- high maintenance costs
- recommend minimum 175 mm asphalt surfacing
- If <10^7 ESA, use of slow-setting binders (slag/lime/fly ash), maybe able to reduce surface

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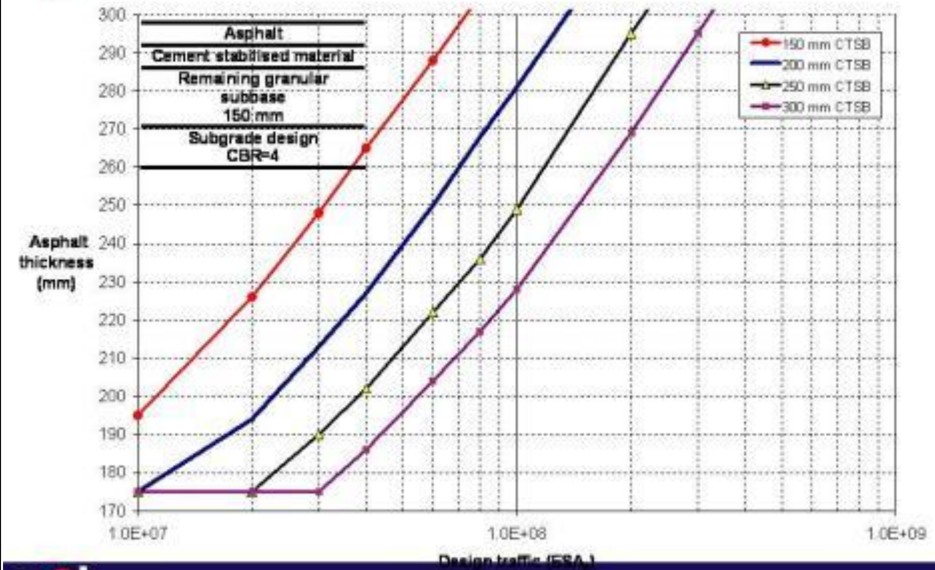
Developed design charts



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Design method
GUIDE TO PAVEMENT TECHNOLOGY
Part 2: Pavement Structural Design
Austroads
GUIDE TO PAVEMENT TECHNOLOGY
Part 5: Pavement Evaluation and Treatment Design
Austroads
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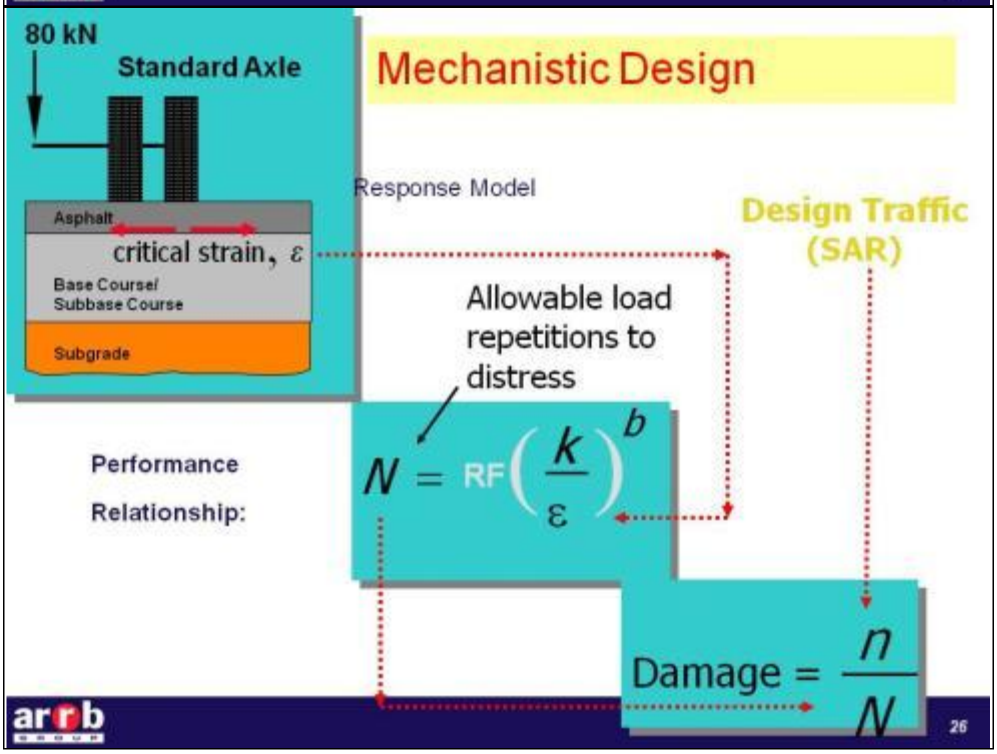
25


80 kN
Standard Axle
Asphalt
critical strain, ε
Base Course/ Subbase Course
Subgrade
Mechanistic Design
Response Model
Design Traffic (SAR)
Allowable load repetitions to distress
Performance Relationship:
N = RF(k/ε)^b
Damage = n/N
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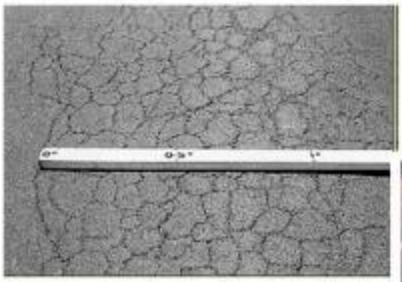
26

Distress modes



27

Pavement structure after treatment

28

Steps in rehab design process

Step	Activity
1	Calculate the design traffic in ESA_5 as described in Section 3.
2	Using the data from construction and maintenance records, test pits and cores determine the insitu material layer types, qualities and thicknesses.
3	Determine a subgrade design CBR for the project, based on insitu dynamic cone penetrometer (DCP), or laboratory soaked CBR testing of material recovered from the test pits.
4	Using step 3 data, assess whether the insitu materials are suitable for cement stabilisation.
5	Using the layer thicknesses, select a trial stabilisation depth and calculate the remaining depth of pavement material beneath the stabilised layer. For pavements with a subgrade design CBR less than 5%, a minimum 100 mm of pavement material is required below the stabilised layer.
6	Using the design charts in Annex 5, determine the asphalt thickness required over the FB stabilised material.

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Assessing material suitability

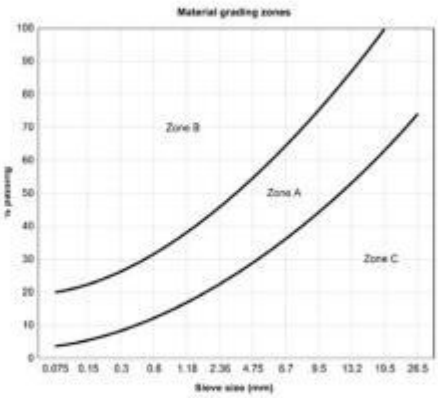
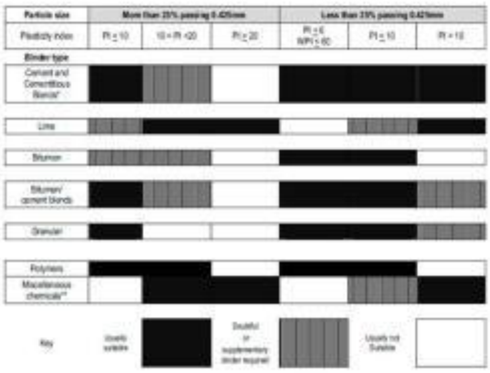


Figure 5.6: Suitable PSD envelopes for bituminous binders (Zone A)



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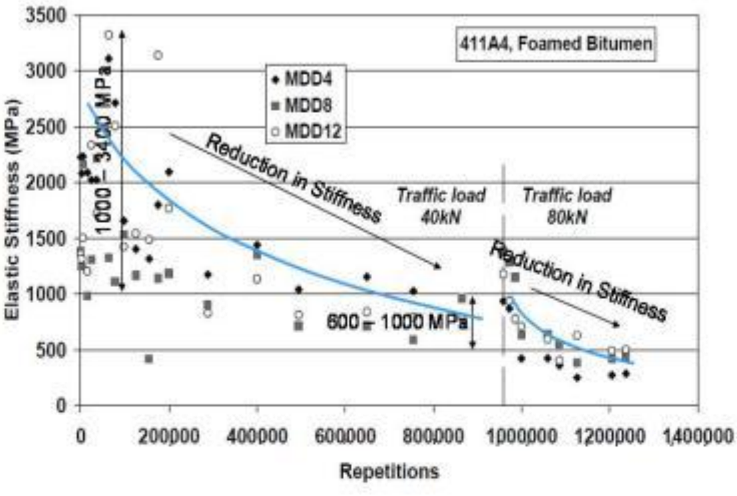
Design of foamed bitumen stabilisation treatments

31

South African research suggest micro-cracks rapidly, reduces in modulus



32

However, as FB more flexible than CTB, incidence of surface cracking much reduced

Table A2.1: Requirements for surfacing thickness for TRL method

Road type category	Traffic design standard (ESA x 10^6)	Minimum thickness of surfacing (mm)
0	30 < Traffic < 80	100
1	10 < Traffic < 30	70
2	2.5 < Traffic < 10	50
3	0.5 < Traffic < 2.5	40
4	< 0.5	40

Source: Merrill et al. (2004)

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Proposed minimum surfacings for FB

Design traffic (ESA_5 x 10^6)	Minimum surfacing
>30	100 mm comprising 40 mm AC WC 60 mm AC Binder
10 < Traffic < 30	80 mm comprising 2 x 40 mm AC WC
1 < Traffic < 10	40 mm AC WC
< 1	30 HRS WC or surface dressing

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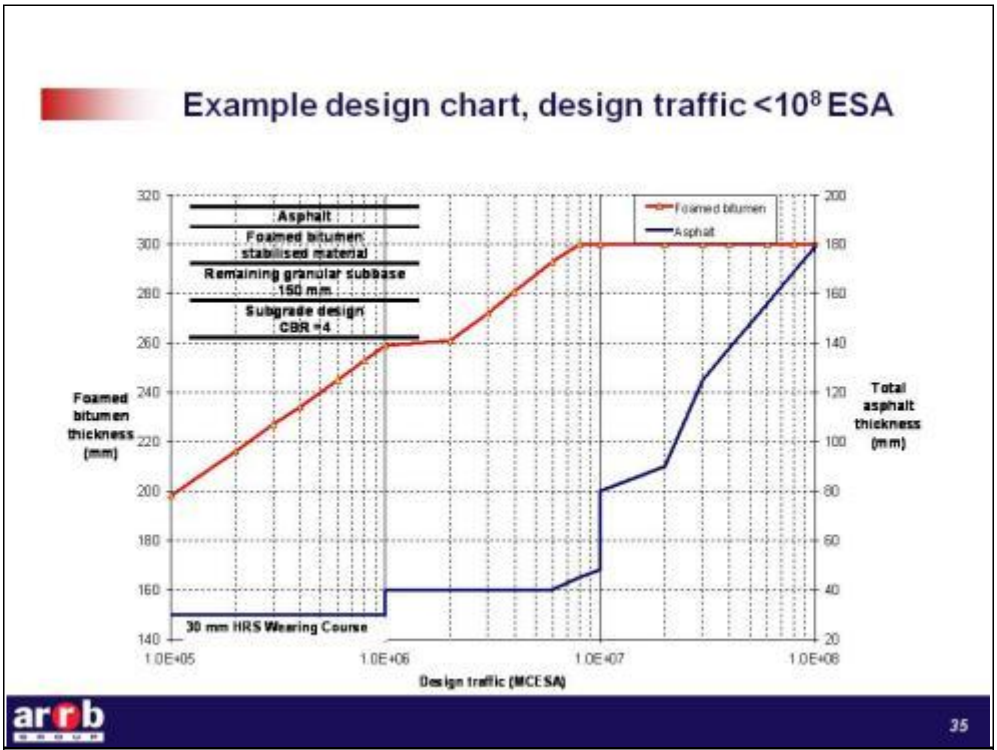
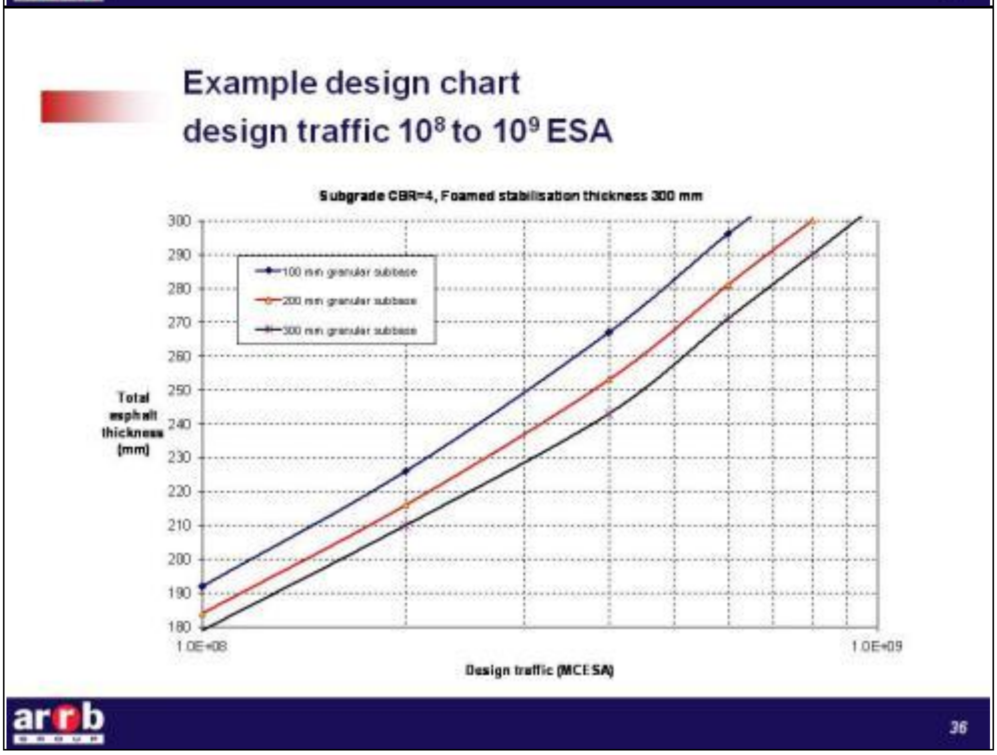

Example design chart, design traffic <10⁸ ESA
Asphalt
Foamed bitumen stabilised material
Remaining granular subbase 150 mm
Subgrade design CBR =4
30 mm HRS Wearing Course
Foamed bitumen
Asphalt
Foamed bitumen thickness (mm)
Total asphalt thickness (mm)
Design traffic (MCESA)
1.0E+05
1.0E+06
1.0E+07
1.0E+08
35


Example design chart
design traffic 10⁸ to 10⁹ ESA
Subgrade CBR=4, Foamed stabilisation thickness 300 mm
100 mm granular subbase
200 mm granular subbase
300 mm granular subbase
Total asphalt thickness (mm)
Design traffic (MCESA)
1.0E+08
1.0E+09
36

Steps in rehab design process

Step	Activity
1	Calculate the design traffic in ESA_5 as described in Section 3.
2	Using the data from construction and maintenance records, test pits and cores determine the insitu material layer types, qualities and thicknesses.
3	Determine a subgrade design CBR for the project, based on insitu dynamic cone penetrometer (DCP), or laboratory soaked CBR testing of material recovered from the test pits.
4	Using step 3 data, assess whether the insitu materials are suitable for FB stabilisation.
5	Using the layer thicknesses, select a trial stabilisation depth and calculate the remaining depth of pavement material beneath the stabilised layer. For pavements with a subgrade design CBR less than 5%, a minimum 100 mm of pavement material is required below the FB layer.
6	Using the design charts in Annexures 3 and 4, determine the asphalt thickness required over the FB stabilised material.

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Summary

- Overlay design – proposed modification to Pusajatan
- Design of cement stabilisation treatments
  - CTB will fatigue crack rapidly
  - If use thin surfacings, high maintenance costs
  - min 175 mm asphalt cover
  - developed design charts, max depth 300 mm
- Design of foamed bitumen stabilisation treatments

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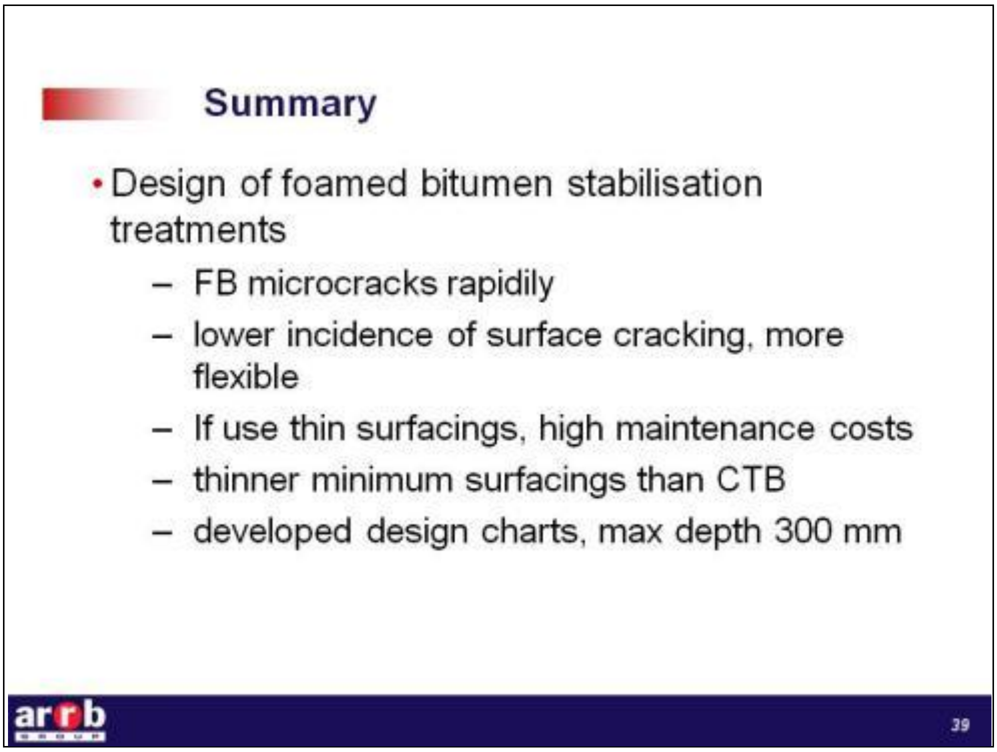
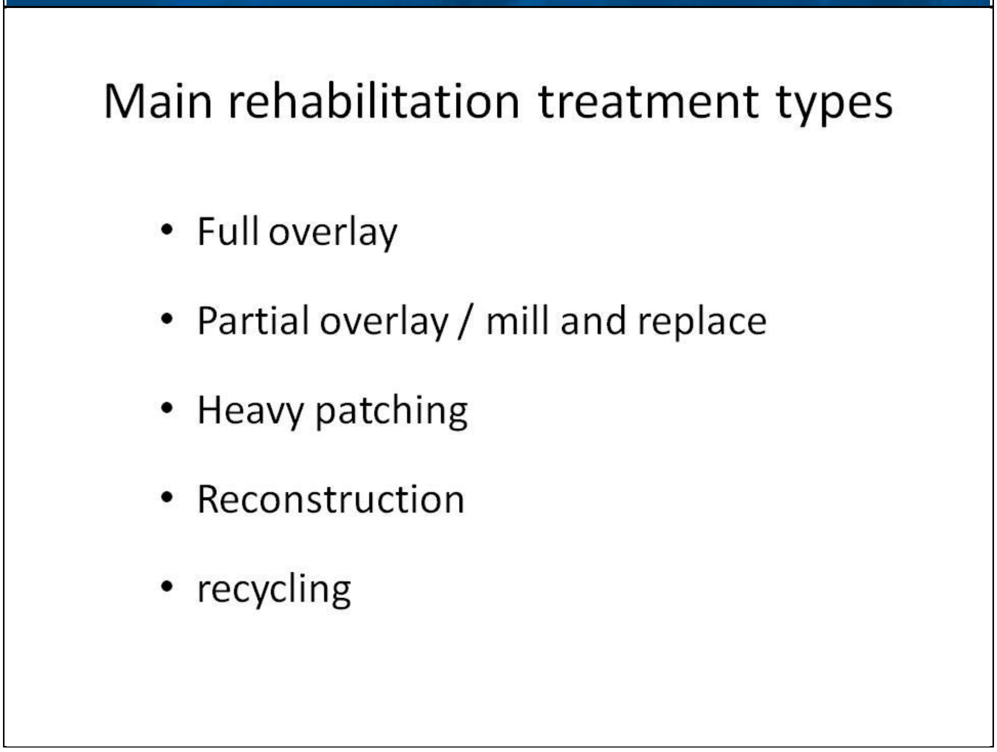

Summary
• Design of foamed bitumen stabilisation treatments
– FB microcracks rapidily
– lower incidence of surface cracking, more flexible
– If use thin surfacings, high maintenance costs
– thinner minimum surfacings than CTB
– developed design charts, max depth 300 mm
arrb GROUP
39

ANNEXE 6: SELECTION OF REHABILITATION TREATMENTS



Warrant 7

When an investigation for reconstruction is justified the rehabilitation treatment to be used …… may be selected by a ***least whole-of-life cost analysis.***

Reconnaissance options

- Visual and IRI ....IRMS
- Deflection / test pit based
- Subgrade CBR
- Soft soil areas
- Drainage issues

Deflection triggers

Deflection values that justify a particular treatment:

1 Deflection triggers that justify an overlay:

below this level no overlay is required except for cosmetic reasons

2 Deflection triggers justifying an investigation for reconstruction

above this level overlay cost might exceed reconstruction or recycling cost

Table 2.3 deflection triggers

Traffic for 10 years (million ESA / lane)	Surfacing type	Deflection triggers justifying an overlay -		Deflection triggers justifying an investigation for reconstruction	
		Characteristic deflection Benkelman Beam (mm)	D_0-D_{200} Curvature FWD (mm)	Characteristic deflection Benkelman Beam (mm)	D_0-D_{200} Curvature FWD (mm)
<0.1	HRS	>2.3	not applicable	>3.0	not applicable
0.1 - 0.2	HRS	>2.1	0.63		
0.2 - 0.5	HRS	>2.0	0.48	>2.7	
0.5 - 1	HRS	>1.5	0.39	> 2.5	0.66
1 - 2	HRS	>1.3	0.31	>2.4	0.54
2 - 3	AC	>1.25	0.28		0.46
2 - 5	AC	>1.2	0.23		0.39
5 - 7	AC	>1.15	0.21		0.35
7 - 10	AC	>1.1	0.19		0.31
>10	AC	not applicable – test pit / deflection / SN analysis is required			

Other triggers for an investigation for reconstruction /recycling

- IRI 8
- Existing pavement condition > 30 % distressed
- Existing pavement condition does not permit a deflection survey – reconstruction is needed in that case

Warrant 10: *A full asphalt overlay may be used for any homogeneous section if:*

- *characteristic deflection > Table 2.3*

  - or –
- *IRI > Table 2.4*

  - or -
- *the existing asphalt shows severe distress comprising potholes, wide and interconnected cracks expected to form potholes, edge breaks and ruts exceeding 30 mm covering at least 5% of the total area and are widely distributed.*

Warrant 11: *mill and replace of selected areas shall be applied if:* • *a full overlay is not required (refer Warrant 9)* • *The existing asphalt shows severe surface distress comprising potholes, wide and interconnected cracks, edge breaks and ruts exceeding 30 mm limited to confined areas that can be treated independently.*
Warrant 12: *Reconstruction shall be considered if any of the following conditions apply:* • *deflections exceed the reconstruction trigger provided by Table 2.3 or* • *roughness exceeding IRI 8 or* • *severe distress requiring heavy patching exceeding 30% of pavement area*

Materials 1: Aggregate Base A

- Supplements propose more CTRB
- CTRB requires good quality base A
- TFAC: serious BASE A segregation on all projects audited
- ≤ 150 mm for best compaction
- Solution: specify a 20 or 25mm grading for Aggregate Base A (Australia = 20mm)

Materials 2: AC Base

- Also suffers from segregation
- Prone to stripping
- Usually not used in Australia
- The better properties of AC BC allow thickness reduction of heavy duty pavements in mechanistic design

Materials 2: AC Base 100 million MCESA

	Original Supplement	Revised – no AC Base GJ Good construction
AC WC	40	40
AC BC	60	60
AC BC (base layers)	-	145
AC Base	160	-
CTB	200	200
Base A	200	150
Base B	200	
Sub-grade – CBR 6		

500 million ESA_5 (Pantura)

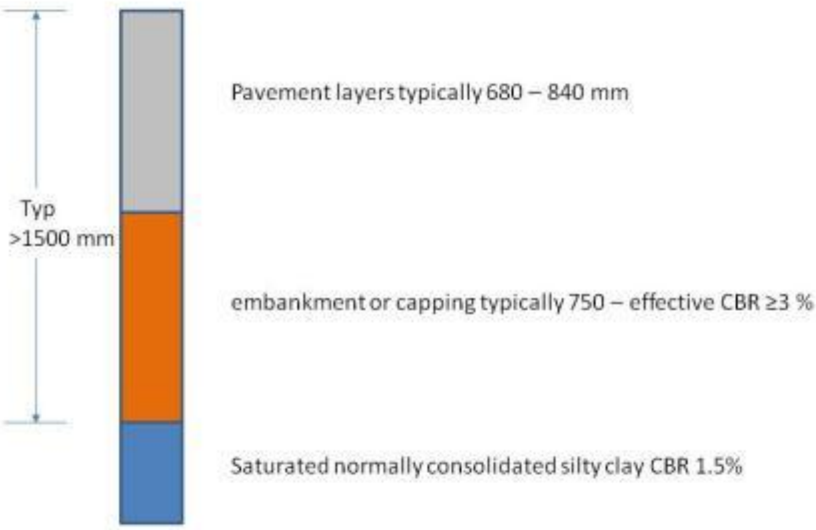
	HLRIP II Pantura 2004 100 million esa	GJ Good construction No AC Base 500 million esa_5
AC WC	40	40
AC BC	60	60
AC BC (base layers)		250
AC Base	180	-
CTB	-	200
Base A	200	150
Base B	200	

DESIGN CHANGE Saving 24%

Warrant 1:

All roadworks construction ....must substantially comply with specified quality standards. ……………………Pavement design must assume reasonable compliance with specified construction quality.

Pantura sub-grade



ANNEXE 7: PAVEMENT DESIGN SUPPLEMENT: PART I – NEW PAVEMENTS - BAHASA INDONESIA – FIRST DRAFT

ANNEXE 8: PAVEMENT DESIGN SUPPLEMENT: PART II – REHABILITATION AND RECYCLING OF FLEXIBLE PAVEMENTS - BAHASA INDONESIA – FIRST DRAFT