

# MSCR: Standard Calculations & Analysis



Matthew Corrigan, P.E.

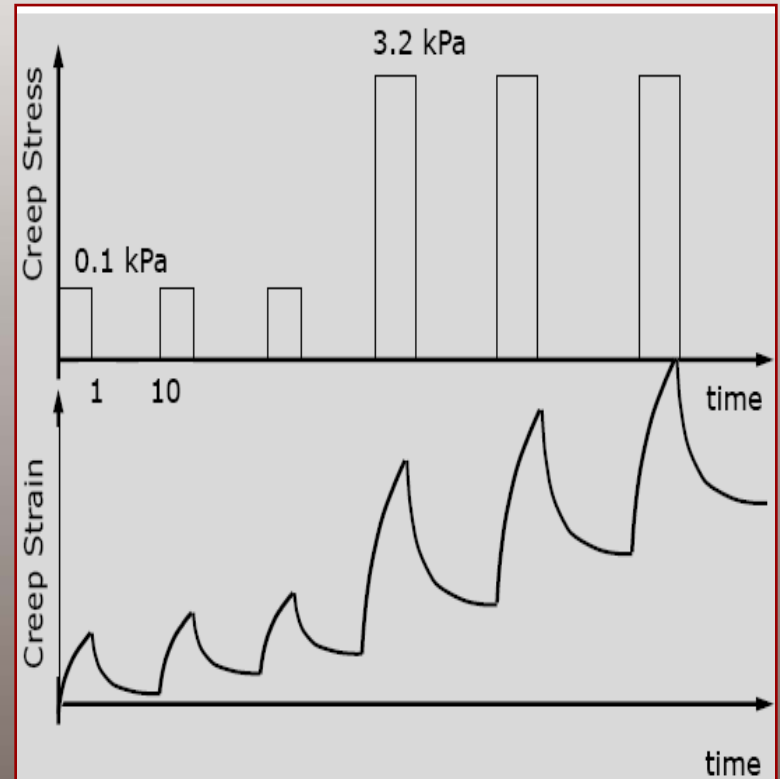
U.S. DOT | Federal Highway Administration  
Asset Management, Pavement, and Construction

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# The Multiple Stress Creep Recovery (MSCR) Test – AASHTO T 350

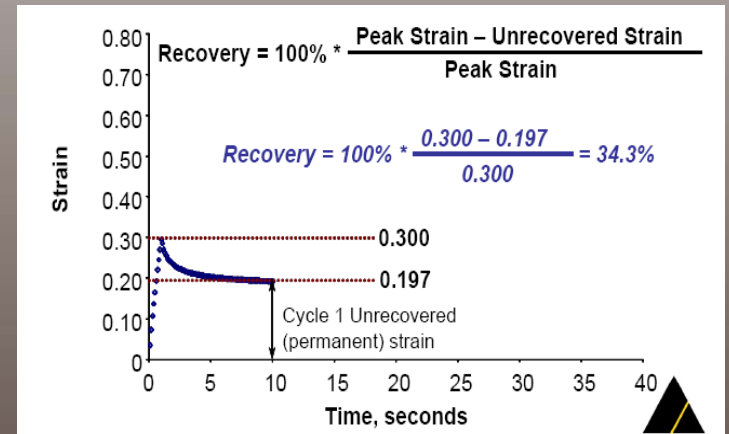
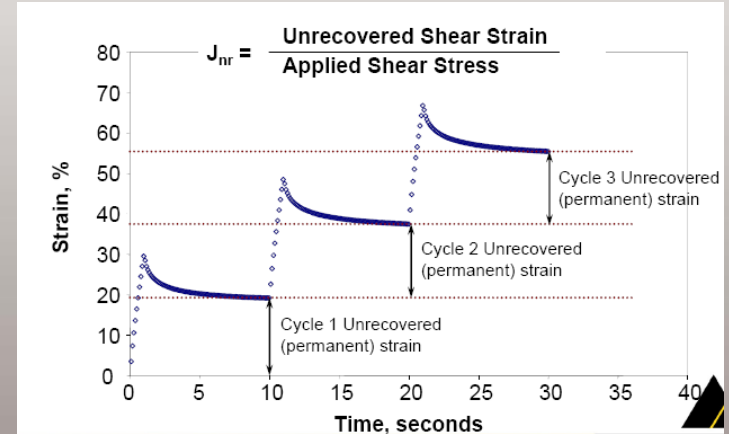
- During the creep interval, a material is subjected to a load (stress) for a fixed amount of time while the resulting deformation (strain) is measured. Applied load interval.
- The recovery interval immediately follows the creep interval wherein the load (stress) is completely removed and the recoil (recovery) of the material is measured. No load interval.
- The controlled and measured parameters are applied stress and resulting strain.
- The creep interval time is 1 second. The recovery interval time is 9 seconds. For a total cycle time of 10 seconds.
- 20 cycles at 0.1 kPa and 10 cycles at 3.2 kPa are conducted.



Example Showing 3 Cycles at the Two Stress Levels

# MSCR Test – Parameters

- $J_{nr}$ , or **non-recoverable compliance**, is simply the unrecovered strain relative to the applied stress.
- Numerically, it is the unrecovered strain over the applied stress.
- **Percent recovery** is how thoroughly the sample returns to its previous shape after being stretched (creep) and then relaxed (recovered).
- Numerically, it is the difference between the strain at the end of the recovery period and the peak strain at the end of the creep period relative to the peak strain.

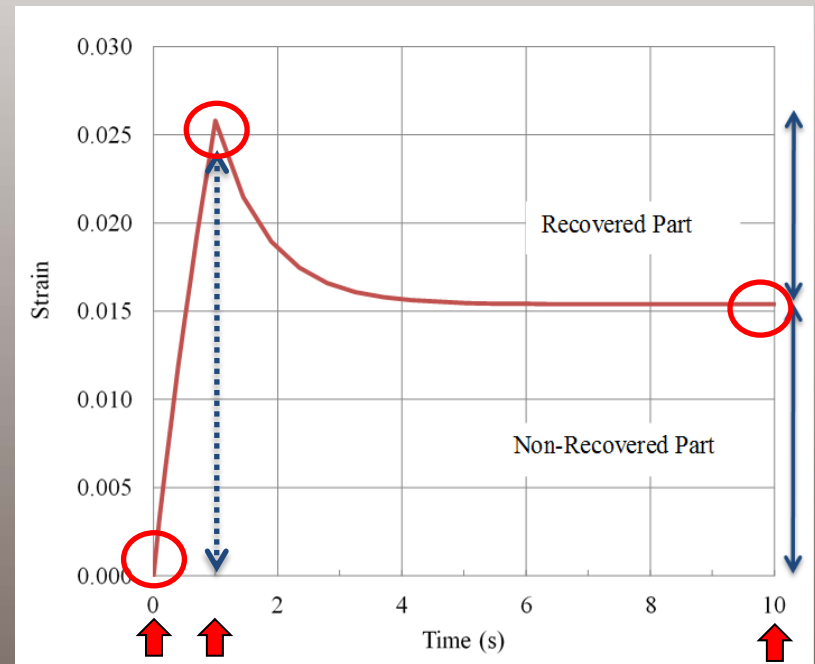


# MSCR Test – Analysis

## ■ Values needed for calculations:

- $\varepsilon_0$ : Initial strain (@ 0 second)
- $\varepsilon_C$ : Strain after the creep portion (@ 1 second)
- $\varepsilon_r$ : Strain at the end of cycle (@ 10 seconds)

- The rest is **mathematical calculations** based on AASHTO T 350.



# Analysis Method

- DSR Software output: (version)
  - Final calculated results
  - Raw data
- Manual calculations:
  - Own developed spreadsheet
  - Template provided by vendor



# Manual Calculations

- If strain values **are available** at those exact times:
  - Straight forward calculations
  - Double check with other methods?
- If strain values **are not** available at those exact times:
  - Extrapolation ?
  - Interpolation ?



# Example of Raw Data

*Available* strain values at those exact desired times

## ■ Data Sampling:

- Creep Region:  
10 data points = 1.00 sec
- Recovery Region:  
90 data points = 9.00 sec
- Sampling Interval:  
0.1 sec

Time	Strain	Creep Compliance	Shear Stress	Torque	Temperature
[s]	[%]	[1/Pa]	[Pa]	[mNm]	[°C]
0.10	1.0681	0.000107	100	0.307	58
0.20	1.8424	0.000184	100	0.307	58
0.30	2.5213	0.000252	100	0.307	58
0.40	3.1298	0.000313	100	0.307	58
0.50	3.7022	0.00037	100	0.307	58
0.60	4.2435	0.000424	100	0.307	58
0.70	4.7843	0.000478	100	0.307	58
0.80	5.3039	0.00053	100	0.307	58
0.90	5.8003	0.00058	100	0.307	58
1.00	6.2757	0.000628	100	0.307	58

•  
•  
•

Time	Strain	Creep Compliance	Shear Stress	Torque	Temperature
[s]	[%]	[1/Pa]	[Pa]	[mNm]	[°C]
9.10	3.0289	0	0	0	58
9.20	3.0212	0	0	0	58
9.30	3.0151	0	0	0	58
9.40	3.0091	0	0	0	58
9.50	3.0027	0	0	0	58
9.60	2.9967	0	0	0	58
9.70	2.9914	0	0	0	58
9.80	2.9854	0	0	0	58
9.90	2.9792	0	0	0	58
10.00	2.9737	0	0	0	58

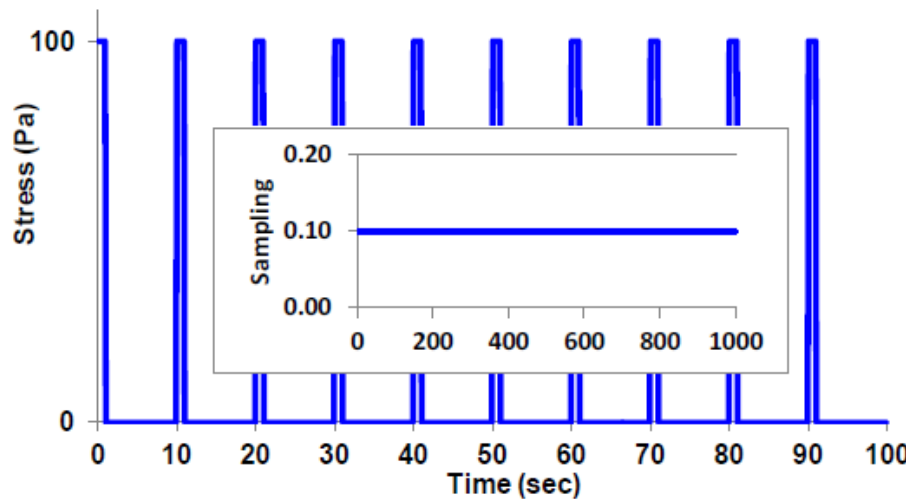


# Recall: ETG May 2013 Presentation

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## DSR#1

- Creep Region = 10 Data Pts = 1 sec
- Recovery Region = 90 Data Pts = 9 sec
- Sampling Interval = 0.1 sec



### Test Time

$$\begin{aligned} &= (10+90) * 10 \\ &= 1,000 \text{ Data Pts} \\ &= 100 \text{ sec} \end{aligned}$$





# Example of Raw Data

*Not available* strain values at those exact desired times

## ■ Data Sampling:

- Creep Region:  
27 data points =  
**0.953 sec**
- Recovery Region:  
63 data points =  
**9.706 sec**
- Sampling Interval:  
**0.013 – 0.402 sec**

time global	newglobal	% strain	compliance J(t)	shear stress	torque	temperature
s	s		1/Pa	Pa	micro N.m	°C
1200	0	0	0	100	306.8	64
1200.013	0.0126	0.40185	4.02E-05	100	306.8	64
1200.038	0.0377	1.2528	1.25E-04	100	306.8	64
1200.063	0.0627	2.0628	2.06E-04	100	306.8	64
1200.088	0.0879	2.8643	2.86E-04	100	306.8	64
1200.113	0.1129	3.6488	3.65E-04	100	306.8	64
1200.138	0.1381	4.4235	4.42E-04	100	306.8	64
1200.163	0.1631	5.1935	5.19E-04	100	306.8	64
1200.188	0.1882	5.9587	5.96E-04	100	306.8	64
1200.213	0.2133	6.7245	6.72E-04	100	306.8	64
1200.238	0.2384	7.4849	7.48E-04	100	306.8	64
1200.263	0.2634	8.2322	8.23E-04	100	306.8	64
1200.289	0.2886	8.9852	8.99E-04	100	306.8	64
1200.314	0.3136	9.7325	9.73E-04	100	306.8	64
1200.351	0.3513	10.873	1.09E-03	100	306.8	64
1200.401	0.4015	12.371	1.24E-03	100	306.8	64
1200.452	0.4517	13.871	1.39E-03	100	306.8	64
1200.502	0.5018	15.362	1.54E-03	100	306.8	64
1200.552	0.552	16.841	1.68E-03	100	306.8	64
1200.602	0.6022	18.338	1.83E-03	100	306.8	64
1200.652	0.6523	19.827	1.98E-03	100	306.8	64
1200.703	0.7025	21.32	2.13E-03	100	306.8	64
1200.753	0.7527	22.801	2.28E-03	100	306.8	64
1200.803	0.8029	24.275	2.43E-03	100	306.8	64
1200.853	0.853	25.761	2.58E-03	100	306.8	64
1200.903	0.9032	27.242	2.72E-03	100	306.8	64
1200.953	0.9534	28.731	2.87E-03	100	306.8	64

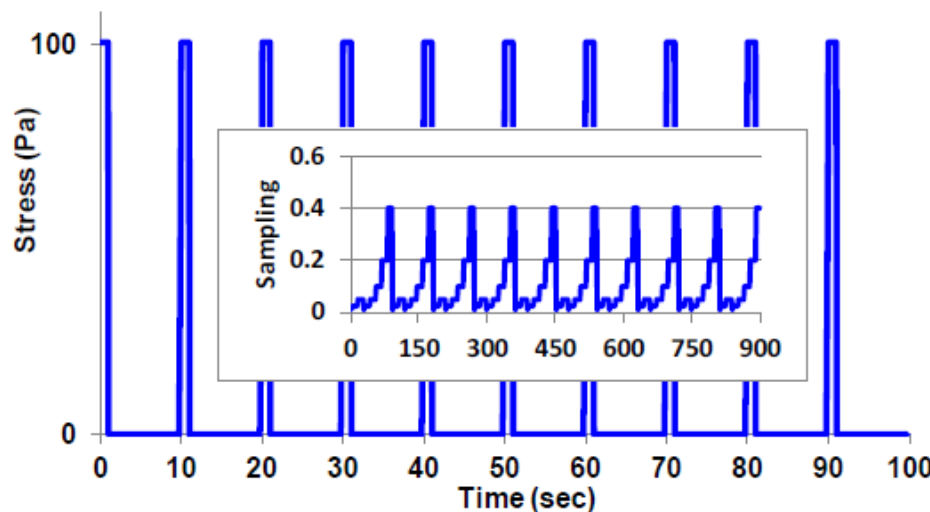


# Recall: ETG May 2013 Presentation

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## DSR#2

- Creep Region = 27 Data Pts = 0.953 sec
- Recovery Region = 63 Data Pts = 9.706 sec
- Sampling Interval = 0.013 - 0.402 sec



### Test Time

$$\begin{aligned} &= (27 + 63) * 10 \\ &= 900 \text{ Data Pts} \\ &= 99.71 \text{ sec} \end{aligned}$$



# Verifying the Analysis Method

*Available strain values not at the exact desired times*

- How are data explicit times determined ?
- Interpolation or Extrapolation ?
  - Effect on the results & outcome ?
  - How many points before or after should be used ?
- User or Vendor responsibility ?
  - Who needs to keep them updated ?
  - Have DSR vendors already taken action ?



# Standardized Method ?

- Can this be another source of variability?
- Need to standardize the method of analysis?



# FHWA Field Support Mobile Asphalt Testing Trailer (MATT)

- mobile asphalt pavement materials lab
  - Site Visits
  - Field Data/Testing/Evaluation
  - Use/Demo Emerging Test Devices
  - POC: Matthew Corrigan



Thank  
You!!

Discussion / Comments / Questions



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