Appendix A

Dynamic Cone Penetrometer

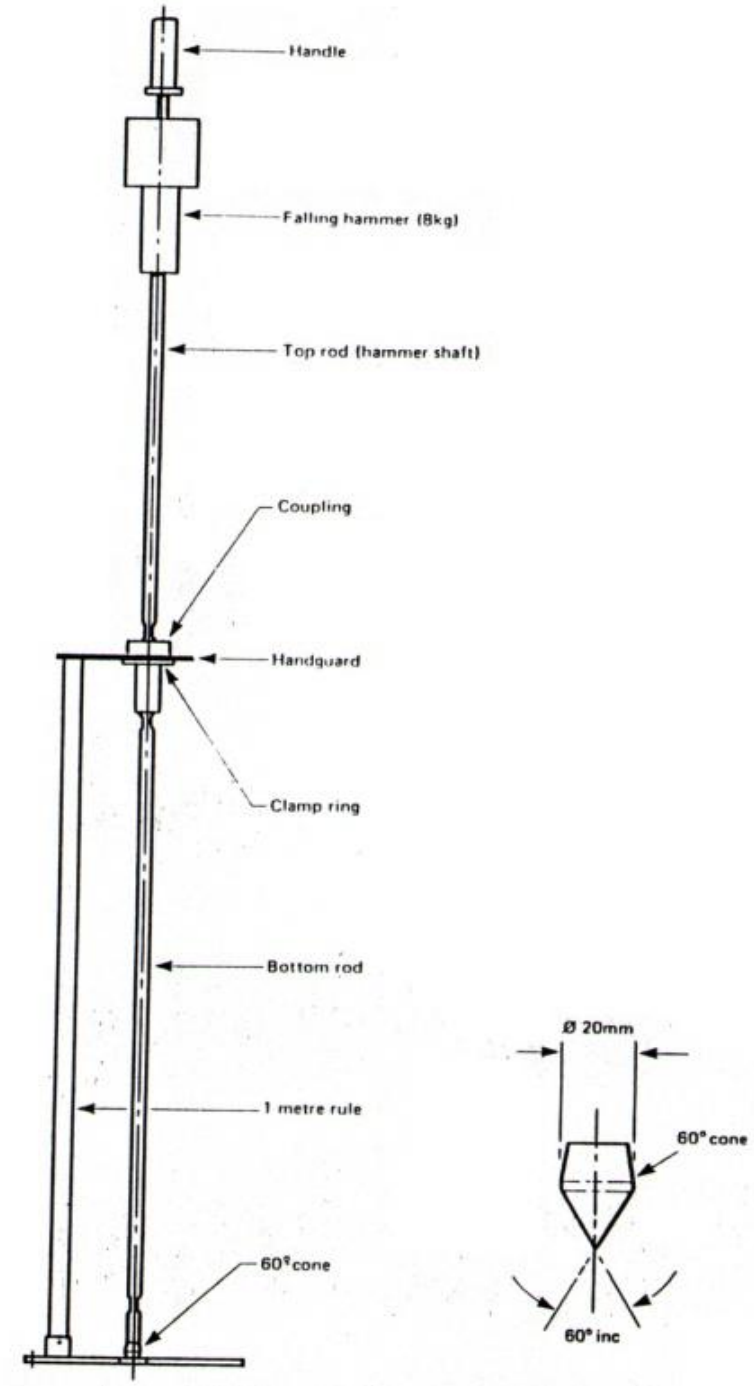

Plate (A1): TRL Dynamic Cone Penetromete

Minnesota Dynamic Cone Penetrometer

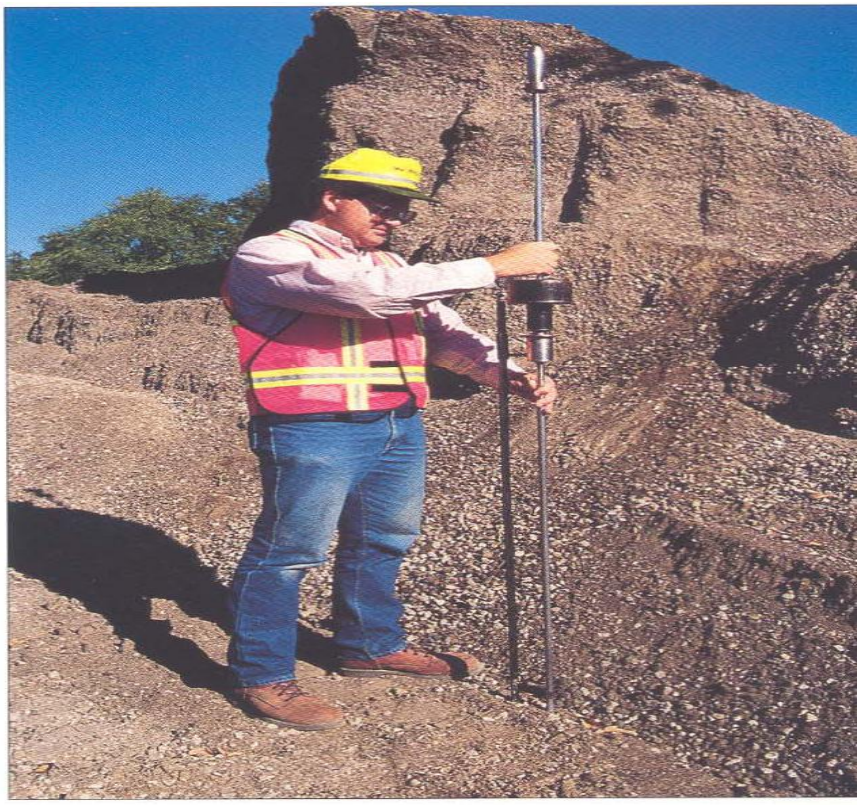

Plate (A2): Minnesota Dynamic Cone Penetrometer

Use a jack to extract the DCP from the soil after testing. Never remove the DCP by striking the hammer against the handle.

Plate (A3): Minnesota DCP Jack after Testing

Appendix B

DCP Field Test Form

Project name…… Date ……

Zero Error……. Surface type……

Chainage…….. Surface Moisture……

Test point	Blow	Depth mm		Test point	Blow	Depth mm
1	0			21		
2				22		
3				23		
4				24		
5				25		
6				26		
7				27		
8				28		
9				29		
10				30		
11				31		
12				32		
13				33		
14				34		
15				35		
16				36		
17				37		
17				38		
19				39		
20				40		

Remark……

……

……

……

Test by……..……

Appendix C

DCP Correlations Chart

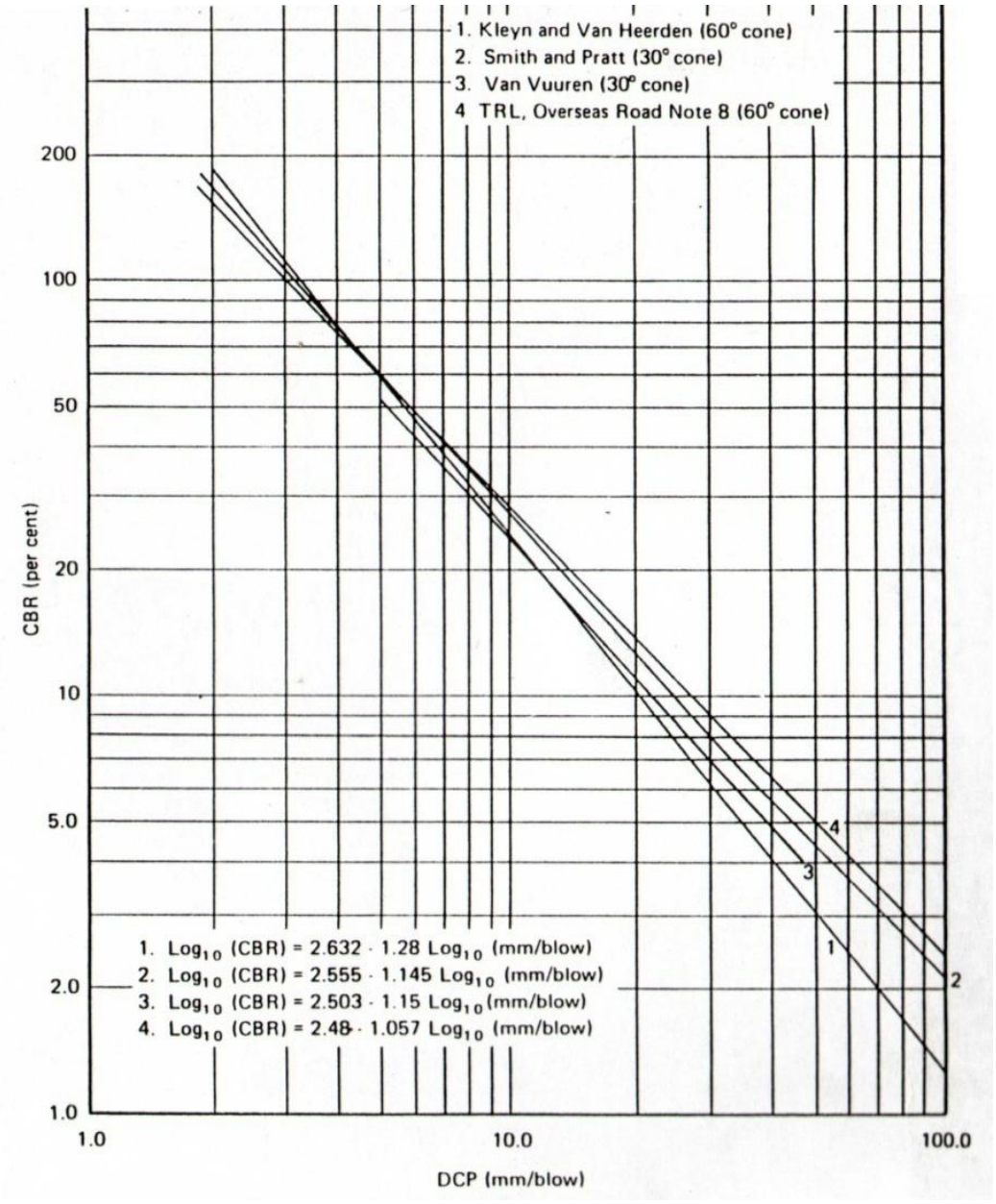

Figure (C1): DCP-CBR Relationship

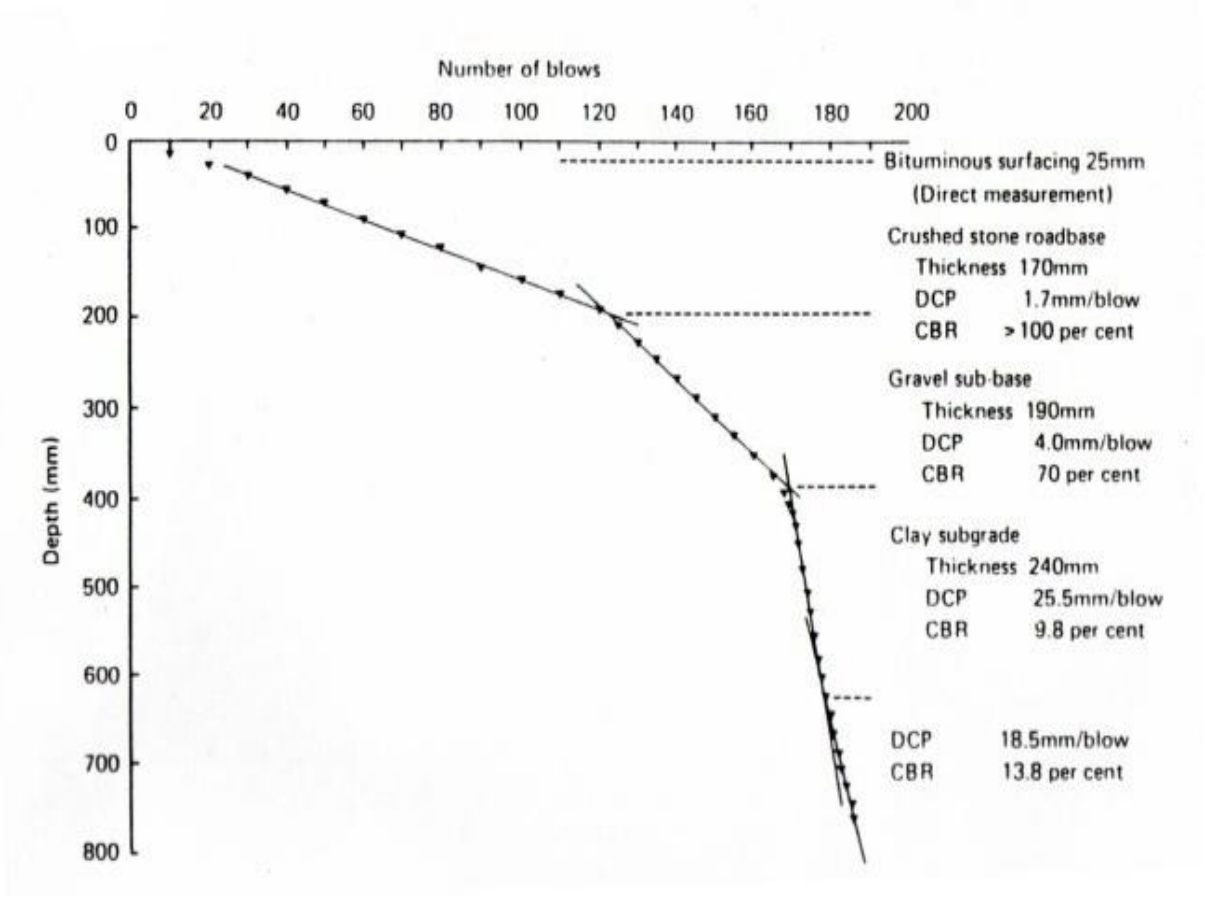

Figure (C2): TRL DCP test result

Table (C1): TRL DCP Standard Test Tesult

Surface type	Thickness(mm)	DCP mm/blow	CBR%
Bituminous surface	25	-	-
Crushed stone base	170	1.7	> 100
Gravel Sub-base	190	4.0	70
Clay Sub-grade	240	25.5	9.8
Sub-grade	100	18.5	13.8

DCP and CBR Correlation Chart (Mn/DOT)

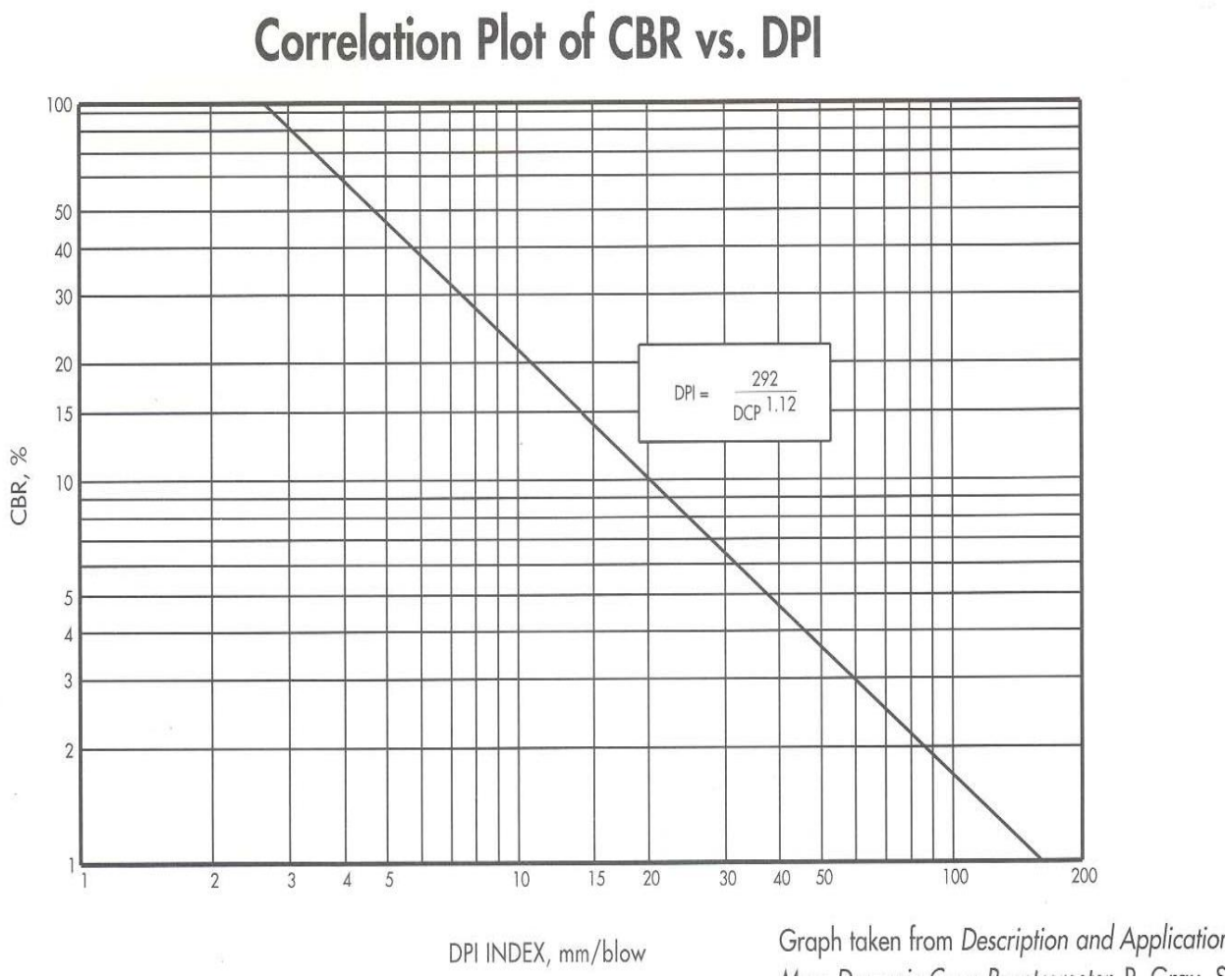

Figure (C3): DCP and CBR correlation chart Mn/DOT

DCP and SPT Correlation Chart (Mn/DOT)

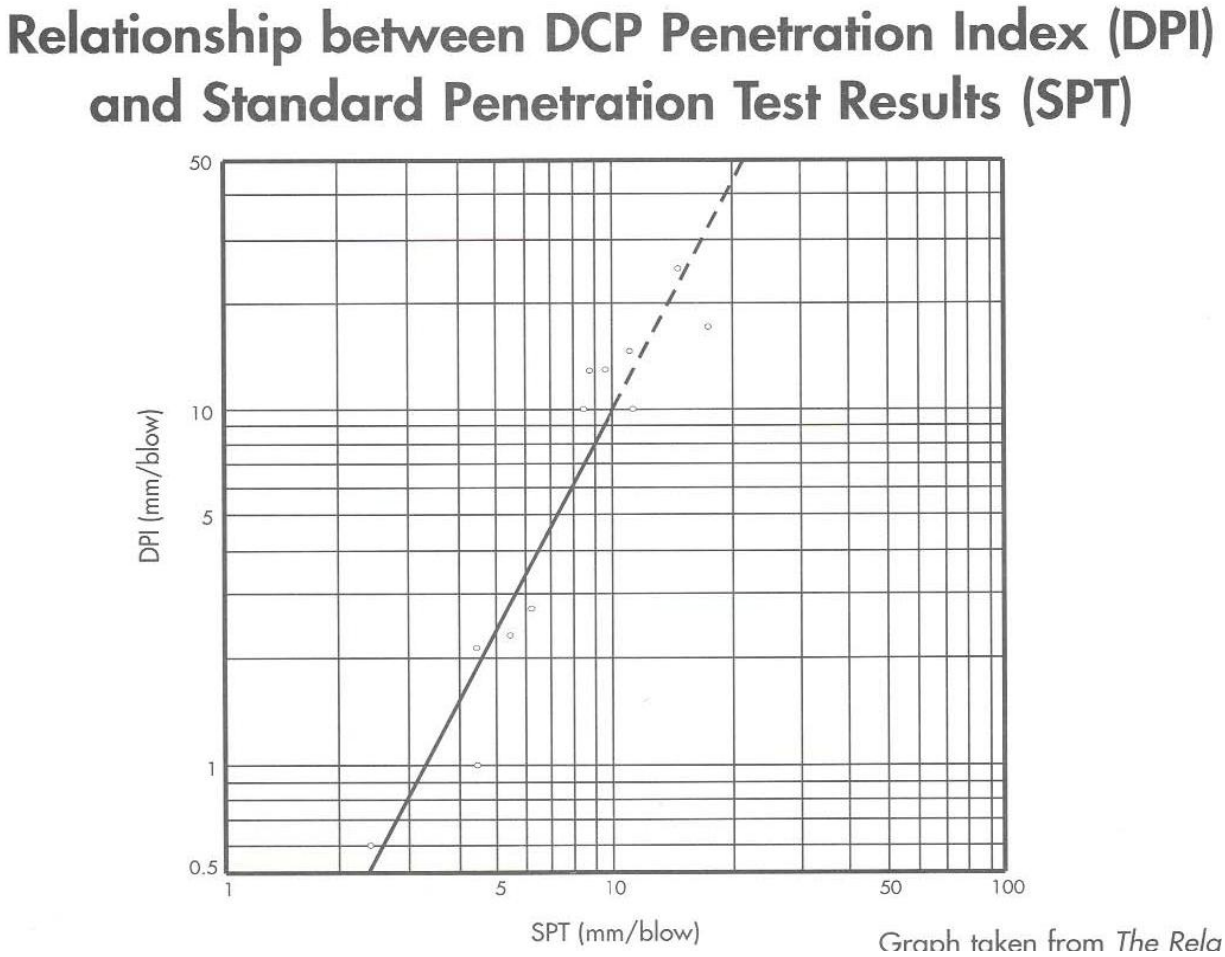

Figure (C4): DCP and SPT correlations chart Mn/DOT

Appendix D

UK-DCP3.1 Computer Software

United Kingdom software version 3.1 replaces version 2.2 which was released by TRL in May 2004, UK DCP 3.1 software is designed for two categories: the analysis of DCP data and the use of the DCP results to design.

UK DCP 3.1 main functions used in this research tabulated below

Table (D1): UK DCP 3.1 main functions

No.	Function	Description
1	Start up	Run UK DCP 3.1 and open a new or existing project. The term 'project' refers to a set of related sites, at each of which a penetration test has been carried out and which will be analyzed together. In normal use, a project will be a single road or a shorter length of uniform construction
2	Test data input	Input site details and penetration data for the tests within a project.
3	Layer analysis	Analyze the penetration data from a test to identify and determine the thicknesses of the distinct Test layers within the pavement. Penetration data can be analyzed manually or automatically.
4	Structural number calculation	Assign the Test layers to specific pavement layers and calculate the Structural Number of each pavement layer.

UK-DCP software to analyze DCP data is intended for users who already have a through understanding of DCP analysis and pavement design contain the following:

1- Project Manager

The Project Manager has two panels: Test Status and Design Status. The Test Status panel is used to analyze DCP data, including penetration data input, layer analysis and strength calculation. The Design Status panel is used to design low volume sealed roads, including survey and cost data input, design section analysis and design production.

2- Test Data Input

Input data for the penetration tests within a project for each penetration test, the following are required.Site details – information about the site where the test was carried out. Upper layers – information about the upper layers which cannot be analyzed by a DCP. Penetration data – data which records the number of blows of the DCP and the depth of penetration Set-Up – information about how each test is carried out, analyzed and displayed.

3- Test Data Analysis

Simple management of data sets and analysis include Graphical analysis of data either manually or automatically

4- Upper layers

UK DCP 3.1 uses penetration data to calculate the strength of most pavement layers. However, some layers are too thin, strong or impenetrable for relationships between penetration rate and strength to be derived. In this case, the strength of the layer is assessed from the type of the layer and its condition. This applies to layer types such as:

Surface

- Thin bituminous seal
- Hot mix asphalt
- Concrete
- Other surface

Base

- Cement treated base
- Bituminous base
- Coarse granular base (such as water Bound Macadam)

Layers Removed

Although Upper layers such as a thin bituminous seal can be penetrated by a DCP, some layers, such as hot mix asphalt or a cement treated base cannot be penetrated. It is necessary to remove these layers by drilling or cutting out before the test can be carried out. When inputting data, the number of upper layers which were removed should be entered. UK DCP 3.1 can accept the removal of 0, 1 or 2 layers.

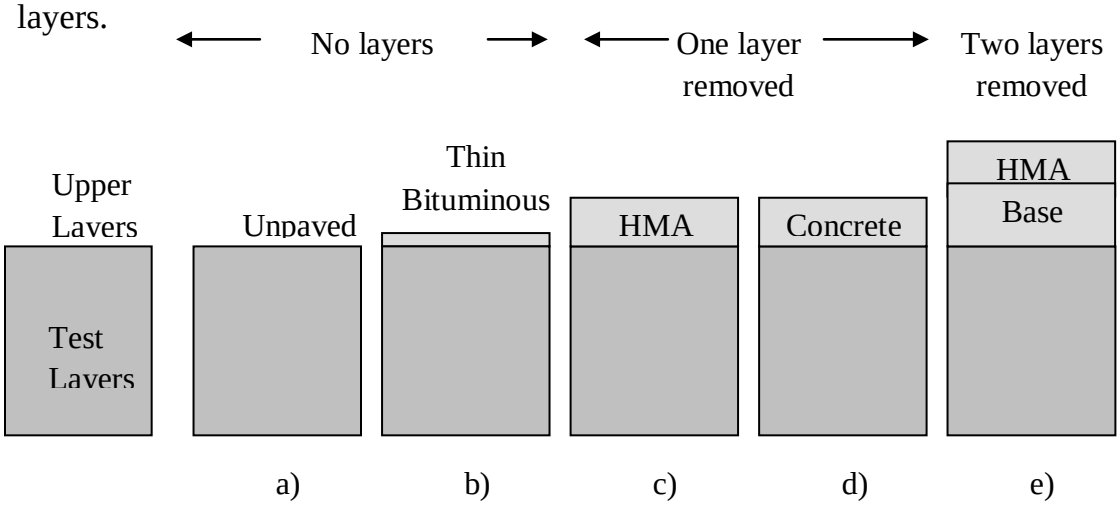

Plate (D1): Layers removed for DCP Test

5- CBR Calculation

The strengths of Test layers are calculated by converting the penetration rate (mm per blow) to a California Bearing Ratio (CBR) value and then from the CBR value to a strength coefficient and finally to a Structural Number. A number of relationships between penetration rate and CBR value have been derived and are given in table D2

Table (D2): Penetration Rate-CBR relationships

Cone angle	Name of relationship	Relationship
60° cone	TRL	$Log_{10}(CBR) = 2.48 – 1.057\ Log_{10}(pen\ rate)$
	Kleyn (pen rate > 2 mm/blow)	$CBR = 410\ (pen\ rate)^{-1.27}$

	Kleyn (pen rate ≤ 2 mm/blow)	$CBR = 66.66 (pen\ rate)^2 – 330 (pen\ rate) + 563.33$
	Expansive Clay Method	$Log_{10}(CBR) = 2.315 – 0.858\ Log_{10}(pen\ rate)$
	100% Planings	$Log_{10}(CBR) = 1.83 – 0.95\ Log_{10}(pen\ rate)$
	50% Planings	$Log_{10}(CBR) = 2.51 – 1.38\ Log_{10}(pen\ rate)$
	User-Defined	$Log_{10}(CBR) = [constant] – [coefficient]\ Log_{10}(Pen\ rate)$ Constant and Coefficient can be defined by the user
30° cone	Smith and Pratt	$Log_{10}(CBR) = 2.555 – 1.145\ Log_{10}(pen\ rate)$
	User-Defined	$Log_{10}(CBR) = [constant] – [coefficient]\ Log_{10}(Pen\ rate)$ Constant and Coefficient can be defined by the user

(Pen rate is the penetration rate measured in millimetres per blow)

6- CBR Adjustment Factor (for moisture)

DCP penetration data obtained from the upper layers of an unpaved road will vary throughout the year as the moisture content of the layers changes with rainfall. For design purposes, DCP testing should be carried out when the road pavement at its weakest, i.e., when the sub grade is at its highest moisture content.

Table (D3): CBR Adjustment Factors

Surface Moisture	Ratio of field moisture content to Optimum Moisture Content (Modified AASHTO)	Default CBR Adjustment Factor
Wet	1	1.00
Moderate	0.75	0.71
Dry	0.5	0.51
Very dry	0.25	0.37
Not assessed or difficult to assess	-	0.5

Appendix E

DCP Classification & Compaction Specification

1-UK- Classification

From an investigation of a series of case histories in Herfordshire, U.K., in which the DCP has been used, Huntley (1990) suggested a tentative classification system of soil based on penetration resistance; n in blows per 100 mm as illustrated in Tables (E1)and (E2).

Table (E1): Classification for granular soils using DCP (Huntley, 1990)

Classification	**n Value Range**		
		Sand	Gravelly sand
Very loose	<1	<1	<3
Loose	1-2	2-3	3-7
Medium dense	3-7	4-10	8-20
Dense	8-11	11-17	21-33
Very Dense	>11	>17	>33

Table (E2): Classification for cohesive soils using DCP (Huntley, 1990)

Classification	**n Value Range**
Very soft	<1
Soft	1-2
Firm	3-4
Stiff	5-8
Very stiff to hard	>8

2-Mn/DOT Compaction Control Specification

The Minnesota Department of Transportation (Mn/DOT) suggests this application to reduce testing time and effort while providing more consistent quality control of base layer compaction (Burnham, 1977). Using this procedure, immediately after the compaction of each layer of granular base material

The DCPI limiting value is valid for all freshly compacted base materials. The DCPI dramatically decreases as the materials setup time increases and under traffic loading.

Minnesota Department of Transportation has revised the limiting penetration rate to the following (Siekmeier et al., 1998):

a) 15 mm/blow in the upper 75 mm (3.0 in);

b) 10 mm/blow at depths between 75 and 150 mm (3 and 6 in); and

c) 5 mm/blow at depths below 150 mm (6 in).

The Minnesota Department of Transportation, based on the analysis of Mn/Road DCP testing, has recommended the following limiting values for DCPI during a rehabilitation study (Burnham, 1997):

a) Silty/Clayey material: DCPI less than 25 mm/blow (1.0 in/blow);

b) Select granular material: DCPI less than 7 mm/blow (0.28 in/blow); and

c) Mn/Road Class 3 special gradation requirements: DCPI less than 5

mm/blow (0.2 in/blow)

Table (E3): Typical CBR and DPI Ranges for Various Soils

Soil type	CBR% Range	DPI mm/blow Range
Clay(CL)	2 - 17	127 - 15
Sand(S-W)	17 - 45	15 - 6
Gravel(G-W)	53 - 100	5 – 2.7

Loose Sand and Gravel will have higher DPI value

Appendix F

Layers Strength Property Tables

1- Al-Gazeera Adjusted 4-Layers Strength Property

Al Gazeera 4-Layer property test point 0.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	7.33	37	22	22
2	2.78	103	50	72
3	1.23	242	223	295
4	1.97	147	596	891

Al Gazeera 4-Layer property test point 1.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	10.31	26	330	330
2	10.83	24	130	460
3	11.43	23	80	540
4	16.25	16	325	865

Al Gazeera 4-Layer property test point 1.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	11.32	23	249	248
2	6.2	44	62	311
3	4.83	57	251	562
4	8.03	33	321	883

Al Gazeera 4-Layer property test point 2.300

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	50.00	5	200	200
2	15.00	17	300	500
3	12.13	22	97	597
4	10.54	25	253	850

Al Gazeera 4-Layer property test point 2.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	25.50	10	153	153
2	7.69	35	123	276
3	10.50	25	336	612
4	11.39	23	262	874

A

l Gazeera 4-Layer property test point 3.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	21.19	12	339	339
2	10.00	26	60	399
3	8.90	30	178	577
4	11.75	22	282	859

Al Gazeera 4-Layer property test point 3.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	15.93	16	223	223
2	18.13	14	544	767
3	13.75	19	55	822
4	10.13	26	81	903

Al Gazeera 4-Layer property test point 4.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	17.00	15	102	102
2	8.74	31	166	268
3	16.27	16	602	870
4	12.50	21	25	895

Al Gazeera 4-Layer property test point 4.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	61.00	4	244	244
2	17.00	15	17	261
3	12.13	22	194	455
4	18.17	14	436	891

Al Gazeera 4-Layer property test point 5.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	51.25	5	205	205
2	20.00	13	400	605
3	24.17	10	145	750
4	15.75	16	126	876

Al Gazeera 4-Layer property test point 5.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	10.00	26	70	70
2	30.44	8	274	344
3	113.33	2	340	684
4	53.00	5	212	896

Al Gazeera 4-Layer property test point 6.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	35.88	7	287	287
2	5.75	48	138	425
3	7.25	37	203	628
4	10.00	26	260	888

Al Gazeera 4-Layer property test point 6.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	30.17	8	181	181
2	12.13	22	291	472
3	19.50	13	78	550
4	23.36	11	327	877

Al Gazeera 4-Layer property test point 7.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	10.94	24	175	175
2	6.00	45	246	421
3	6.58	41	329	750
4	8.80	30	132	882

Al Gazeera 4- Layer property test point 7.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	17.88	14	143	143
2	9.71	27	204	347
3	14.36	18	359	706
4	12.63	21	202	908

Al Gazeera 4-Layer property test point 8.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	27.33	9	164	164
2	13.50	19	189	353
3	20.06	13	321	674
4	22.00	12	220	894

Al Gazeera 4-Layer property test point 8.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	7.64	35	84	84
2	30.00	8	60	144
3	40.56	6	649	793
4	31.67	8	95	888

Al Gazeera 4-Layer property test point 9.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	26.37	10	501	501
2	17.75	14	142	643
3	15.63	17	125	768
4	13.88	19	111	879

Al Gazeera 4-Layer property test point 9.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	10.36	26	145	145
2	6.23	44	536	681
3	7.00	39	42	723
4	8.35	32	167	890

Al Gazeera 4-Layer property test point 10.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	6.5	42	182	182
2	9.75	27	78	260
3	23.33	11	140	400
4	37.14	7	520	920

Al Gazeera 4-Layer property test point 10.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	16.67	15	100	100
2	7.21	37	382	482
3	17.00	15	136	618
4	25.90	10	259	877

Al Gazeera 4-Layer property test point 11.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	13.63	19	109	109
2	5.00	55	20	129
3	3.54	79	393	522
4	5.67	48	363	885

Al Gazeera 4-Layer property test point 11.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	72.00	3	144	144
2	25.86	10	181	325
3	16.63	15	133	458
4	20.79	12	395	853

Al Gazeera 4-Layer property test point 12.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	75.33	3	226	226
2	9.10	29	264	490
3	22.25	11	89	579
4	37.14	7	260	839

Al Gazeera 4-Layer property test point 12.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	54.25	4	217	217
2	19.00	13	19	236
3	15.59	17	452	688
4	18.40	14	184	872

Al Gazeera 4-Layer property test point 13.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	11.41	23	308	308
2	17.14	15	360	668
3	20.90	12	209	877
4	14.00	19	28	905

Al Gazeera one-Layer property test point 13.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	18.56	14	891	891

Al Gazeera 4-Layer property test point 14.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	26.50	9	106	106
2	10.86	24	478	584
3	13.75	19	55	639
4	15.50	17	248	887

Al Gazeera 4-Layer property test point 14.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	21.13	12	169	169
2	6.77	40	298	467
3	20.71	12	145	612
4	31.88	8	255	867

Al Gazeera 4-Layer property test point 15.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	23.50	11	658	658
2	28.50	9	57	715
3	42.00	6	168	883
4	10.00	26	10	893

Al Gazeera 4-Layer property test point 15.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	38.73	6	426	426
2	18.89	14	170	596
3	22.40	11	224	820
4	24.33	10	73	893

Al Gazeera one-Layer property test point 16.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	15.29	17	887	887

Al Gazeera 4-Layer property test point 16.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	29.50	8	118	118
2	38.62	6	502	620
3	47.50	5	95	715
4	57.33	4	172	887

Al Gazeera one-Layer property test point 17.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	17.20	15	877	877

4-Layer property test point 17.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	12.25	21	196	196
2	9.82	27	491	687
3	11.00	24	44	731
4	13.42	19	161	892

Al Gazeera 4-Layer property test point 18.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	5.75	47	328	328
2	8.4	32	84	412
3	10.98	24	483	895
4	1.00	302	1	896

2-Alsteen Adjusted 4-Layers Layer Strength Property

Alsteen 4-Layer property test point 3.800

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	13.33	20	160	160
2	20.75	12	415	575
3	17.50	15	70	645
4	15.00	17	150	795

Alsteen 4-Layer property test point 4.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	8.5	31	165	165
2	11.07	24	310	475
3	8.43	32	118	593
4	6.38	43	102	695

Alsteen 4-Layer property test point 4.200

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	5.63	49	215	215
2	4.08	68	200	415
3	3.00	95	90	505
4	2.14	135	150	655

Alsteen 4-Layer property test point 4.400

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	5.00	55	85	85
2	6.03	45	350	435
3	6.75	40	135	570
4	7.78	35	140	710

Alsteen 4-Layer property test point 4.600

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	4.64	60	155	155
2	3.17	89	285	440
3	2.43	118	85	525
4	2.08	140	83	608

Alsteen 4-Layer property test point 4.800

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	3.83	73	333	333
2	4.88	57	122	455
3	8.00	34	120	575
4	15.56	17	280	855

Alsteen 4-Layer property test point 4.820

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	2.96	96	210	210
2	2.07	140	207	417
3	0.39	827	54	471
4	1.54	191	139	610

Alsteen 4-Layer property test point 5.000

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	4.84	57	317	317
2	6.32	43	158	475
3	9.00	30	180	655
4	14.27	18	157	812

Alsteen 4-Layer property test point 5.200

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	6.36	43	148	148
2	2.42	119	157	305
3	5.50	50	330	635
4	8.85	30	177	812

Alsteen 4-Layer property test point 5.220

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	3.40	83	156	156
2	6.20	44	62	218
3	8.40	32	378	596
4	14.75	18	295	891

Alsteen 4-Layer property test point 5.400

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	7.10	38	380	380
2	10.00	26	240	620
3	12.92	20	155	775
4	11.67	23	35	810

Alsteen 4-Layer property test point 5.500

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	1.98	147	171	171
2	3.48	81	87	258
3	7.35	37	147	405
4	16.30	16	440	845

Alsteen 4-Layer property test point 5.600

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	1.98	147	171	171
2	3.48	81	87	258
3	7.35	37	147	405
4	16.30	16	440	845

Alsteen 4-Layer property test point 5.800

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	2.86	100	115	115
2	4.00	70	160	275
3	6.80	40	170	445
4	5.14	53	360	805

Alsteen 4-Layer property test point 6.300

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	7.50	36	145	145
2	10.48	25	262	407
3	12.60	21	63	470
4	18.75	14	375	845

Alsteen 4-Layer property test point 6.700

NO.	DCP(mm/blow)	CBR (%)	Thickness(mm)	Depth to bottom layer (mm)
1	5.50	50	88	88
2	6.29	43	302	390
3	17.00	15	85	475
4	30.00	8	390	865

Appendix G
Modulus Values

1-Modulus of Elasticity Values

Table (G1) typical modulus of elasticity values for various materials Colorado Asphalt Pavement Association (CAPA).

Table (G1): Typical Modulus of Elasticity Values for Various Materials

Material	Elastic Modulus	
	MPa	psi
Diamond	1,200,000	170,000,000
Steel	200,000	30,000,000
Aluminum	70,000	10,000,000
Wood	7,000-14,000	1,000,000-2,000,000
Crushed Stone	150-300	20,000-40,000
Silty Soils	35-150	5,000-20,000
Clay Soils	35-100	5,000-15,000
Rubber	7	1,000

Table (G2): Over-Excavation Recommendations (from CAPA, 2000)

Subgrade Plasticity Index	Depth of Over-Excavation Below Normal Subgrade Elevation
10 - 20	0.7 meters (2 ft.)
20 - 30	1.0 meter (3 ft.)
30 - 40	1.3 meters (4 ft.)
40 - 50	1.7 meters (5 ft.)
More than 50	2.0 meters (6 ft.)

2-Mechanistic Resilient Modulus Values

For unbound soil materials, the property of choice is the resilient modulus (Mr). Determination of Mr will achieve through repeated loading tests. Due to the elaborate nature of this test and the fact that testing equipment are not widely available, alternative means for obtaining the Mr parameter were suggested by NCHRP new design guide.

Table (G3): Capacity parameters for a sample set of unbound materials tested using the Mr–PD approach

Material #	Material Description	AASHTO Class	Mre (MPa)	% Maximum PD
1	25-mm maximum size crushed stone material	A-1-b	170	0.12
2	13-mm maximum size crushed stone material	A-1-a	250	0.15
3	Naturally occurring gravel	A-1-a	180	0.33
4	Granular subbase material (not clean, fines = 15%)	A-1-b	85	1.56
5	Crushed gravel (25-mm maximum aggregate size)	A-1-a	112	0.56
6	Clay type 1	A-4	35	0.26
7	Clay type 2	A-6	50	1.26
8	Silty sand material	A-2-4	60	0.81
9	Clean sand material	A-3	65	0.33

Table (G4): Soil Classification Table – Relative compaction 95% MPD

Table (G4): Soil Classification Table – Relative compaction 95% MPD

Granular material classes							
Mechanistic Class8	Physical Properties				Mre (MPa) 9 Under stress prevailing in road layers		
	Nominal Maximum Size (mm) 1	% Passing 2.00 mm	% Passing 0.425 mm	% Passing 0.075 mm	Base High stress (80 – 150kPa)	Sub-Base Med. stress (20 – 80kPa)	Subgrade Low stress (≤20kPa)
NRCG1	13.2	23 –	11 –	5 – 7	210–	160–	150
NRCG2	19.0	16 –	10 –	5 – 7	155–	115–	120
NRCG52	13.2	35 –	18 –	8 – 13	–	–	100
NRCG3	13.2 –	17 –	10 –	5 – 15	–	125–	110
NRCG4	25.4	55 –	28 –	12 –	–	80–	70
Sand classes							
Mechanistic Class8	Physical Properties				Mre (MPa) 9 Under stress prevailing in road layers		
	% Gravel3	% Sand4	% Fines5		Base High stress (80 – 150kPa)	Sub-Base Med. stress (20 – 80kPa)	Subgrade Low stress (≤20kPa)
NRCS1	0	75 – 80	20 – 25		–	60–75	50
NRCS2	2 – 20	69 – 96	2 – 11		–	–	60
Cohesive material classes 10							

Mechanistic Class8	Physical Properties				Mre (MPa) 9 Under stress prevailing in road layers		
	% Clay6	% Silt7	Liquid Limit (%)	Plasticity Index (%)	Base High stress (80 – 150kPa)	Sub-Base Med. stress (20 – 80kPa)	Subgrade Low stress (≤20kPa)
NRCC1	>18	≤50	Max	Min 11	–	40–75	55
NRCC2	≤18	>50	Max	Max 10	–	45–60	40
NRCC3	>18	>50	Max	Max 10	–	–	30

1 Nominal maximum size of particles corresponds to the largest opening sieve on which there is a minimum of 5 percent by weight retained.

2 This material is very sensitive to stress and should only be used in pavement layers where the stress level does not exceed 21 kPa.

3 Material passing the 75 mm sieve and retained on the 2.00 mm sieve.

4 Material passing the 2.00 mm sieve and retained on the 0.075 mm sieve.

5 Material passing the 0.075 mm sieve.

6 % Clay is the material fraction < 0.002 mm

7 % Silt is the material fraction passing the 0.075 mm sieve and larger than 0.002 mm.

8 Mechanistic class refer to the class of the material as identified by its capacity (i.e. "% maximum PD" and Mre)

9 Elastic resilient modulus ranges, ± 10%, corresponding to provisional stress levels prevailing in road layers

[10] M_{re} values listed for cohesive soils are determined at optimum moisture condition