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The development of a road materials database: Interim Report: 1st Draft

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Abstract:

The data required for a road materials database has been identified and a basic structure formulated. A set of Excel workbooks and associated worksheets has been developed as a foundation for the database and as an interim means of gathering test data. A modular approach has been used to minimise processing time. It is recommended that a standard format for all future as-built/completion data be adopted by Gautrans and its appointed consultants and contractors to allow cost-effective data capture, once the database has been commissioned.

Keywords:

Road material database, APT, HVS, LTPP

Proposals for implementation:

Continue with development of database

Related documents:

None

Signatures:

LR Sampson	LR Sampson	B Verhaeghe	**Information**	P Hendricks
Language Editor	**Technical Review**	**Prog Manager**	**Centre**	**Director**

TERMS OF REFERENCE

CSIR Transportek was requested by Gautrans to develop a road materials database. The terms of reference for the study were to:

- Determine what data should be included in the database
- Design a database structure
- Develop an Excel spreadsheet for temporary collection of data
- Provide assistance to the database programmer during the programming of the database (programming by M Verbruggen)

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TABLE OF CONTENTS

1. INTRODUCTION

Recently, extensive work has been carried out on the development of techniques, mix design and structural design methods based on data from controlled laboratory, Heavy Vehicle Simulator and field tests in South Africa. This has enabled the development of guideline documents for the design and use of materials, such as foamed bitumen, bituminous emulsion, hot mix asphalt, cement and lime treated materials and modified binders. These developments concentrated on the activities on the right-hand side of the research, development and implementation (RDI) cycle shown in Figure 1. However, as new information becomes available the various guidelines will need to be revised and updated. Hence it is becoming increasingly important that a comprehensive materials database be developed to establish an up-to-date record of projects using specific material types with an ongoing performance track record. This would be in line with the activities on the left-hand side of the RDI cycle.

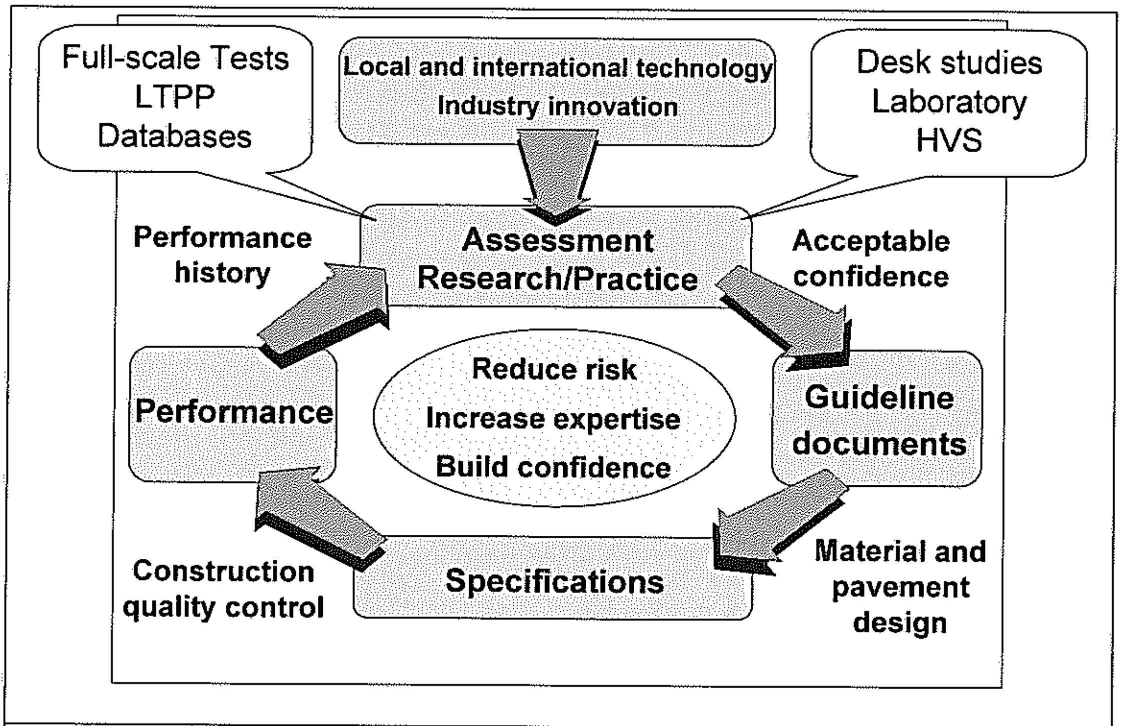

Figure 1 Research, development and implementation cycle for pavement engineering technology

Although numerous experiments have been and are monitored by various organisations in the country, there is currently no effective, standardised method of capturing data for periodically updating best practice. This study covers the development of a database to capture the pre-construction, design and construction data of new and rehabilitated roads. The database will be designed in such a way as to facilitate the capture of data for any type of experiment and material type. An associated study "A Protocol for the Establishment and Operation of LTPP Sections" (CSIR Report No CR-2003/11[1]), covers the establishment of long-term pavement performance (LTPP) sections for obtaining real-life performance data for these projects.

In this report, the contents and structure of the proposed database are described, the development of a spreadsheet to capture initial test data is summarised (with printouts) and aspects relating to implementation of the database are discussed.

2. DATA REQUIRED IN THE DATABASE

The following minimum data requirements were considered necessary for a road materials database:

- Inventory data
    - Province
    - Region or district (in province)
    - Location (from town or node, to town or node)
    - Road number
    - Chainage (start, end)
    - Completion date of construction
    - Road description (category and classification (TRH4[2])
    - Climate (Weinert[3] and Thornthwaite[4])
    - Shoulders (material, sealed or unsealed and width)
    - Lane detail (number of lanes, lane number (one entry per lane), lane width)
    - Subgrade description (material type, Colto[5] design class)
    - Lower selected layer (material type, thickness, stabilizer type, Colto design class)
    - Upper selected layer (material type, thickness, stabilizer type, Colto design class)
    - Lower subbase (material type, thickness, stabilizer type, Colto design class)
    - Upper subbase (material type, thickness, stabilizer type, Colto design class)
    - Base (material type, thickness, stabilizer type, Colto design class)
    - Prime (type)
    - Tack coat (type)
    - Surfacing (type, thickness, nominal size, binder type, modifier type)
    - Reseal-1 (type, thickness, nominal size, binder type, modifier type, date)
    - Reseal-2 (type, thickness, nominal size, binder type, modifier type, date)
    - Reseal-3 (type, thickness, nominal size, binder type, modifier type, date)
    - Traffic count-1 (date, annual average daily traffic, per cent heavies)
    - Traffic count-2 (date, annual average daily traffic, per cent heavies)
    - Rainfall (either monthly or annual)
- Road data
    - Subgrade
        - Chainage

        - Grading (per cent passing 63, 53, 26.5, 19, 13, 9.5, 6.7, 4.75, 2.0, 0.425 and 0.075 mm sieves), grading modulus and maximum size)
        - Atterberg Limits (liquid limit, plastic limit, plasticity index, bar linear shrinkage)
        - Mod AASHTO maximum dry density and optimum moisture content
        - California Bearing Ratio (at 100, 98, 95 93 and 90 per cent Mod AASHTO compaction) and swell
        - Material classification (Colto[5] and AASHTO[6])
        - Field information (density, moisture content and relative compaction)
    - Lower selected and upper selected layers
        - As for subgrade plus
        - Thickness
    - Lower and upper subbase layers
        - As for selected layers plus (for pre and post construction)
        - Stabilizer detail (content, unconfined compressive strength (UCS), indirect tensile strength (ITS) and initial consumption of stabilizer (ICS))
    - Base
        - As for subbase layers
    - Base design detail
        - Untreated material
            - Chainage and sample number for material removed from the road
            - Borrow pit number and sample number for material sampled in borrow pits
            - Grading (per cent passing 63, 53, 26.5, 19, 13, 9.5, 6.7, 4.75, 2.0, 0.425 and 0.075 mm sieves), grading modulus, maximum size and flakiness index
            - Apparent relative density, bulk relative density and water absorption
            - Atterberg Limits (liquid limit, plastic limit, plasticity index, bar linear shrinkage)
            - Mod AASHTO maximum dry density and optimum moisture content
            - California Bearing Ratio (at 100, 98, 95, 93 and 90 per cent Mod AASHTO compaction) and swell
            - Material classification (Colto and AASHTO)
            - pH, electrical conductivity and soluble salt content

- Aggregate Strength (10%FACT, aggregate crushing value (ACV), aggregate impact value (AIV))
      - Durability (durability mill index (DMI))
    - Treated material (cementitious stabilizers)
      - Stabilizer content
      - ICS
      - Strength (UCS, carbonated UCS, ITS and strain at break)
      - Atterberg limits after treatment
      - Durability (wet and dry brushing, erosion, erodibility)
    - Treated material (bituminous stabilizers)
      - Stabilizer content
      - Strength (UCS, ITS and strain at break)
      - Atterberg limits after treatment
      - Durability (test to be determined)
    - Cross reference to file on seal/asphalt design
  - Prime
    - Chainage
    - Application rate
    - Spray temperature
    - Kinematic viscosity
  - Tack coat
    - As for prime
  - Surfacing
    - Chainage
    - Seal
      - Average least dimension (ALD)
      - Aggregate strength (10%FACT and ACV)
      - Water absorption
      - Binder application
      - Stone application
    - Asphalt
      - Marshal stability and flow
      - Maximum theoretical relative density and bulk relative density
      - Thickness
      - Density
    - Concrete
      - Strength
  - Reseals
    - As per surfacing

- Surfacing design detail
  - Source (stone, binder, batching plant)
  - Aggregate
    - Grading analysis
    - Flakiness index
    - Average least dimension
    - Sand equivalent
    - Durability (10%FACT, aggregate crushing value (ACV), polished stone value (PSV))
  - Binder/asphalt
    - Penetration (before and after rolling thin film oven test)
    - Softening point (before and after rolling thin film oven test)
    - Viscosity (before and after rolling thin film oven test)
    - Ductility (before and after rolling thin film oven test)
    - Spot test
    - Adhesion
    - Water content
    - Particle charge
    - Binder content
    - Permeability
  - Marshall properties (voids in mix, voids in mineral aggregate, indirect tensile strength, dynamic creep)
  - Ball penetration
  - Concrete
    - Water : cement ratio
    - Cement content
    - Slump
    - Strength
  - Cross reference to file on seal/asphalt/concrete design

3. STRUCTURE OF THE DATABASE

The database should have two main components - an inventory and individual road detail.

3.1. Inventory

The inventory will include all the basic information provided in the previous chapter. The road number will link the inventory to the individual roads. It will provide summary data that should not change during the life of the road. Provision has been made for lower and upper selected layers, lower and upper subbase layers and a single base layer. Only high standard roads will have this full complement of layers. For lighter structures, detail will only be captured for the relevant layers. The original surfacing and all subsequent reseals and/or overlays will be captured. The road number will also link to periodic traffic counts.

3.2. Road Detail

Each road will be stored in the database as a separate entity, linked to the inventory by the road number. Sub-levels will store data on the subgrade, each layer and the surfacing. Additional sublevels will store data on the base and surfacing design.

Specialist investigation and specific details vary from project to project and implementer to implementer. These data are, however, integral to the project and should be stored in their original formats (spreadsheet) where possible with appropriate links to the road inventory and specific layer field.

3.3. Search Facility

In order to optimise use of the database, an effective search facility that can isolate individual projects, test methods, material types, climatic indices, etc will be essential.

4. DEVELOPMENT OF THE DATA SPREADSHEETS

Two workbook formats were developed, one for the inventory and one for the individual road material data, as described in the previous chapter. These workbooks are linked by the road number, which is also part of the filename. The inventory workbook consists of three worksheets:

- Basic inventory data as described in Chapter 2
- Time related traffic data
- Rainfall data

The material workbook for each road consists of 11 worksheets:

- Subgrade
- Lower selected layer
- Upper selected layer
- Lower subbase
- Upper subbase
- Base
- Base design detail
- Prime
- Tack coat
- Surfacing
- Surfacing design detail

The data requirements listed in Chapter 2 are accommodated in these worksheets.

Examples of the worksheet formats, with data from Road P243/1 (Vereeniging to Heidelberg) are provided as an illustration in Appendix A.

To assist with data input and interpretation, many of the spreadsheet cells have been supplemented with comments boxes. These provide equivalents of drop-down menus, help screens and various pertinent comments regarding the contents and required input of the cells.

5. IMPLEMENTATION OF THE PROPOSED DATABASE

5.1. Inventory

The standard/fixed information applicable to each road would generally be similar to that used in a road management system (RMS). However, unlike the RMS information, it is probable that the "road links" in the database would be much longer and not necessarily associated with fixed nodes.

Although most roads are constructed to a standard design for the majority of their length, aspects such as subgrade conditions, borrow-pit availability and material selection often result in significantly different pavement profiles along the length of the road. It is not practically possible to delineate uniform sections consisting of identical pavement materials and structures. The facility to take this into account in the inventory is provided by permitting, for example, more than one material type and a combination of stabilizers (eg foamed bitumen and cement), for any specific layer.

In terms of the road inventory distinctions are made along any road on the basis of significant changes in surfacing (eg seal to asphalt), base course (eg stabilized to crushed stone) and subbase (if stabilization is used).

The inventory should remain essentially the same throughout the service life of the road. However, major betterment (eg addition of lanes, sealed shoulders, etc) partial rehabilitation or reconstruction could result in a redefinition of uniform sections. This can be accommodated by subdividing any road in the inventory (according to chainage) to describe any new pavement structure, with an associated comment box. The new data will simply be added as new fields in the existing material database.

5.2. Material Data

Each worksheet equivalent in the database is populated with all the data for the respective layer. This will include the as-built/completion/quality results obtained from the consultant and contractor on each project. These data are normally provided at anything from 100 to 200 m intervals along the entire length of the road and include the results of a variety of properties. In order to reduce the volumes of data requiring capture, the data should be supplied to the road authority in a standard spreadsheet format that can be imported directly into the database (this would also ensure that the data captured during construction fulfils the minimum requirements for all projects).

If the data is not provided in a standard and compatible format, it is unlikely that this data will ever be captured effectively into the database, based on the pure volume of data generated during typical projects. It is important that the concept of the database is not lost as a result of the significant volumes of data that will become available and any potential inefficiencies in data capture. In some cases, it may be necessary to reduce the overall data volumes by omitting, for example, intermediate chainages (eg recording data every 1.0 km instead every of 0.1 km).

5.3. Specific Design Data

For base and surfacing designs in particular, design testing is carried out early in the project. This necessarily requires the use of randomly selected borrow pit samples, centre line samples on recycling projects, or samples from quarries or batching plants. The test results obtained are thus not necessarily related to any specific chainage on the road.

During designs involving treatment of materials using, for example, bitumen, cement or lime, numerous tests to determine stabilizer contents, material strengths or moduli, durability, etc are carried out. The test selected and the test parameters (eg confining pressures and loading rates in triaxial tests) tend to vary from laboratory to laboratory and depending on the pavement design parameters. Much of this data is often available only in the form of design reports or documentation.

This information is normally expensive to collect and is valuable for later analysis and interpretation and future designs and thus should be documented with other information pertaining to the road. As a minimum, a reference to the documented information, or preferably capture of the information as a separate field in the database should be ensured. The nature of the information is such that providing fields in the database for every conceivable data format is impracticable.

5.4. Benefits of the Proposed Database

A database of the nature envisioned in this report would provide an extensive source of pertinent road construction test results. To gain maximum benefit from this valuable information, it is essential that it can be easily accessed in a format that can be used directly in statistical analysis packages. Typical applications would be:

- Evaluation of the variability of different tests

- Comparison of the results obtained from different laboratories
- Development of correlation models between different tests
- Input into long-term pavement performance analyses
- Comparison of pre-design, design and as-built records
- Source of information for future projects

6. CONCLUSIONS

The development of a comprehensive material database that will allow maximum benefit from the expensive testing (both routine and non-routine) carried out on road projects is commendable. However, in view of the enormous volume of data associated with road construction projects, steps will need to be implemented to ensure that the undertaking is sustained.

The data required for the proposed road materials database has been identified and a basic structure formulated. A set of Excel workbooks and associated worksheets has been developed as a foundation for the database and as an interim means of gathering test data. A modular approach has been used to minimise processing time. It is recommended that a standard format for all future as-built/completion data be adopted by Gautrans and its appointed consultants and contractors to allow cost-effective data capture, once the database has been commissioned.

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APPENDIX A

SPREADSHEET FOR TEST DATA CAPTURE

APPENDIX A: SPREADSHEETS FOR TEST DATA CAPTURE

Examples of the inventory and road spreadsheets are provided on the following pages. Test data from Road P243/1 between Heidelberg and Vereeniging (HVS tests on foamed bitumen and bitumen emulsion treated bases) are included.

Inventory

Province	Region	Location		Road No	Chainage		Completion date	Road class		Climate		Shoulders		Lane			Subgrade	
		From	To		Start	End		Category	Classification	Weinert	Thorn	Sealed	Width	No lanes	Lane No	Width	Material	Design class
Gauteng	Vereeniging	Vereenigin	Heidel	P243/1	14.2	14.3	2000	C	ES1	2.4	-20	0		2	2	3.7	9	
Gauteng	Vereeniging	Vereenigin	Heidel	P243/1	14.3	14.4	2000	C	ES1	2.4	-20	0		2	2	3.7	9	
Gauteng																		
Gauteng																		
Gauteng																		
Gauteng																		
Gauteng																		
Gauteng																		
Gauteng																		
Gauteng																		
Gauteng																		
Gauteng																		
Gauteng																		

Lower selected				Upper selected				Lower subbase				Upper subbase			
Material	Thickness	Stabilizer	Design class	Material	Thickness	Stabilizer	Design class	Material	Thickness	Stabilizer	Design class	Material	Thickness	Stabilizer	Design class
								1,9	65	1	C4				
								1,9	65	1	C4				

Base				Prime	Tack	Surfacing				
Material	Thickness	Stabilizer	Design class	Type	Type	Type	Thickness	Size	Binder	Modifier
1,9	250	1,3	FB2			Asphalt	30		60/70	B12
1,9	250	1,4	ETG			Asphalt	30		60/70	B12

Reseal1						Reseal2						Reseal3					
Type	Thickness	Size	Binder	Modifier	Date	Type	Thickness	Size	Binder	Modifier	Date	Type	Thickness	Size	Binder	Modifier	Date

Traffic

Province	Region	Location		Road No	Chainage		Count1			Count2			Count 3			Count 4		
		From	To		Start	End	Year	AADT	%Heavy	Year	AADT	%Heavy	Year	AADT	%Heavy	Year	AADT	%Heavy

Rainfall

Province	Region	Location		Road No	Chainage		Year 1			Year 2			Year 3			
		From	To		Start	End	Year	Gauge location	Rainfall	Year	Gauge location	Rainfall	Year	Gauge location	Rainfall	Year

Subgrade

Chainage	Grading														Atterberg limits				Mod	
	P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS	MDD	OMC
14																				
14.1																				
14.2					100	98			80	63	47	31	1.59		35.4	17.4	18	7.15	2133	8.9
14.3					100	98			75	58	51	41	1.5		40.5	18.5	22	9.69	1963	11.5
14.4																				
14.5																				
14.6																				
14.7																				
14.8																				
14.9																				
15																				
15.1																				
15.2																				
15.3																				
15.4																				
15.5																				
15.6																				
15.7																				
15.8																				
15.9																				
16																				

CBR						Classification		Field		
100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction
	13	15	15	14		G10	A-2-6	1887	12.4	88
	17	12	10	9		G10	A-7	1589	15.4	78

Lower Selected Layer

Chainage	Thickness	Grading														Atterberg limits				Mod	
		P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS	MDD	OMC
14																					
14.1																					
14.2																					
14.3																					
14.4																					
14.5																					
14.6																					
14.7																					
14.8																					
14.9																					
15																					
15.1																					
15.2																					
15.3																					
15.4																					
15.5																					
15.6																					
15.7																					
15.8																					
15.9																					
16																					

CBR						Classification		Field		
100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction

Upper Selected Layer

Chainage	Thickness	Grading														Atterberg limits				Mod	
		P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS	MDD	OMC
14																					
14.1																					
14.2																					
14.3																					
14.4																					
14.5																					
14.6																					
14.7																					
14.8																					
14.9																					
15																					
15.1																					
15.2																					
15.3																					
15.4																					
15.5																					
15.6																					
15.7																					
15.8																					
15.9																					
16																					

CBR						Classification		Field		
100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction

Lower subbase

																Preconstruction					
Chainage	Thickness	Grading														Atterberg limits				Mod	
		P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS	MDD	OMC
14																					
14.1																					
14.2	150					100	99			85	65	54	40	1.41		32.7	17.7	15	7	1976	12.5
14.3																					
14.4																					
14.5																					
14.6																					
14.7																					
14.8																					
14.9																					
15																					
15.1																					
15.2																					
15.3																					
15.4																					
15.5																					
15.6																					
15.7																					
15.8																					
15.9																					
16																					

CBR						Classification		Field			Stabilizer			
100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction	Content	UCS	ITS	ICS
	31	26	20	11		G10	A-6							

Postconstruction																				
Thickness	Grading													Atterberg limits				Mod	
	P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS	MDD	OMC
65													1.42				15		1976	12.5
65													1.42				15		1976	12.5

CBR						Classification		Field			Stabilizer			
100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction	Content	UCS	ITS	ICS
		26	20			G10		1706	13.8	86				
		26	20			G10		1723	15.6	87				

Upper subbase

																			Preconstruction
Chainage	Thickness	Grading														Atterberg limits			
		P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS
14																			
14.1																			
14.2																			
14.3																			
14.4																			
14.5																			
14.6																			
14.7																			
14.8																			
14.9																			
15																			
15.1																			
15.2																			
15.3																			
15.4																			
15.5																			
15.6																			
15.7																			
15.8																			
15.9																			
16																			

Mod		CBR						Classification		Field			Stabilizer			
MDD	OMC	100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction	Content	UCS	ITS	ICS

Postconstruction																		
Thickness	Grading														Atterberg limits			
	P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS

Mod		CBR						Classification		Field			Stabilizer			
MDD	OMC	100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction	Content	UCS	ITS	ICS

Base

																				Preconstruction	
Chainage	Thickness	Grading														Atterberg limits				Mod	
		P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS	MDD	OMC
14																					
14.1																					
14.2	150		100	87	80	74	71			53	41	34	12	2.13				NP		2100	8.5
14.3																					
14.4																					
14.5																					
14.6																					
14.7																					
14.8																					
14.9																					
15																					
15.1																					
15.2																					
15.3																					
15.4																					
15.5																					
15.6																					
15.7																					
15.8																					
15.9																					
16																					

CBR						Classification		Field			Stabilizer			
100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction	Content	UCS	ITS	ICS
		66	47	28	0.2									

Postconstruction																				
Thickness	Grading														Atterberg limits				Mod	
	P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	Max size	LL	PL	PI	LS	MDD	OMC
																	0			
250																			2013	11.2
250																			2013	11.2

CBR						Classification		Field			Stabilizer			
100	98	95	93	90	Swell	Colto	AASHTO	F Density	F MC	Compaction	Content	UCS	ITS	ICS
								2034	11.4	101	1.8,2	1791	230	
								2033	11.4	101	1.8,2	2375	325	

Base Detail

Source																						
Road		Borrow pit		Cross	Grading																	
Chainage	Sample No	Borrow pit No	Sample No	reference	P63	P53	P37	P26.5	P19	P13	P9.5	P6.7	P4.75	P2	P425	P075	GM	FI-index	ARD	BRD	WA
14				CR-2001/32			100	97	88	80	73	65	57	43	31	13					5

Untreated																														
																	Durability and strength													
Atterberg limits				Mod		CBR						Classification					10%FACT			ACV		DMI								
LL	PL	PI	LS	MDD	OMC	100	98	95	93	90	Swell	Colto	AASHTO	pH	EC	Salts	Wet	Dry	Ratio	Wet	Dry	A425	API	B425	BPI	C425	CPI	D425	DPI	DMI
26.8	19.8	7	2.6	2025	9.1		56	23	18	6	0.6																			

				Treated																			
												Cementitious											
Aggegate Impact Value				Stabilizer content					Strength			A Limits after treatment				W/D Brush		Carb UCS		Erosion		Erodibility (concrete)	
Dry	Wet	Ratio	Glycol	Cement	Lime	Res bit	Other	ICS	UCS	ITS	S at B	LL	PL	PI	LS	Density	%loss	Density	UCS	Density	% Loss	Density	% Loss
				1		1.8																	

Prime

Chainage	Application rate	Temperature	K-Viscosity
14			
14.1			
14.2			
14.3			
14.4			
14.5			
14.6			
14.7			
14.8			
14.9			
15			
15.1			
15.2			
15.3			
15.4			
15.5			
15.6			
15.7			
15.8			
15.9			
16			

Tack coat

Chainage	Application rate	Temperature	K-Viscosity
14			
14.1			
14.2			
14.3			
14.4			
14.5			
14.6			
14.7			
14.8			
14.9			
15			
15.1			
15.2			
15.3			
15.4			
15.5			
15.6			
15.7			
15.8			
15.9			
16			

Surfacing

	Surfacing 1																
	Seal					Aspahlt							Concrete	Seal			
Chainage	ALD	10%FACT	ACV	Water absortion	Application	Thickness	Stability	Flow	Density	Voids	MTRD	BRD	Strength	ALD	10%FACT	ACV	Water absortion
14																	
14.1																	
14.2						30			2318	5.5							
14.3						30			2318	5.5							
14.4																	
14.5																	
14.6																	
14.7																	
14.8																	
14.9																	
15																	
15.1																	
15.2																	
15.3																	
15.4																	
15.5																	
15.6																	
15.7																	
15.8																	
15.9																	
16																	

Reseal 1								Reseal 2												
	Aspahlt						Concrete	Seal					Aspahlt					
Application rate	Thickness	Stability	Flow	Density	MTRD	BRD	Strength	ALD	10%FACT	ACV	Water absortion	Application	Thickness	Stability	Flow	Density	MTRD	BRD

Surfacing detail

Chainage						Stone													
	Source			Cross reference		Grading													
	Stone	Binder	Asphalt plant	Seal design	Asphalt design	P26	P19	P13	P9.5	P6.7	P4.75	P2	P0.425	P0.075	F-Index	ALD	Sand equiv	MTRD	BRD

Surfacing1																							
								Binder															
								Before rolling thin film oven test								After rolling thin film oven test							
Strength/durability										Viscosity								Viscosity					
10%FACT			ACV			PSV	Water absorption	Penetration	Soft Point	Brookefield		Saybolt F	Kinematic	Ductility		Penetration	Soft Point	Brookefield		Saybolt F	Kinematic	Ductility	
Dry	Wet	Ratio	Dry	Wet	Glycol					60	135							60	135				

	Adhesion						Marshall properties					Concrete			
Spot	R&W	Vialit	Rolling stone	Dean&S	Pcharge	Binder content	Voids in mix	Voids in aggregate	ITS	Dynamic creep	Permeability	Cement content	W:C ratio	Slump	Strength