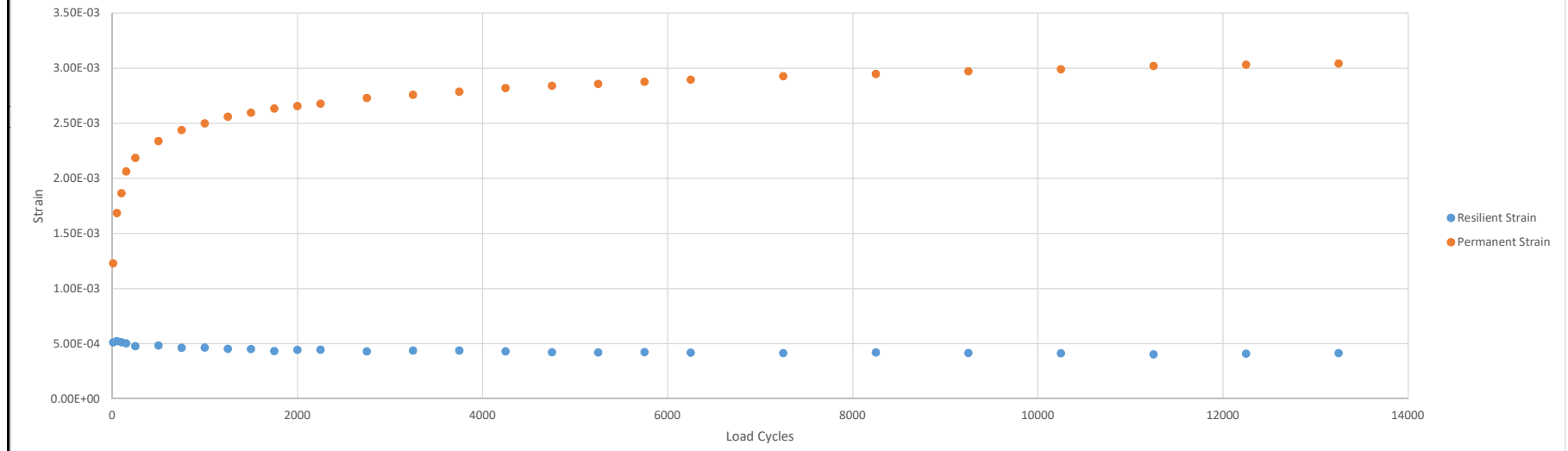


## University of Manitoba

### Pavement Research Group

#### Permanent Deformation Test Summary

Sample ID	UGM-1(.9.7)	Project	Design Parameters and Specifications of UGM
Replicate #	1	Sampled by	Yukon Department of Highways and Public Works
Date Tested	30/11/2017	Soil Type	Gravel with 9.7% fines
Sample Dry Density	2274	Max. Dry Density (Kg/m <sup>3</sup> )	2362
Sample Moisture (%)	6.74	Optimum Moisture (%)	6.4



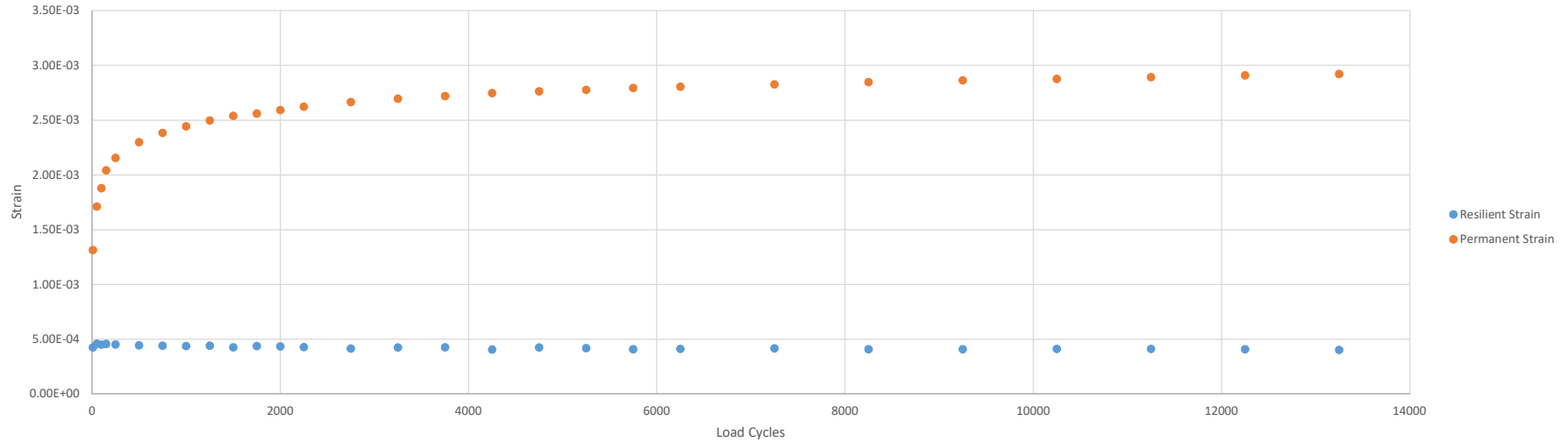
No. of Cycles	10	50	100	150	250	500	750	1000	
Resilient Strain	5.12E-04	5.23E-04	5.14E-04	5.03E-04	4.77E-04	4.84E-04	4.64E-04	4.66E-04	
Permanent Strain	1.23E-03	1.69E-03	1.87E-03	2.06E-03	2.19E-03	2.34E-03	2.44E-03	2.50E-03	
No. of Cycles	1250	1500	1750	2000	2250	2750	3250	3750	
Resilient Strain	4.53E-04	4.53E-04	4.34E-04	4.44E-04	4.46E-04	4.30E-04	4.39E-04	4.38E-04	
Permanent Strain	2.56E-03	2.60E-03	2.63E-03	2.66E-03	2.68E-03	2.73E-03	2.76E-03	2.79E-03	
No. of Cycles	4250	4750	5250	5750	6250	7250	8250	9250	
Resilient Strain	4.30E-04	4.23E-04	4.21E-04	4.24E-04	4.20E-04	4.14E-04	4.21E-04	4.16E-04	
Permanent Strain	2.82E-03	2.84E-03	2.86E-03	2.88E-03	2.89E-03	2.93E-03	2.95E-03	2.97E-03	
No. of Cycles	10250	11250	12250	13250	<b>MEPDG Model</b>				
Resilient Strain	4.13E-04	4.03E-04	4.10E-04	4.15E-04	$\varepsilon_p = \varepsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$			$\varepsilon_0$	<b>0.3756</b>
Permanent Strain	2.99E-03	3.02E-03	3.03E-03	3.04E-03				$\rho$	<b>27.56</b>
								$\beta$	<b>0.2483</b>
								<b>R2</b>	<b>0.999</b>
Tested By	Amin Mneina								
Review By	Dr. Ahmed Shalaby								

## University of Manitoba

### Pavement Research Group

#### Permanent Deformation Test Summary

Sample ID	UGM-1(9.7)	Project	Design Parameters and Specifications of UGM
Replicate #	2	Sampled by	Yukon Department of Highways and Public Works
Date Tested	1/12/2017	Soil Type	Gravel with 9.7% fines
Sample Dry Density	2330	Max. Dry Density (Kg/m <sup>3</sup> )	2362
Sample Moisture (%)	7.09	Optimum Moisture (%)	6.4



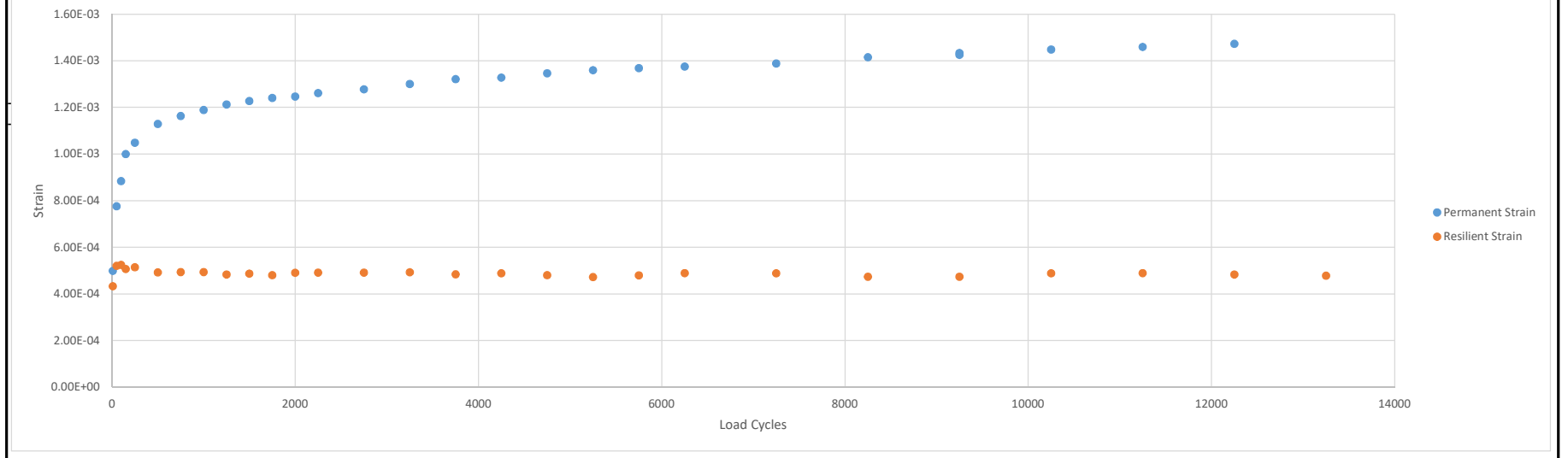
No. of Cycles	10	50	100	150	250	500	750	1000	
Resilient Strain	4.23E-04	4.58E-04	4.51E-04	4.57E-04	4.52E-04	4.44E-04	4.40E-04	4.37E-04	
Permanent Strain	1.31E-03	1.71E-03	1.88E-03	2.04E-03	2.16E-03	2.30E-03	2.38E-03	2.44E-03	
No. of Cycles	1250	1500	1750	2000	2250	2750	3250	3750	
Resilient Strain	4.41E-04	4.26E-04	4.38E-04	4.34E-04	4.27E-04	4.15E-04	4.24E-04	4.25E-04	
Permanent Strain	2.50E-03	2.54E-03	2.56E-03	2.59E-03	2.62E-03	2.66E-03	2.70E-03	2.72E-03	
No. of Cycles	4250	4750	5250	5750	6250	7250	8250	9250	
Resilient Strain	4.06E-04	4.24E-04	4.18E-04	4.09E-04	4.11E-04	4.16E-04	4.08E-04	4.08E-04	
Permanent Strain	2.75E-03	2.76E-03	2.78E-03	2.79E-03	2.80E-03	2.83E-03	2.85E-03	2.86E-03	
No. of Cycles	10250	11250	12250	13250	MEPDG Model $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$			<b><math>\epsilon_0</math></b>	<b>0.3583</b>
Resilient Strain	4.11E-04	4.11E-04	4.08E-04	4.02E-04				<b><math>\rho</math></b>	<b>18.98</b>
Permanent Strain	2.88E-03	2.89E-03	2.91E-03	2.92E-03				<b><math>\beta</math></b>	<b>0.2417</b>
								<b>R2</b>	<b>0.999</b>

Tested By: Amin Mneina  
 Reviewed By: Dr. Ahmed Shalaby

**University of Manitoba**  
**Pavement Research Group**

Permanent Deformation Test Summary

Sample ID	UGM-1(12.3)	Project	Drainable Base
Replicate #	1	Sampled by	Manitoba Infrastructure
Date Tested	29/1/2018	Soil Type	Gravel with 12% fines
Sample Dry Density	2100.92	Max. Dry Density (Kg/m3)	2156
Sample Moisture (%)	8.54	Optimum Moisture (%)	8.70%

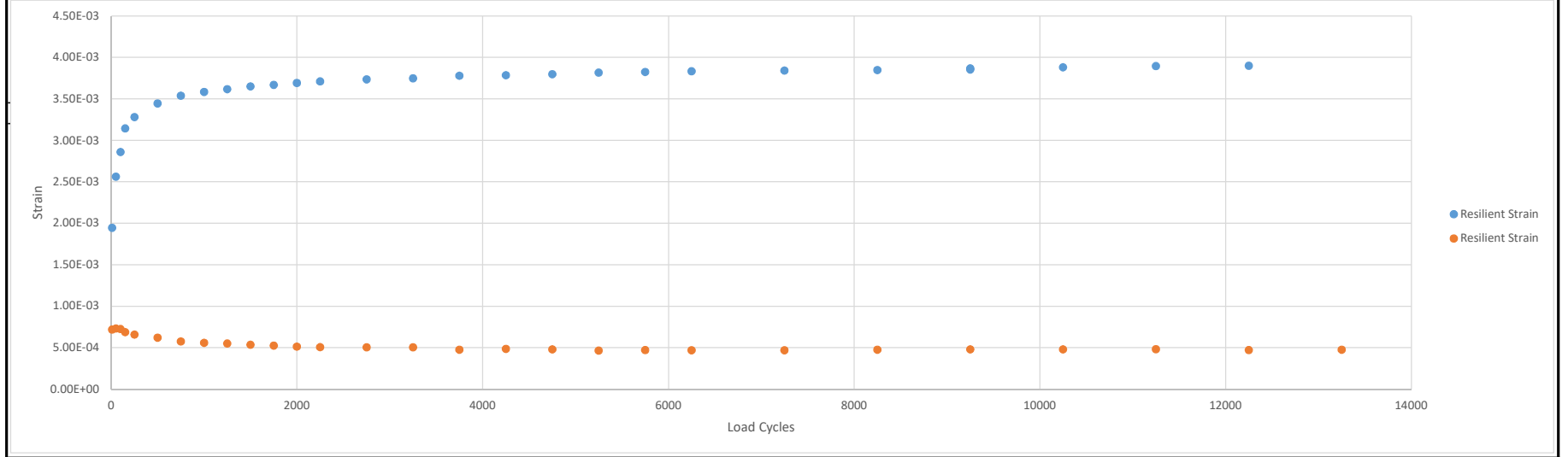


No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>	
Resilient Strain	4.33E-04	5.21E-04	5.25E-04	5.07E-04	5.14E-04	4.92E-04	4.94E-04	4.93E-04	
Permanent Strain	4.99E-04	7.76E-04	8.84E-04	1.00E-03	1.05E-03	1.13E-03	1.16E-03	1.19E-03	
No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>	
Resilient Strain	4.84E-04	4.87E-04	4.81E-04	4.91E-04	4.92E-04	4.91E-04	4.93E-04	4.84E-04	
Permanent Strain	1.21E-03	1.23E-03	1.24E-03	1.25E-03	1.26E-03	1.28E-03	1.30E-03	1.32E-03	
No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>	
Resilient Strain	4.88E-04	4.81E-04	4.72E-04	4.80E-04	4.90E-04	4.89E-04	4.74E-04	4.74E-04	
Permanent Strain	1.33E-03	1.35E-03	1.36E-03	1.37E-03	1.38E-03	1.39E-03	1.42E-03	1.43E-03	
No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	MEPDG Model $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$			$\epsilon_0$	<b>0.171</b>
Resilient Strain	4.89E-04	4.89E-04	4.83E-04	4.78E-04				$\rho$	<b>30.75</b>
Permanent Strain	1.43E-03	1.45E-03	1.46E-03	1.47E-03	$\beta$	<b>0.2895</b>			
								R2	<b>0.991</b>
Tested By	Amin Mneina								
Review By	Dr. Ahmed Shalaby								

**University of Manitoba**  
**Pavement Research Group**

Permanent Deformation Test Summary

Sample ID	UGM-1(12.3)	Project	Drainable Base
Replicate #	2	Sampled by	Manitoba Infrastructure
Date Tested	18/2/2018	Soil Type	Gravel with 12% fines
Sample Dry Density	2082.81	Max. Dry Density (Kg/m3)	2156
Sample Moisture (%)	8.34	Optimum Moisture (%)	8.70%



No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>
Resilient Strain	7.17E-04	7.29E-04	7.24E-04	6.85E-04	6.57E-04	6.20E-04	5.73E-04	5.58E-04
Permanent Strain	1.94E-03	2.56E-03	2.86E-03	3.14E-03	3.28E-03	3.44E-03	3.54E-03	3.58E-03
No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>
Resilient Strain	5.50E-04	5.34E-04	5.24E-04	5.11E-04	5.05E-04	5.04E-04	5.03E-04	4.75E-04
Permanent Strain	3.62E-03	3.65E-03	3.67E-03	3.69E-03	3.71E-03	3.73E-03	3.75E-03	3.78E-03
No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>
Resilient Strain	4.85E-04	4.78E-04	4.65E-04	4.70E-04	4.68E-04	4.68E-04	4.74E-04	4.79E-04
Permanent Strain	3.78E-03	3.80E-03	3.81E-03	3.82E-03	3.83E-03	3.84E-03	3.85E-03	3.85E-03

No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	<b>MEPDG Model</b> $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$	$\epsilon_0$	<b>0.4043</b>
Resilient Strain	4.78E-04	4.80E-04	4.70E-04	4.75E-04		$\rho$	<b>10.24</b>
Permanent Strain	3.87E-03	3.88E-03	3.89E-03	3.90E-03		$\beta$	<b>0.4531</b>
						<b>R2</b>	<b>0.999</b>

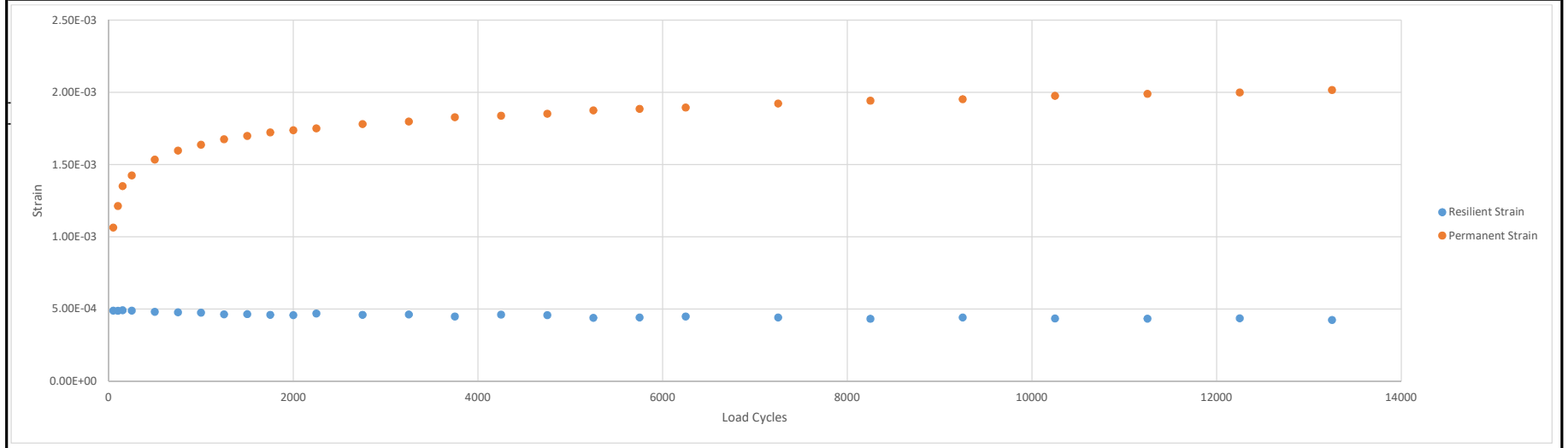
Tested By	Amin Mneina
Reviewd By	Dr. Ahmed Shalaby

## University of Manitoba

### Pavement Research Group

#### Permanent Deformation Test Summary

Sample ID	UGM-2(3.5)	Project	Design Parameters and Specifications of UGM
Replicate #	1	Sampled by	Yukon Department of Highways and Public Works
Date Tested	12/10/2017	Soil Type	Gravel with 3.5% fines
Sample Dry Density	2192.558731	Max. Dry Density (Kg/m <sup>3</sup> )	2206
Sample Moisture (%)	7.27	Optimum Moisture (%)	9

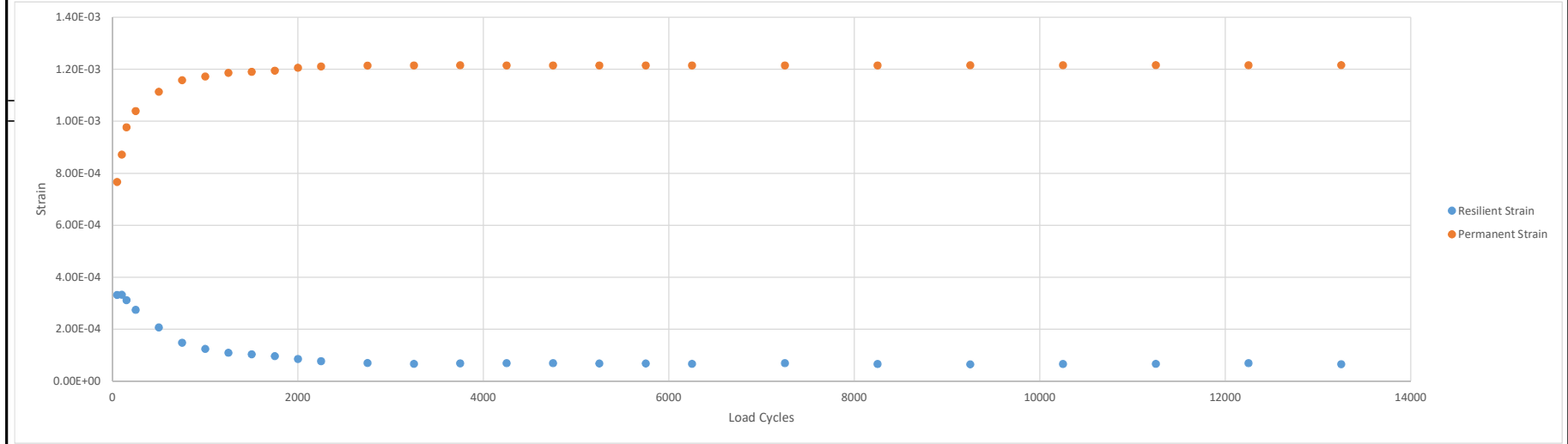


No. of Cycles	10	50	100	150	250	500	750	1000	
Resilient Strain		4.88E-04	4.87E-04	4.91E-04	4.89E-04	4.81E-04	4.77E-04	4.74E-04	
Permanent Strain		1.06E-03	1.21E-03	1.35E-03	1.42E-03	1.53E-03	1.60E-03	1.64E-03	
No. of Cycles	1250	1500	1750	2000	2250	2750	3250	3750	
Resilient Strain	4.64E-04	4.65E-04	4.60E-04	4.57E-04	4.69E-04	4.59E-04	4.62E-04	4.49E-04	
Permanent Strain	1.68E-03	1.70E-03	1.72E-03	1.74E-03	1.75E-03	1.78E-03	1.80E-03	1.83E-03	
No. of Cycles	4250	4750	5250	5750	6250	7250	8250	9250	
Resilient Strain	4.60E-04	4.57E-04	4.39E-04	4.41E-04	4.48E-04	4.41E-04	4.32E-04	4.41E-04	
Permanent Strain	1.84E-03	1.85E-03	1.88E-03	1.89E-03	1.89E-03	1.92E-03	1.94E-03	1.95E-03	
No. of Cycles	10250	11250	12250	13250	MEPDG Model				
Resilient Strain	4.35E-04	4.33E-04	4.35E-04	4.24E-04	$\epsilon_p = \epsilon_0 * e^{-\left(\frac{p}{N}\right)^\beta}$			$\epsilon_0$	0.2766
Permanent Strain	1.98E-03	1.99E-03	2.00E-03	2.02E-03				$\rho$	36.58
								$\beta$	0.191
								R2	0.999
Tested By	Amin Mneina								
Reviewed By	Dr. Ahmed Shalaby								

**University of Manitoba**  
**Pavement Research Group**

Permanent Deformation Test Summary

Sample ID	UGM-2(3.5)	Project	Design Parameters and Specifications of UGM
Replicate #	2	Sampled by	Yukon Department of Highways and Public Works
Date Tested	18/10/2017	Soil Type	Gravel with 3.5% fines
Sample Dry Density	2201	Max. Dry Density (Kg/m3)	2206
Sample Moisture (%)	6.9%	Optimum Moisture (%)	9



No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>	
Resilient Strain		3.31E-04	3.32E-04	3.11E-04	2.74E-04	2.07E-04	1.48E-04	1.24E-04	
Permanent Strain		7.66E-04	8.72E-04	9.76E-04	1.04E-03	1.11E-03	1.16E-03	1.17E-03	
No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>	
Resilient Strain	1.09E-04	1.03E-04	9.59E-05	8.55E-05	7.66E-05	6.95E-05	6.66E-05	6.83E-05	
Permanent Strain	1.19E-03	1.19E-03	1.19E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	
No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>	
Resilient Strain	6.92E-05	6.92E-05	6.75E-05	6.78E-05	6.67E-05	6.91E-05	6.56E-05	6.43E-05	
Permanent Strain	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	
No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	MEPDG Model $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$			<b><math>\epsilon_0</math></b>	<b>0.239</b>
Resilient Strain	6.61E-05	6.65E-05	6.90E-05	6.54E-05				<b><math>\rho</math></b>	<b>27.42</b>
Permanent Strain	1.21E-03	1.22E-03	1.22E-03	1.22E-03	<b><math>\beta</math></b>	<b>0.3798</b>			
						<b>R2</b>	<b>0.998</b>		

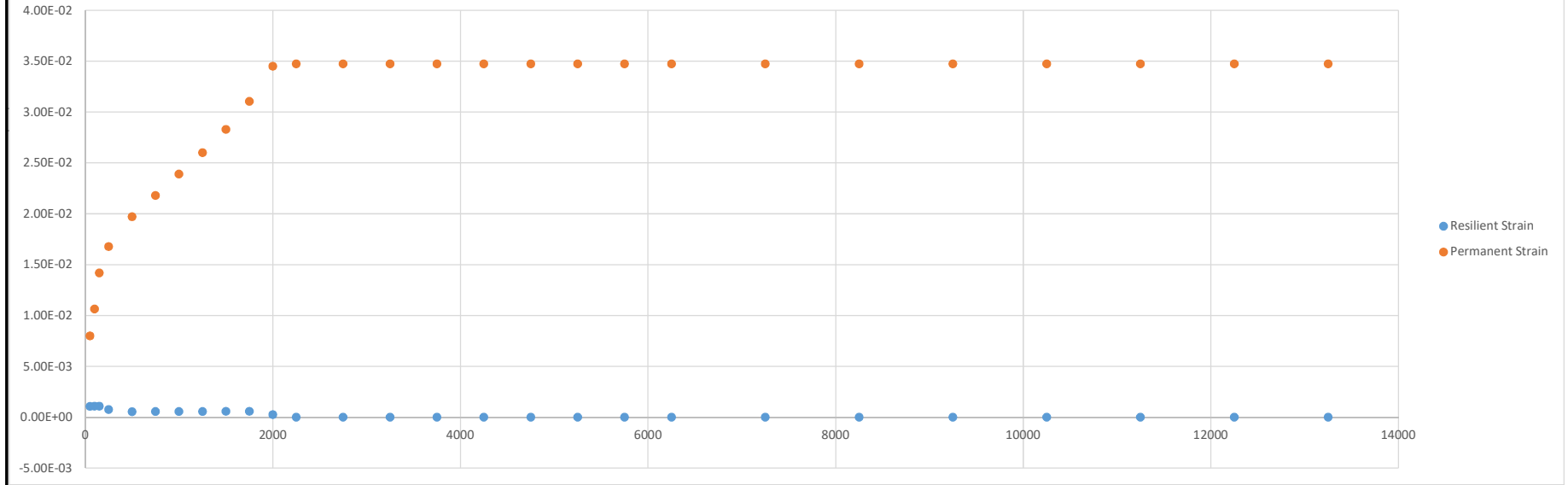
Tested By	Amin Mneina
Reviewd By	Dr. Ahmed Shalaby

# University of Manitoba

## Pavement Research Group

### Resilient Modulus Test Summary

Sample ID	UGM-2(6.4)	Project	Design Parameters and Specifications of UGM
Replicate #	1	Sampled by	Yukon Department of Highways and Public Works
Date Tested	16/10/2017	Soil Type	Gravel with 6.4% fines
Sample Dry Density	2262.331195	Max. Dry Density (Kg/m <sup>3</sup> )	2287
Sample Moisture (%)	7.27	Optimum Moisture (%)	8.5



No. of Cycles	10	50	100	150	250	500	750	1000
Resilient Strain	1.07E-03	1.08E-03	1.09E-03	7.54E-04	5.44E-04	5.53E-04	5.60E-04	5.60E-04
Permanent Strain	7.99E-03	1.06E-02	1.42E-02	1.68E-02	1.97E-02	2.18E-02	2.39E-02	2.39E-02

No. of Cycles	1250	1500	1750	2000	2250	2750	3250	3750
Resilient Strain	5.57E-04	5.73E-04	5.80E-04	2.47E-04	3.83E-16	3.83E-16	3.83E-16	-1.52E-09
Permanent Strain	2.60E-02	2.83E-02	3.11E-02	3.45E-02	3.47E-02	3.47E-02	3.47E-02	3.47E-02

No. of Cycles	4250	4750	5250	5750	6250	7250	8250	9250
Resilient Strain	-1.52E-09	-4.57E-09	-7.62E-09	1.20E-07	3.83E-16	-1.52E-09	-1.52E-09	-1.52E-09
Permanent Strain	3.47E-02	3.47E-02	3.47E-02	3.47E-02	3.47E-02	3.47E-02	3.47E-02	3.47E-02

No. of Cycles	10250	11250	12250	13250	<b>MEPDG Model</b>		$\epsilon_0$	<b>4.136</b>
Resilient Strain	-1.52E-09	-1.52E-09	3.83E-16	-1.52E-09	$\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$		$\rho$	<b>208.8</b>
Permanent Strain	3.47E-02	3.47E-02	3.47E-02	3.47E-02			$\beta$	<b>0.5119</b>
							<b>R2</b>	<b>0.941</b>

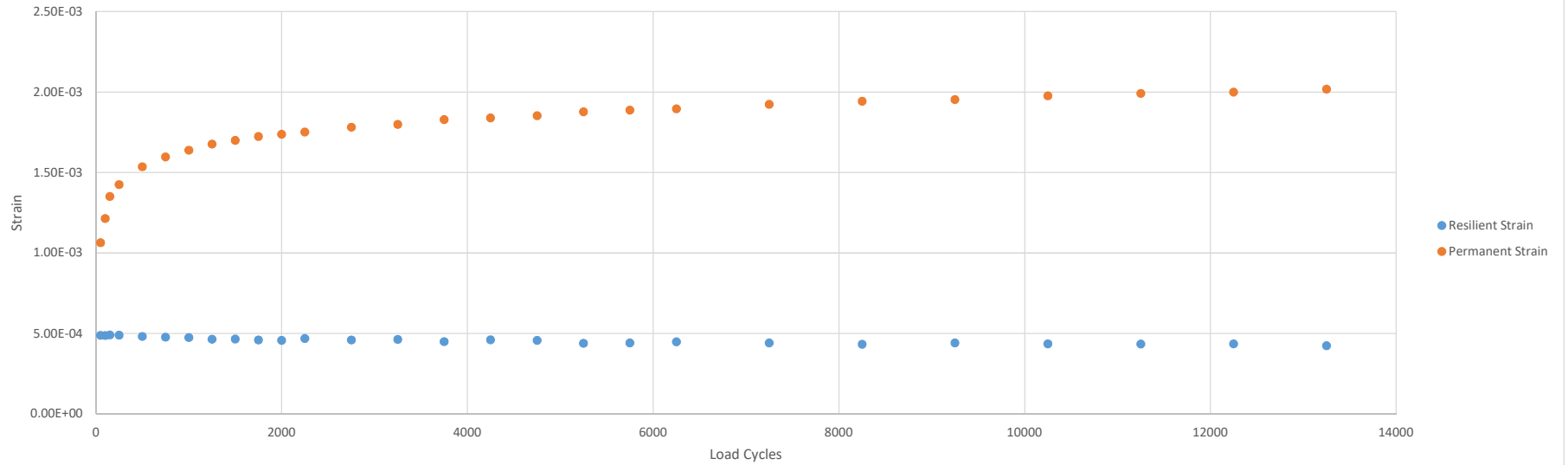
Tested By	Amin Mneina	
Reviewed By	Dr. Ahmed Shalaby	

## University of Manitoba

### Pavement Research Group

#### Permanent Deformation Test Summary

Sample ID	UGM-2(6.4)	Project	Design Parameters and Specifications of UGM
Replicate #	2	Sampled by	Yukon Department of Highways and Public Works
Date Tested	18/10/2017	Soil Type	Gravel with 6.4% fines
Sample Dry Density	2236	Max. Dry Density (Kg/m <sup>3</sup> )	2287
Sample Moisture (%)	5.74	Optimum Moisture (%)	8.5



No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>
Resilient Strain		4.88E-04	4.87E-04	4.91E-04	4.89E-04	4.81E-04	4.77E-04	4.74E-04
Permanent Strain		1.06E-03	1.21E-03	1.35E-03	1.42E-03	1.53E-03	1.60E-03	1.64E-03

No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>
Resilient Strain	4.64E-04	4.65E-04	4.60E-04	4.57E-04	4.69E-04	4.59E-04	4.62E-04	4.49E-04
Permanent Strain	1.68E-03	1.70E-03	1.72E-03	1.74E-03	1.75E-03	1.78E-03	1.80E-03	1.83E-03

No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>
Resilient Strain	4.60E-04	4.57E-04	4.39E-04	4.41E-04	4.48E-04	4.41E-04	4.32E-04	4.41E-04
Permanent Strain	1.84E-03	1.85E-03	1.88E-03	1.89E-03	1.89E-03	1.92E-03	1.94E-03	1.95E-03

No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	<b>MEPDG Model</b> $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$	<b><math>\epsilon_0</math></b>	<b>0.2383</b>
Resilient Strain	4.35E-04	4.33E-04	4.35E-04	4.24E-04		<b><math>\rho</math></b>	<b>9.91</b>
Permanent Strain	1.98E-03	1.99E-03	2.00E-03	2.02E-03		<b><math>\beta</math></b>	<b>0.2383</b>
						<b>R2</b>	<b>0.999</b>

Tested By: Amin Mneina  
 Reviewed By: Dr. Ahmed Shalaby

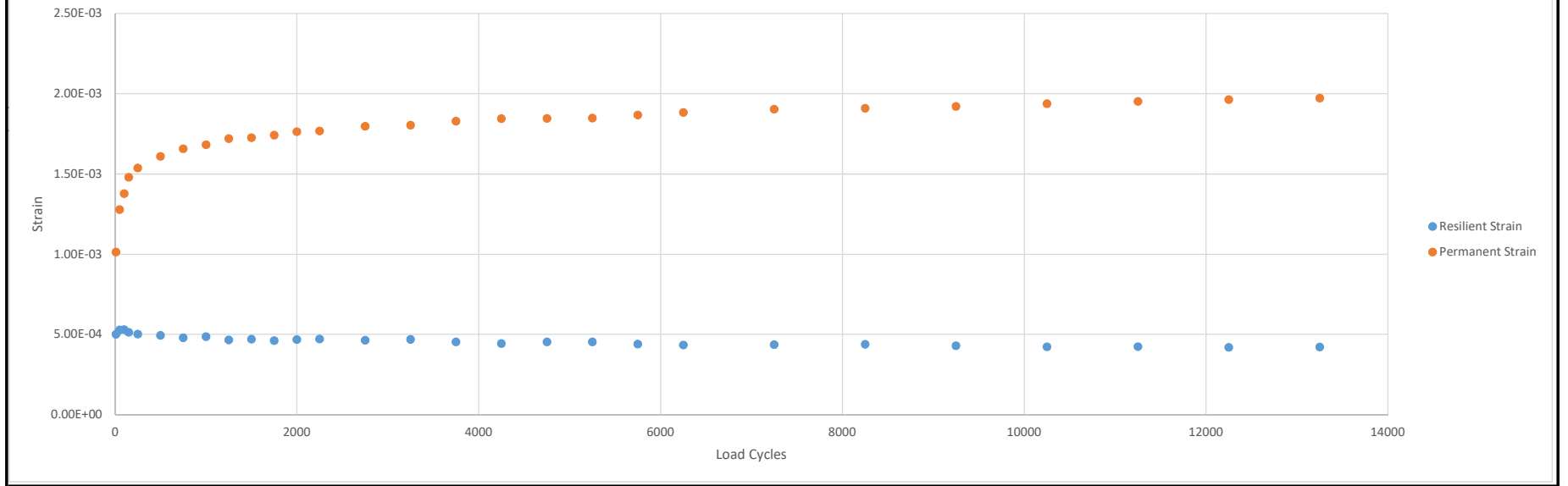


# University of Manitoba

## Pavement Research Group

### Permanent Deformation Test Summary

Sample ID	UGM-2(6.4)	Project	Design Parameters and Specifications of UGM
Replicate #	3	Sampled by	Yukon Department of Highways and Public Works
Date Tested	5/12/2017	Soil Type	Gravel with 6.4% fines
Sample Dry Density	2278	Max. Dry Density (Kg/m <sup>3</sup> )	2287
Sample Moisture (%)	6.54	Optimum Moisture (%)	8.5

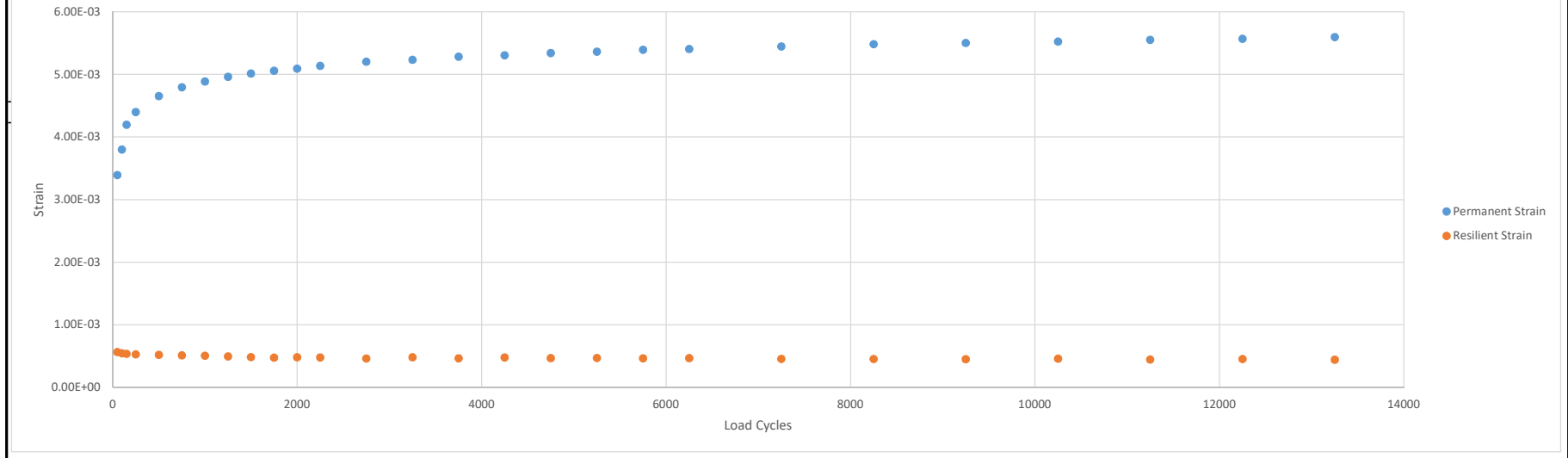


No. of Cycles	10	50	100	150	250	500	750	1000
Resilient Strain	5.01E-04	5.27E-04	5.29E-04	5.13E-04	5.02E-04	4.93E-04	4.79E-04	4.86E-04
Permanent Strain	1.01E-03	1.28E-03	1.38E-03	1.48E-03	1.54E-03	1.61E-03	1.66E-03	1.68E-03
No. of Cycles	1250	1500	1750	2000	2250	2750	3250	3750
Resilient Strain	4.66E-04	4.70E-04	4.61E-04	4.68E-04	4.71E-04	4.63E-04	4.69E-04	4.53E-04
Permanent Strain	1.72E-03	1.73E-03	1.74E-03	1.76E-03	1.77E-03	1.80E-03	1.80E-03	1.83E-03
No. of Cycles	4250	4750	5250	5750	6250	7250	8250	9250
Resilient Strain	4.43E-04	4.53E-04	4.53E-04	4.40E-04	4.34E-04	4.37E-04	4.38E-04	4.29E-04
Permanent Strain	1.84E-03	1.85E-03	1.85E-03	1.87E-03	1.88E-03	1.90E-03	1.91E-03	1.92E-03
No. of Cycles	10250	11250	12250	13250	MEPDG Model $\epsilon_p = \epsilon_0 * e^{-\left(\frac{p}{N}\right)^\beta}$			
Resilient Strain	4.23E-04	4.23E-04	4.19E-04	4.21E-04				$\epsilon_0$
Permanent Strain	1.94E-03	1.95E-03	1.96E-03	1.97E-03	$\rho$	<b>7.653</b>		
					$\beta$	<b>0.2277</b>		
					<b>R2</b>	<b>0.995</b>		
Tested By	Amin Mneina							
Reviewed By	Dr. Ahmed Shalaby							

**University of Manitoba**  
**Pavement Research Group**

Permanent Deformation Test Summary

Sample ID	UGM-3(3.9)	Project	Design Parameters and Specifications of UGM
Replicate #	1	Sampled by	Yukon Department of Highways and Public Works
Date Tested	13/10/2017	Soil Type	Gravel with 3.9% fines
Sample Dry Density	2201.54	Max. Dry Density (Kg/m3)	2221
Sample Moisture (%)	7.11	Optimum Moisture (%)	9.2

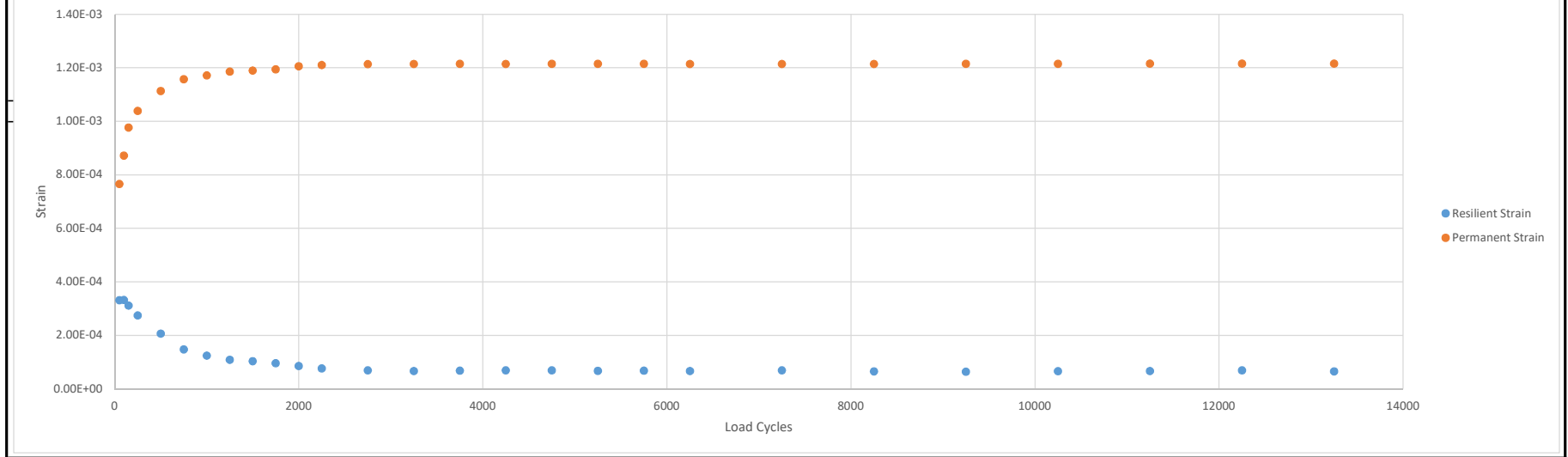


No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>	
Resilient Strain		5.64E-04	5.46E-04	5.39E-04	5.29E-04	5.20E-04	5.14E-04	5.07E-04	
Permanent Strain		3.39E-03	3.80E-03	4.20E-03	4.40E-03	4.65E-03	4.79E-03	4.88E-03	
No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>	
Resilient Strain	4.95E-04	4.86E-04	4.76E-04	4.82E-04	4.81E-04	4.63E-04	4.82E-04	4.67E-04	
Permanent Strain	4.96E-03	5.01E-03	5.06E-03	5.09E-03	5.13E-03	5.20E-03	5.23E-03	5.28E-03	
No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>	
Resilient Strain	4.81E-04	4.67E-04	4.70E-04	4.65E-04	4.69E-04	4.58E-04	4.54E-04	4.52E-04	
Permanent Strain	5.31E-03	5.34E-03	5.36E-03	5.39E-03	5.40E-03	5.45E-03	5.48E-03	5.50E-03	
No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	MEPDG Model $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$			$\epsilon_0$	<b>0.628</b>
Resilient Strain	4.59E-04	4.46E-04	4.54E-04	4.44E-04				$\rho$	<b>9.334</b>
Permanent Strain	5.52E-03	5.55E-03	5.57E-03	5.59E-03				$\beta$	<b>0.293</b>
								<b>R2</b>	<b>0.999</b>
Tested By	Amin Mneina								
Review By	Dr. Ahmed Shalaby								

**University of Manitoba**  
**Pavement Research Group**

Permanent Deformation Test Summary

Sample ID	UGM-3(3.9)	Project	Design Parameters and Specifications of UGM
Replicate #	2	Sampled by	Yukon Department of Highways and Public Works
Date Tested	17/10/2017	Soil Type	Gravel with 3.9% fines
Sample Dry Density	2199.79	Max. Dry Density (Kg/m3)	2221
Sample Moisture (%)	7.74	Optimum Moisture (%)	9.2



No. of Cycles	10	50	100	150	250	500	750	1000
Resilient Strain		3.31E-04	3.32E-04	3.11E-04	2.74E-04	2.07E-04	1.48E-04	1.24E-04
Permanent Strain		7.66E-04	8.72E-04	9.76E-04	1.04E-03	1.11E-03	1.16E-03	1.17E-03
No. of Cycles	1250	1500	1750	2000	2250	2750	3250	3750
Resilient Strain	1.09E-04	1.03E-04	9.59E-05	8.55E-05	7.66E-05	6.95E-05	6.66E-05	6.83E-05
Permanent Strain	1.19E-03	1.19E-03	1.19E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03
No. of Cycles	4250	4750	5250	5750	6250	7250	8250	9250
Resilient Strain	6.92E-05	6.92E-05	6.75E-05	6.78E-05	6.67E-05	6.91E-05	6.56E-05	6.43E-05
Permanent Strain	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03	1.21E-03

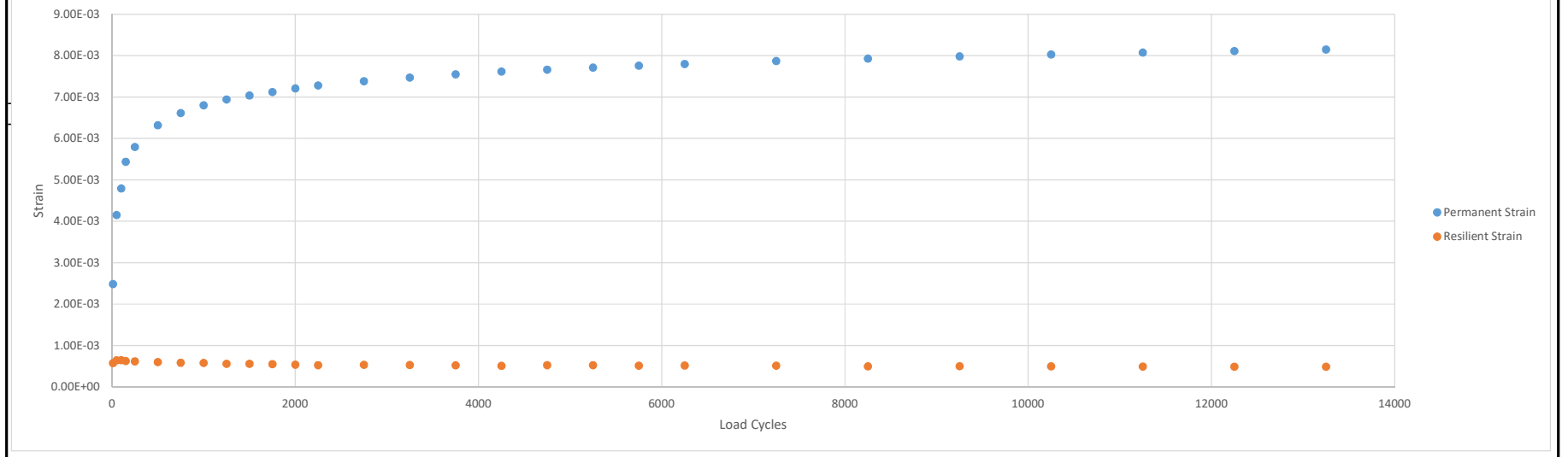
No. of Cycles	10250	11250	12250	13250	<p align="center"><b>MEPDG Model</b></p> $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$	$\epsilon_0$	<b>0.1248</b>
Resilient Strain	6.61E-05	6.65E-05	6.90E-05	6.54E-05		$\rho$	<b>18.1</b>
Permanent Strain	1.21E-03	1.22E-03	1.22E-03	1.22E-03		$\beta$	<b>0.641</b>
						<b>R2</b>	<b>0.985</b>

Tested By	Amin Mneina
Reviewd By	Dr. Ahmed Shalaby

**University of Manitoba**  
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Permanent Deformation Test Summary

Sample ID	UGM-3(6.9)	Project	Drainable Base
Replicate #	1	Sampled by	Manitoba Infrastructure
Date Tested	13/2/2018	Soil Type	Gravel with 6.9% fines
Sample Dry Density	2040.78	Max. Dry Density (Kg/m3)	2053
Sample Moisture (%)	10.71	Optimum Moisture (%)	10.10%

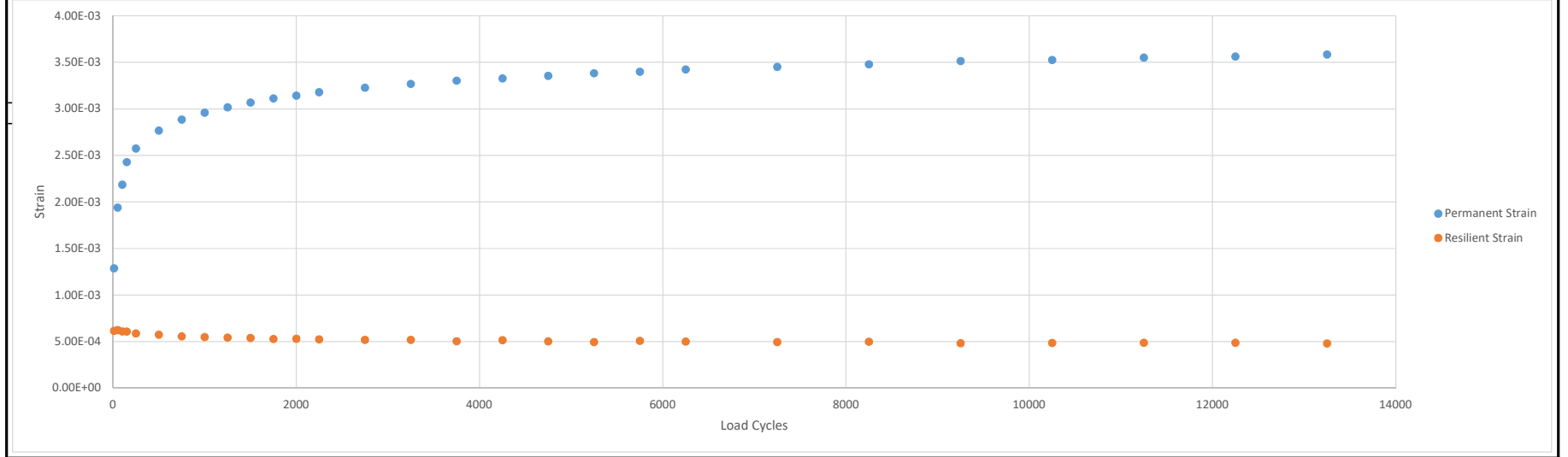


No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>	
Resilient Strain	5.77E-04	6.47E-04	6.51E-04	6.29E-04	6.18E-04	6.02E-04	5.85E-04	5.82E-04	
Permanent Strain	2.49E-03	4.15E-03	4.79E-03	5.44E-03	5.80E-03	6.32E-03	6.62E-03	6.80E-03	
No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>	
Resilient Strain	5.61E-04	5.60E-04	5.52E-04	5.41E-04	5.29E-04	5.37E-04	5.30E-04	5.23E-04	
Permanent Strain	6.94E-03	7.04E-03	7.12E-03	7.21E-03	7.28E-03	7.38E-03	7.47E-03	7.55E-03	
No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>	
Resilient Strain	5.11E-04	5.29E-04	5.29E-04	5.15E-04	5.20E-04	5.16E-04	4.99E-04	5.03E-04	
Permanent Strain	7.62E-03	7.66E-03	7.71E-03	7.76E-03	7.80E-03	7.87E-03	7.93E-03	7.98E-03	
No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	MEPDG Model $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$			$\epsilon_0$	<b>0.9012</b>
Resilient Strain	5.01E-04	4.94E-04	4.93E-04	4.92E-04				$\rho$	<b>34.46</b>
Permanent Strain	8.03E-03	8.07E-03	8.11E-03	8.15E-03	$\beta$	<b>0.3721</b>			
								R2	<b>0.998</b>
Tested By	Amin Mneina								
Review By	Dr. Ahmed Shalaby								

**University of Manitoba**  
**Pavement Research Group**

Permanent Deformation Test Summary

Sample ID	UGM-3(6.9)	Project	Drainable Base
Replicate #	2	Sampled by	Manitoba Infrastructure
Date Tested	23/2/2018	Soil Type	Gravel with 6.9% fines
Sample Dry Density	2035.90	Max. Dry Density (Kg/m3)	2053
Sample Moisture (%)	10.54	Optimum Moisture (%)	10.10%



No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>
Resilient Strain	6.15E-04	6.24E-04	6.10E-04	6.08E-04	5.89E-04	5.75E-04	5.56E-04	5.50E-04
Permanent Strain	1.29E-03	1.94E-03	2.19E-03	2.43E-03	2.57E-03	2.77E-03	2.88E-03	2.96E-03

No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>
Resilient Strain	5.44E-04	5.41E-04	5.30E-04	5.31E-04	5.25E-04	5.19E-04	5.20E-04	5.05E-04
Permanent Strain	3.02E-03	3.07E-03	3.11E-03	3.14E-03	3.18E-03	3.23E-03	3.27E-03	3.30E-03

No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>
Resilient Strain	5.16E-04	5.03E-04	4.96E-04	5.09E-04	5.02E-04	4.96E-04	4.99E-04	4.82E-04
Permanent Strain	3.33E-03	3.35E-03	3.38E-03	3.40E-03	3.42E-03	3.45E-03	3.48E-03	3.51E-03

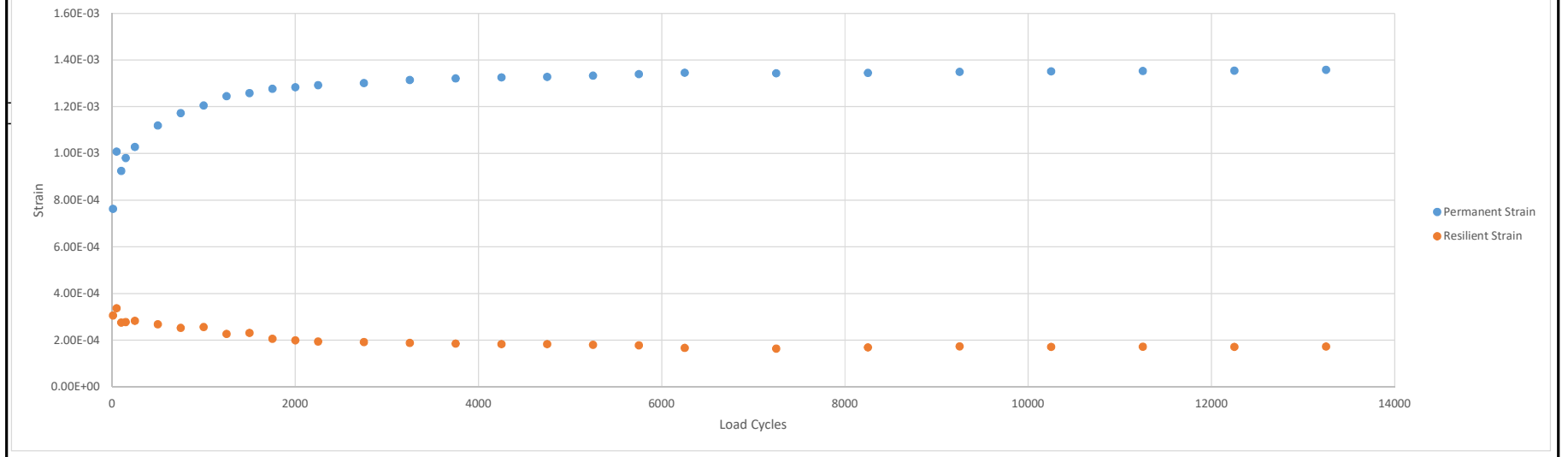
No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	<b>MEPDG Model</b>  $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$	<b><math>\epsilon_0</math></b>	<b>0.4155</b>
Resilient Strain	4.87E-04	4.88E-04	4.89E-04	4.82E-04		<b><math>\rho</math></b>	<b>28.47</b>
Permanent Strain	3.52E-03	3.55E-03	3.56E-03	3.58E-03		<b><math>\beta</math></b>	<b>0.3031</b>
						<b>R2</b>	<b>0.998</b>

Tested By	Amin Mneina
Reviewd By	Dr. Ahmed Shalaby

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Permanent Deformation Test Summary

Sample ID	UGM-3.(7.1)	Project	Drainable Base
Replicate #	1	Sampled by	Manitoba Infrastructure
Date Tested	6/2/2018	Soil Type	Limestone with 7.1% fines
Sample Dry Density	2226.43	Max. Dry Density (Kg/m3)	2226
Sample Moisture (%)	6.72	Optimum Moisture (%)	6.90%

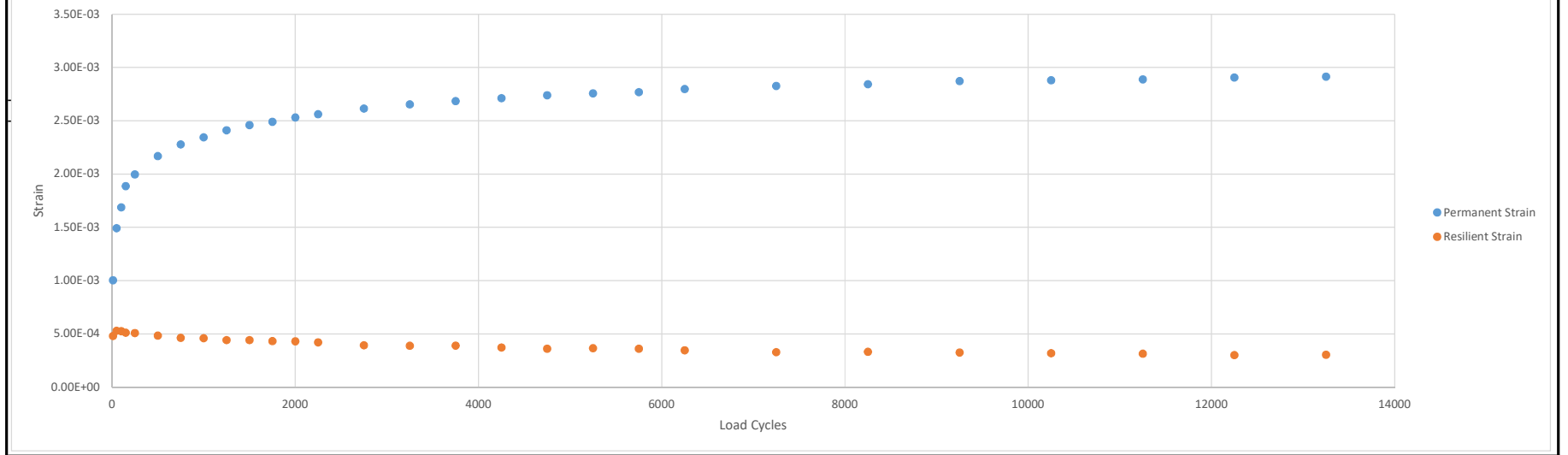


No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>	
Resilient Strain	3.06E-04	3.37E-04	2.76E-04	2.78E-04	2.83E-04	2.69E-04	2.53E-04	2.56E-04	
Permanent Strain	7.63E-04	1.01E-03	9.25E-04	9.81E-04	1.03E-03	1.12E-03	1.17E-03	1.21E-03	
No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>	
Resilient Strain	2.27E-04	2.32E-04	2.06E-04	2.00E-04	1.94E-04	1.92E-04	1.88E-04	1.86E-04	
Permanent Strain	1.25E-03	1.26E-03	1.28E-03	1.28E-03	1.29E-03	1.30E-03	1.31E-03	1.32E-03	
No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>	
Resilient Strain	1.83E-04	1.84E-04	1.80E-04	1.78E-04	1.67E-04	1.64E-04	1.69E-04	1.74E-04	
Permanent Strain	1.33E-03	1.33E-03	1.33E-03	1.34E-03	1.35E-03	1.34E-03	1.35E-03	1.35E-03	
No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	MEPDG Model $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$			$\epsilon_0$	<b>0.1676</b>
Resilient Strain	1.72E-04	1.72E-04	1.72E-04	1.73E-04				$\rho$	<b>6.322</b>
Permanent Strain	1.35E-03	1.35E-03	1.35E-03	1.36E-03	$\beta$	<b>0.2158</b>			
					$R^2$	<b>0.956</b>			
Tested By	Amin Mneina								
Review By	Dr. Ahmed Shalaby								

**University of Manitoba**  
**Pavement Research Group**

Permanent Deformation Test Summary

Sample ID	UGM-3(7.1)	Project	Drainable Base
Replicate #	2	Sampled by	Manitoba Infrastructure
Date Tested	22/2/2018	Soil Type	Limestone with 7.1% fines
Sample Dry Density	2221.77	Max. Dry Density (Kg/m3)	2226
Sample Moisture (%)	6.67	Optimum Moisture (%)	6.90%



No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>
Resilient Strain	4.80E-04	5.29E-04	5.25E-04	5.12E-04	5.09E-04	4.84E-04	4.62E-04	4.60E-04
Permanent Strain	1.00E-03	1.49E-03	1.69E-03	1.89E-03	2.00E-03	2.17E-03	2.28E-03	2.34E-03

No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>
Resilient Strain	4.41E-04	4.41E-04	4.33E-04	4.30E-04	4.20E-04	3.94E-04	3.88E-04	3.91E-04
Permanent Strain	2.41E-03	2.46E-03	2.49E-03	2.53E-03	2.56E-03	2.62E-03	2.65E-03	2.68E-03

No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>
Resilient Strain	3.72E-04	3.61E-04	3.65E-04	3.61E-04	3.47E-04	3.29E-04	3.32E-04	3.26E-04
Permanent Strain	2.71E-03	2.74E-03	2.76E-03	2.77E-03	2.80E-03	2.83E-03	2.84E-03	2.87E-03

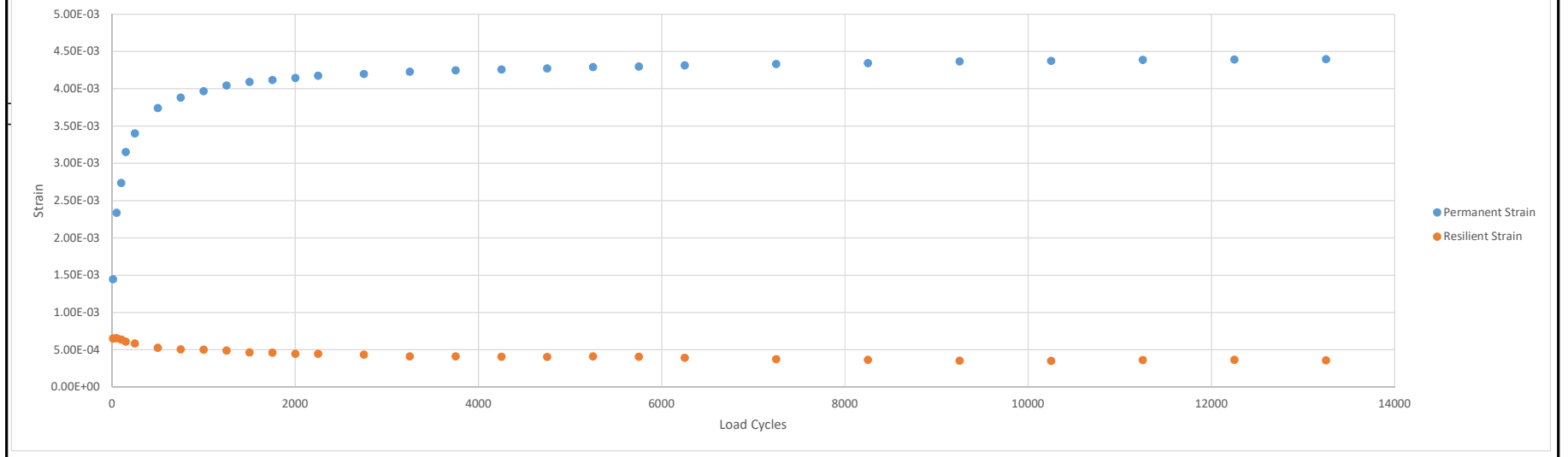
No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	<b>MEPDG Model</b> $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$	<b><math>\epsilon_0</math></b>	<b>0.3645</b>
Resilient Strain	3.20E-04	3.13E-04	3.01E-04	3.04E-04		<b><math>\rho</math></b>	<b>45.37</b>
Permanent Strain	2.88E-03	2.89E-03	2.91E-03	2.91E-03		<b><math>\beta</math></b>	<b>0.2662</b>
						<b>R2</b>	<b>0.999</b>

Tested By	Amin Mneina
Reviewd By	Dr. Ahmed Shalaby

**University of Manitoba**  
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Permanent Deformation Test Summary

Sample ID	UGM-4(3.3)	Project	Drainable Base
Replicate #	1	Sampled by	Manitoba Infrastructure
Date Tested	7/2/2018	Soil Type	Gravel with 3.3% fines
Sample Dry Density	2215.41	Max. Dry Density (Kg/m3)	2220
Sample Moisture (%)	7.65	Optimum Moisture (%)	7.80%



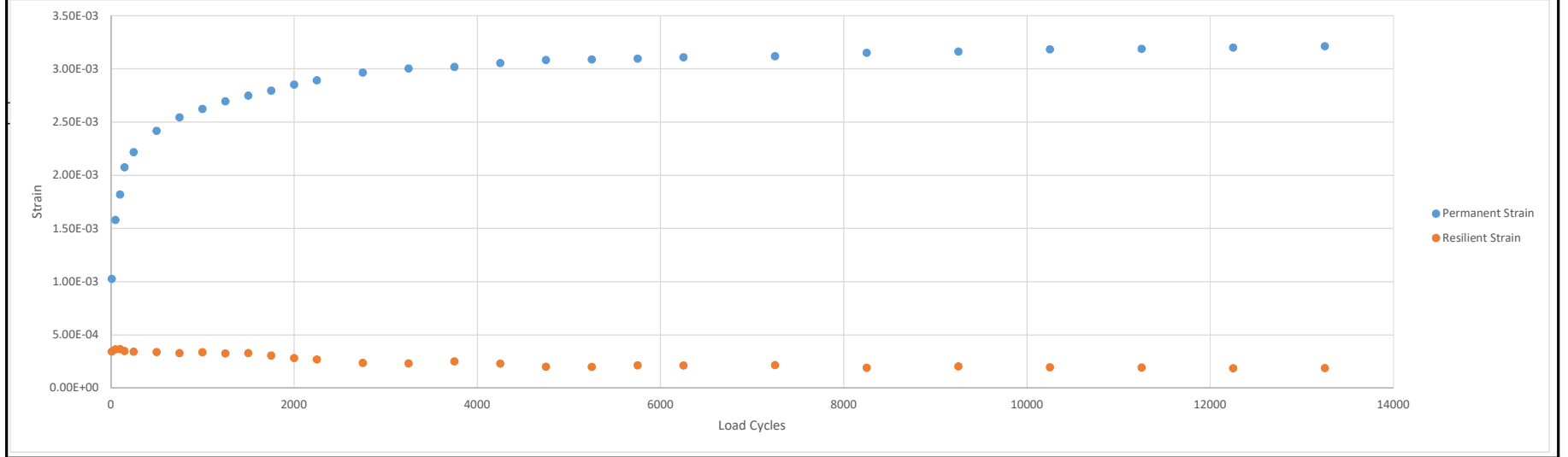
No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>	
Resilient Strain	6.51E-04	6.56E-04	6.37E-04	6.11E-04	5.85E-04	5.26E-04	5.06E-04	5.00E-04	
Permanent Strain	1.44E-03	2.34E-03	2.74E-03	3.15E-03	3.40E-03	3.74E-03	3.88E-03	3.97E-03	
No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>	
Resilient Strain	4.90E-04	4.65E-04	4.61E-04	4.46E-04	4.45E-04	4.35E-04	4.12E-04	4.11E-04	
Permanent Strain	4.04E-03	4.09E-03	4.12E-03	4.15E-03	4.18E-03	4.20E-03	4.23E-03	4.25E-03	
No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>	
Resilient Strain	4.06E-04	4.04E-04	4.11E-04	4.08E-04	3.94E-04	3.75E-04	3.66E-04	3.53E-04	
Permanent Strain	4.26E-03	4.27E-03	4.29E-03	4.30E-03	4.31E-03	4.33E-03	4.35E-03	4.37E-03	
No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	MEPDG Model $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$			$\epsilon_0$	<b>0.4609</b>
Resilient Strain	3.50E-04	3.62E-04	3.64E-04	3.59E-04				$\rho$	<b>28.2</b>
Permanent Strain	4.37E-03	4.39E-03	4.39E-03	4.40E-03				$\beta$	<b>0.5105</b>
								<b>R2</b>	<b>0.998</b>
Tested By	Amin Mneina								
Review By	Dr. Ahmed Shalaby								



**University of Manitoba**  
**Pavement Research Group**

Permanent Deformation Test Summary

Sample ID	UGM-4(3.3)	Project	Drainable Base
Replicate #	2	Sampled by	Manitoba Infrastructure
Date Tested	21/2/2018	Soil Type	Gravel with 6.9% fines
Sample Dry Density	2220.22	Max. Dry Density (Kg/m3)	2220
Sample Moisture (%)	7.28	Optimum Moisture (%)	7.80%



No. of Cycles	<b>10</b>	<b>50</b>	<b>100</b>	<b>150</b>	<b>250</b>	<b>500</b>	<b>750</b>	<b>1000</b>
Resilient Strain	3.45E-04	3.65E-04	3.68E-04	3.49E-04	3.44E-04	3.40E-04	3.30E-04	3.38E-04
Permanent Strain	1.03E-03	1.58E-03	1.82E-03	2.08E-03	2.22E-03	2.42E-03	2.55E-03	2.62E-03

No. of Cycles	<b>1250</b>	<b>1500</b>	<b>1750</b>	<b>2000</b>	<b>2250</b>	<b>2750</b>	<b>3250</b>	<b>3750</b>
Resilient Strain	3.27E-04	3.30E-04	3.07E-04	2.83E-04	2.70E-04	2.38E-04	2.32E-04	2.53E-04
Permanent Strain	2.70E-03	2.75E-03	2.80E-03	2.85E-03	2.89E-03	2.97E-03	3.01E-03	3.02E-03

No. of Cycles	<b>4250</b>	<b>4750</b>	<b>5250</b>	<b>5750</b>	<b>6250</b>	<b>7250</b>	<b>8250</b>	<b>9250</b>
Resilient Strain	2.32E-04	2.03E-04	2.00E-04	2.15E-04	2.14E-04	2.16E-04	1.93E-04	2.05E-04
Permanent Strain	3.05E-03	3.08E-03	3.09E-03	3.10E-03	3.11E-03	3.12E-03	3.15E-03	3.16E-03

No. of Cycles	<b>10250</b>	<b>11250</b>	<b>12250</b>	<b>13250</b>	<b>MEPDG Model</b> $\epsilon_p = \epsilon_0 * e^{-\left(\frac{\rho}{N}\right)^\beta}$	<b><math>\epsilon_0</math></b>	<b>0.3781</b>
Resilient Strain	1.97E-04	1.95E-04	1.87E-04	1.89E-04		<b><math>\rho</math></b>	<b>43.22</b>
Permanent Strain	3.18E-03	3.19E-03	3.20E-03	3.21E-03		<b><math>\beta</math></b>	<b>0.3255</b>
						<b>R2</b>	<b>0.998</b>

Tested By	Amin Mneina
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