Bridge management systems: An asset management tool for road structures

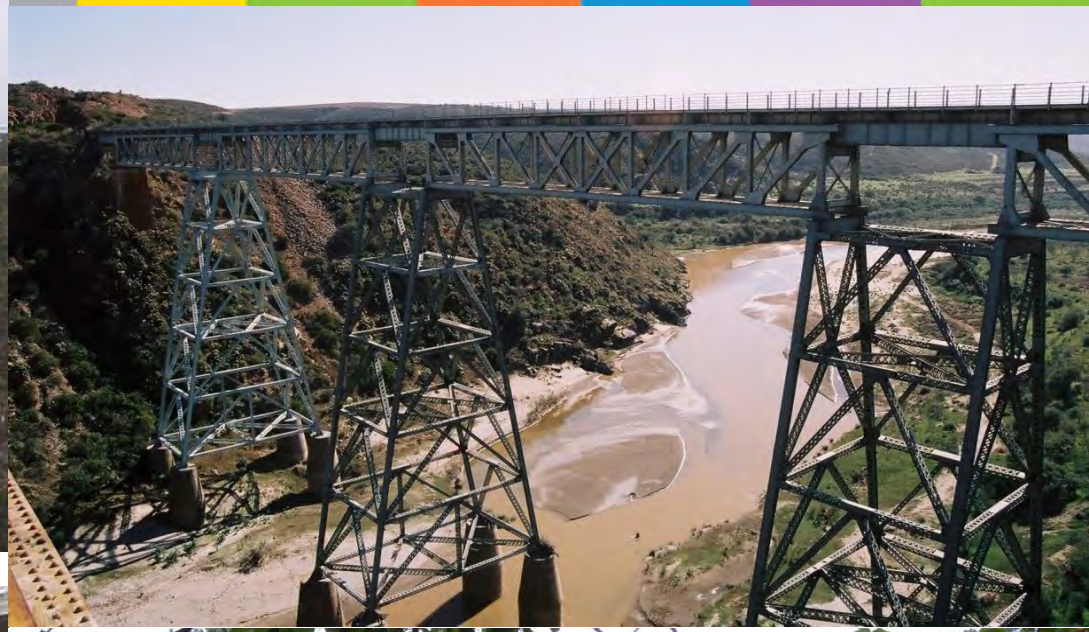
4th Biennial Conference

Presented by: Paul A Nordengen

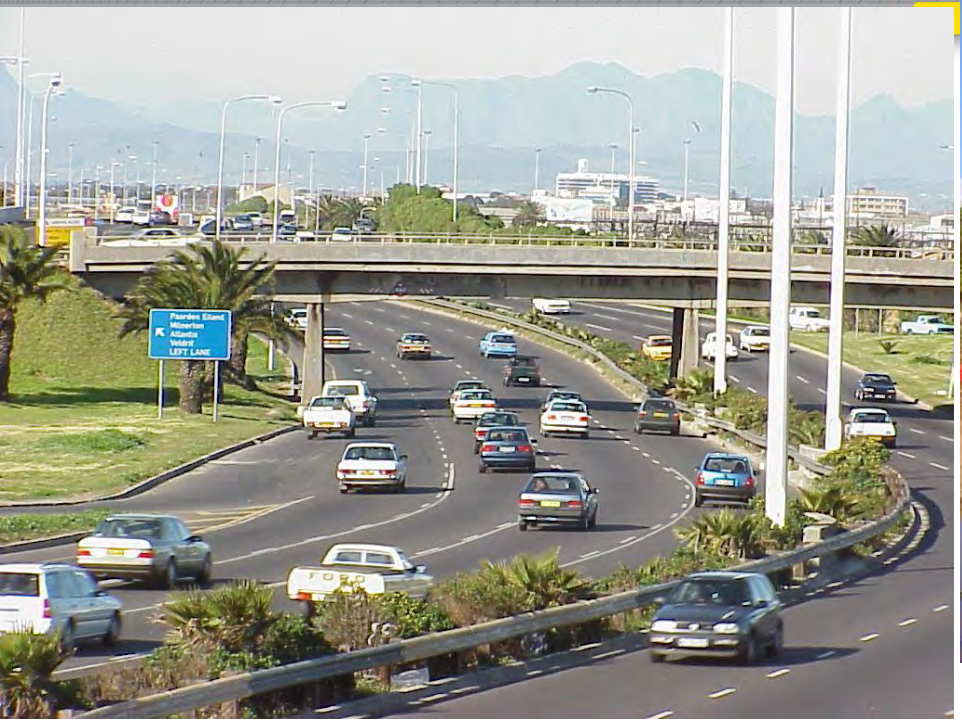
Date: 10 October 2012

our future through science

Atypical Road Bridges in South Africa



Typical Road Bridges in South Africa

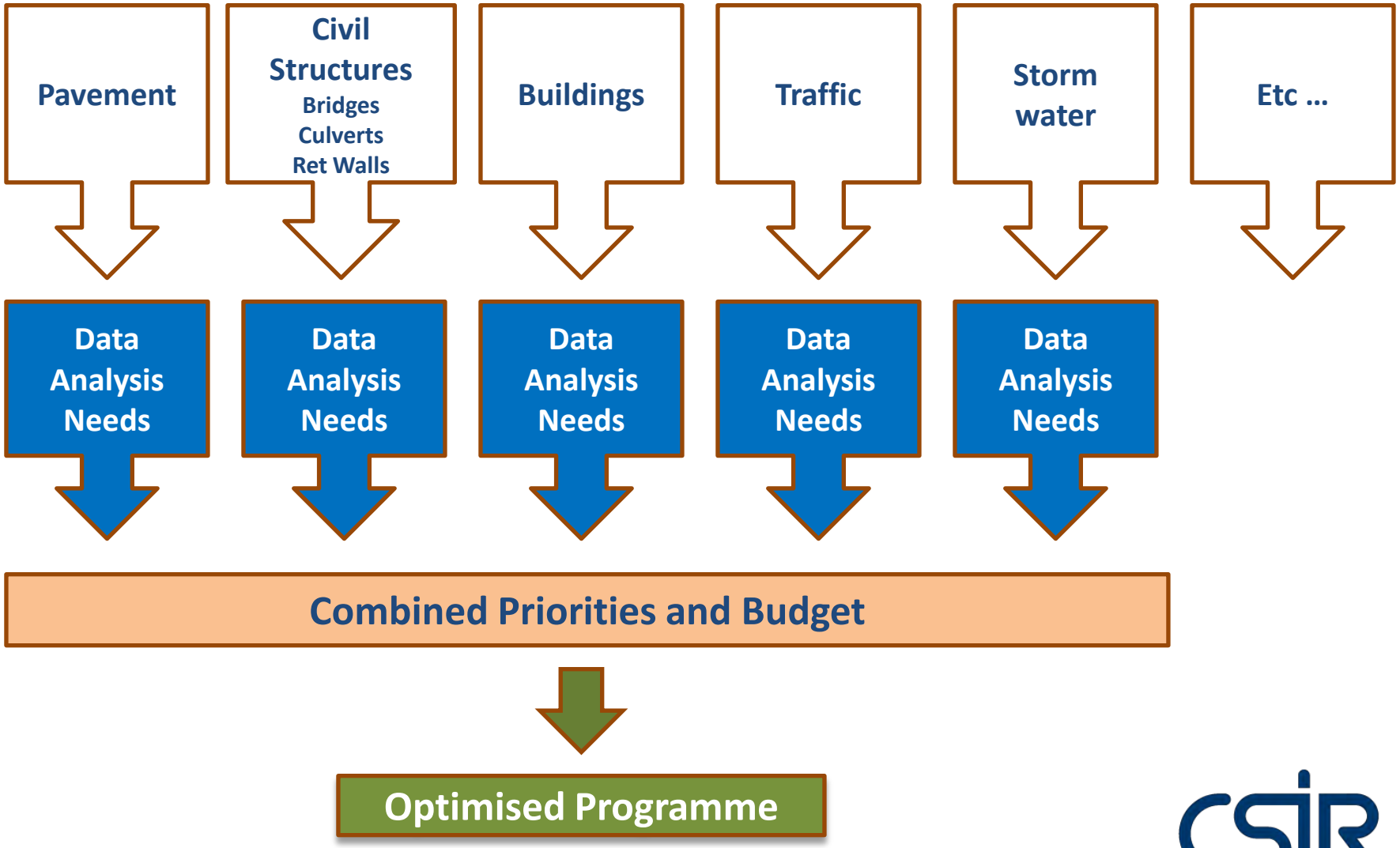



NOTICE
THIS BRIDGE HAS
BEEN DESIGNED
TO CARRY 4 AXLE
LOADS OF 4 TONS
EACH & A PEDES-
TRIAN LOAD OF
100 LBS PER SQ
FOOT

Why use infrastructure management systems?

- Road authorities need to allocate scarce funds optimally in an orderly and systematic way
- Need to consider both the immediate and long term horizons
- The information on which funding decisions are based must be credible
- *Ad hoc* decisions are not acceptable

Infrastructure Management



Bridge Project Funding

- Road projects and bridge projects compete for the same “pot” of funds
- Road failures are more common and more visible but bridge failures when they do occur may be catastrophic
- Need to guard against funds for bridge projects being reallocated to road projects. Thus the results from bridge inspections and the BMS must be credible
- Delay bridge repairs indefinitely and at some stage a catastrophic failure will occur somewhere!

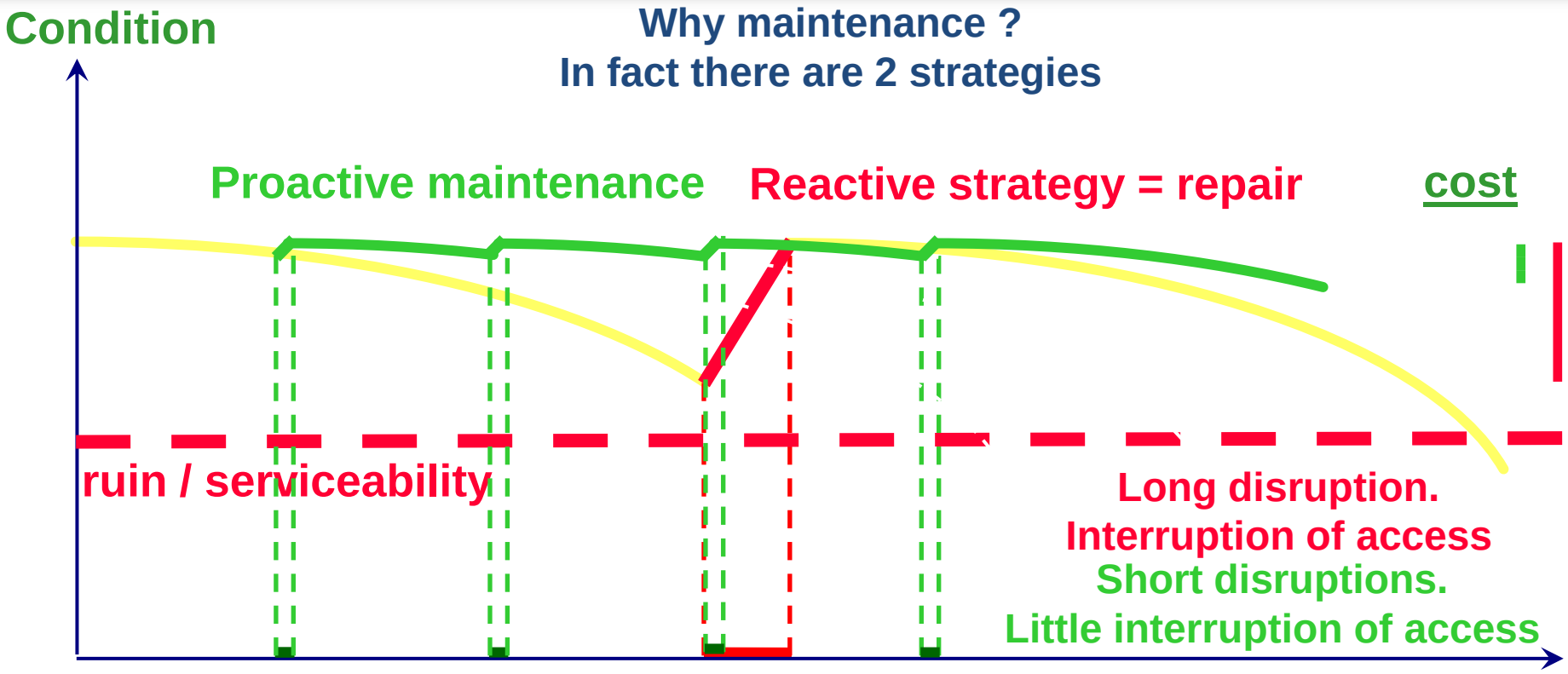
Bridge Failures

Oh ..... !!!!

Bridge Management System

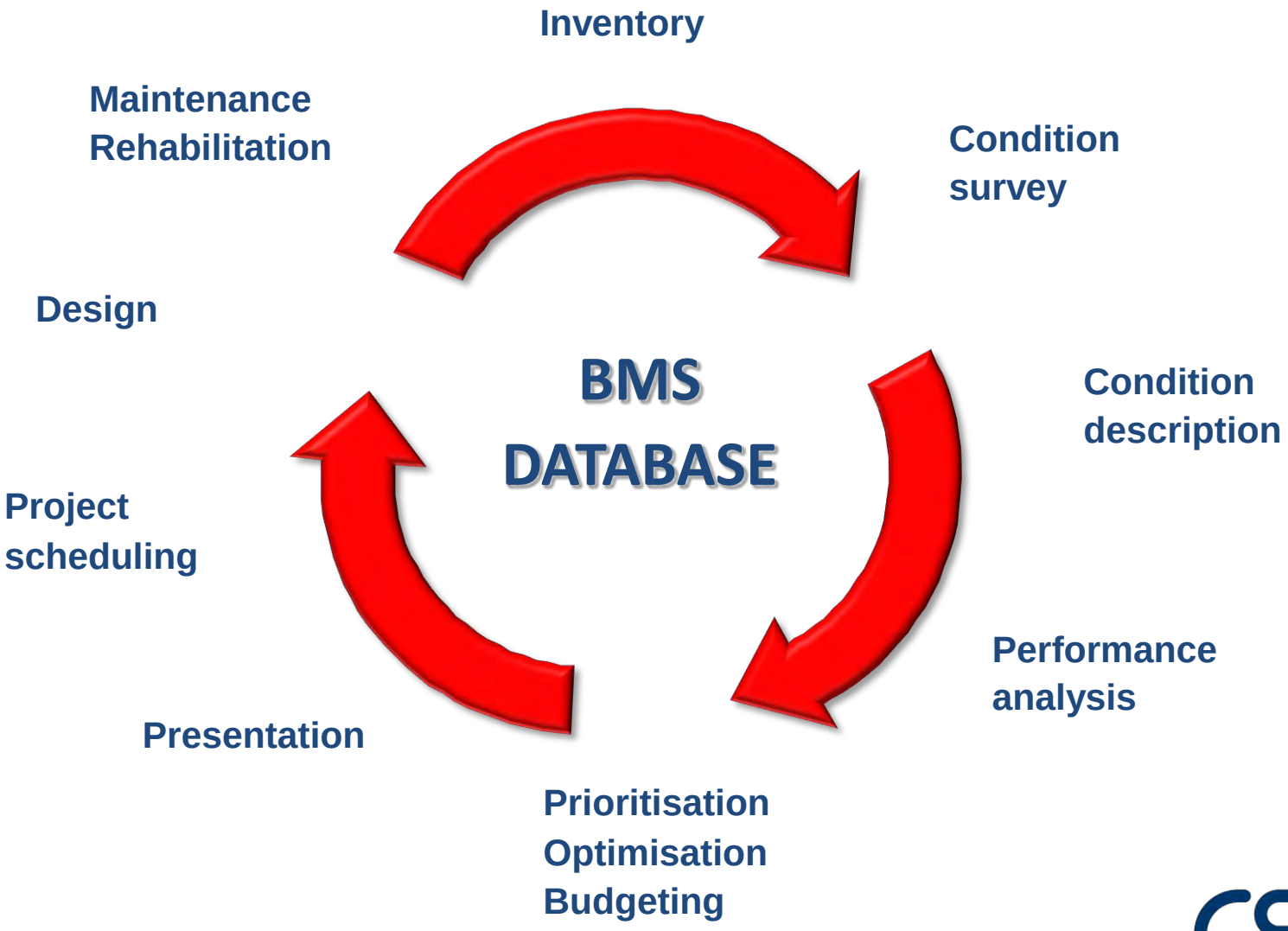
- All Bridge Management Systems rely primarily on:
  - Inventory data
  - Inspection data
- Inspection data needs to be updated on a regular basis
- Most BMS's in the world rely on visual inspections as their primary data source to determine the condition of a bridge
- Diagnostic testing is generally used for detail project inspections only once projects are identified

Proactive Maintenance of Infrastructure



Early detection of defects, through prompt diagnosis of symptoms, allows defects to be treated quickly, thus allowing meaningful savings to be made on maintenance expenditure.

Activity Flow in a BMS



BMS Inspections

- Because of the gradual rate of deterioration of structures it is not necessary to carry out inspections on an annual or bi-annual basis as is the case for roads
- Inspections generally take place on a five yearly cycle. This is very much the international norm.
- Only in special cases are more frequent inspections necessary
- Inspections (although visual) are also used determine approximate repair budgets

BMS Inspections

- The inspection methodology, based on the CSIR STRUMAN Bridge Management System, is simple and practical
- All visible defects are rated and quantified
- Inspections are on a network level and are not intended to replace project inspections
- Visual inspections at a network level are more cost effective

Bridge Inspection Items

21 basic bridge elements are inspected and evaluated. These are:

1. Approach embankment
2. Guardrails
3. Waterway
4. Embankment protection
5. Abutment foundations
6. Abutments
7. Wing & retaining walls
8. Surfacing/ballast
9. Deck drainage
10. Kerbs/sidewalks
11. Parapets & handrails
12. Pier protection work
13. Pier foundations
14. Piers & Pylons
15. Bearings
16. Support drainage
17. Expansion joints
18. Longitudinal members (decks & arches)
19. Transverse members
20. Deck slabs & arches
21. Miscellaneous

Condition Survey

- Survey is required to identify defects on the structure
- Defects are rated to place them in order of priority
- Rating should accurately represent the effect of the defect on the structural integrity of the structure
- It should also represent the effect of the defect on safety of the user and the serviceability of structure
- Survey should be systematic to ensure all defects are recorded

The DER Rating System

D – DEGREE of defect	How bad or severe is the defect
E – EXTENT of defect	How common is the defect on the inspection item being inspected
R – RELEVANCY of defect	Considers the consequences of defects with regard the safety of the user and the structural integrity of the structure
U – URGENCY to carry out the remedial work	Provides a way of applying time limits on the repair requirements

The DER Rating System

Category	X	U	0	1	2	3	4
Degree/ Severity (D)	N/A	Unable To Inspect	No defect	Minor	Fair	Poor	Severe
Extent (E)				Local	> Local	< General	General
Relevancy (R)				Minimum	Moderate	Major	Critical
Urgency (U)	Make Safe (MS)	Record (R)	Monitor	Routine	< 10 yrs	< 5 yrs	ASAP

Examples of Defects

- Spalling
- Scour
- Erosion
- Settlement
- Honeycombing
- Defective drains
- Cracks - bending, shear,...
- Rotating abutments
- Defective guardrails
- Insufficient cover to reinforcement
- Defective surfacing
- Excessive deflections
- Expansion joints not watertight
- Defects on concrete surface
- Flood debris accumulation


47


47

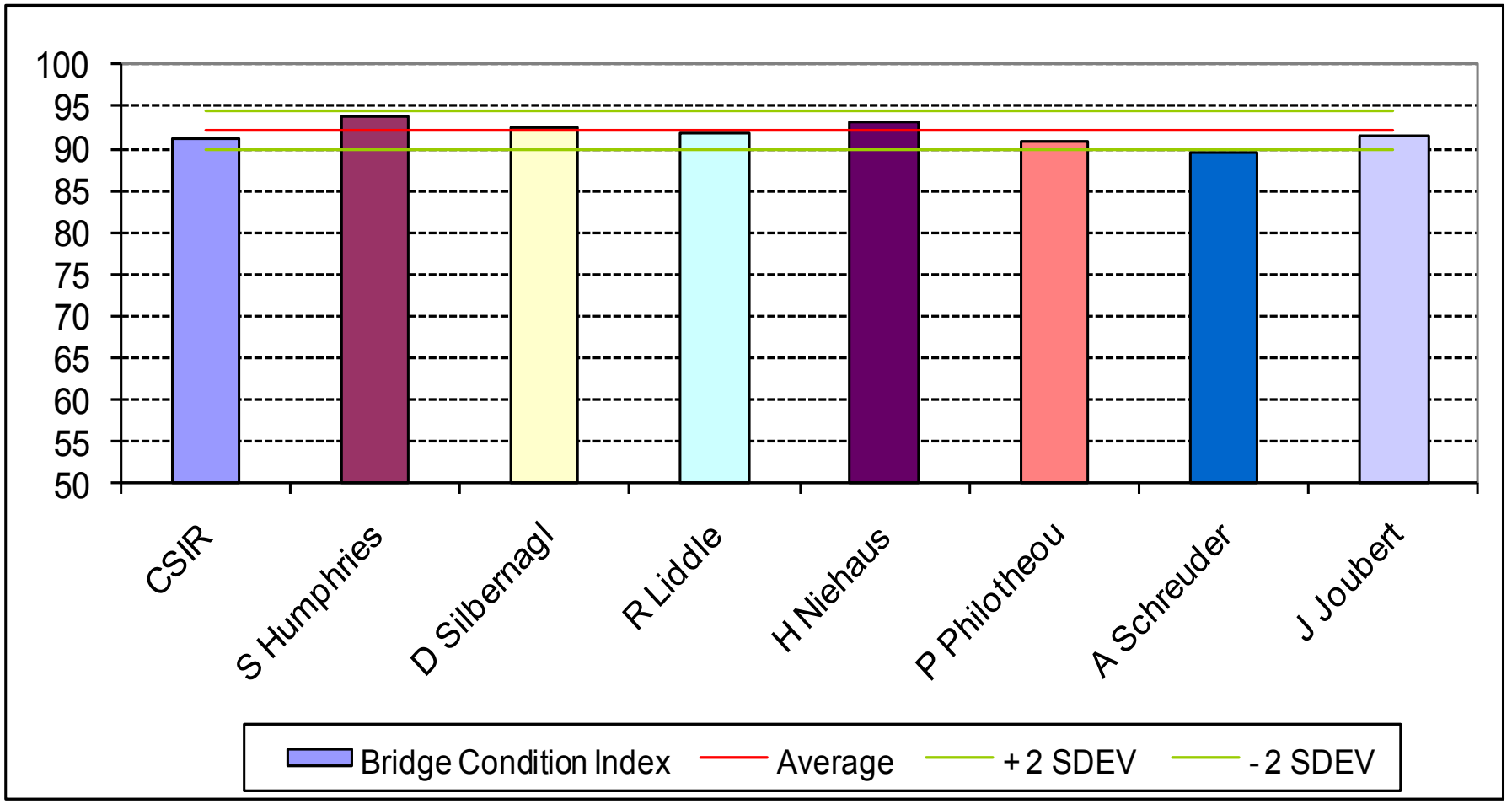
Advantages of the DER System

- The bridge inspector is not required to condition rate each and every element
- Only elements with defects are rated i.t.o DER and then only the most significant defect with the highest relevancy
- Time on site is reduced as one is only looking for defects and not trying to estimate a condition rating for the structure

Bridge Inspector Requirements

- Good understanding of structural behaviour
- Experienced (minimum of 5 years design experience)
- Trained in the use of the DER rating system
- Pay attention to detail

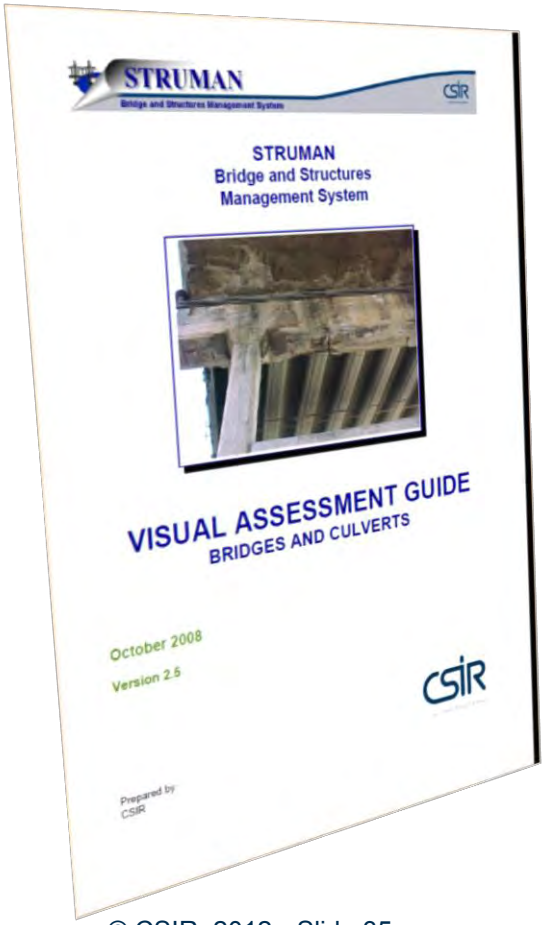
Assessment of Bridge Inspectors: Calibration Inspections



System Components

DER Methodology

Documentation



Software System

CSIR
our future through science

STRUMAN - Database: D:\Systems\StrumanBMS\aDataFiles\Namibia_Data\STRUMANDATA_NAMIBIARA_NETWORK05-01.MDB

File Edit Find Structure List Data Reports Photos Graphs Sheets Map Validation Calculations Parameters Preferences Help

STRUMAN Bridge and Structures Management System
Namibia Roads Authority
Version: 6.0.42

Bridge Use : Yes | Classification : Medium Bridge | Status : Current | Ownership : Roads Authority Namibia | Road: D2475, 53.02 km

Structure Type: All Structures | Module: Start Module

Search | Number: B0003 | Name: Omatako River

Outputs
- Inventory Sheet
- Completed Inspection Sheet
- Indices and Ranking
- Structure Summary (Costs exc
- Asset Value Summary (Costs e
- Photo : Inventory
- Photo : Inspection
- Inventory Summary List
- Inspection Summary List

Inventory Sheet

Location Details - Namibia

ROAD REFERENCE SYSTEM (RRS)

Link ID	1001169	Network ID	5
Road No.	D2475	Primary Feature	River
Road Type		Feature Name	OMATAKO RIVER
Maintenance Region		Feature Road No.	
Magisterial District		Feature Road km	
Direction		Secondary Feature	
Road Km Chainage	53.02	Secondary Feature Name	
Road Over/Under	Over	Other Bridge No.	
Other Authority	N/A		
Orientation	North/South	Approach Emb. Orientation	North/South
		Direction of River Flow	East

GPS Coordinates

Survey System		Latitude (South) DDD	MM	SS.S	Longitude (East) DDD	MM	SS.S	Elevation (m)
WGS84	Start	2225			17	3	29	
	Middle	21	13	22	17	3	29	
	End	21	13	22	17	3	29	

Contract Details

Design Engineers		Contract Number	
Contractors		Year Completed	1938
Contract Price		Completion Period	months
Escalated Cost			
otal Cost (Design & Construct)			

Structural Features - Bridge

No. of Spans	4	No. of Piers	3	No. of Abutments	2
Facility Carried	Road			fcu Slabs	MPa
Bridge Type	Simply supported			fcu Beams	MPa
				fcu Piers	MPa
Bridge Description	Medium: Road Over River			fcu Abutments	MPa
Deck Constr. Method	Cast in-situ				
Parapet Handrails	R C wall				
Approach Slabs	No				
Abutment Gallery	No				

Deck - Bridge

Position	Type	Material	Span Length (m)	Deck Soffit Profile	Avg Deck Depth (m)	Min Deck Depth (m)	Max Deck Depth (m)
AS	Solid slab	Reinforced concrete	9.5	Straight	0.5	0.45	0.45

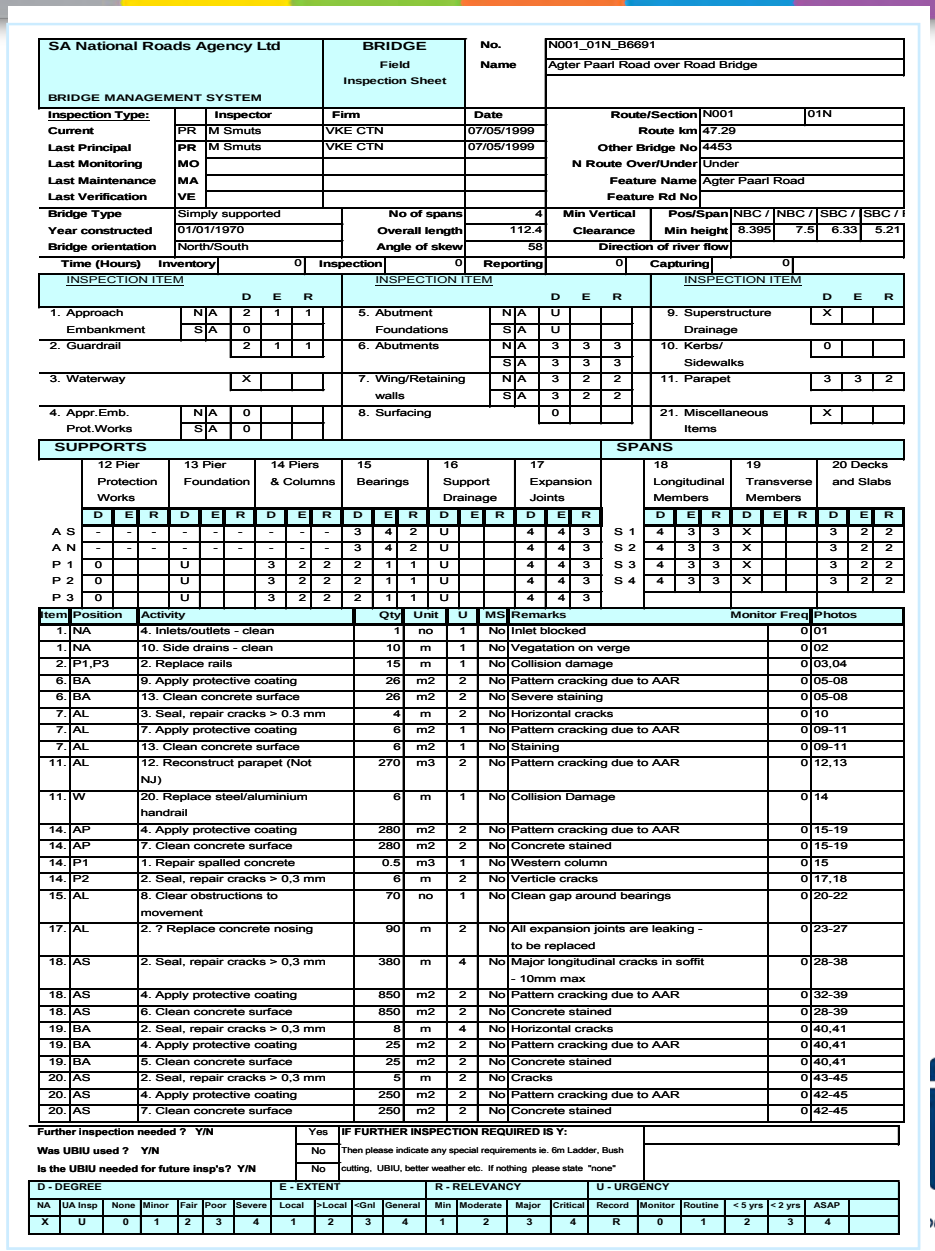
Bearings - Bridge

Position	Type	Fixity
AS	Malthoid	Fixed using dowel pins

Ready | Record 1 of 2720 | Single selection | MS Access Jet DB | DB ver: 4.191.00

Example of an Inspection Sheet

- In most cases one A4 sheet is completed for each bridge
- There is a separate photographic record sheet



SA National Roads Agency Ltd — BRIDGE MANAGEMENT SYSTEM — BRIDGE Field Inspection Sheet

No.	N001_01N_B6691
Name	Agter Paarl Road over Road Bridge

Inspection Type:		Inspector	Firm	Date
Current	PR	M Smuts	VKE CTN	07/05/1999
Last Principal	PR	M Smuts	VKE CTN	07/05/1999
Last Monitoring	MO			
Last Maintenance	MA			
Last Verification	VE			

Route/Section	N001	01N							
Route km	47.29								
Other Bridge No	4453								
N Route Over/Under	Under								
Feature Name	Agter Paarl Road								
Feature Rd No									
Bridge Type	Simply supported		No of spans	4	Min Vertical Clearance	Pos/Span	NBC /	NBC /	SBC /	SBC /
Year constructed	01/01/1970		Overall length	112.4		Min height	8.395	7.5	6.33	5.21
Bridge orientation	North/South		Angle of skew	58	Direction of river flow					

Time (Hours) Inventory 0 Inspection 0 Reporting 0 Capturing 0

INSPECTION ITEM		D	E	R
1. Approach Embankment	NA	2	1	1
	SA	0		
2. Guardrail		2	1	1
3. Waterway		X		
4. Appr.Emb. Prot.Works	NA	0		
	SA	0		
5. Abutment Foundations	NA	U		
	SA	U		
6. Abutments	NA	3	3	3
	SA	3	3	3
7. Wing/Retaining walls	NA	3	2	2
	SA	3	2	2
8. Surfacing		0		
9. Superstructure Drainage		X		
10. Kerbs/ Sidewalks		0		
11. Parapet		3	3	2
21. Miscellaneous Items		X		

SUPPORTS

	12 Pier Protection Works			13 Pier Foundation			14 Piers & Columns			15 Bearings			16 Support Drainage			17 Expansion Joints		
	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R
A S	-	-	-	-	-	-	-	-	-	3	4	2	U			4	4	3
A N	-	-	-	-	-	-	-	-	-	3	4	2	U			4	4	3
P 1	0			U			3	2	2	2	1	1	U			4	4	3
P 2	0			U			3	2	2	2	1	1	U			4	4	3
P 3	0			U			3	2	2	2	1	1	U			4	4	3

SPANS

	18 Longitudinal Members			19 Transverse Members			20 Decks and Slabs		
	D	E	R	D	E	R	D	E	R
S 1	4	3	3	X			3	2	2
S 2	4	3	3	X			3	2	2
S 3	4	3	3	X			3	2	2
S 4	4	3	3	X			3	2	2

Item	Position	Activity	Qty	Unit	U	MS	Remarks	Monitor Freq	Photos
1.	NA	4. Inlets/outlets - clean	1	no	1	No	Inlet blocked	0	01
1.	NA	10. Side drains - clean	10	m	1	No	Vegatation on verge	0	02
2.	P1,P3	2. Replace rails	15	m	1	No	Collision damage	0	03,04
6.	BA	9. Apply protective coating	26	m2	2	No	Pattern cracking due to AAR	0	05-08
6.	BA	13. Clean concrete surface	26	m2	2	No	Severe staining	0	05-08
7.	AL	3. Seal, repair cracks > 0.3 mm	4	m	2	No	Horizontal cracks	0	10
7.	AL	7. Apply protective coating	6	m2	1	No	Pattern cracking due to AAR	0	09-11
7.	AL	13. Clean concrete surface	6	m2	1	No	Staining	0	09-11
11.	AL	12. Reconstruct parapet (Not NJ)	270	m3	2	No	Pattern cracking due to AAR	0	12,13
11.	W	20. Replace steel/aluminium handrail	6	m	1	No	Collision Damage	0	14
14.	AP	4. Apply protective coating	280	m2	2	No	Pattern cracking due to AAR	0	15-19
14.	AP	7. Clean concrete surface	280	m2	2	No	Concrete stained	0	15-19
14.	P1	1. Repair spalled concrete	0.5	m3	1	No	Western column	0	15
14.	P2	2. Seal, repair cracks > 0,3 mm	6	m	2	No	Verticle cracks	0	17,18
15.	AL	8. Clear obstructions to movement	70	no	1	No	Clean gap around bearings	0	20-22
17.	AL	2. ? Replace concrete nosing	90	m	2	No	All expansion joints are leaking - to be replaced	0	23-27
18.	AS	2. Seal, repair cracks > 0,3 mm	380	m	4	No	Major longitudinal cracks in soffit - 10mm max	0	28-38
18.	AS	4. Apply protective coating	850	m2	2	No	Pattern cracking due to AAR	0	32-39
18.	AS	6. Clean concrete surface	850	m2	2	No	Concrete stained	0	28-39
19.	BA	2. Seal, repair cracks > 0,3 mm	8	m	4	No	Horizontal cracks	0	40,41
19.	BA	4. Apply protective coating	25	m2	2	No	Pattern cracking due to AAR	0	40,41
19.	BA	5. Clean concrete surface	25	m2	2	No	Concrete stained	0	40,41
20.	AS	2. Seal, repair cracks > 0,3 mm	5	m	2	No	Cracks	0	43-45
20.	AS	4. Apply protective coating	250	m2	2	No	Pattern cracking due to AAR	0	42-45
20.	AS	7. Clean concrete surface	250	m2	2	No	Concrete stained	0	42-45

Further Inspection needed ? Y/N	Yes	IF FURTHER INSPECTION REQUIRED IS Y:
Was UBIU used ? Y/N	No	Then please indicate any special requirements ie. 6m Ladder, Bush
Is the UBIU needed for future insp's? Y/N	No	cutting, UBIU, better weather etc. If nothing please state "none"

D - DEGREE							E - EXTENT				R - RELEVANCY				U - URGENCY					
NA	UA Insp	None	Minor	Fair	Poor	Severe	Local	>Local	<Gnl	General	Min	Moderate	Major	Critical	Record	Monitor	Routine	< 5 yrs	< 2 yrs	ASAP
X	U	0	1	2	3	4	1	2	3	4	1	2	3	4	R	0	1	2	3	4

Example of an Inspection Sheet

SA National Roads Agency Ltd BRIDGE MANAGEMENT SYSTEM	BRIDGE Field Inspection Sheet	No.	N001_01N_B699
		Name	Agter Paarl Road over Road Bridge
		GIS: X	
		Y	

Inspection Type:		Inspector	Firm	Date
Current	PR	M Smuts	VKE CTN	07-May-99
Last Principal	PR	M Smuts	VKE CTN	07-May-99
Last Monitoring	MO			
Last Maintenance	MA			
Last Verification	VE			

Route/Section	N001	01N	
Route km	47.29		
Other Bridge No	4453		
N Route Over/Under	Under		
Feature Name	Agter Paarl Road		
Feature Rd No			

Bridge Type	Simply supported	No of spans	4	Min Vertical	Pos/Span	NBC /	NBC /	SBC /	SBC / Right
Year constructed	01-Jan-70	Overall length	112.4	Clearance	Min height	8.395	7.5	6.33	5.21
Bridge orientation	North/South	Angle of skew	58	Direction of river flow					

Time (Hours) Inventory	0	Inspection	0	Reporting	0	Capturing	0

INSPECTION ITEM			D	E	R
1. Approach Embankment	N	A	2	1	1
	S	A	0		
2. Guardrail			2	1	1
3. Waterway			X		
4. Appr.Emb. Prot.Works	N	A	0		
	S	A	0		

INSPECTION ITEM			D	E	R
5. Abutment Foundations	N	A	U		
	S	A	U		
6. Abutments	N	A	3	3	3
	S	A	3	3	3
7. Wing/Retaining walls	N	A	3	2	2
	S	A	3	2	2
8. Surfacing			0		

INSPECTION ITEM	D	E	R
9. Superstructure Drainage	X		
10. Kerbs/ Sidewalks	0		
11. Parapet	3	3	2
21. Miscellaneous Items	X		

SUPPORTS

	12 Pier Protection Works			13 Pier Foundation			14 Piers & Columns			15 Bearings			16 Support Drainage			17 Expansion Joints		
	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R
A S	-	-	-	-	-	-	-	-	-	3	4	2	U			4	4	3
A N	-	-	-	-	-	-	-	-	-	3	4	2	U			4	4	3
P 1	0			U			3	2	2	2	1	1	U			4	4	3
P 2	0			U			3	2	2	2	1	1	U			4	4	3
P 3	0			U			3	2	2	2	1	1	U			4	4	3

SPANS

	18 Longitudinal Members			19 Transverse Members			20 Decks and Slabs		
	D	E	R	D	E	R	D	E	R
S 1	4	3	3	X			3	2	2
S 2	4	3	3	X			3	2	2
S 3	4	3	3	X			3	2	2
S 4	4	3	3	X			3	2	2

Example of an Inspection Sheet

Item	Position	Activity	Qty	Unit	U	MS	Remarks	Monitor Freq	Photos
17.	AL	2. ? Replace concrete nosing	90	m	2	No	All expansion joints are leaking - to be replaced	0	23-27
18.	AS	2. Seal, repair cracks > 0,3 mm	380	m	4	No	Major longitudinal cracks in soffit - 10mm max	0	28-38
18.	AS	4. Apply protective coating	850	m2	2	No	Pattern cracking due to AAR	0	32-39
18.	AS	6. Clean concrete surface	850	m2	2	No	Concrete stained	0	28-39
19.	BA	2. Seal, repair cracks > 0,3 mm	8	m	4	No	Horizontal cracks	0	40,41
19.	BA	4. Apply protective coating	25	m2	2	No	Pattern cracking due to AAR	0	40,41
19.	BA	5. Clean concrete surface	25	m2	2	No	Concrete stained	0	40,41
20.	AS	2. Seal, repair cracks > 0,3 mm	5	m	2	No	Cracks	0	43-45
20.	AS	4. Apply protective coating	250	m2	2	No	Pattern cracking due to AAR	0	42-45
20.	AS	7. Clean concrete surface	250	m2	2	No	Concrete stained	0	42-45
20.	S2	1. Repair spalled concrete	0.5	m3	1	No	None	0	42
1.	NA	4. Inlets/outlets - clean	1	no	1	No	Inlet blocked	0	01
1.	NA	10. Side drains - clean	10	m	1	No	Vegatation on verge	0	02
2.	P1,P3	2. Replace rails	15	m	1	No	Collision damage	0	03,04
6.	BA	9. Apply protective coating	26	m2	2	No	Pattern cracking due to AAR	0	05-08
6.	BA	13. Clean concrete surface	26	m2	2	No	Severe staining	0	05-08
7.	AL	3. Seal, repair cracks > 0.3 mm	4	m	2	No	Horizontal cracks	0	10
7.	AL	7. Apply protective coating	6	m2	1	No	Pattern cracking due to AAR	0	09-11
7.	AL	13. Clean concrete surface	6	m2	1	No	Staining	0	09-11
11.	AL	12. Reconstruct parapet (Not NJ)	270	m3	2	No	Pattern cracking due to AAR	0	12,13
11.	W	20. Replace steel/aluminium handrail	6	m	1	No	Collision Damage	0	14
14.	AP	4. Apply protective coating	280	m2	2	No	Pattern cracking due to AAR	0	15-19
14.	AP	7. Clean concrete surface	280	m2	2	No	Concrete stained	0	15-19
14.	P1	1. Repair spalled concrete	0.5	m3	1	No	Western column	0	15
14.	P2	2. Seal, repair cracks > 0,3 mm	6	m	2	No	Verticle cracks	0	17,18
15.	AL	8. Clear obstructions to movement	70	no	1	No	Clean gap around bearings	0	20-22

Inspector's assessment of structure condition and further comments:

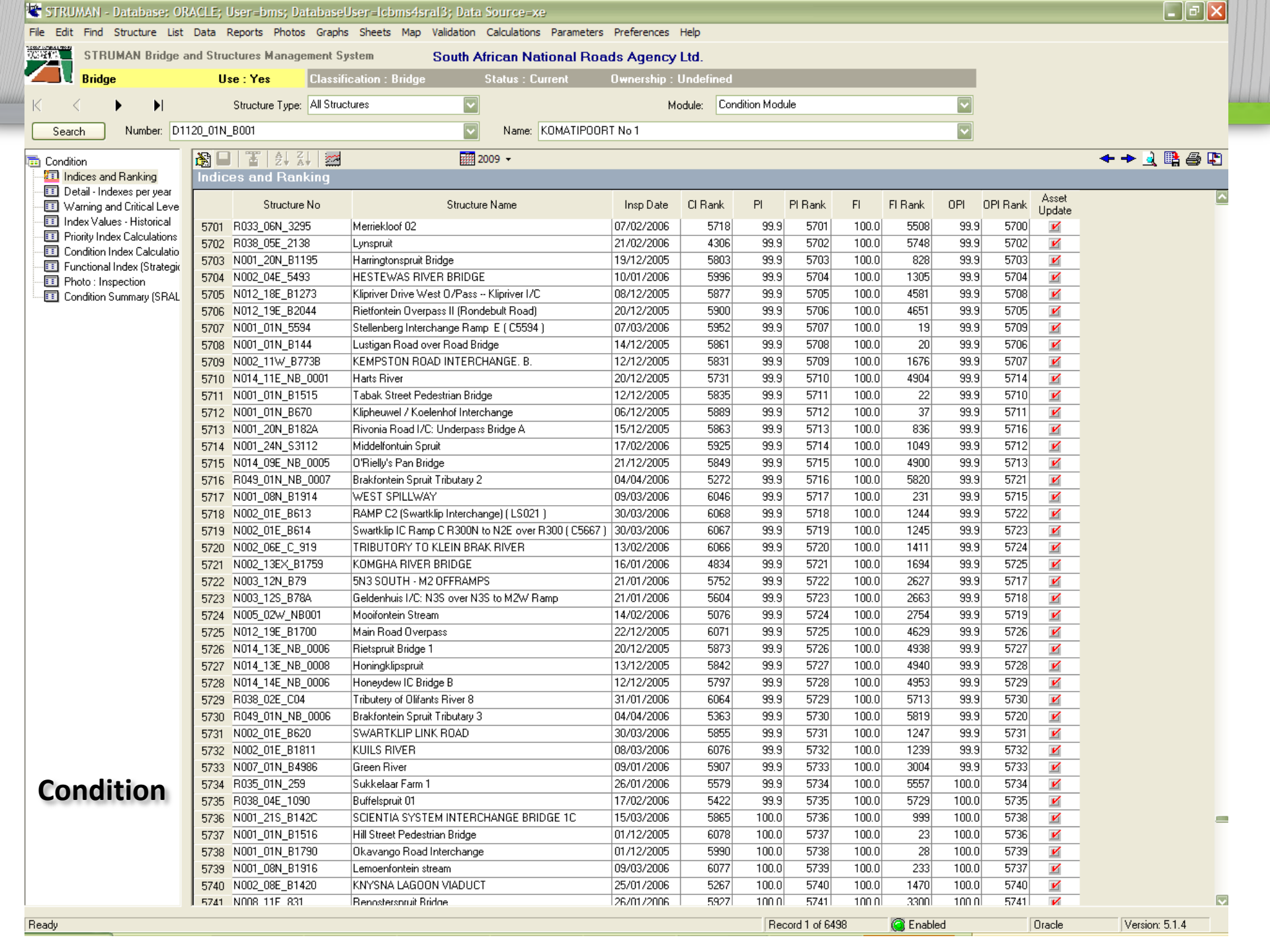
Major longitudinal cracks in deck soffit - up to 10mm wide - needs urgent attention.
All exposed concrete surfaces are stained and covered with pattern cracking due to AAR.
All exposed concrete surfaces to be painted with a protective coating.

Further inspection needed ? Y/N	No	**IF FURTHER INSPECTION REQUIRED IS Y:**
Was UBIU used ? Y/N	No	Then please indicate any special requirements ie. 6m Ladder, Bush cutting, UBIU, better weather etc. If nothing please state "none"
Is the UBIU needed for future insp's? Y/N	No	

D - DEGREE							E - EXTENT				R - RELEVANCY				U - URGENCY					
NA	UA Insp	None	Minor	Fair	Poor	Severe	Local	>Local	<Gnl	General	Min	Moderate	Major	Critical	Record	Monitor	Routine	< 1 yrs	< 2 yrs	ASAP
X	U	0	1	2	3	4	1	2	3	4	1	2	3	4	R	0	1	2	3	4

Prioritisation

- Required for maintenance, repair and rehabilitation activities on structures in a network
- Structures with the greatest need for repair should be given the highest priority
- Two major categories are used to prioritise structures
  - Structural adequacy
  - Functional index
- Structural adequacy is a function of D,E&R ratings
- Functional index is a function of the following
  - Type of structure, Class of structure, Detour length, etc...
- Secondary to optimisation process



	Structure No	Structure Name	Insp Date	CI Rank	PI	PI Rank	FI	FI Rank	OPI	OPI Rank	Asset Update
5701	R033_06N_3295	Merriekloof 02	07/02/2006	5718	99.9	5701	100.0	5508	99.9	5700	
5702	R038_05E_2138	Lynspruit	21/02/2006	4306	99.9	5702	100.0	5748	99.9	5702	
5703	N001_20N_B1195	Harringtonspruit Bridge	19/12/2005	5803	99.9	5703	100.0	828	99.9	5703	
5704	N002_04E_5493	HESTEWAS RIVER BRIDGE	10/01/2006	5996	99.9	5704	100.0	1305	99.9	5704	
5705	N012_18E_B1273	Klipriver Drive West O/Pass -- Klipriver I/C	08/12/2005	5877	99.9	5705	100.0	4581	99.9	5708	
5706	N012_19E_B2044	Rietfontein Overpass II (Rondebult Road)	20/12/2005	5900	99.9	5706	100.0	4651	99.9	5705	
5707	N001_01N_5594	Stellenberg Interchange Ramp E (C5594)	07/03/2006	5952	99.9	5707	100.0	19	99.9	5709	
5708	N001_01N_B144	Lustigan Road over Road Bridge	14/12/2005	5861	99.9	5708	100.0	20	99.9	5706	
5709	N002_11W_B773B	KEMPSTON ROAD INTERCHANGE. B.	12/12/2005	5831	99.9	5709	100.0	1676	99.9	5707	
5710	N014_11E_NB_0001	Harts River	20/12/2005	5731	99.9	5710	100.0	4904	99.9	5714	
5711	N001_01N_B1515	Tabak Street Pedestrian Bridge	12/12/2005	5835	99.9	5711	100.0	22	99.9	5710	
5712	N001_01N_B670	Klipheuwel / Koelenhof Interchange	06/12/2005	5889	99.9	5712	100.0	37	99.9	5711	
5713	N001_20N_B182A	Rivonia Road I/C: Underpass Bridge A	15/12/2005	5863	99.9	5713	100.0	836	99.9	5716	
5714	N001_24N_S3112	Middelfontuin Spruit	17/02/2006	5925	99.9	5714	100.0	1049	99.9	5712	
5715	N014_09E_NB_0005	O'Rielly's Pan Bridge	21/12/2005	5849	99.9	5715	100.0	4900	99.9	5713	
5716	R049_01N_NB_0007	Brakfontein Spruit Tributary 2	04/04/2006	5272	99.9	5716	100.0	5820	99.9	5721	
5717	N001_08N_B1914	WEST SPILLWAY	09/03/2006	6046	99.9	5717	100.0	231	99.9	5715	
5718	N002_01E_B613	RAMP C2 (Swartklip Interchange) (LS021)	30/03/2006	6068	99.9	5718	100.0	1244	99.9	5722	
5719	N002_01E_B614	Swartklip IC Ramp C R300N to N2E over R300 (C5667)	30/03/2006	6067	99.9	5719	100.0	1245	99.9	5723	
5720	N002_06E_C_919	TRIBUTORY TO KLEIN BRAK RIVER	13/02/2006	6066	99.9	5720	100.0	1411	99.9	5724	
5721	N002_13EX_B1759	KOMGHA RIVER BRIDGE	16/01/2006	4834	99.9	5721	100.0	1694	99.9	5725	
5722	N003_12N_B79	5N3 SOUTH - M2 OFFRAMPS	21/01/2006	5752	99.9	5722	100.0	2627	99.9	5717	
5723	N003_12S_B78A	Geldenhuis I/C: N3S over N3S to M2W Ramp	21/01/2006	5604	99.9	5723	100.0	2663	99.9	5718	
5724	N005_02W_NB001	Mooifontein Stream	14/02/2006	5076	99.9	5724	100.0	2754	99.9	5719	
5725	N012_19E_B1700	Main Road Overpass	22/12/2005	6071	99.9	5725	100.0	4629	99.9	5726	
5726	N014_13E_NB_0006	Rietspruit Bridge 1	20/12/2005	5873	99.9	5726	100.0	4938	99.9	5727	
5727	N014_13E_NB_0008	Honingklipspruit	13/12/2005	5842	99.9	5727	100.0	4940	99.9	5728	
5728	N014_14E_NB_0006	Honeydew IC Bridge B	12/12/2005	5797	99.9	5728	100.0	4953	99.9	5729	
5729	R038_02E_C04	Tributery of Olifants River 8	31/01/2006	6064	99.9	5729	100.0	5713	99.9	5730	
5730	R049_01N_NB_0006	Brakfontein Spruit Tributary 3	04/04/2006	5363	99.9	5730	100.0	5819	99.9	5720	
5731	N002_01E_B620	SWARTKLIP LINK ROAD	30/03/2006	5855	99.9	5731	100.0	1247	99.9	5731	
5732	N002_01E_B1811	KUILS RIVER	08/03/2006	6076	99.9	5732	100.0	1239	99.9	5732	
5733	N007_01N_B4986	Green River	09/01/2006	5907	99.9	5733	100.0	3004	99.9	5733	
5734	R035_01N_259	Sukkelaar Farm 1	26/01/2006	5579	99.9	5734	100.0	5557	100.0	5734	
5735	R038_04E_1090	Buffelspruit 01	17/02/2006	5422	99.9	5735	100.0	5729	100.0	5735	
5736	N001_21S_B142C	SCIENTIA SYSTEM INTERCHANGE BRIDGE 1C	15/03/2006	5865	100.0	5736	100.0	999	100.0	5738	
5737	N001_01N_B1516	Hill Street Pedestrian Bridge	01/12/2005	6078	100.0	5737	100.0	23	100.0	5736	
5738	N001_01N_B1790	Okavango Road Interchange	01/12/2005	5990	100.0	5738	100.0	28	100.0	5739	
5739	N001_08N_B1916	Lemoenfontein stream	09/03/2006	6077	100.0	5739	100.0	233	100.0	5737	
5740	N002_08E_B1420	KNYSNA LAGOON VIADUCT	25/01/2006	5267	100.0	5740	100.0	1470	100.0	5740	
5741	N008_11E_831	Benostersnruit Bridge	26/01/2006	5927	100.0	5741	100.0	3300	100.0	5741	

Condition Indices Graph

Structure Type: All Structures

Number of Structures : 1430

Close

STRUMAN - Database: D:\Systems\StrumanBMS\aDataFiles\Namibia_Data\STRUMANDATA_NAMIBIARA_NETWORK05-01.MDB

File Edit Find Structure List Data Reports Photos Graphs Sheets Map Validation Calculations Parameters Preferences Help

STRUMAN Bridge and Structures Management System
Namibia Roads Authority

Version: 6.0.42

Bridge Use : Yes | Classification : Medium Bridge | Status : Current | Ownership : Roads Authority Namibia | Road: D2475, 53.02 km

Structure Type: All Structures | Module: Start Module

Search | Number: B0003 | Name: Omatako River

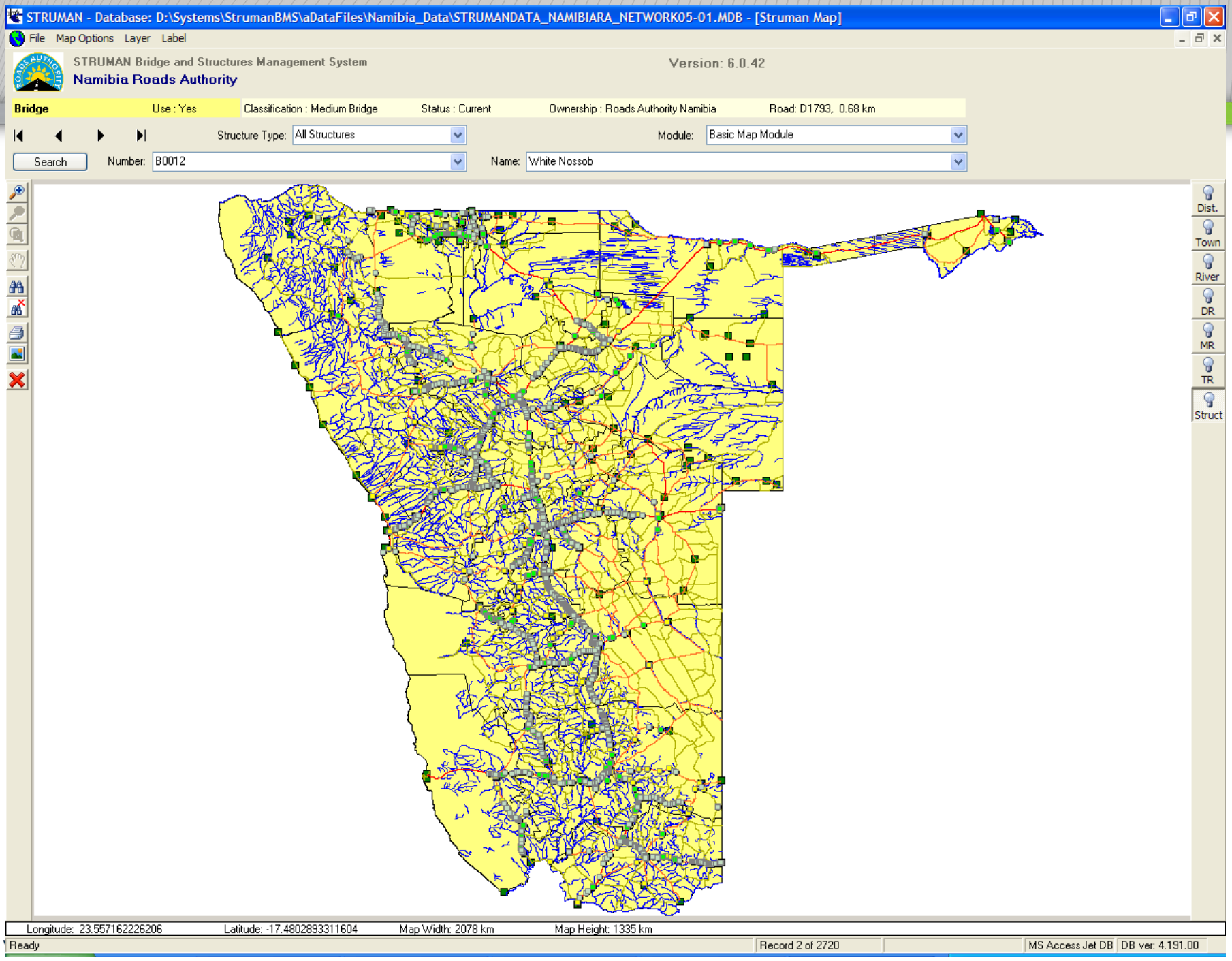
Outputs
- Inventory Sheet
- Completed Inspection Sheet
- Indices and Ranking
- Structure Summary (Costs exc
- Asset Value Summary (Costs e
- Photo : Inventory
- Photo : Inspection
- Inventory Summary List
- Inspection Summary List

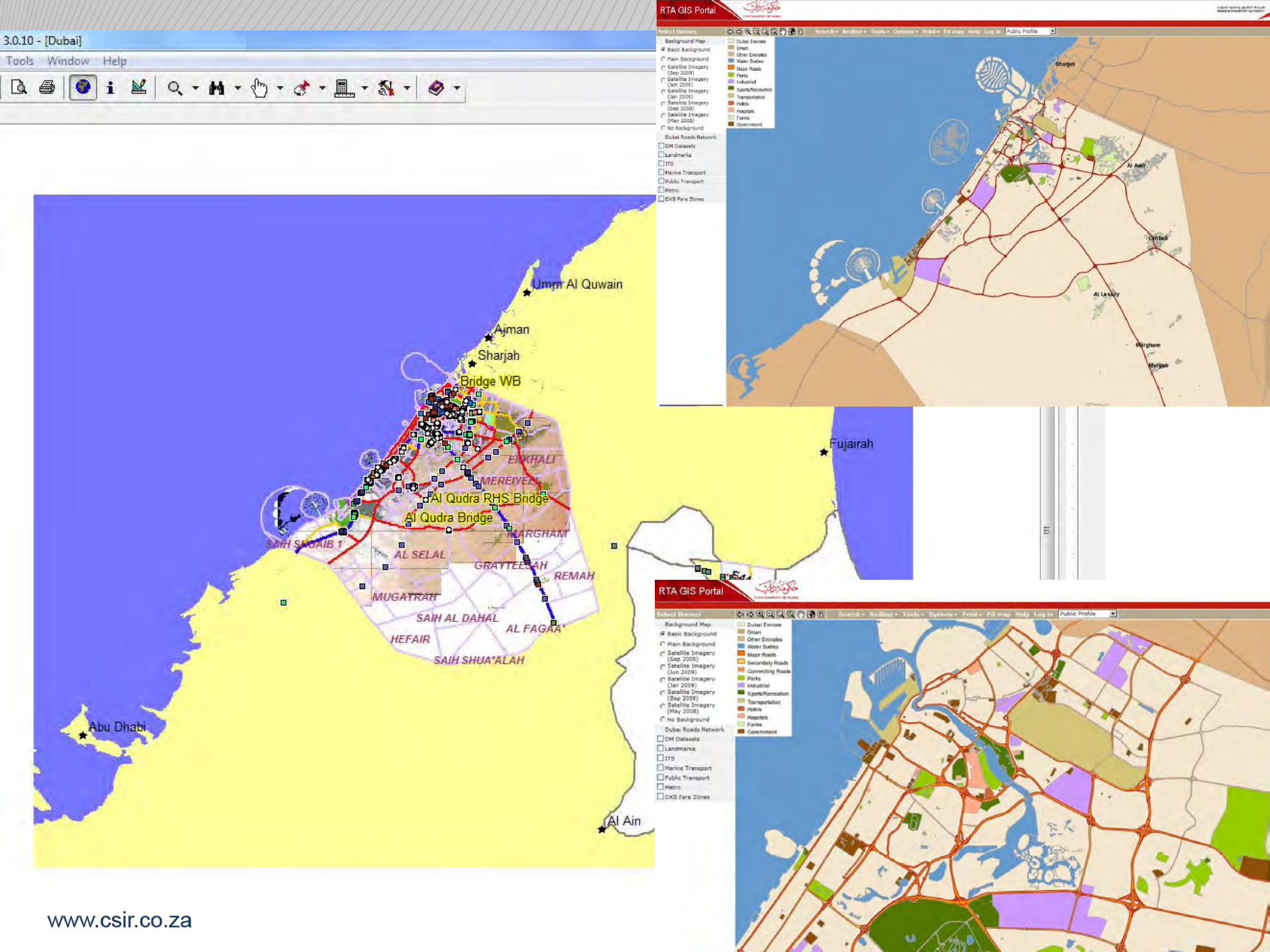
Photo : Inventory

No of Photo's = 13

Photo	Photo No	Photo Date	Direction	Description
	V01	03/06/2008	SE	View 1: Bridge in Elevation.
	V02	03/06/2008	NW	View 2: Bridge in Elevation from opposite side.
	V03	03/06/2008	S	View 3: Bridge from upper approach.
	V04	03/06/2008	N	View 4: Bridge from upper approach (opposite end).
	V05	03/06/2008	W	View 5: View taken from the top of the bridge of feature crossed.
	V06	03/06/2008	E	View 6: View taken from the top of the bridge of feature crossed.

Ready | Record 1 of 2720 | Edit Enabled | MS Access Jet DB | DB ver: 4.191.00


STRUMAN - Database: D:\Systems\StrumanBMS\aDataFiles\Namibia_Data\STRUMANDATA_NAMIBIARA_NETWORK05-01.MDB - [Struman Map]
File
Map Options
Layer
Label
STRUMAN Bridge and Structures Management System
Namibia Roads Authority
Version: 6.0.42
Bridge
Use : Yes
Classification : Medium Bridge
Status : Current
Ownership : Roads Authority Namibia
Road: D1793, 0.68 km
Structure Type:
All Structures
Module:
Basic Map Module
Search
Number:
B0012
Name:
White Nossob
Dist.
Town
River
DR
MR
TR
Struct
Longitude: 23.557162226206
Latitude: -17.4802893311604
Map Width: 2078 km
Map Height: 1335 km
Ready
Record 2 of 2720
MS Access Jet DB
DB ver: 4.191.00


3.0.10 - [Dubai]
Tools Window Help
RTA GIS Portal
Umm Al Quwain
Ajman
Sharjah
Bridge WB
Fujairah
AL KHALI
MEREIYEEL
Al Qudra RHS Bridge
Al Qudra Bridge
SAIH SHOAIB 1
AL SELAL
GRAYTEESAH
REMAH
MUGAITRAH
SAIH AL DAHAL
AL FAGAA'
HEFAIR
SAIH SHUA'ALAH
Abu Dhabi
Al Ain
RTA GIS Portal

Asset Value

- Based on the DEPRECIATED REPLACEMENT COST method.
- Asset Value derived from the following:
  - Replacement cost
  - Percentage depreciation
  - Maintenance cost

$$AV = (RC \times d) - MC$$

Where:

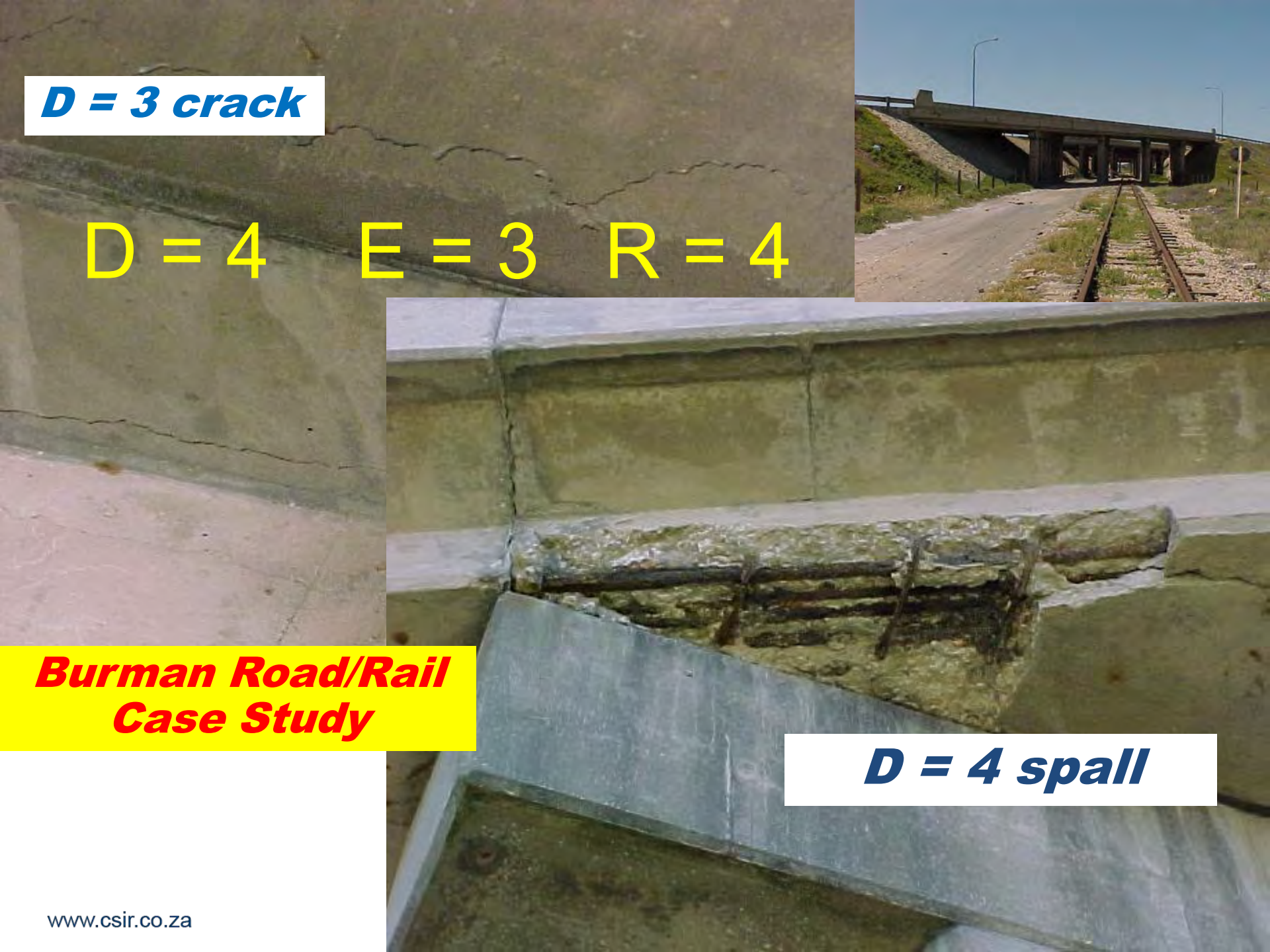
AV = Asset Value in Rand

RC = Replacement Cost in Rand

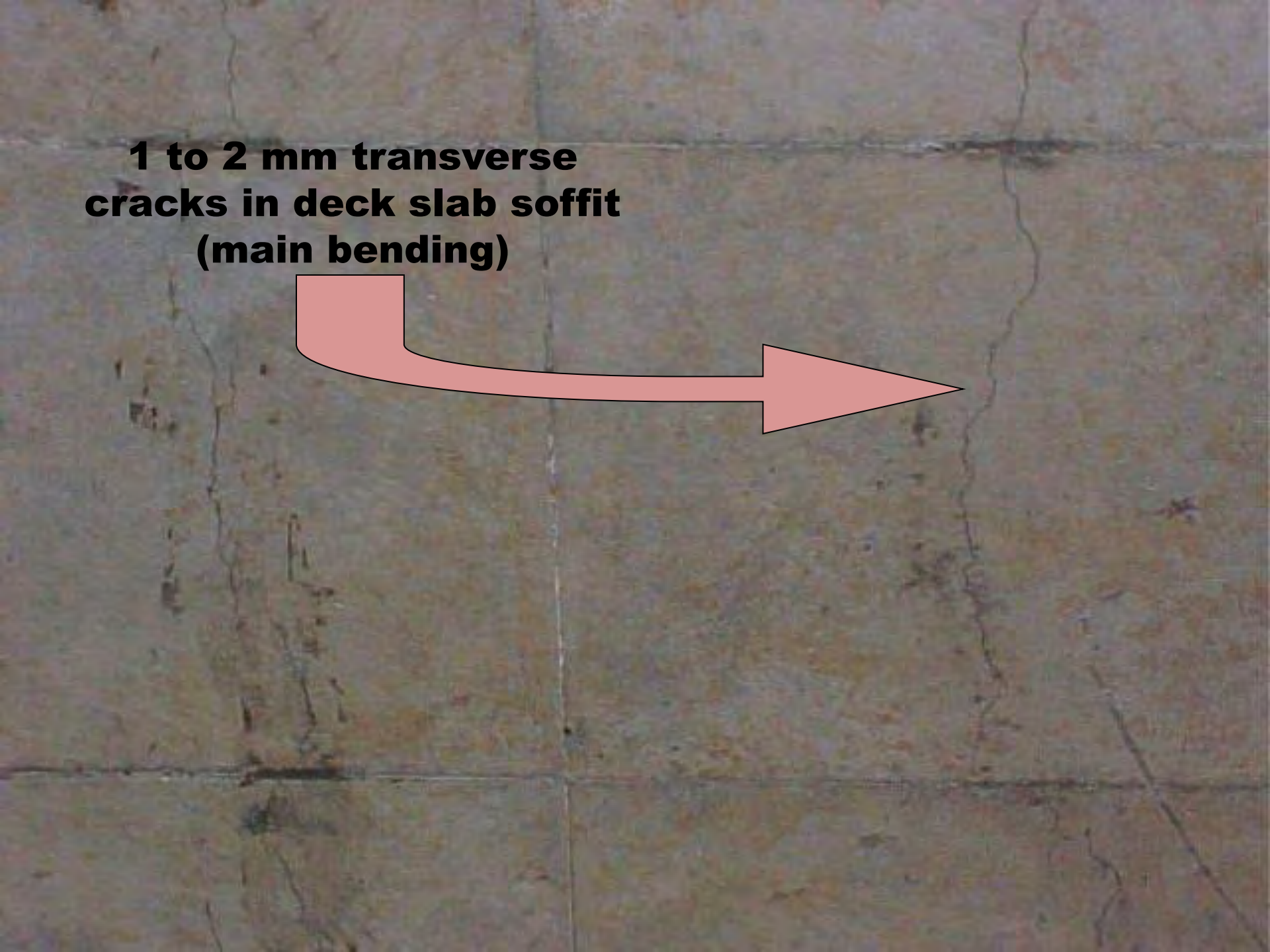
d = Percentage Depreciation

MC= Maintenance Cost in Rand

Case Study 1
Burman Road/Rail Bridge


D = 3 crack
D = 4 E = 3 R = 4
Burman Road/Rail
Case Study
D = 4 spall

Case Study 2
Brown Stream Bridge


1 to 2 mm transverse
cracks in deck slab soffit
(main bending)

Rating of defect (crack)

- *Thickness of slab 700mm*
- *Sag in deck edge – can be seen in elevation view*
- *3 mm joints in barrier had closed up*

D = 3

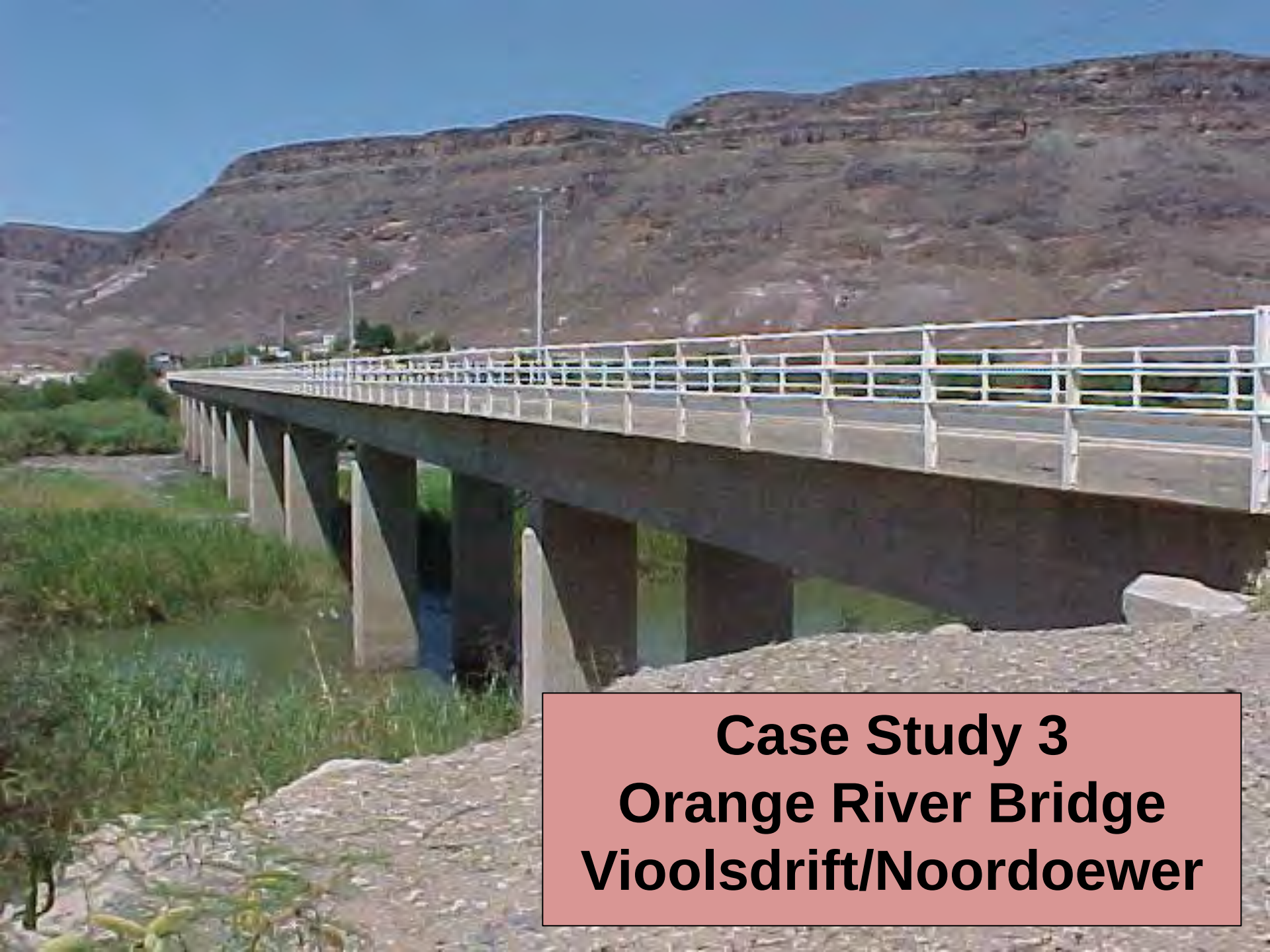
E = 2

R = 4

Remedial Work

OPI was No 52 out of 2 000

- *A design check was done & deck found to have only 30% of LL Capacity*
- *Strengthening not feasible due to steel stressed beyond yield*
- *Could hear crunching of concrete when vehicles crossed*
- *Deck was demolished and replaced*
- *During demolition the deck collapsed under its own weight!*



Case Study 3
Orange River Bridge
Vioolsdrift/Noordoewer


ORANGE
70

Deck Rating (Honeycombed)

D = 3

E = 2

R = 2

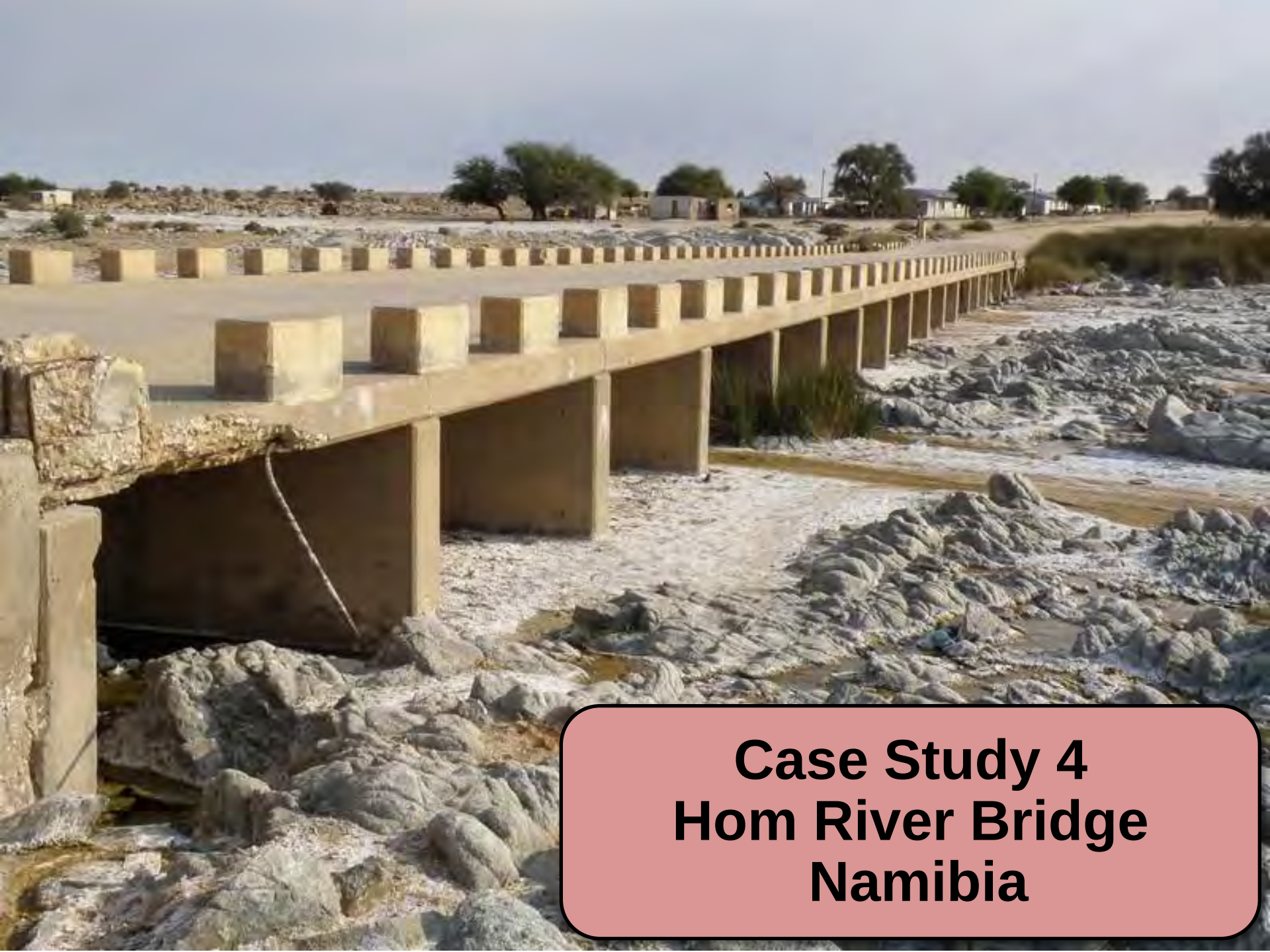
NB: No corrosion due to dry climate
Hence R = 2 and not 3

Bearing and abutment failure

D = 4

E = 2

R = 4



Case Study 4
Hom River Bridge
Namibia

BMS Implementation

- Taiwan Area National Freeway Bureau
- Dubai Road Transport Authority
- Spoornet
- SA National Roads Agency Limited
- N3 Toll Concession Ltd, TRAC & Bakwena
- Western Cape Department of Transport
- Eastern Cape Department of Transport
- Mpumalanga Provincial Government
- KwaZulu-Natal Department of Transport
- Botswana Roads Department
- Swaziland Ministry of Public Works & Transport
- Namibia Roads Authority
- City of Cape Town, Johannesburg Roads Agency
- Nelson Mandela Metro, Mangaung Metro
- Sasol (Secunda)
- Namibia Ports Authority (NamPort)

Conclusions

By having a Bridge Management System:

- Structures are maintained at acceptable levels of service
- Defects are identified timeously and repaired ecconomically
- Prioritisation (optimisation) of work (expenditure)
  - Funds channeled to more important defects
  - Expenditure reduced on less important defects
- Improved control of expenditure by management
- Accessibility of information
  - Decision making easier (Impact of decisions)
  - Detail of output depends on user

Thank you

our future through science