APPENDIX A

SUPPLEMENTARY INFORMATION (TABLES AND FIGURES) TO ASSIST DISCUSSION IN CHAPTER 4

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A.I INTRODUCTION

In this Appendix supplementary information, mostly in the form of tables and figures are given to assist the discussion on permanent deformation behaviour of pavements with lightly cementitios layers, in Chapter 4.

No detailed discussions are given here, as it is already given in Chapter 4. However, a discussion on an anomali found in the permanent deformation on one of the HVS test sections (Section 289A4) is given here, because it is considered important from an pavement evaluation point of view. This anomali is discussed in the following Paragraph A.2, after the tables and figures relating to Chapter 4.

TABLE A.1 DESIGN DATA FOR THE BASE AND SUBBASE OF THE DEEP PAVEMENT, ROAD 1932 (ROOIWAL)

Characteristic	Base (Quarry No. 20)*	Subbase (Quarry No. 5)*
Lab. density at 100% mod. AASHTO (kg/m^3)** (design stage)	2280	2083
Lab. density at 100% mod. AASHTO (kg/m^3) (during construction)**	2190	2160
In situ density (kg/m^3)	2083	2072
% of mod. AASHTO	95,1	96,0
Lab. optimum moisture content, % (design stage)	10,3	9,0
Lab. optimum moisture content, % (during construction)	7,9	7,4
In situ optimum moisture content, %	8,9	6,1
TRB-classification	A2-6(0)	A2-4(0)
Grading modulus (GM)	1,98	2,0
Design stabiliser content, % (PBFC) (m/m)	3,0	3,0
In situ stabiliser content, % (EDTA)	3,6	3,7
Plasticity index, PI (After stabilisation), %	3,6	7,9
Linear shrinkage, %	1,6	3,5

* See TPA report S4/79 (Pienaar, 1979).
** The densities are for the unstabilised material only.

TABLE A.2 DESIGN UNCONFINED COMPRESSIVE STRENGTH (UCS) RESULTS OF THE DEEP PAVEMENT, ROAD 1932 (ROOIWAL).

Characteristic	Base (Quarry No. 20)*	Subbase (Quarry No. 5)*
Soaked-UCS after 7 days at 100 % mod. AASHTO, kPa (design stage)	2000	2350
Soaked-UCS after 7 days at indicated % mod. AASHTO, kPa (contruction stage)	1400 (95,1%)	2250 (96,0%)
In situ soaked-UCS after 7 days at indicated % mod. AASHTO, kPa (contruction stage)	780 (95,1%)	1000 (96,0%)
Soaked-UCS after 28 days at indicated % mod. AASHTO, kPa (contruction stage)	1800 (95,1%)	2950 (96,0%)
In situ soaked-UCS after 28 days at indicated % mod. AASHTO, kPa (construction stage)	1210 (95,1%)	1500 (96,0%)

* See Table A.1

TABLE A.3 SUMMARY OF HVS TEST PROGRAMMES FOR THE VARIOUS TESTS DONE ON ROAD 1932 AT ROOIWAL

HVS-SECTION	TRAFFICKING WHEEL-LOAD (kN)	TYRE PRESSURE (kPa)	RANGE OF ACTUAL REPETITIONS	E80s*	TOTAL E80s	TEST CONDITIONS
250A4	40	690	0 - 596 874	596 874		IN SITU MOISTURE AND TEMPERATURE
	70	690	596 874 - 805 318	1 955 205		"
	100	690	805 318 - 817 674	482 625	3 034 704	"
250A4A	70	690	817 674 - 1 386 674	5 337 220		"
	100	690	1 386 674 - 1 617 674	9 022 860		"
	40	690	1 617 674 - 2 131 618	513 944		"
	70	690	2 131 618 - 2 468 974	3 164 399	18 038 423	"
250A4B	70	690	0 - 569 000	5 337 220		WATER AT 450 mm AFTER 217 000 REPETITIONS
	100	690	569 000 - 800 000	9 022 860		
	40	690	800 000 - 1 313 944	513 944		WATER AT 20 mm AFTER 800 000 REPETITIONS TO END OF TEST
	70	690	1 313 944 - 1 651 300	3 164 399	18 038 423	
251A4	70	690	0 - 502 182	4 710 467		WATER AT 450 mm AFTER 217 000 REPETITIONS
	100	690	502 182 - 843 579	13 334 966	18 045 433	WATER CONTINUED
260A4	40	520	0 - 1 947 403	1 947 403	1 947 403	WATER AT 20 mm TO 450 mm FROM 10^6 REPETITIONS (MP 9 TO 15)
274A4	40	520	0 - 1 676 275	1 676 275	1 676 275	"
275A4	40	700	0 - 2 105 910	2 105 910	2 105 910	"
289A4	70	700	0 - 1 894 826	17 773 346	17 773 346	"
294A4	100	700	0 - 1 756 646	68 614 592	68 614 592	"
337A4	150(S)	1445	0 - 48 000	-		IN SITU MOISTURE AND TEMPERATURE
338A4	150(S)	960	0 - 200 000	-		"
345A4	40	420	?	TOTAL:	149 274 510	"

* For comparison purposes, d=4 in $(p/40)^d$, where d = relative damage coefficient and p = wheel load
(S) = Single wheel load tests (Aircraft wheel, Boeing 747)

TABLE A.4 PERCENTAGE PERMANENT DEFORMATION MEASURED AT THE END OF THE HVS TESTS ON THE VARIOUS TEST SECTIONS OF THE DEEP PAVEMENT. IN (%)

HVS-SECTION	DEPTHS (mm)	RELATIVELY DRY STATE	RELATIVELY WET STATE
260A4	0-180	64	70
	180-330	10	19
	330-480	10	3
	480- ∞	15	8
250A4	0-180	53	-
	180-330	6	-
	330-480	18	-
	480- ∞	24	-
274A4	0-180	86	-
	180-330	9	-
	330-480	2	-
	480- ∞	3	-
275A4	0-180	86	-
	180-330	2	-
	330-480	8	-
	480- ∞	4	-
289A4	0-180	-	73
	180-330	-	15
	330-480	-	7
	480- ∞	-	5
260A4	0-180	54	72
	180-480	30	19
	480- ∞	16	9
AVERAGE	0-180	67 (17)	75 (7)
(STD. DEV)	180-330	9 (4)	11 (7)
	330-480	10 (7)	7 (3)
	480- ∞	14 (9)	7 (2)

- No result

TABLE A.5 IN SITU DRY DENSITIES (kg/m^3) AND OVEN DRY MOISTURE CONTENTS (%) OF THE VARIOUS HVS TEST SECTIONS ON THE DEEP PAVEMENT, ROAD 1932 (ROOIWAL).

HVS-SECTION	DEPTH (mm)	A*	B	C	D
250A4A	0-100	1797(12,4)	1928(11,7)	1926(13,6)	1791(15,6)
	250-350	1730(12,3)	1692(13,4)	1829(14,2)	1780(15,8)
	360-460	1871(8,0)	1898(9,2)	1951(10,9)	1864(11,9)
	550-650	1845(6,5)	1974(6,4)	1983(7,1)	1918(7,0)
250A4B	0-100	1860(12,6)	1915(12,9)	1965(14,3)	1761(15,9)
	250-350	1898(9,8)	1903(11,1)	2011(10,4)	1877(13,4)
	360-460	1939(7,8)	1838(7,6)	1895(7,7)	1810(9,9)
	550-650	1939(6,0)	1918(6,4)	1901(6,3)	1872(7,1)
260A4	0-100	1768(13,1)	1766(13,4)	1743(13,8)	1768(13,8)
(MP 2)	260-360	1936(9,9)	1960(9,7)	1960(9,20	1985(9,0)
	360-460	1983(6,9)	2034(5,6)	193296,0)	1999(6,10
	520-620	1751(10,3)	1720(11,10	1946(8,4)	2014(7,7)
260A4	0-100	1830(13,1)	1821(14,2)	1833(15,2)	1830(14,6)
(MP 13)	300-400	1830(10,6)	1932(9,9)	1793(10,1)	1884(10,90
	400-500	2021(6,50	2006(6,3)	1972(7,4)	1952(7,5)
	500-600	1904(9,3)	1941(9,4)	2021(8,10)	2038(8,9)
251A4	0-100	1787(12,6)	1941(11,5)	2046(11,5)	1774(14,3)
	180-280	1714(12,1)	1768(13,2)	1833(14,0)	1833(14,0)
	300-400	1885(11,0)	1882(11,0)	1920(12,0)	1892(13,0)
	400-500	1921(5,0)	1998(5,6)	1991(6,6)	--
	0-100	1816(12,0)	1948(11,5)	1902(12,0)	1826(12,4)
	180-280	1782(11,3)	1750(12,2)	1809(12,0)	1752(13,0)
	300-400	1889(9,5)	1888(10,2)	1881(10,5)	1881(10,6)
275A4	0-100	1846(12,5)	1895(13,9)	1820(13,6)	1811(13,3)
(MP2)	180-280	1929(14,5)	1896(15,1)	1843(16,9)	1833(17,6)
	380-480	1932(9,7)	2007(9,0)	1940(8,4)	2009(8,4)
	520-620	1629(12,1)	--	1847(13,0)	1665(15,4)
275A4					
(MP 12)	0-100	1837(12,4)	1884(13,4)	1989(13,7)	1830(14,4)
	180-280	1893(12,9)	1839(13,6)	1889(13,3)	1797(16,1)
	400-500	1930(7,8)	1996(7,1)	1986(8,3)	1977(9,7)
	500-600	1683(9,3)	1722(9,4)	1778(9,4)	1771(10,7)

TABLE A.5 (CONTINUED) IN SITU DRY DENSITIES (kg/m^3) AND OVEN DRY MOISTURE CONTENTS (%) OF THE VARIOUS HVS TEST SECTIONS ON THE DEEP PAVEMENT, ROAD 1932 (ROOIWAL).

HVS-SECTION	DEPTH (mm)	A*	B	C	D
289A4 (MP 3)	0-100	1989(12,0)	1953(15,0)	1962(14,1)	1995(8,3)
	180-280	1837(13,9)	1913(13,7)	1828(14,3)	1821(14,9)
	300-400	1866(12,0)	1985(11,3)	1759(10,6)	1895(10,3)
	500-600	2028(9,0)	2067(8,3)	2151(7,3)	2130(6,7)
289A4 (MP 12)	0-100	1982(13,9)	1992(13,6)	1976(14,2)	1992(11,0)
	180-280	1873(13,4)	2033(14,0)	1959(14,5)	1870(14,6)
	300-400	1944(10,9)	2000(9,8)	1975(9,4)	1960(7,7)
	500-600	1868(9,4)	2061(6,1)	1827(11,3)	1808(10,3)
294A4 (MP 2)	0-50	1862(13,5)	1888(13,8)	1861(13,6)	1849(13,7)
	50-100	1833(13,5)	1902(13,8)	1905(13,6)	1865(13,7)
	180-280	1866(13,3)	1895(12,6)	1736(12,1)	1849(12,1)
	320-420	1848(10,9)	1969(11,3)	1899(12,4)	1842(12,1)
	520-620	1955(8,5)	1920(8,7)	2023(9,3)	1979(8,6)
294A4 (MP 12)	0-50	1918(13,9)	1854(14,9)	1790(13,0)	1918(14,0)
	50-100	1881(13,9)	1879(14,9)	1881(13,0)	1935(14,0)
	180-280	1830(14,3)	1968(13,9)	1837(15,3)	1716(16,2)
	320-420	1895(11,4)	1878(11,8)	1836(13,2)	1837(13,8)
	520-620	1829(8,5	1840(11,5)	1852(9,6)	2005(8,9)

* Measuring position in test pit (see Figure 4.6, in Chapter 4).

TABLE A.6 DESIGN DATA FOR THE SHALLOW PAVEMENT, ROAD 2212 (BULTFONTEIN).

Characteristic	Subbase (Quarry No. 1556)*	Base (Quarry No. 1556)*
Lab. density at 100% mod. AASHTO (kg/m^3) (design stage)**	2100	2210
Lab. density at 100% mod. AASHTO (kg/m^3) (during construction)**	-	2150
In situ density (kg/m^3)	-	2069
% of mod. AASHTO	-	96,3
Lab. optimum moisture content, % (design stage)	9,0	7,4
Lab. optimum moisture content, % (during construction)	-	7,7
In situ optimum moisture content, %	-	7,2
TRB-classification	A2-4(0)	A1-A(0)
Grading modulus (GM)	1,73	2,34
Design stabiliser content, % (PBFC) (m/m)	2,0	3,0
In situ stabiliser content, % (EDTA)	-	2,62
Plasticity index, PI (After stabilisation), %	NP	SP
Linear shrinkage, %	4,0	2,0

* See TPA report S2/81 (Marais, 1981).
** The densities are for the unstabilised material only.

TABLE A.7 DESIGN UNCONFINED COMPRESSIVE STRENGTH (UCS) RESULTS OF THE BASE AND SUBBASE OF THE SHALLOW PAVEMENT, ROAD 2212 (BULTFONTEIN).

Characteristic	Subbase (Quarry No. 1556)*	Base (Quarry No. 1556)*
Soaked-UCS after 7 days at 97 % mod. AASHTO, kPa (design stage)	2400	1800
Soaked-UCS after 7 days at indicated % mod. AASHTO, kPa (contruction stage)	-	1164 (96,3%)

* See previous Table A.6

TABLE A.8 SUMMARY OF HVS TEST PROGRAMMES FOR THE VARIOUS TESTS DONE ON ROAD 2212 AT BULTFONTEIN

HVS-SECTION	TRAFFICKING WHEEL-LOAD (kN)	TYRE PRESSURE (kPa)	RANGE OF ACTUAL REPETITIONS	E80s*	TEST CONDITIONS
306A4	40	700	0 - 2 450 000	2 450 000	WATER AT 20 mm TO 450 mm FROM 10^6 REPETITIONS (MP 9 TO 15)
307A4	70	700	0 - 2 450 000	22 978 320	"
308A4	100	700	0 - 2 640 000	103 125 000	"
309A4	150(S)	1445	46 000	-	"
			TOTAL:	128 553 000	

* For comparison purposes, d=4 in $(p/40)^d$, where d = relative damage coefficient and p = wheel load

(S) = Single wheel load tests (Aircraft wheel, Boeing 747)

TABLE A.9 IN SITU DRY DENSITIES (kg/m^3) AND OVEN DRY MOISTURE CONTENTS (%) OF THE VARIOUS HVS TEST SECTIONS ON THE SHALLOW PAVEMENT, ROAD 2212 (BULTFONTEIN).

HVS-SECTION	DEPTH (mm)	A*	B	C	D
306A4	0-100	1906(11,7)	2093 (9,6)	2023(10,5)	1933 (9,7)
(MP 13)	120-220	1896(10,2)	1982 (9,7)	2036(10,2)	1890(10,8)
	220-320	1724(10,1)	1883(10,0)	1796(10,7)	1818(11,4)
	320-420	2087 (3,6)	2083 (6,6)	2102 (6,5)	1986 (5,5)
	420-520	1929 (4,6)	1965 (3,5)	1927 (7,9)	1975 (6,5)
	520-620	1770 (7,5)	1770(11,1)	1867(12,2)	1795(11,3)
306A4	0-100	1865(10,7)	2034(10,3)	1980(11,0)	1903(10,6)
(MP 5)	120-220	- (10,5)	- (10,4)	- (10,4)	- (10,0)
	220-320	1926(10,0)	1942 (9,7)	2010 (9,4)	1825(10,0)
	320-420	2121 (5,5)	2032 (7,8)	2101 (5,5)	2032 (5,4)
	420-520	1759 (6,0)	1949 (3,5)	1969 (2,9)	-
	600-700	1797 (6,5)	1728 (5,8)	1785 (8,6)	1726 (9,7)
	700-800	1838 (6,3)	1680 (7,9)	1673(11,0)	1756(10,0)
307A4	0-60	1844(10,4)	1950 (9,0)	2036 (8,6)	2000 (6,7)
(MP 4)	60-110	1786 (9,7)	1879 (9,1)	1875 (7,6)	1851 (8,1)
	110-180	1837(11,4)	1954(11,4)	1897 (7,6)	1886 (9,0)
	180-450	2016 (8,3)	2066 (8,0)	2035 (8,8)	2030 (8,9)
	450-530	-	1872 (3,8)	1950 (4,4)	1945 (4,0)
	530-800	1847 (6,5)	1965 (4,7)	1996 (5,1)	1967 (3,8)
307A4	0-60	1853 (8,9)	1991 (8,8)	1990 (9,7)	2016 (7,1)
(MP 10)	60-110	1778(10,2)	1864 (9,8)	1920(10,3)	1897 (8,3)
	110-180	1795(11,5)	1957(10,7)	1904(12,8)	1899 (9,0)
	180-450	1930 (8,7)	2108 (8,2)	2026 (9,3)	2071 (8,1)
	450-530	1899 (5,0)	1895 (5,9)	1891 (6,4)	1873 (6,0)
	530-800	1782 (7,1)	2011 (3,9)	1912 (5,2)	1960 (6,6)
308A4	0-100	1806(11,7)	1928(10,6)	1939(10,8)	1866(12,4)
(MP 2,5)	180-280	1883(10,8)	2022 (9,8)	1936 (9,6)	1862(10,3)
	220-320	1887 (9,9)	1954 (9,8)	1841 (9,9)	1980 (9,7)
	350-500	1913 (7,7)	2072 (4,8)	2095 (4,6)	2103 (4,7)
	500-600	1893 (7,0)	1977 (2,3)	1990 (2,6)	1968 (6,3)
	650-800	1829 (9,0)	1822 (8,7)	1841 (8,7)	1835 (8,5)
308A4	0-100	1832(10,4)	2016(10,9)	1945(12,6)	1958(10,0)
(MP 12)	180-280	1896 (8,8)	1899 (9,6)	1942 (9,7)	1905 (9,8)
	210-310	1942 (8,4)	1961 (9,8)	1871(10,0)	1908(10,4)
	360-510	1814 (8,7)	2044 (5,2)	2112 (5,2)	2150 (4,9)
	460-560	1876 (5,0)	1946 (3,4)	2013 (3,8)	1983 (6,3)
	600-800	1820 (8,4)	1848 (8,7)	1865 (8,0)	1858 (8,8)

* Measuring position in test pit, see previous Figure 4.6 in Chapter 4.

TABLE A.10 IN SITU DRY DENSITIES (kg/m^3) AND OVEN DRY MOISTURE CONTENTS (%) OF THE TWO HVS TEST SECTIONS 309A4 (SHALLOW) AND 337A4 (DEEP).

HVS-SECTION	DEPTH (mm)	A*	B	C	D
309A4 (MP 4)	0-100	1811 (9,5)	1889(10,9)	1731(10,5)	-
	200-300	1836 (9,7)	1942 (9,7)	1907 (9,2)	1865 (9,6)
	310-410	1803(10,3)	2198 (5,3)	2181 (4,5)	2055 (4,4)
	500-600	1889 (2,0)	1967 (3,4)	1965 (4,3)	1896 (4,0)
	675-875	1809(10,2)	1884(11,6)	1901(10,6)	1951 (9,6)
309A4 (MP 13)	0-100	1732(11,4)	1870(10,7)	1843 (9,9)	1867(10,2)
	180-280	1904 (9,7)	1893(11,5)	1854(10,0)	1944 (9,8)
	220-320	1811 (8,8)	2133 (4,9)	2170 (3,9)	2084 (4,3)
	520-620	1840 (7,6)	1920 (2,2)	2012 (2,9)	1843 (5,3)
	650-850	1779 (9,4)	1880 (7,9)	1963 (6,4)	1910 (7,2)
337A4 (MP 8)	0-150	1699(14,0)	1851(15,1)	1903(14,5)	1834(14,2)
	180-280	1842(15,0)	1877(15,1)	1816(14,5)	1748(15,0)
	280-330	1926(13,6)	1923(15,3)	1905(11,5)	1868(10,1)
	420-620	1964 (9,5)	1957(10,0)	1927 (9,6)	1890(10,0)

* Measuring position in test pit, see previous Figure 4.6, in Chapter 4.

A.2 Anomaly in some of the permanent deformation results of the deeper pavement and discussion

If the permanent deformation development on Sections 275A4 (40 kN), 289A4 (70 kN) and 294A4 (100 kN) is compared (Figures A.2 (b), A.3 (a) and 4.5 (b)), it is seen that the rate of permanent deformation (before the introduction of excessive water or rain and potholing) on Section 289A4, which was the 70 kN test, was higher than those measured on the 100 kN test on Section 294A4. The previous Table 4.2 in Chapter 4, indicates that the rate of deformation during the relatively "dry" state on the 70 kN test (Section 289A4) is approximately 1,34 times higher than the rate in the "dry" state on the 100 kN test (Section 294A4).

The final dry densities of the upper 100 mm of the base layer in the trafficked area (positions B and C) on Section 289A4, compared to those of Sections 275A4 and 294A4, also indicates a relative densification on Section 289A4 (see previous Table A.5).

Initially, these three test were planned to study only one variable, ie the effect of wheel load, and therefore relative damage, on this pavement. These three test sections were originally selected on the basis of "similar" initial surface deflections and "similar" DCP characteristics in terms of balance, ie "deep" pavements. The irregularity in the permanent deformation result on Section 289A4, prompted closer investigation into the underlying reasons for this anomaly, as it is normally assumed that the rate of deformation (damage) on the "same" pavement is directly proportional to the wheel load on that pavement.

In Table A.11, the initial road surface deflection (RSD) and radius of curvature (RC) on these three sections are summarised.

TABLE A.11 INITIAL SURFACE DEFLECTION (40 kN) AND RADIUS OF CURVATURE (RC) OF THE THREE HVS TEST SECTIONS

SECTION	HVS-TEST LOAD* (kN)	RSD (μm)	RC (m)	STD. DEV.		COEFA. OF VARIATION	
				RSD (μm)	RC (m)	RSD (%)	RC (%)
275A4	40	263(24)	327(10)	33	133	13	41
289A4	70	276(64)	338(24)	60	185	22	55
294A4	100	244(62)	301(24)	47	151	19	50

* This is the trafficking dual wheel load on the test section. The surface deflections were measured under a 40 kN dual wheel load with the Road Surface Deflectometer. The radius of curvature was calculated from the surface deflection measurements, and is similar to the Dehlen radius of curvature (Horak, 1987).

() Number of measurements

The table indicates that the coefficient of variation in the deflection (RSD) results is markedly lower than those of the radius of curvature (RC). This is probably so because the RSD is a direct measurement, while the RC is calculated from the deflection basin of the RSD measurement, using approximately eight data points (4 data points each side of the maximum deflection value). This relatively low number of data points allows small variations in the data to influence the calculation of the RC. However, the RC is normally a good indicator of the structural state of the pavement system and may give a better explanation of its behaviour under accelerated trafficking.

The table also indicates that small differences exist between the RSD values of the three sections, but at the time of HVS testing, these differences were ignored, and the deflections on these three section were considered similar.

Greater differences, however, exist between the RC values, but because these RC values were indirectly obtained, the differences were ignored in the selection of these sections and it was considered that the RC values were also similar.

Closer investigation into the underlying reasons for the rather unexpected results of the HVS test showed that the majority of the deformation occurred in the base only.

The DCP was then used to evaluate the bases of the three test sections more critically. It was found that the relative strength of the upper 50 mm and the lower 170 mm of the bases differed significantly. The various DCP parameters measured on these sections are summarised in Table A.12.

TABLE A.12 DCP PARAMETERS MEASURED ON THE THREE SECTIONS.

SECTION	HVS LOAD REPS. (N)	DCP PARAMETERS*			
		DN_{50} (mm/blow)	DN_{50-220} (mm/blow)	DNR	DSN_{200} (blows)
275A4	0	1,2	1,8	0,667	140
	10^6	1,3	2,0	0,650	144
	$2,1x10^6$	2,7	2,3	1,173	90
289A4	0	1,9	1,1	1,727	200
	10^6	2,7	1,7	1,588	115
	$1,89x10^6$	2,4	2,1	1,142	100
294A4	0	0,7	2,1	0,333	190
	10^6	1,2	2,6	0,461	115
	$1,7x10^6$	2,0	2,9	0,689	100

* DN_{50} = Average rate of penetration of the DCP in the top 50 mm of the base layer.

DN_{50-220} = Average rate of penetration of the DCP from a depth of 50 mm to 220 mm in the base layer.

DNR = Ratio between DN_{50} and DN_{50-220}: DN_{50}/DN_{50-220}.

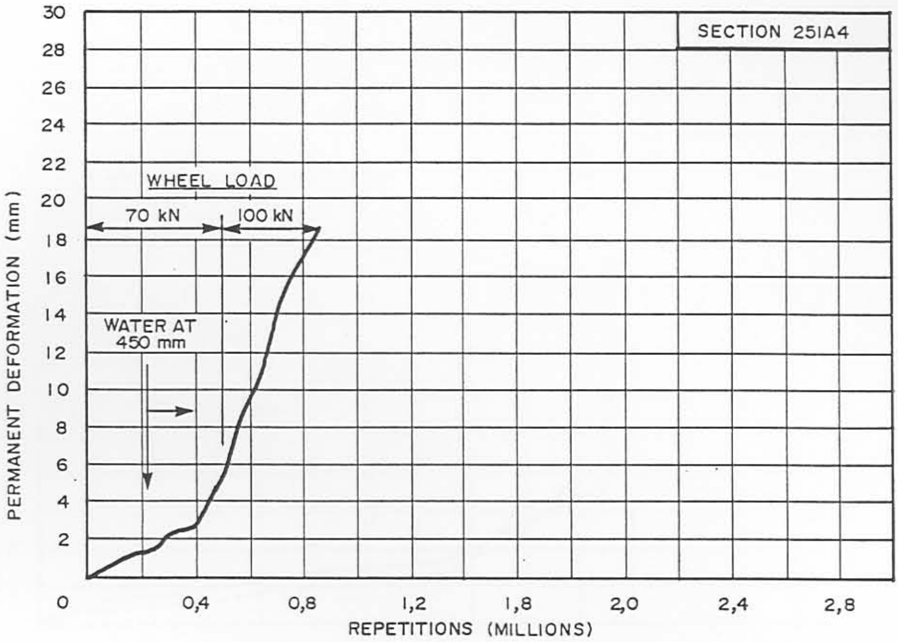
DSN_{220} = Total number of blows to penetrate to a depth of 220 mm in the pavement.

The table indicates the highest initial penetration rate of the upper 50 mm of the base (DN_{50}) and the lowest penetration rate of the layer between 50 mm and 220 mm (DN_{50-220}), was measured on Section 289A4. This result is more clearly indicated by the DNR parameter, which was the highest for Section 289A4

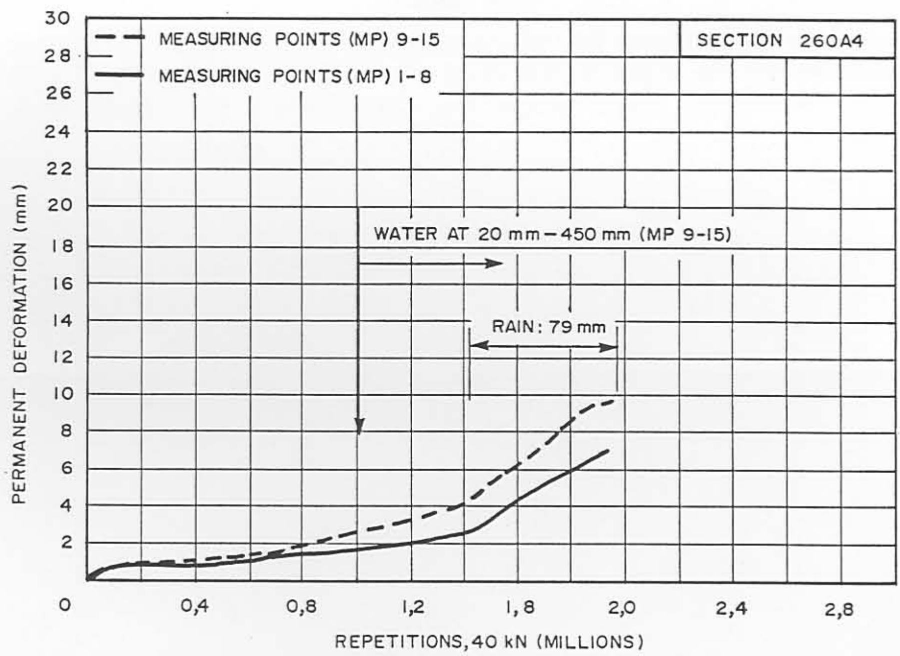
This means that the upper 50 mm of the base of this section is relatively "softer" than those on the other two sections, while the reverse is true for the lower 50 mm to 220 mm. It is concluded that this "softer" zone on a relatively "harder" bottom is directly responsible for the unexpected deformation, because for Section 294A4, the upper 50 mm appears to be relatively "harder" than the lower 50 mm to 220 mm.

The table also indicates another interesting result: the DNR on Sections 275A4 and 294A4 increased with increased HVS load repetitions, while for Section 289A4, the DNR decreased. In terms of pavement behaviour a decrease in DNR is an indication that densification occurred during trafficking (Section 289A4). This was also confirmed by the densities in the base measured with the nuclear apparatus, as was shown in the previous Paragraph 4.2.4.5, in Chapter 4. An increase in DNR, however, is indicative of a de-densification or crushing in the upper 50 mm of the base (Sections 275A4 and 294A4). This de-densification was also confirmed by the nuclear density measurements as well as the test pit investigations mentioned earlier.

The results of these three HVS test sections again demonstrates the complex nature of the behaviour of pavements and emphasises that surface deflection only does not predict the ultimate behaviour of these pavements accurately. However, intensive in situ measurements (DCP, depth-deflections, density etc) and observations during accelerated testing, better definitions and even quantification of different failure mechanisms is possible. It is my opinion that with this approach, relevant, accurate and valuable models for pavement behaviour can be established in future.



(a) HVS SECTION 251A4

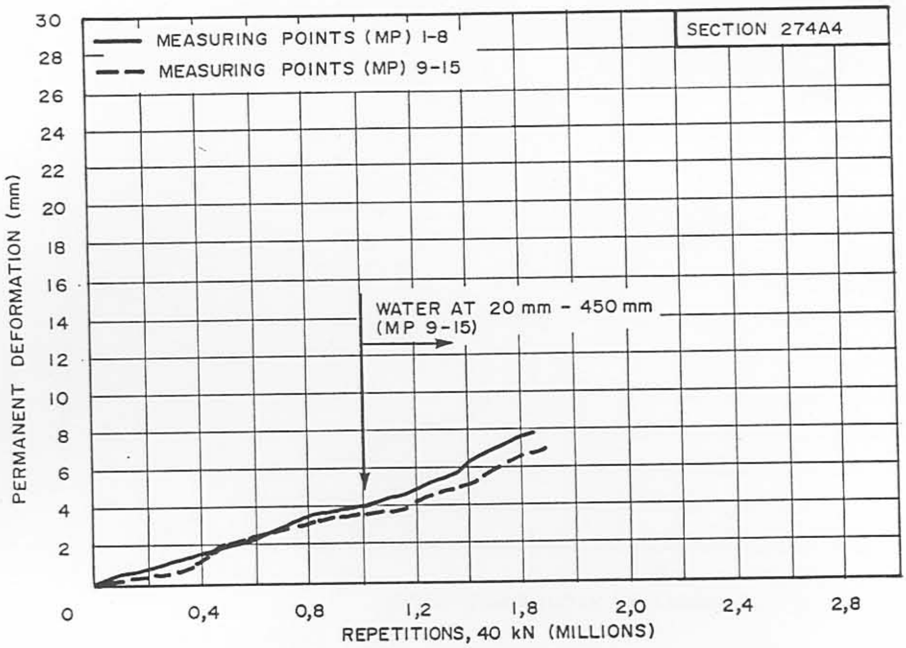


(b) HVS SECTION 260A4

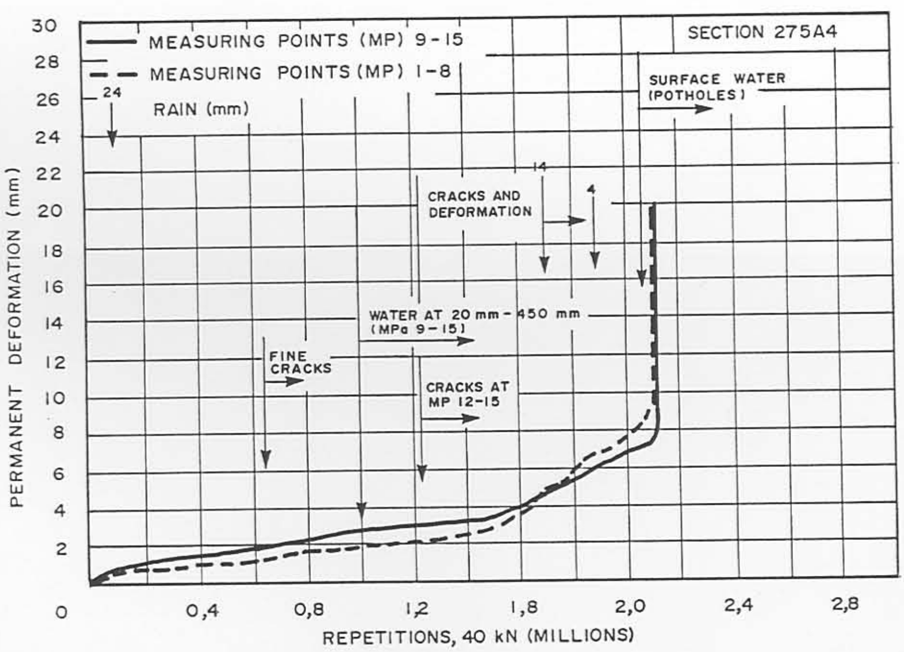
FIGURE A.1

AVERAGE PAVEMENT DEFORMATION AS MEASURED IN HVS TESTS 251A4 AND 260A4 UNDER INDICATED DUAL WHEEL LOADS ON ROAD 1932 (ROOIWAL)

940-4-5900/7 BD



(a) HVS SECTION 274A4

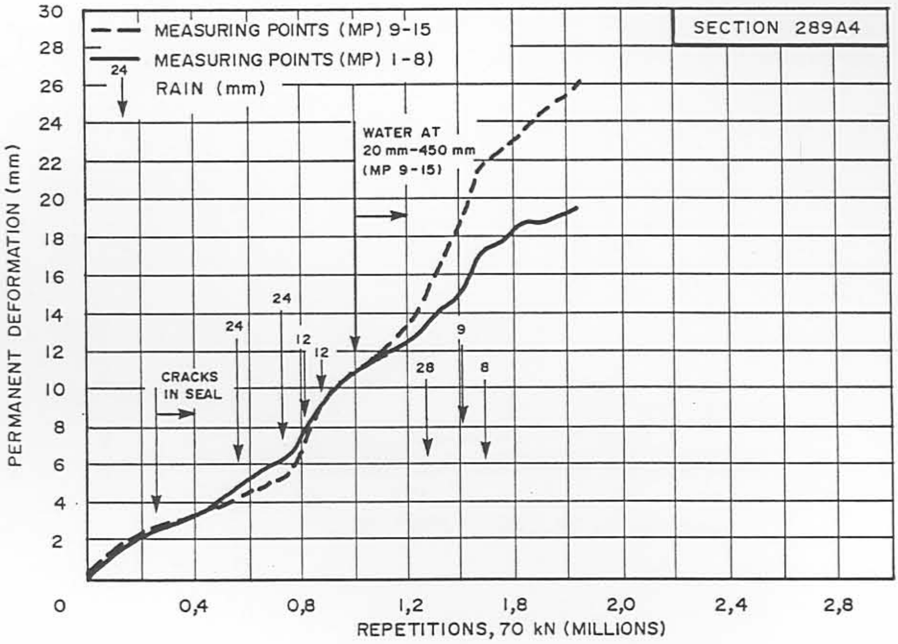


(b) HVS SECTION 275A4

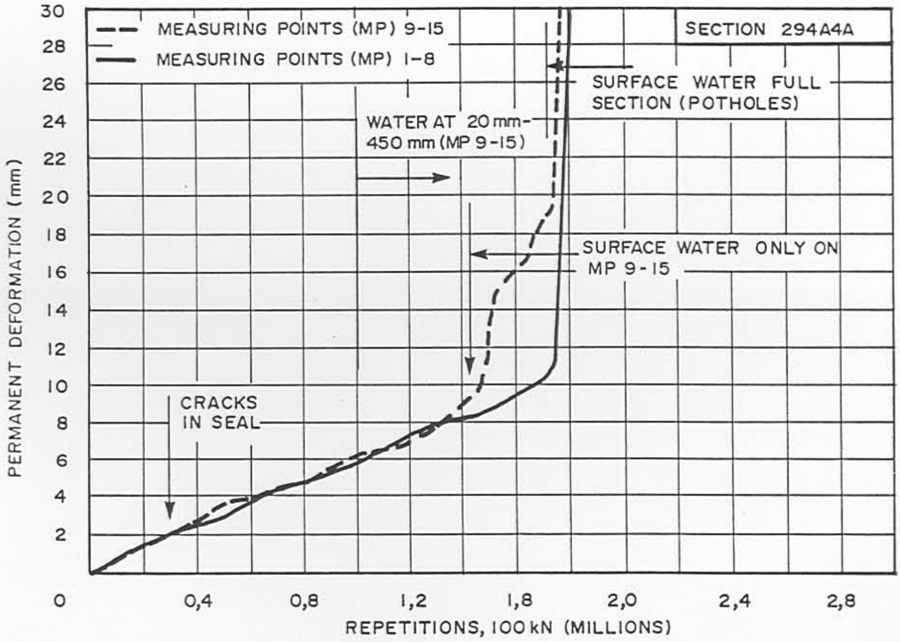
FIGURE A.2

AVERAGE PERMANENT DEFORMATION AS MEASURED IN HVS TESTS 274A4 AND 275A4 AT VARIOUS STAGES OF TRAFFICKING AND MOISTURE CONDITIONS ON ROAD 1932 (ROOIWAL)

940-4-5900/8 BD



(a) HVS SECTION 289A4



(b) HVS SECTION 294A

FIGURE A.3

AVERAGE PERMANENT DEFORMATION AS MEASURED IN HVS TESTS 289A4 AND 294A4 AT VARIOUS STAGES OF TRAFFICKING AND MOISTURE CONDITIONS UNDER THE INDICATED DUAL WHEEL LOADS ON ROAD 1932 (ROOIWAL)

940-4-5900/10 BD

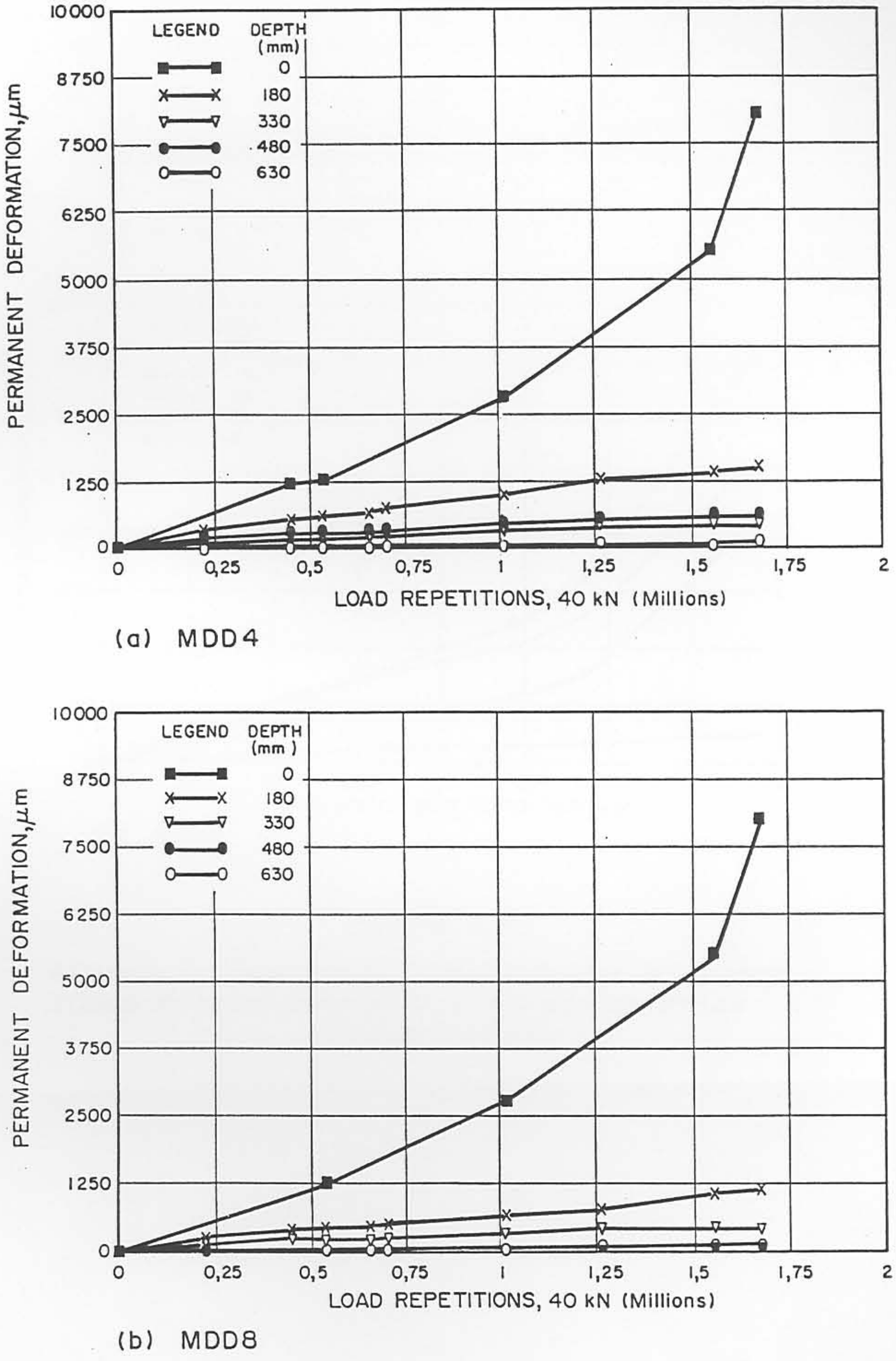
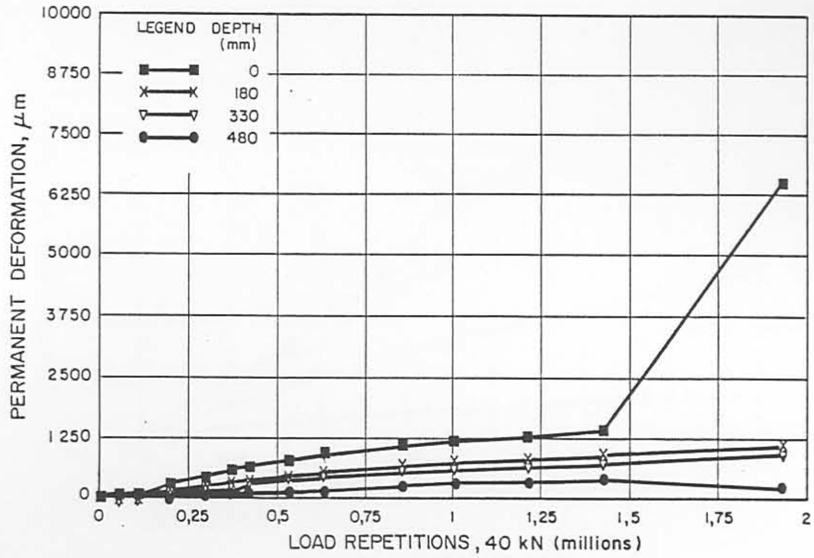
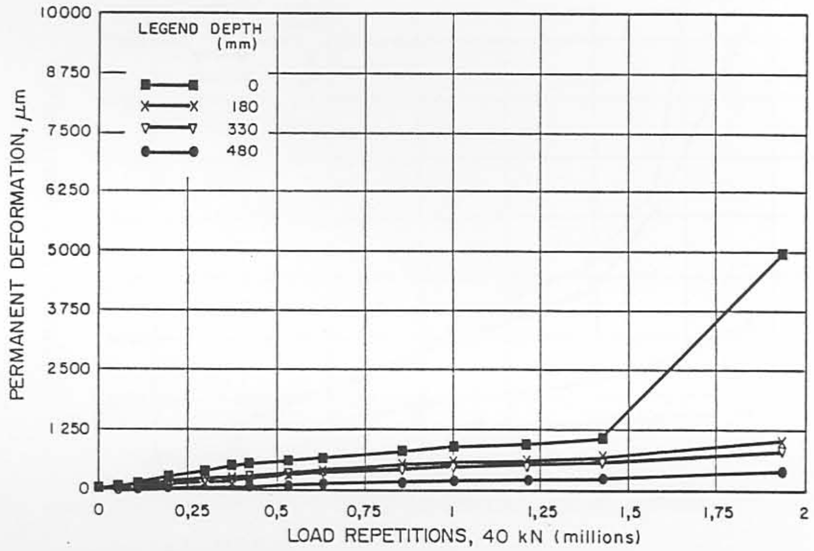


FIGURE A.4

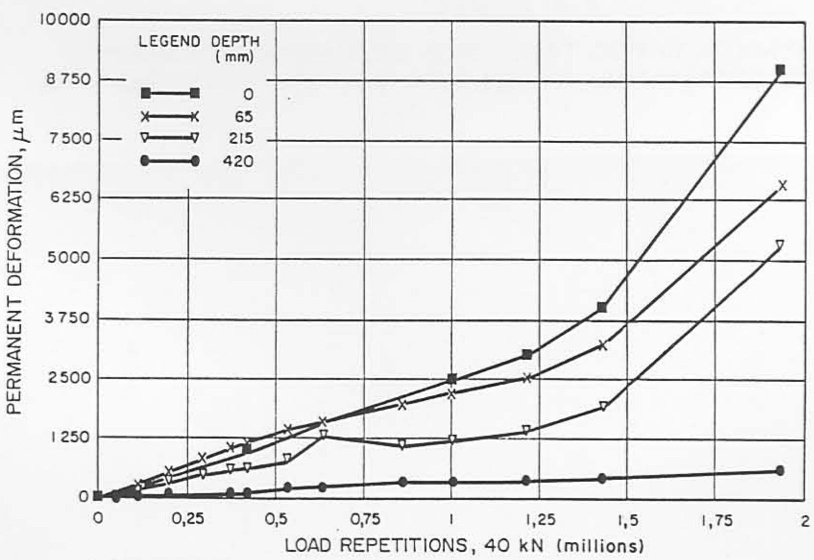
PERMANENT DEFORMATION AT DIFFERENT DEPTHS AT VARIOUS STAGES OF TRAFFICKING ON HVS TEST SECTION 274A4 (ROAD 1932, ROOIWAL)



(a) MDD4



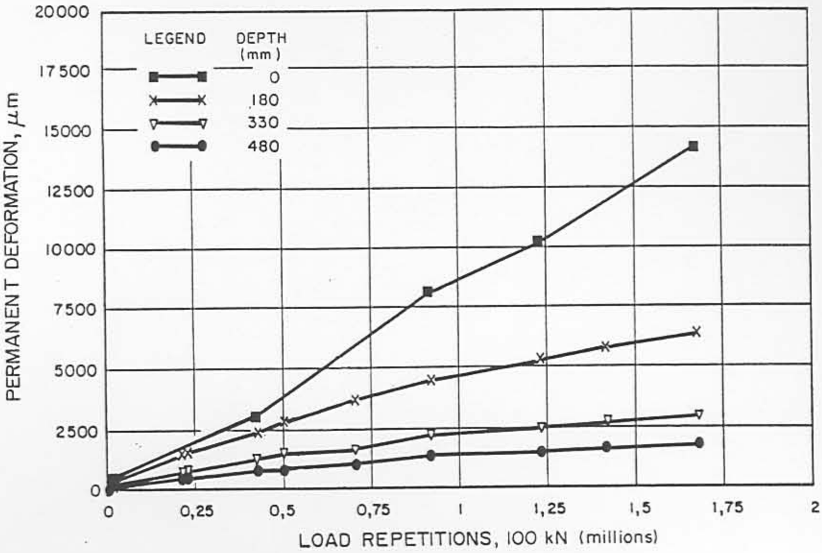
(b) MDD8



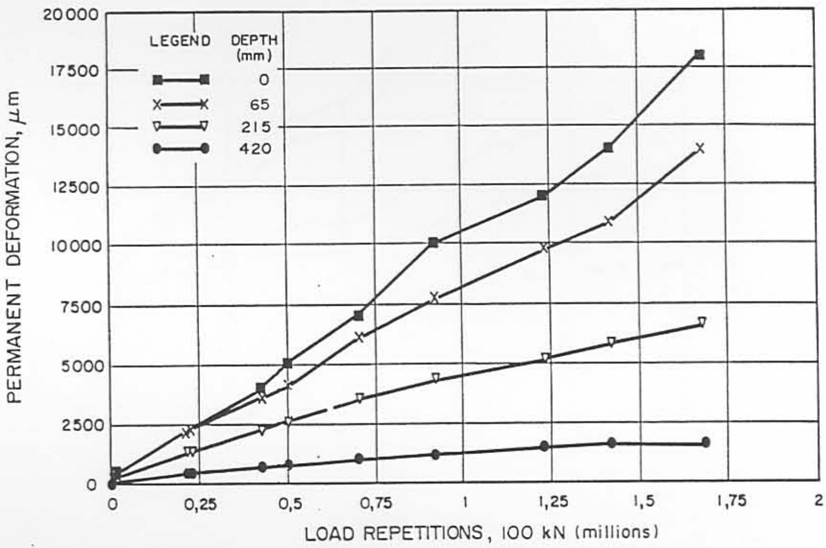
(c) MDD12

FIGURE A.5

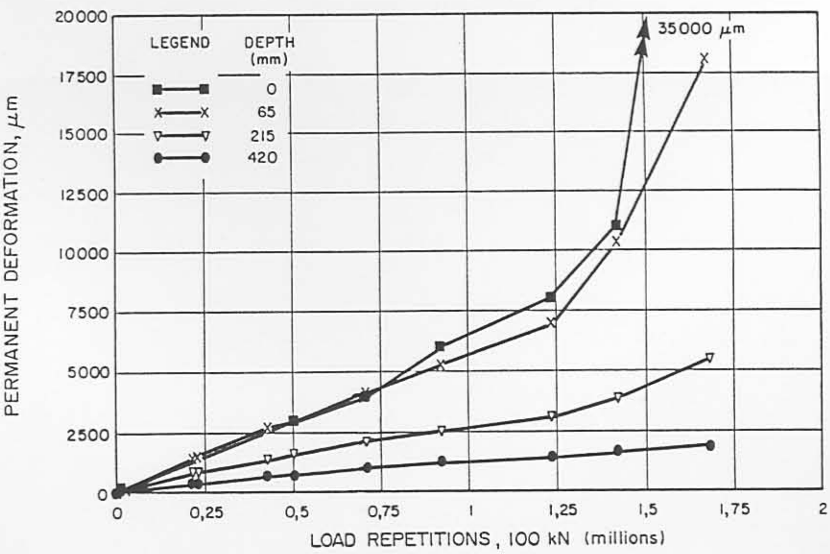
PEMANENT DEFORMATION AT DIFFERENT DEPTHS AT VARIOUS STAGES OF TRAFFICKING ON HVS TEST SECTION 275A4 (ROAD 1932, ROOIWAL)



(a) MDD4



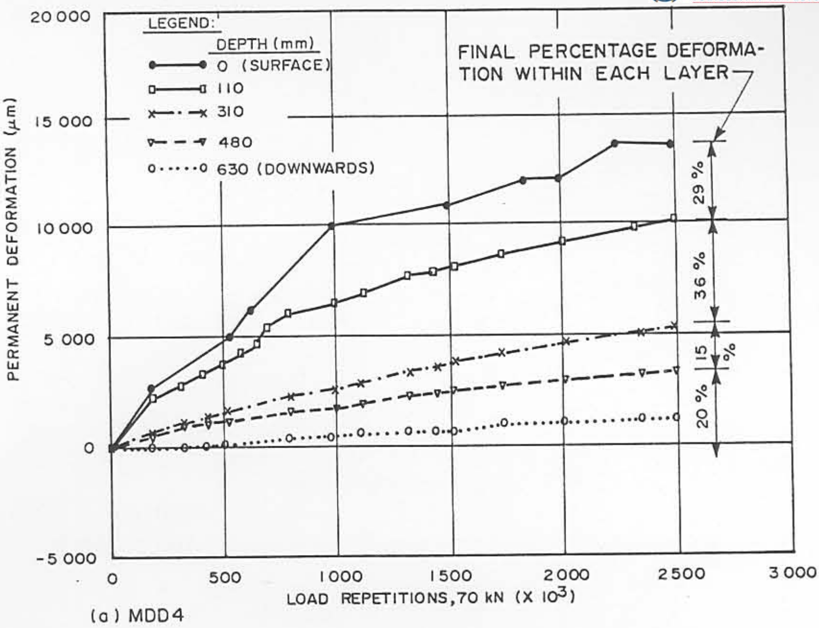
(b) MDD8



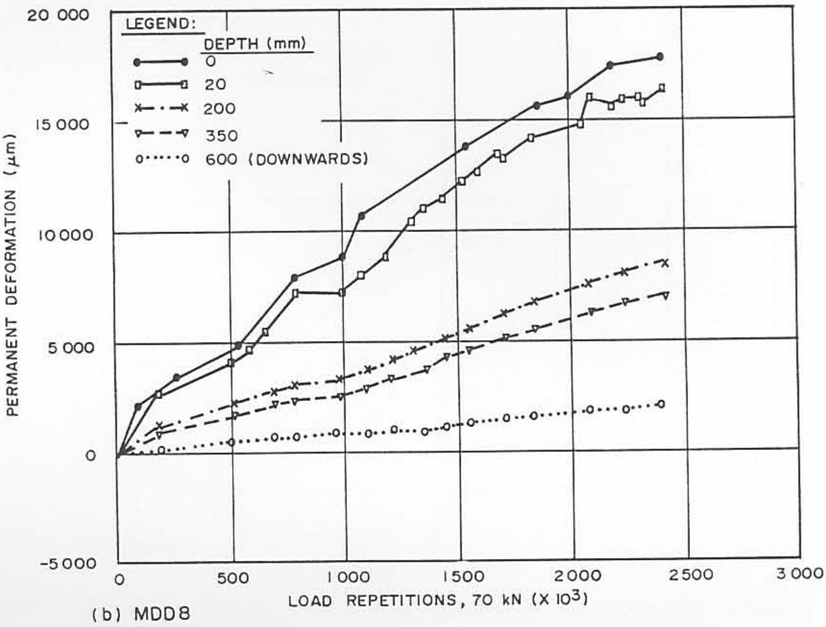
(c) MDD12

FIGURE A.6

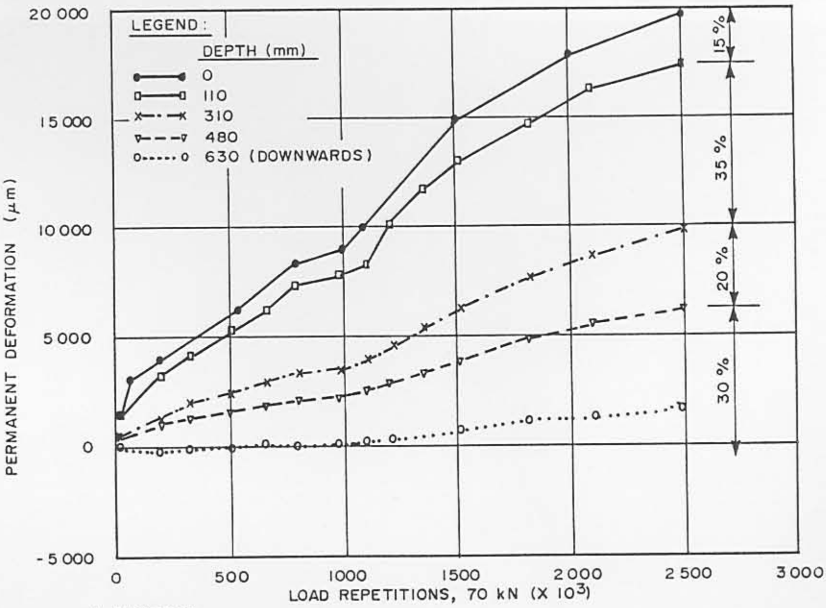
PERMANENT DEFORMATION AT DIFFERENT DEPTHS AT VARIOUS STAGES OF TRAFFICKING ON HVS TEST SECTION 294A4 (ROAD 1932, ROOIWAL)



(a) MDD4



(b) MDD8



(c) MDD12

FIGURE A.7

PERMANENT DEFORMATION AT DIFFERENT DEPTHS AT VARIOUS STAGES OF TRAFFICKING OF A 70 kN DUAL WHEEL LOAD ON HVS TEST SECTION 307A4 (ROAD 2212, BULTFONTEIN)

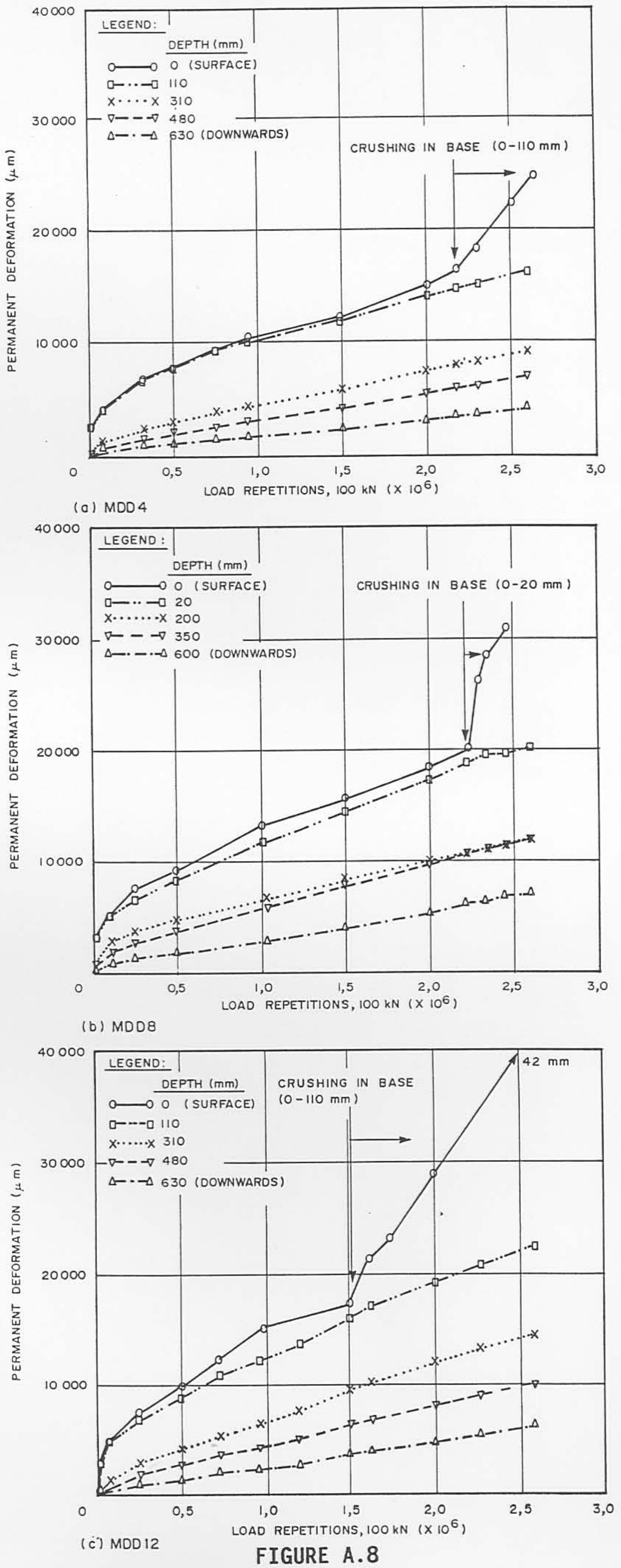


FIGURE A.8

PERMANENT DEFORMATION AT DIFFERENT DEPTHS AT VARIOUS STAGES OF TRAFFICKING OF A 100 kN DUAL WHEEL LOAD ON HVS TEST SECTION 308A4