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**THÈSE de DOCTORAT DE L'UNIVERSITÉ DE LYON**  
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**Laboratoire de Tribologie et Dynamique des Systèmes (UMR  
5513)**  
à  
**l'École Nationale des Travaux Publics de l'Etat**

**École Doctorale 162**  
**Mécanique, Energétique, Génie civil et Acoustique**

Spécialité / discipline de doctorat :  
**Génie civil**

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par :  
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**Relation entre les performances  
thermomécaniques des liants et des  
enrobés bitumineux avec prise en  
compte de l'adhésion liant-granulat  
(Annexes)**

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N° d'ordre NNT : 2020LYSET013

**Ph.D. THESIS OF THE UNIVERSITY OF LYON**  
carried out at  
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(UMR 5513)**  
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**Mécanique, Energétique, Génie civil et Acoustique**

Specialty:  
**Civil Engineering**

Publicly defended on October 23<sup>rd</sup>, 2020  
by  
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**Relationship between  
thermomechanical performances of  
bituminous binders and mixtures with  
focus on the binder-aggregate adhesion  
(Appendices)**

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# Table of contents

1.	Thermomechanical tests on bituminous binders .....	7
1.1.	Complex shear modulus test .....	7
1.1.1.	Dynamic Shear Rheometer (DSR) .....	7
1.1.1.2.	B_DSR .....	8
1.1.1.4.	Bm_DSR .....	10
1.1.1.6.	S_DSR .....	12
1.1.1.8.	Sm_DSR .....	14
1.1.2.	Annular Shear Rheometer (ASR) .....	15
1.1.2.2.	B_ASR_sp1 .....	16
1.1.2.3.	B_ASR_sp5 .....	18
1.1.2.4.	Bm_ASR_sp2 .....	20
1.1.2.5.	S_ASR_sp2 .....	22
1.1.2.6.	Sm_ASR_sp1 .....	24
1.1.2.7.	B_40%_ASR_sp1 .....	26
1.1.2.8.	B_40%(+)_ASR_sp2 .....	28
1.1.2.9.	B_40%(-)_ASR_sp1 .....	30
1.1.3.	Unified ASR+DSR results .....	31
1.1.3.2.	B_ASR_sp5+DSR .....	32
1.1.3.4.	Bm_ASR_sp2+DSR .....	34
1.1.3.6.	S_ASR_sp2+DSR .....	36
1.1.3.8.	Sm_ASR_sp1+DSR .....	38
1.1.4.	2S2P1D model constants and WLF parameters .....	39
1.2.	Strain Amplitude Sweep (SAS) test .....	41
1.2.1.	SAS test with DSR at 10°C/25Hz .....	41
1.2.1.1.	B_DSR_SAS .....	41
1.2.1.2.	Bm_DSR_SAS .....	41
1.2.1.3.	S_DSR_SAS .....	41
1.2.1.4.	Sm_DSR_SAS .....	42
1.2.1.5.	LVE limits with DSR .....	42
1.2.2.	SAS test with ASR at 10°C/10Hz .....	43
1.2.2.1.	B_ASR .....	43
1.2.2.2.	Bm_ASR .....	43
1.2.2.3.	S_ASR .....	45
1.2.2.4.	Sm_ASR .....	46

# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test

1.2.2.5.	B_40%_ASR.....	47
1.2.2.6.	B_40%(+)_ASR.....	48
1.2.2.7.	B_40%(-)_ASR.....	49
1.3.	Steric hardening identification test with DSR at 10°C/25Hz.....	50
1.4.	Continuous fatigue test with DSR at 10°C/25Hz.....	53
1.4.1.	B_DSR.....	53
1.4.2.	Bm_DSR.....	58
1.4.3.	S_DSR.....	64
1.4.4.	Sm_DSR.....	71
1.5.	Load and Rest Periods (LRP) tests with ASR at 10°C/10Hz.....	77
1.5.1.	B_ASR.....	77
1.5.1.1.	B_ASR_sp6 (10700µm/m).....	77
1.5.1.2.	B_ASR_sp7 (5350µm/m).....	86
1.5.2.	Bm_ASR.....	94
1.5.2.1.	Bm_ASR_sp2 (10800µm/m).....	94
1.5.2.2.	Bm_ASR_sp3 (5200µm/m).....	102
1.5.2.3.	Bm_ASR_sp4 (21700µm/m).....	111
1.5.3.	S_ASR.....	119
1.5.3.1.	S_ASR_sp5 (9000µm/m).....	119
1.5.3.2.	S_ASR_sp6 (4320µm/m).....	128
1.5.4.	Sm_ASR.....	136
1.5.4.1.	Sm_ASR_sp6 (9180µm/m).....	136
1.5.4.2.	Sm_ASR_sp6 (5620µm/m).....	145
1.5.5.	B_40%_ASR.....	153
1.5.5.1.	B_40%_ASR_sp5 (3000µm/m).....	153
1.5.5.2.	B_40%_ASR_sp6 (4350µm/m).....	162
1.5.6.	B_40%(+)_ASR.....	170
1.5.6.1.	B_40%(+)_ASR_sp3 (2970µm/m).....	170
1.5.6.2.	B_40%(+)_ASR_sp1 (4300µm/m).....	179
1.5.7.	B_40%(-)_ASR.....	187
1.5.7.1.	B_40%(-)_ASR_sp3 (3000µm/m).....	187
1.5.7.2.	B_40%(-)_ASR_sp4 (2000µm/m).....	196
2.	Thermomechanical tests on bituminous mixtures.....	205
2.1.	Complex modulus tests.....	205
2.1.1.	2-Point Bending (2PB) test on trapezoidal specimen.....	205
2.1.1.2.	B_CO_5.8.....	206

# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test

2.1.1.3.	B_CO_4.8 .....	207
2.1.1.4.	Bm_CO_5.8.....	208
2.1.1.5.	Bm_CO_4.8.....	209
2.1.1.6.	S_CO_5.8 .....	210
2.1.1.7.	S_CO_4.8 .....	211
2.1.1.8.	Sm_CO_5.8 .....	212
2.1.1.9.	Sm_CO_4.8 .....	213
2.1.1.10.	Bm_BI_5.8.....	214
2.1.1.11.	Bm_CR_5.8 .....	215
2.1.1.12.	Bm_HL_5.8.....	216
2.1.1.13.	Bm_BE_5.8.....	217
2.1.1.14.	S_BI_5.8 .....	218
2.1.1.15.	S_CR_5.8.....	219
2.1.1.16.	S_HL_5.8 .....	220
2.1.1.17.	S_BE_5.8 .....	221
2.1.1.18.	B_CO(+)_5.8.....	222
2.1.1.19.	B_CO(-)_5.8.....	223
2.1.2.	Tension-compression (TC) test on cylindrical specimen .....	224
2.1.2.1.	B_CO_5.8_sp12.....	224
2.1.2.2.	B_CO_5.8_sp11.....	226
2.1.2.3.	B_CO(+)_5.8_sp10 .....	228
2.1.2.4.	B_CO(-)_5.8_sp5.....	230
2.1.2.5.	2S2P1D model constants and WLF parameters .....	232
2.2.	Fatigue tests.....	233
2.2.1.	2PB test on trapezoidal specimen at 10°C/25Hz.....	233
2.2.1.1.	B_CO_5.8 .....	233
2.2.1.2.	B_CO_4.8 .....	234
2.2.1.3.	Bm_CO_5.8.....	235
2.2.1.4.	Bm_CO_4.8.....	236
2.2.1.5.	S_CO_5.8 .....	237
2.2.1.6.	S_CO_4.8 .....	238
2.2.1.7.	Sm_CO_5.8 .....	239
2.2.1.8.	Sm_CO_4.8 .....	240
2.2.1.9.	Bm_BI_5.8.....	241
2.2.1.10.	Bm_CR_5.8 .....	242
2.2.1.11.	Bm_HL_5.8.....	243

# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test

2.2.1.12.	Bm_BE_5.8.....	244
2.2.1.13.	S_BI_5.8.....	245
2.2.1.14.	S_CR_5.8.....	246
2.2.1.15.	S_HL_5.8.....	247
2.2.1.16.	S_BE_5.8.....	248
2.2.1.17.	B_CO(+)_5.8.....	249
2.2.1.18.	B_CO(-)_5.8.....	250
2.2.1.19.	B_CO(o)_5.8.....	251
2.2.2.	TC test on cylindrical specimen at 10°C/10Hz.....	252
2.2.2.1.	B_CO_5.8.....	252
2.2.2.1.1.	B_CO_5.8_sp1.....	254
2.2.2.1.2.	B_CO_5.8_sp3.....	255
2.2.2.1.3.	B_CO_5.8_sp4.....	256
2.2.2.1.4.	B_CO_5.8_sp5.....	257
2.2.2.1.5.	B_CO_5.8_sp7.....	258
2.2.2.1.6.	B_CO_5.8_sp8 (failed).....	259
2.2.2.1.7.	B_CO_5.8_sp9.....	260
2.2.2.1.8.	B_CO_5.8_sp10.....	261
2.2.2.1.9.	B_CO_5.8_sp11.....	262
2.2.2.2.	B_CO(+)_5.8.....	262
2.2.2.2.2.	B_CO(+)_5.8_sp2.....	266
2.2.2.2.3.	B_CO(+)_5.8_sp5.....	267
2.2.2.2.4.	B_CO(+)_5.8_sp6.....	268
2.2.2.2.5.	B_CO(+)_5.8_sp8.....	269
2.2.2.2.6.	B_CO(+)_5.8_sp9.....	270
2.2.2.2.7.	B_CO(+)_5.8_sp10.....	271
2.2.2.2.8.	B_CO(+)_5.8_sp11 (failed).....	272
2.2.2.2.9.	B_CO_5.8_sp12.....	273
2.2.2.3.	B_CO(-)_5.8.....	273
2.2.2.3.1.	B_CO(-)_5.8_sp1.....	276
2.2.2.3.2.	B_CO(-)_5.8_sp3.....	277
2.2.2.3.3.	B_CO(-)_5.8_sp4.....	278
2.2.2.3.4.	B_CO(-)_5.8_sp5.....	279
2.2.2.3.5.	B_CO(-)_5.8_sp6.....	280
2.2.2.3.6.	B_CO(-)_5.8_sp8.....	281
2.2.2.3.7.	B_CO(-)_5.8_sp9.....	282

# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test

2.2.2.3.8. B_CO(-)_5.8_sp10.....	283
2.2.2.3.9. B_CO(-)_5.8_sp12.....	284
2.3. Indirect Tensile Strength test .....	285
3. Thin film thermomechanical tests .....	286
3.1. Complex modulus.....	286
3.1.1. B_CO_300_LD_sp1 .....	287
3.1.2. B_CO_300_LD_sp2 .....	303
3.1.3. B_CO_300_SD_sp1 .....	317
3.2. Stripping tests .....	329
3.2.1. B_CO_100_SD_sp1 .....	329
3.2.2. B_CO_300_SD_sp1 .....	329
3.2.3. B_CO_300_SD_sp2 .....	330
3.2.4. B_CO_300_SD_sp3 .....	331
4. Simulation of the thin film test using FEM .....	333
4.1. Stress and strain homogeneity verification .....	333
4.1.1. Stress and strain distribution for D=80mm, e=300μm, Gb=45MPa, vb=0.35.....	333
4.1.2. Comparison of axial strain with simulated extensometer VS local values .....	337
4.2. Influence of aspect ratio, G and Poisson's ratio on simulated modulus .....	338
5. Surface analysis tests.....	<b>Erreur ! Signet non défini.</b>
5.1. Contact angle method .....	<b>Erreur ! Signet non défini.</b>
5.1.1. Probe liquids on CO rock plates .....	<b>Erreur ! Signet non défini.</b>
5.1.2. Probe liquids on glass plates .....	<b>Erreur ! Signet non défini.</b>
5.1.3. Probe liquids on bitumen .....	<b>Erreur ! Signet non défini.</b>
5.1.4. Bitumen on mineral substrate .....	<b>Erreur ! Signet non défini.</b>
5.2. X-Ray Photoelectron spectroscopy.....	<b>Erreur ! Signet non défini.</b>
5.2.1. CO aggregates .....	<b>Erreur ! Signet non défini.</b>
5.2.2. Glass beads .....	<b>Erreur ! Signet non défini.</b>
5.3. Pendant drop.....	<b>Erreur ! Signet non défini.</b>

## 1. Thermomechanical tests on bituminous binders

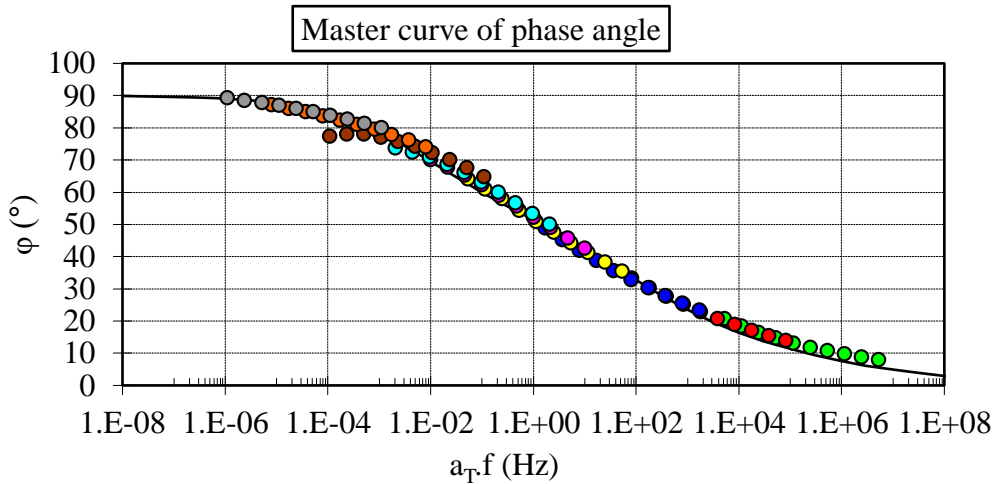
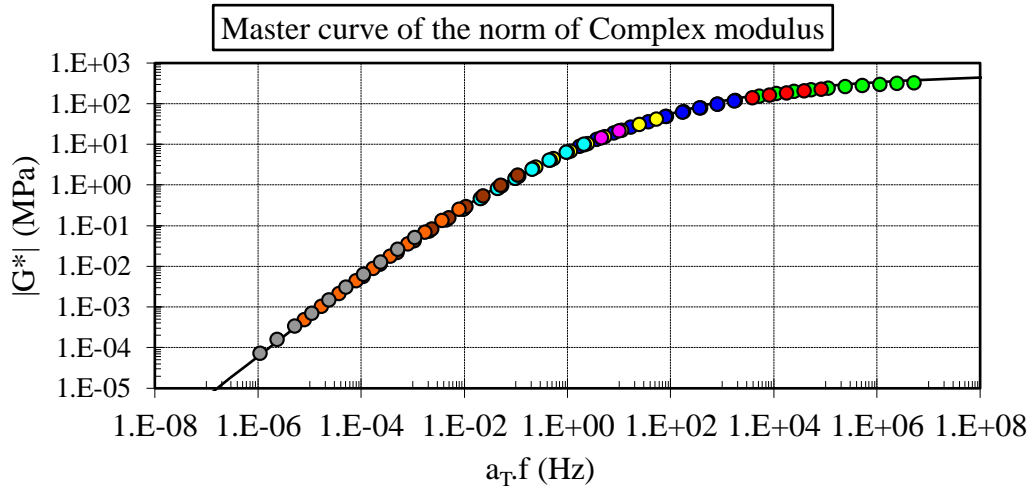
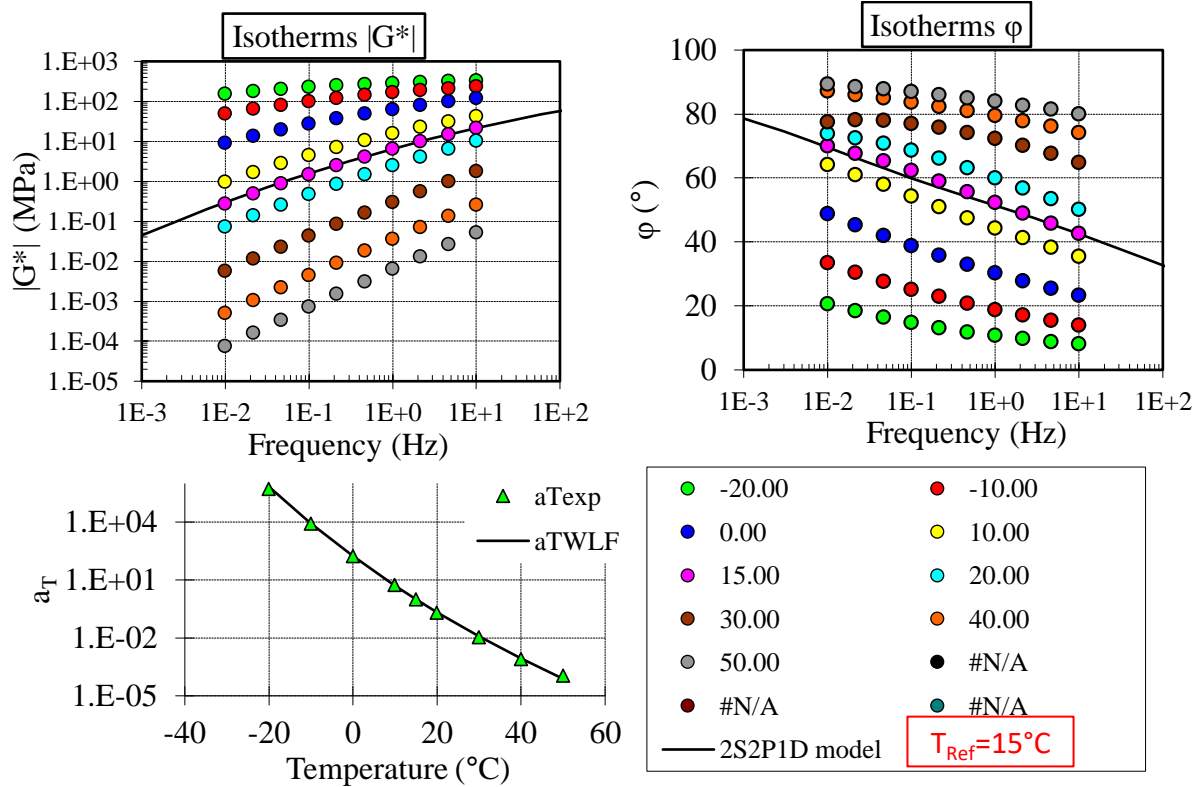
### 1.1. Complex shear modulus test

#### 1.1.1. Dynamic Shear Rheometer (DSR)

# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test

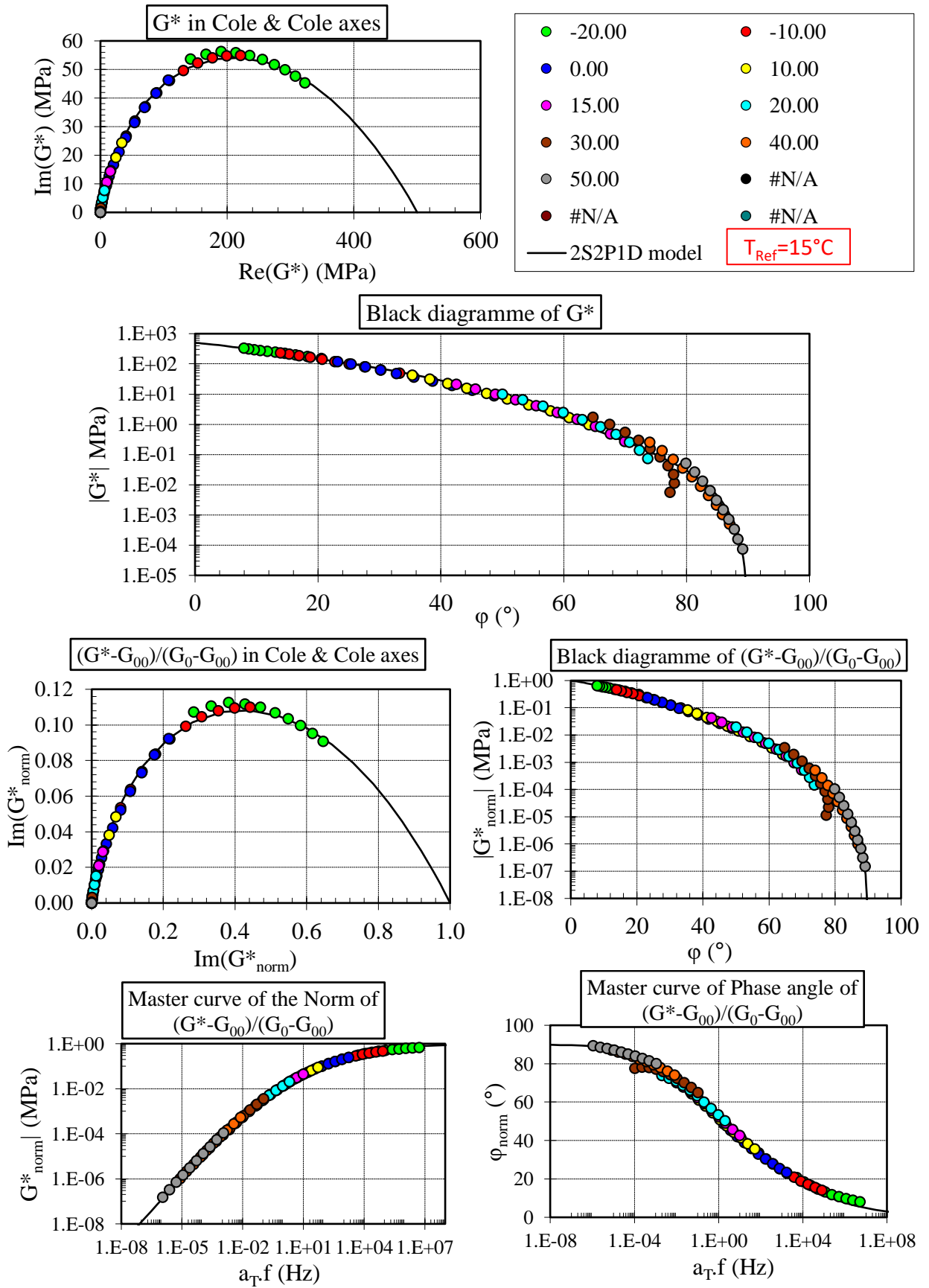
### 1.1.1.2. B\_DSR





# 1 Thermomechanical tests on bituminous binders

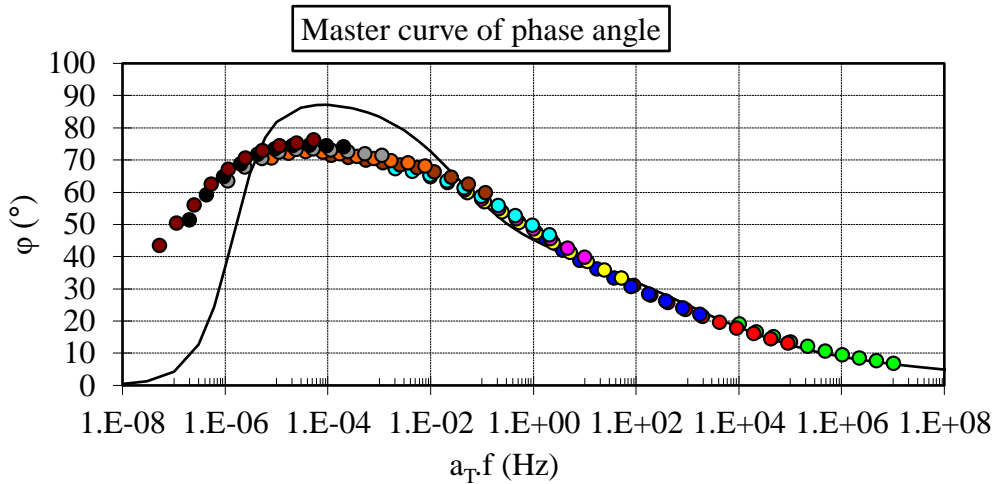
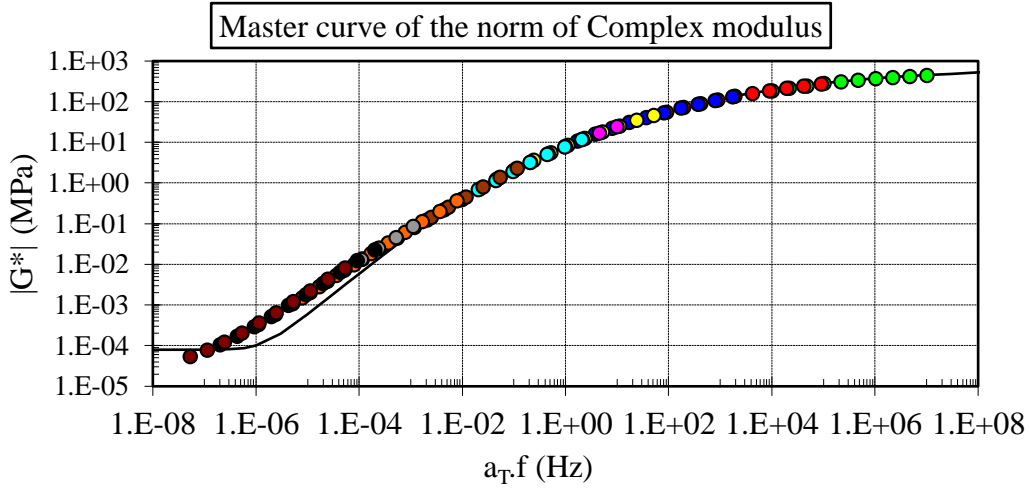
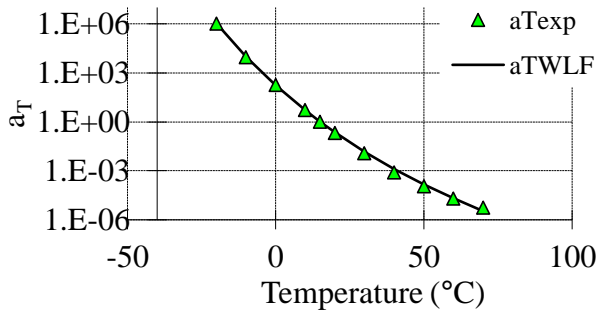
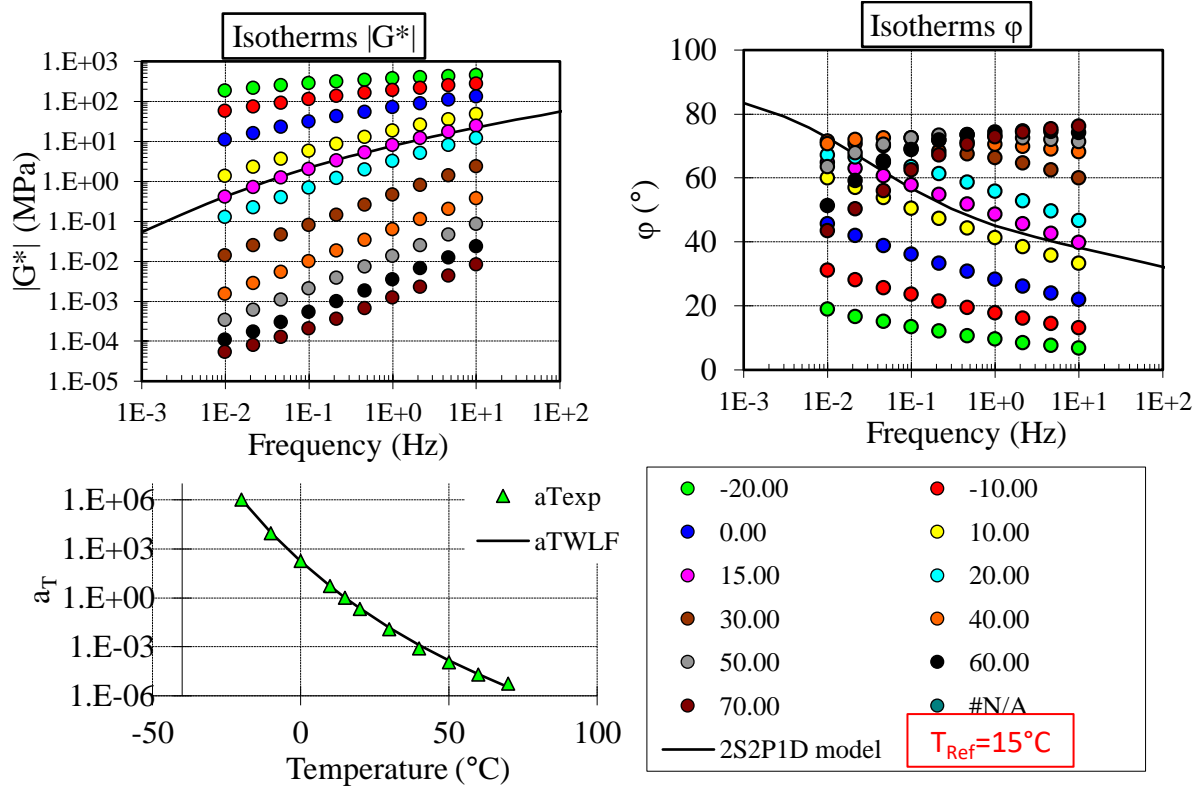
## 1.1 Complex shear modulus test



# 1 Thermomechanical tests on bituminous binders

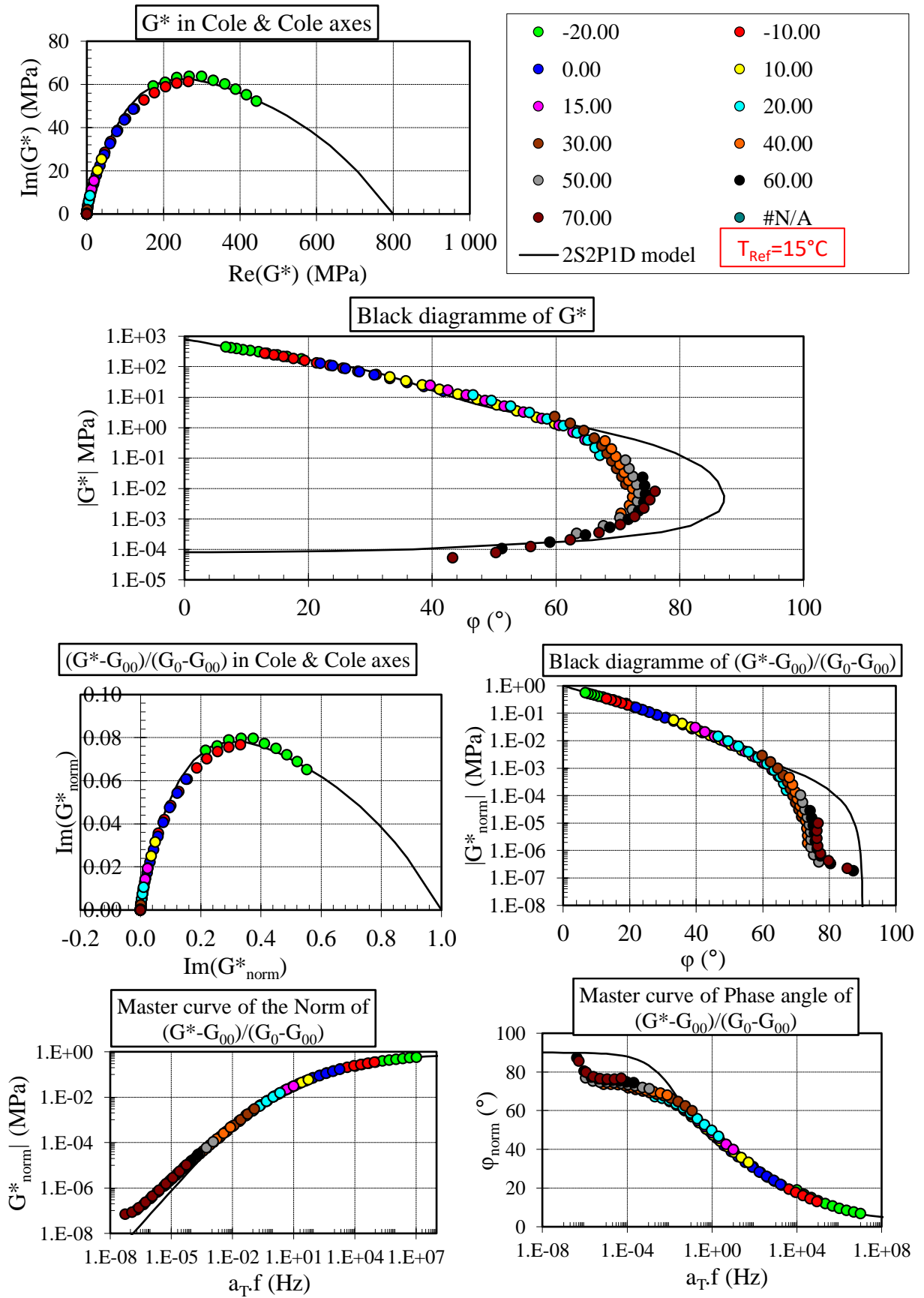
## 1.1 Complex shear modulus test

### 1.1.1.4. Bm\_DSR



# 1 Thermomechanical tests on bituminous binders

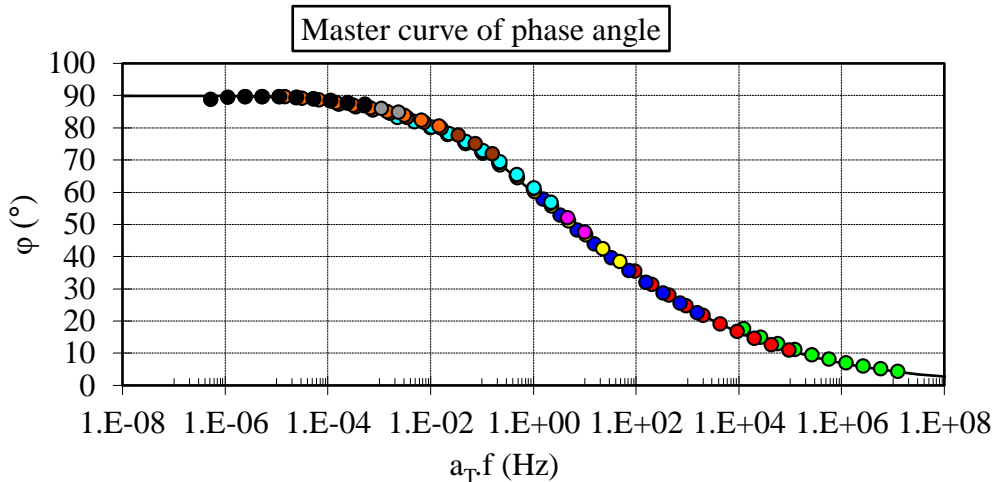
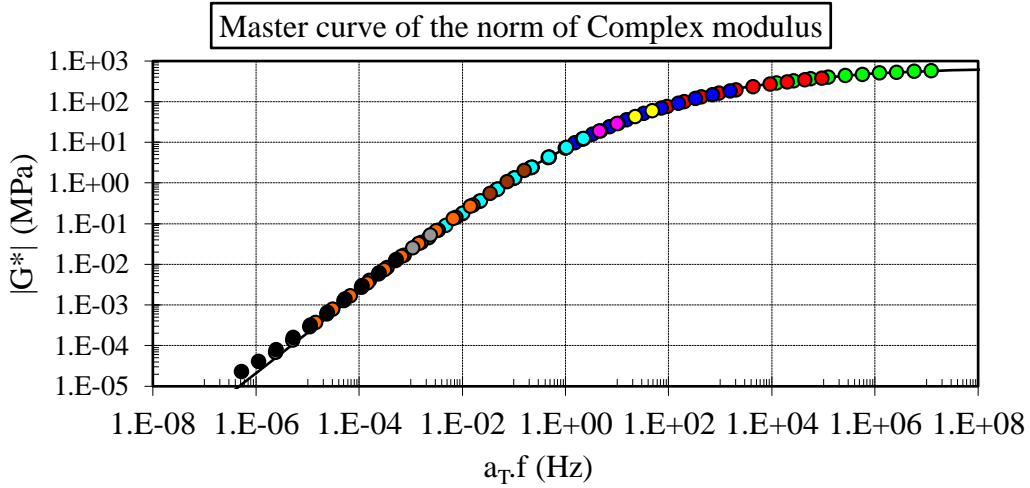
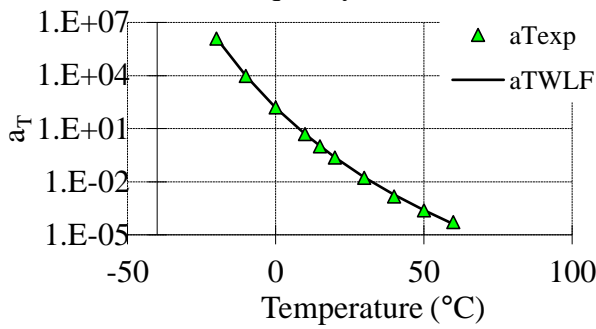
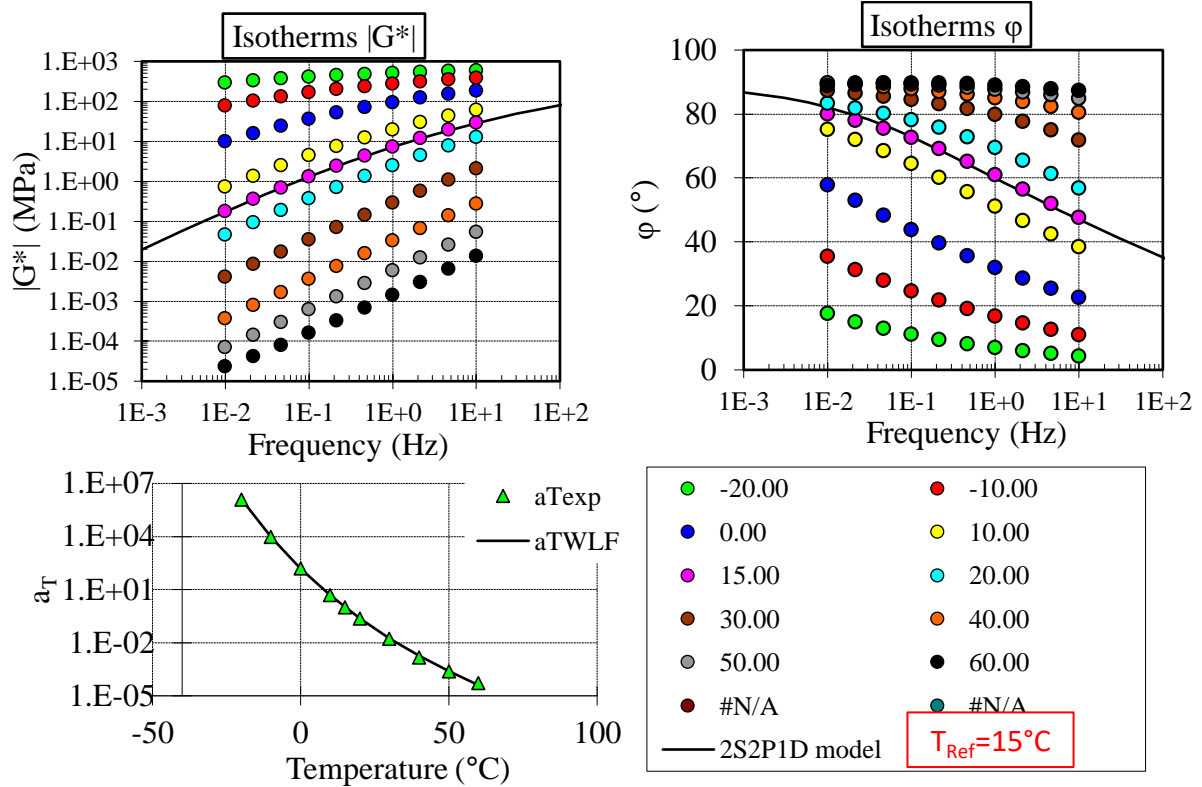
## 1.1 Complex shear modulus test



# 1 Thermomechanical tests on bituminous binders

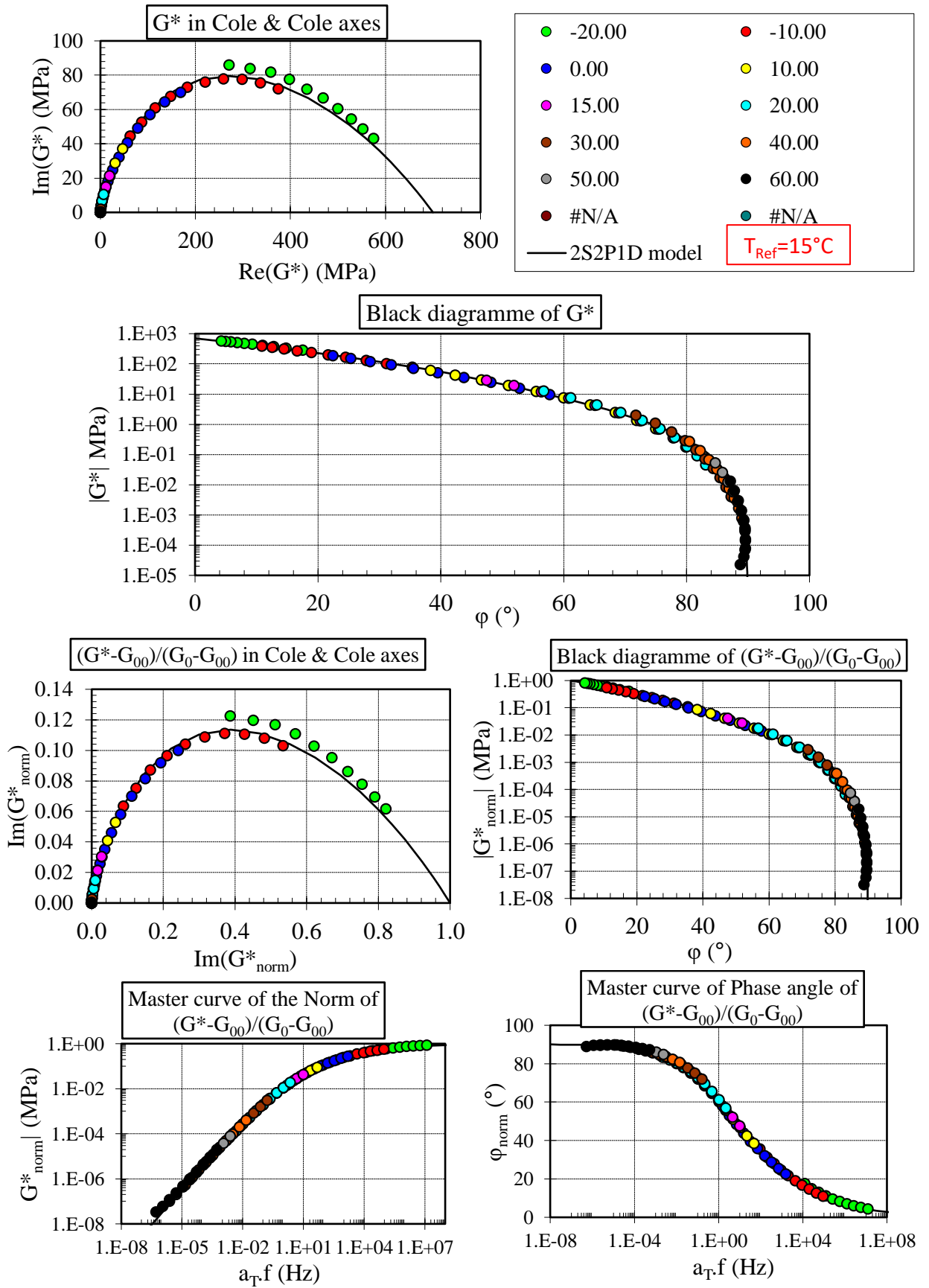
## 1.1 Complex shear modulus test

### 1.1.1.6. S\_DSR



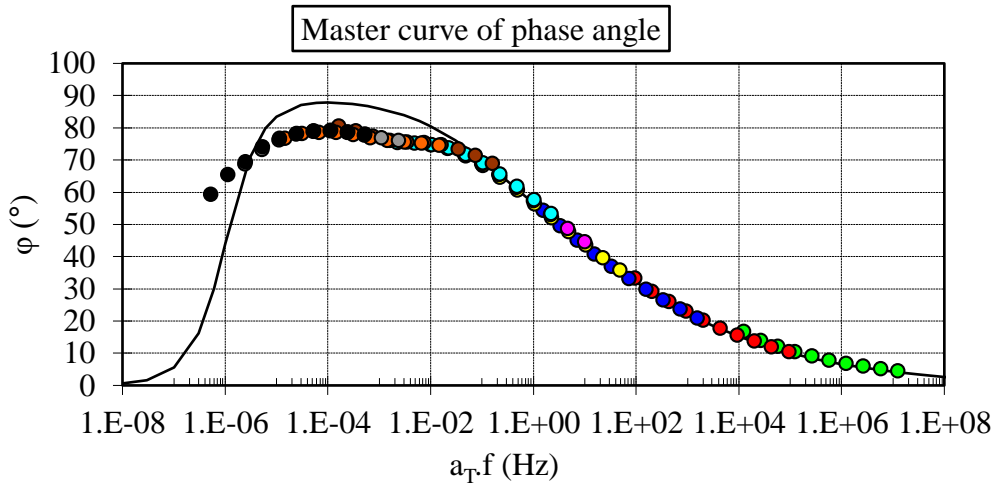
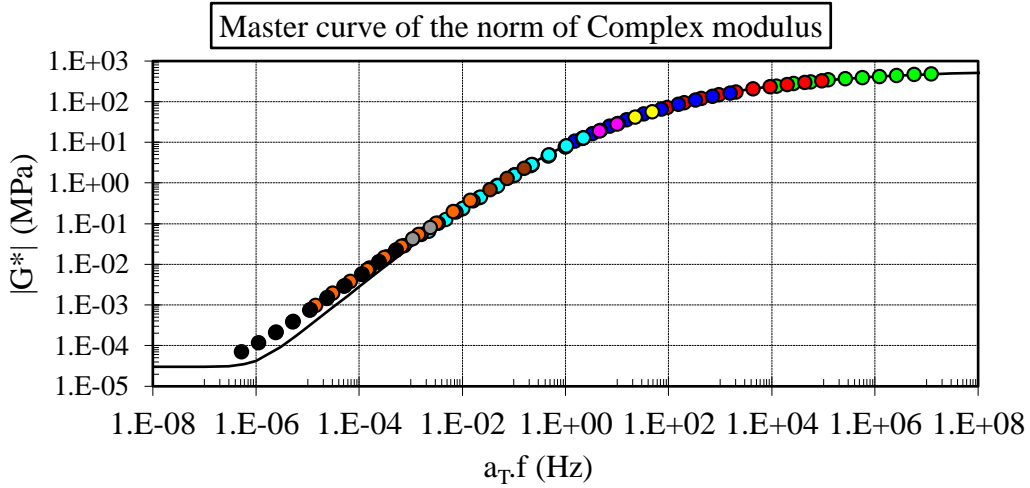
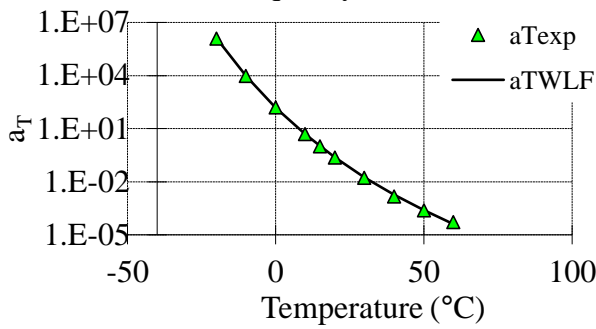
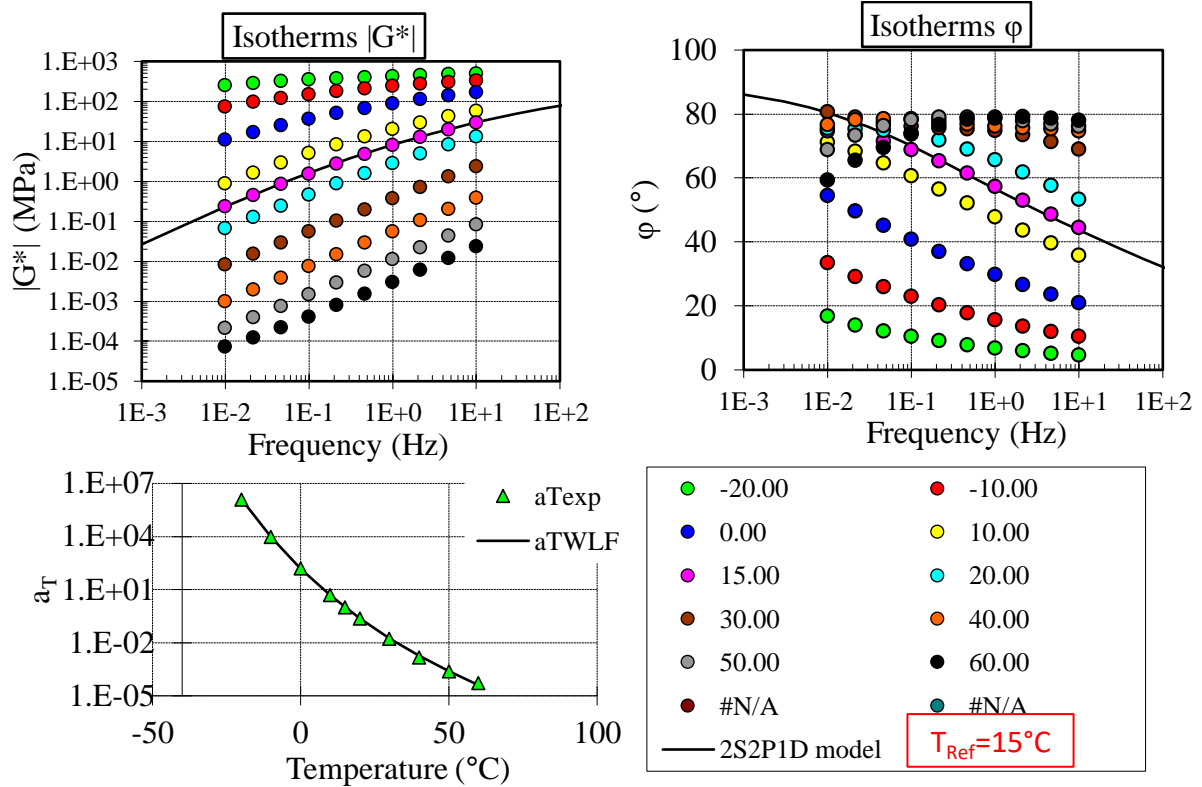
# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test



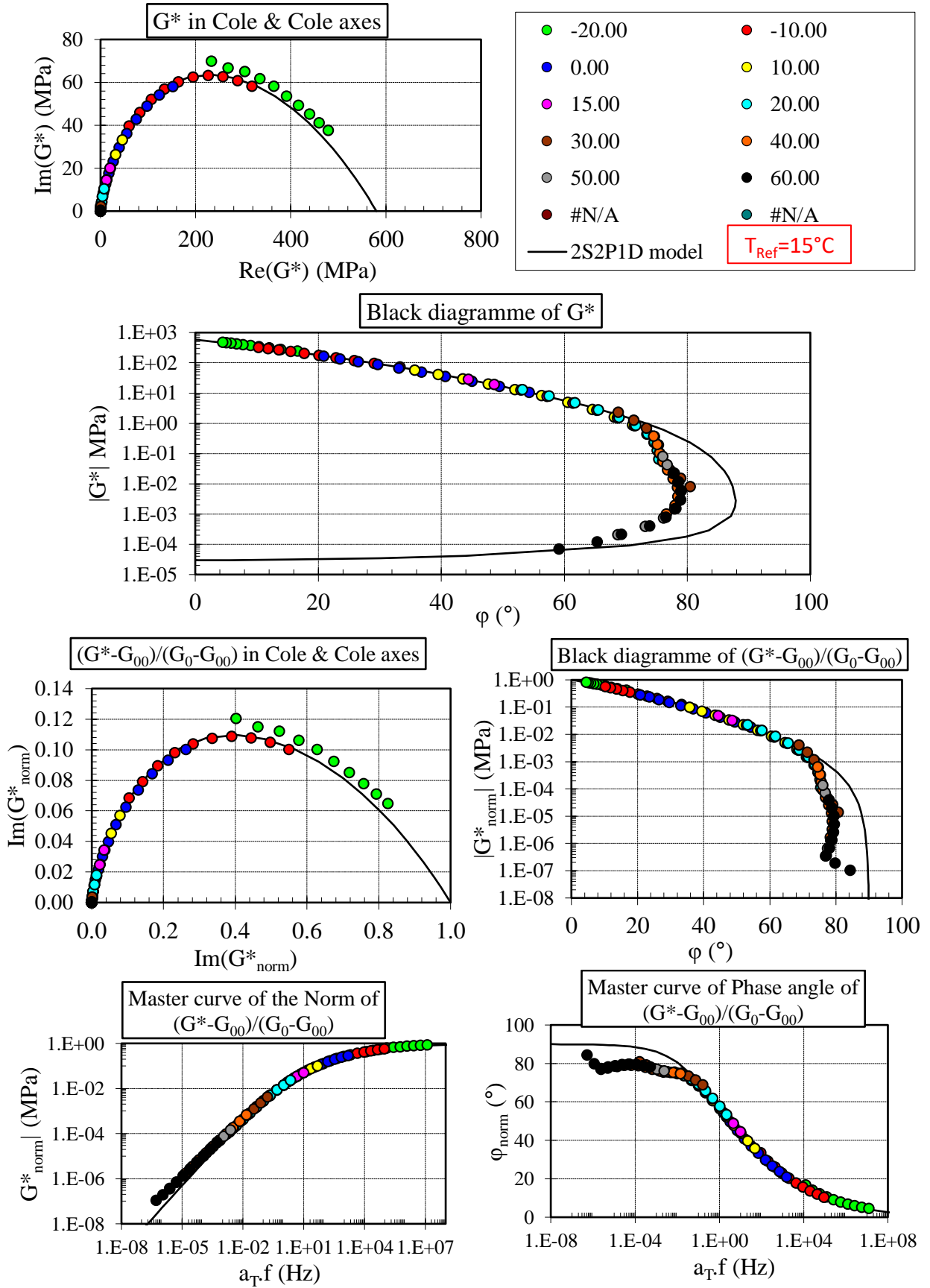
1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

1.1.1.8. Sm\_DSR



# 1 Thermomechanical tests on bituminous binders

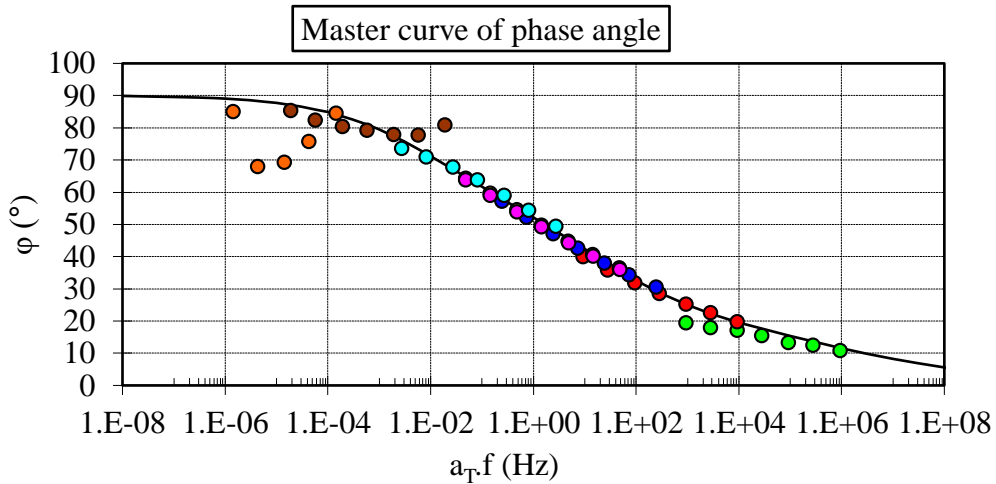
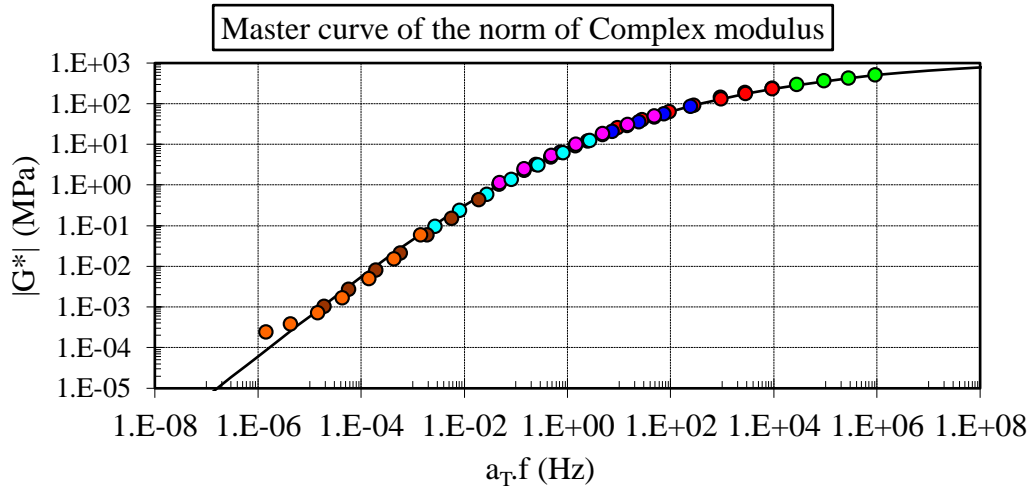
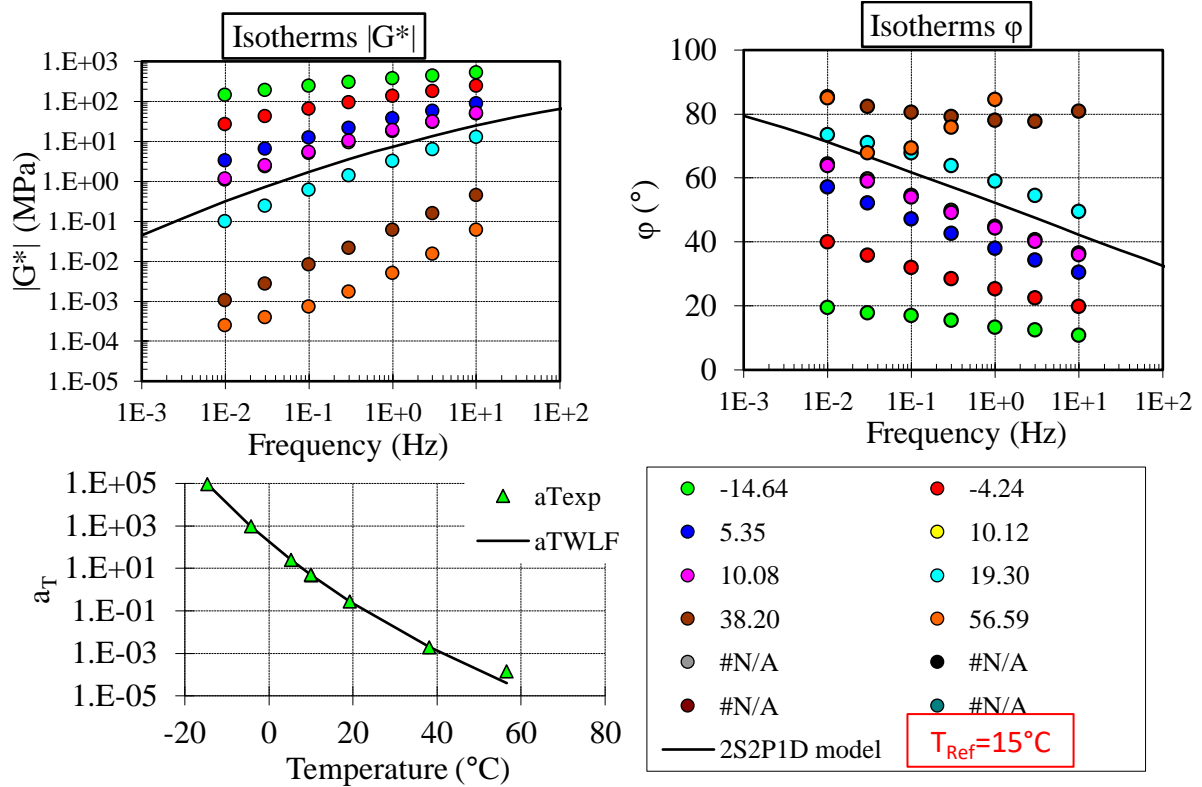
## 1.1 Complex shear modulus test



### 1.1.2. Annular Shear Rheometer (ASR)

1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

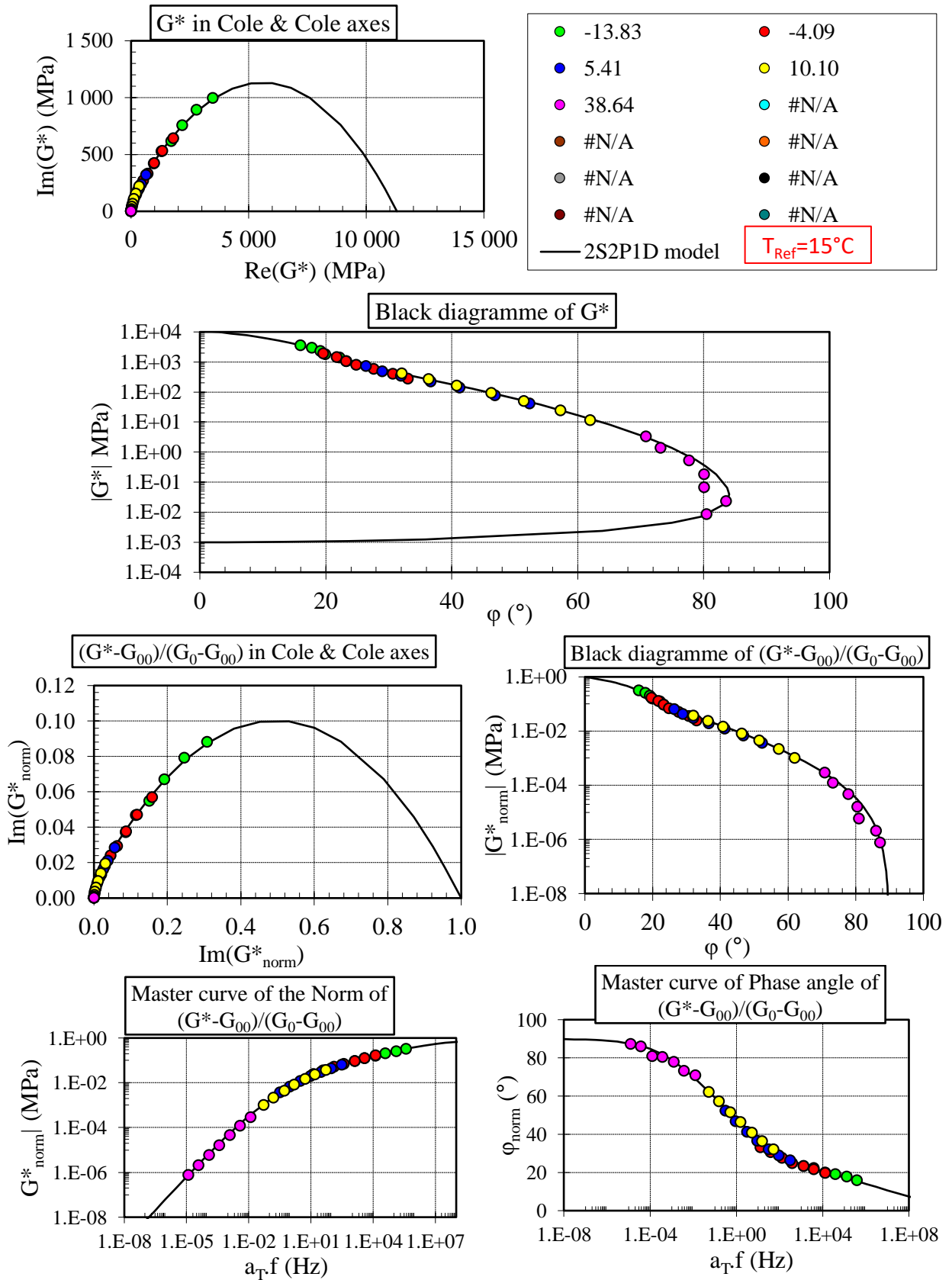
1.1.2.2. B\_ASR\_sp1





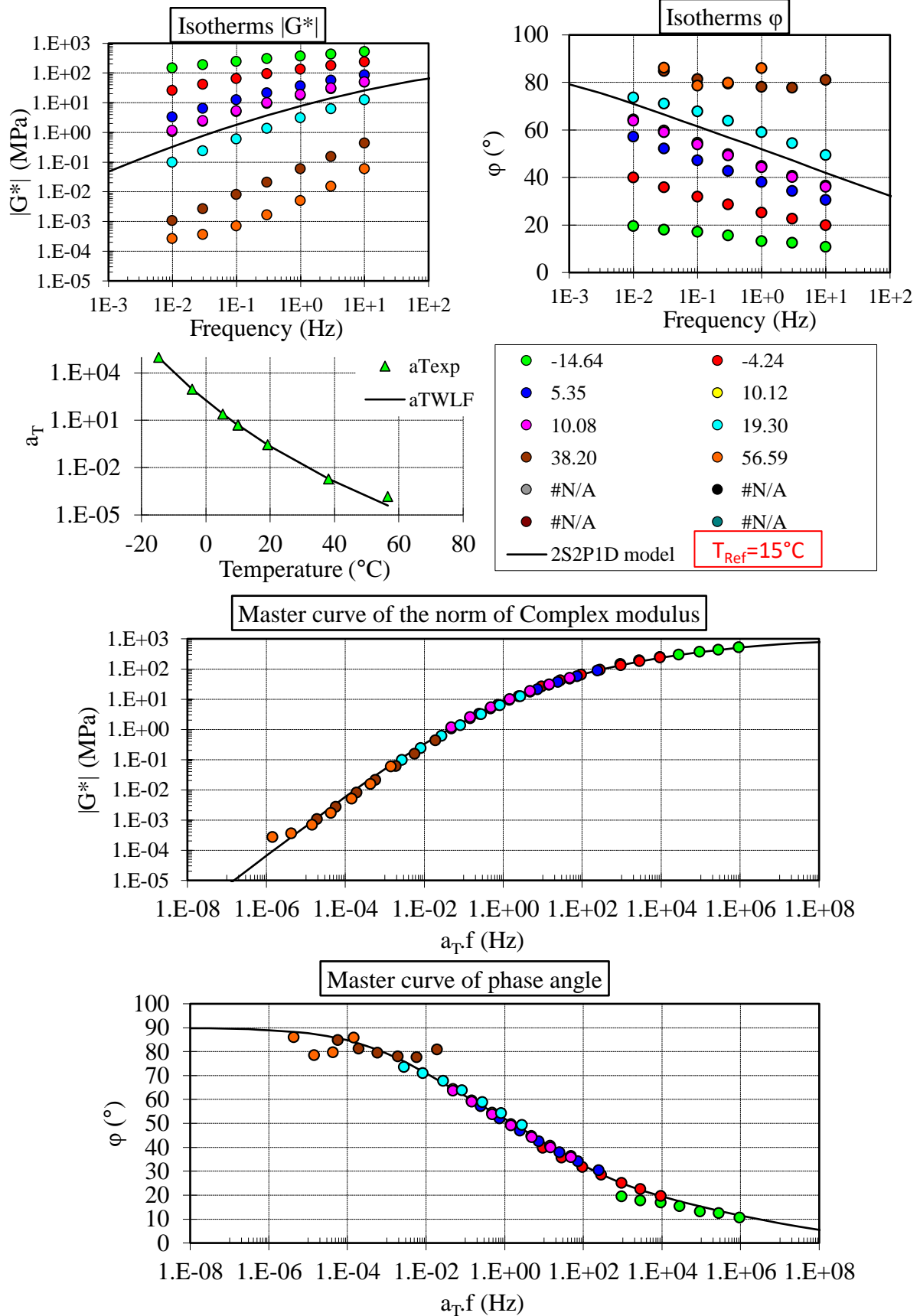
# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test



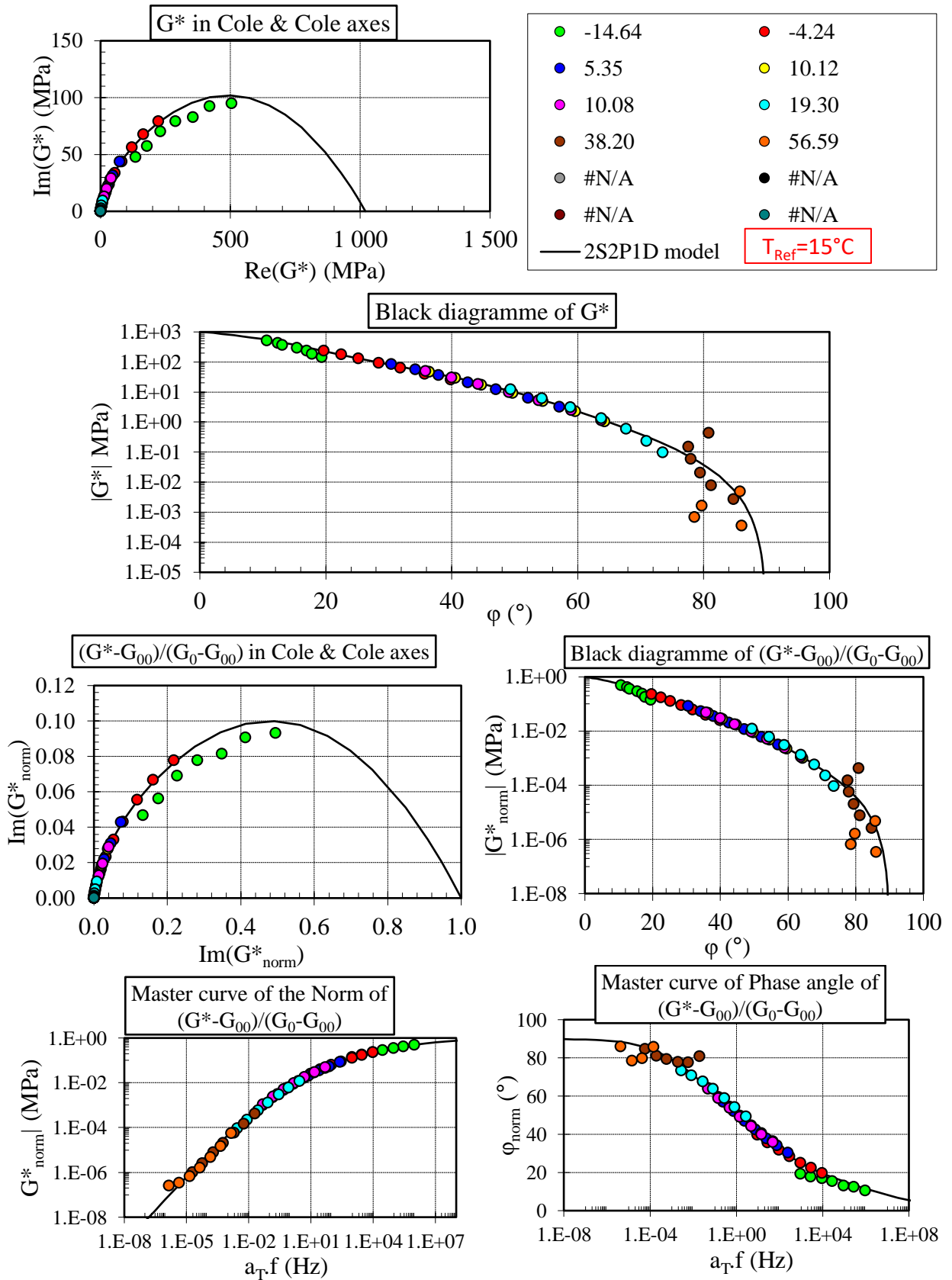
1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

1.1.2.3. B\_ASR\_sp5



# 1 Thermomechanical tests on bituminous binders

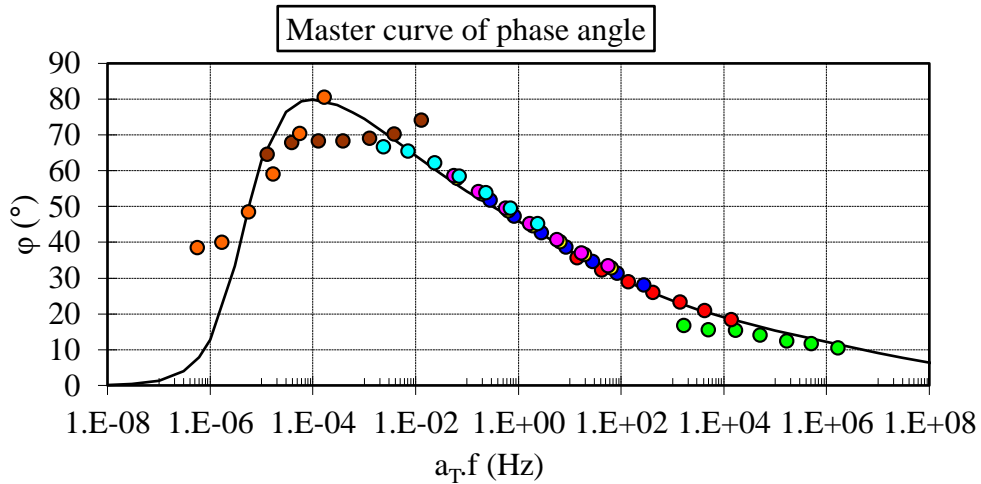
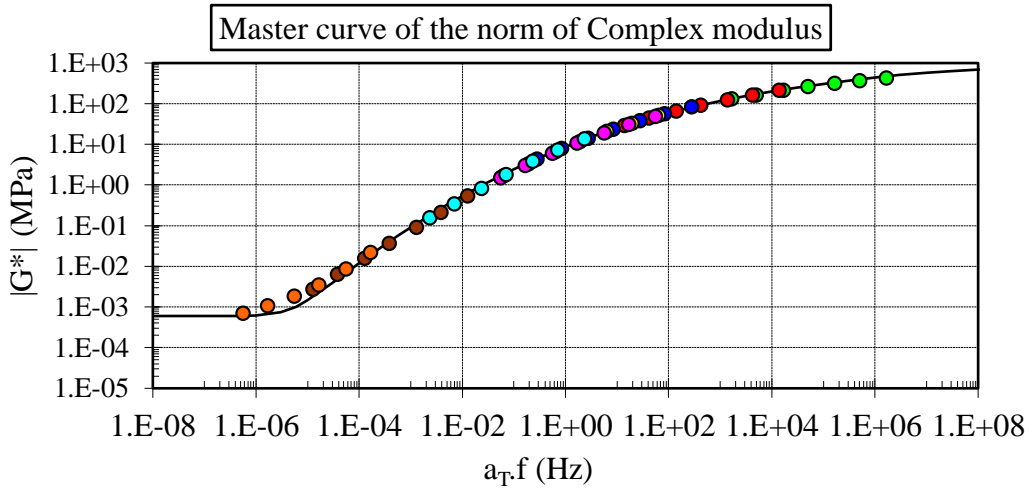
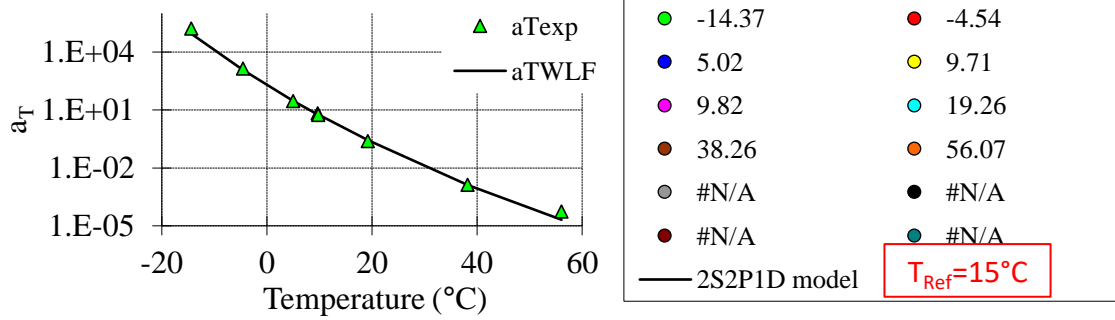
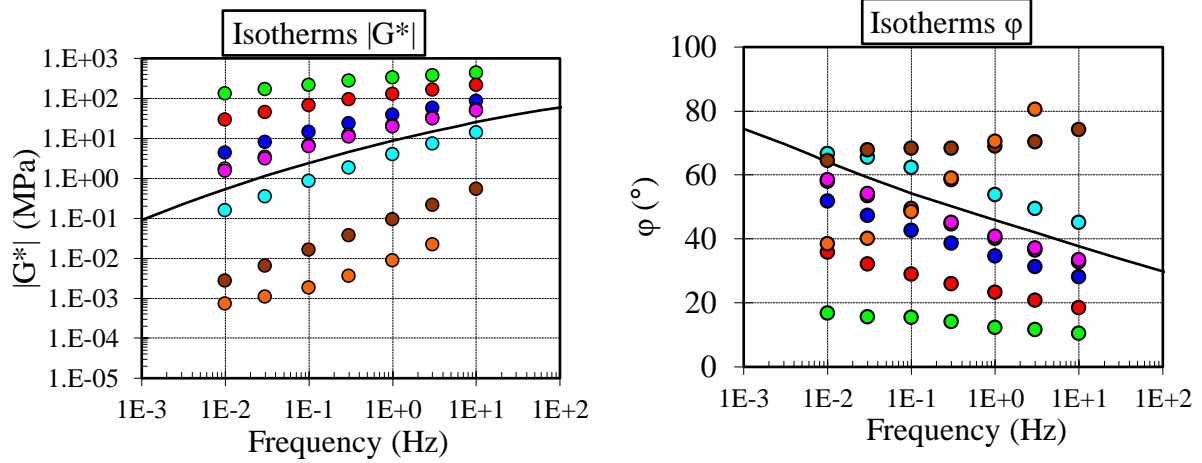
## 1.1 Complex shear modulus test



# 1 Thermomechanical tests on bituminous binders

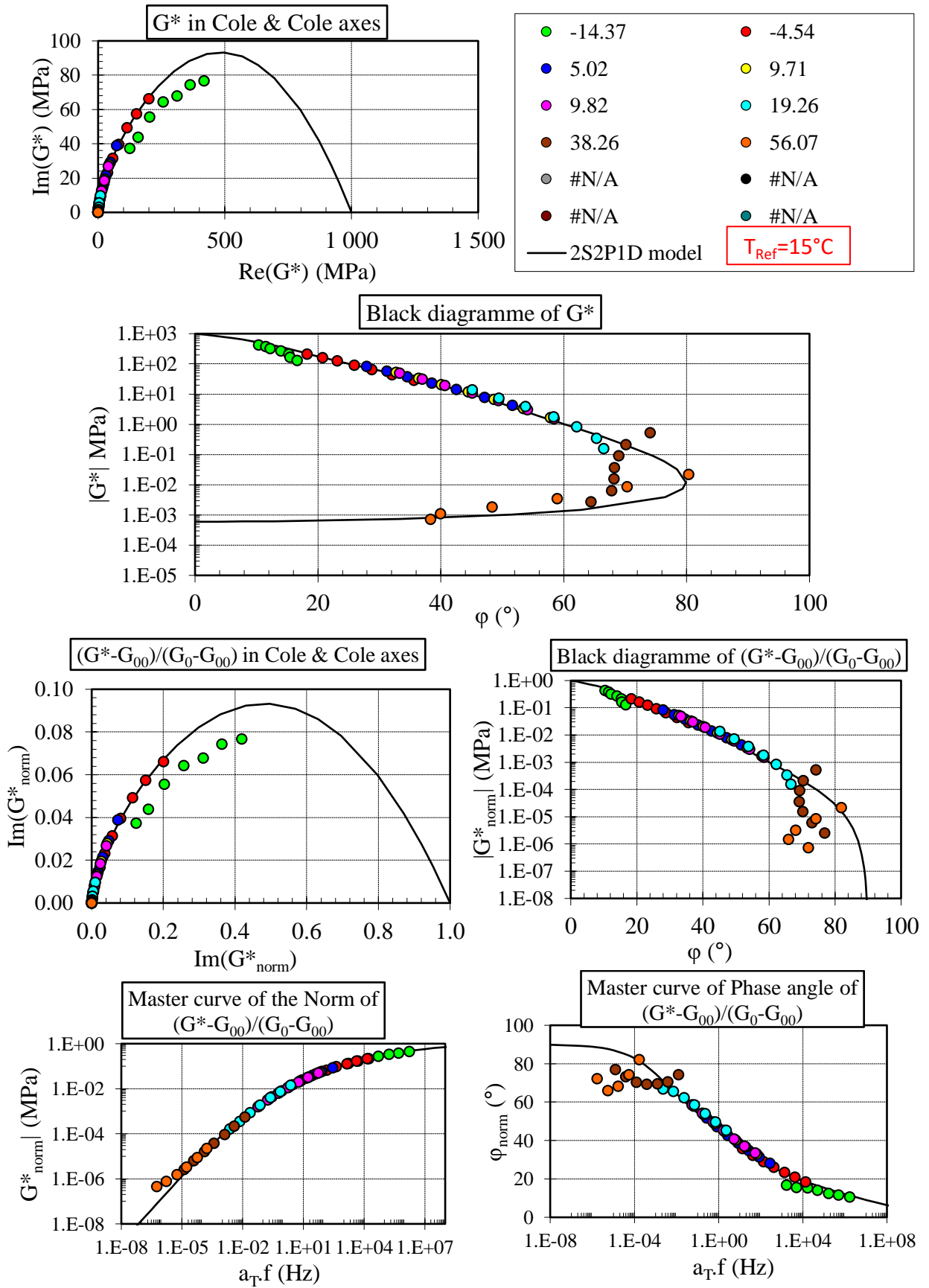
## 1.1 Complex shear modulus test

### 1.1.2.4. Bm\_ASR\_sp2



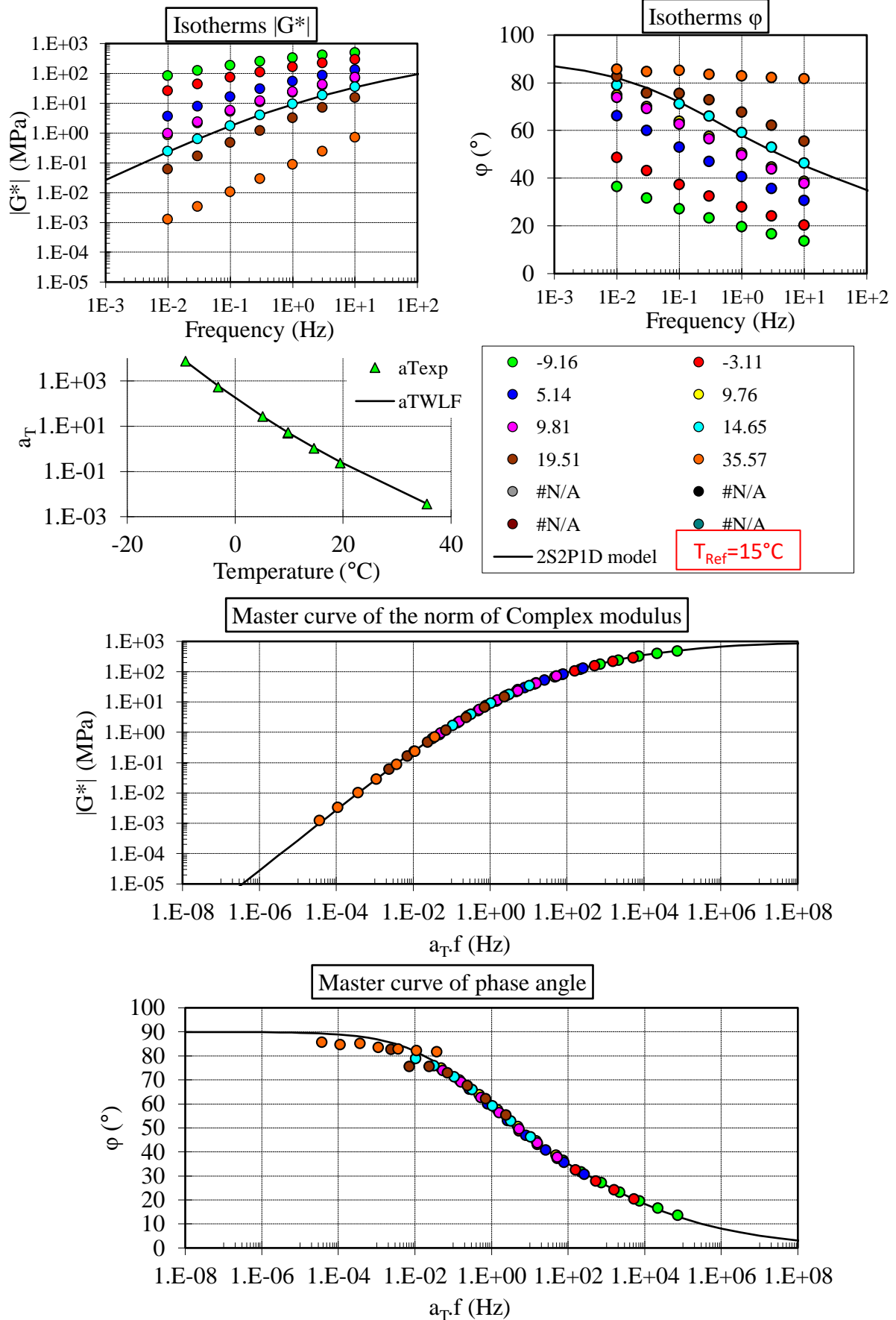
# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test



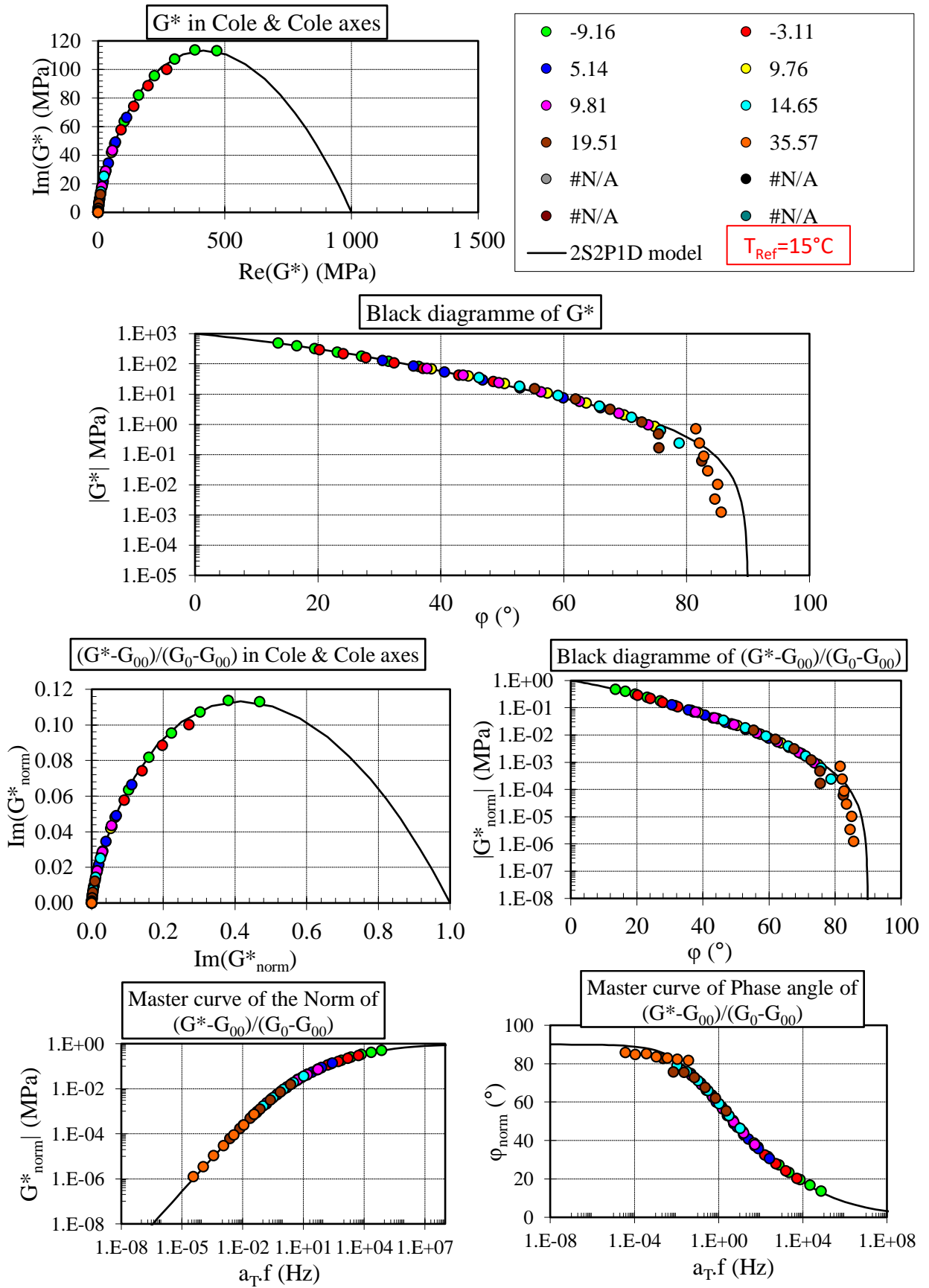
1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

1.1.2.5. S\_ASR\_sp2



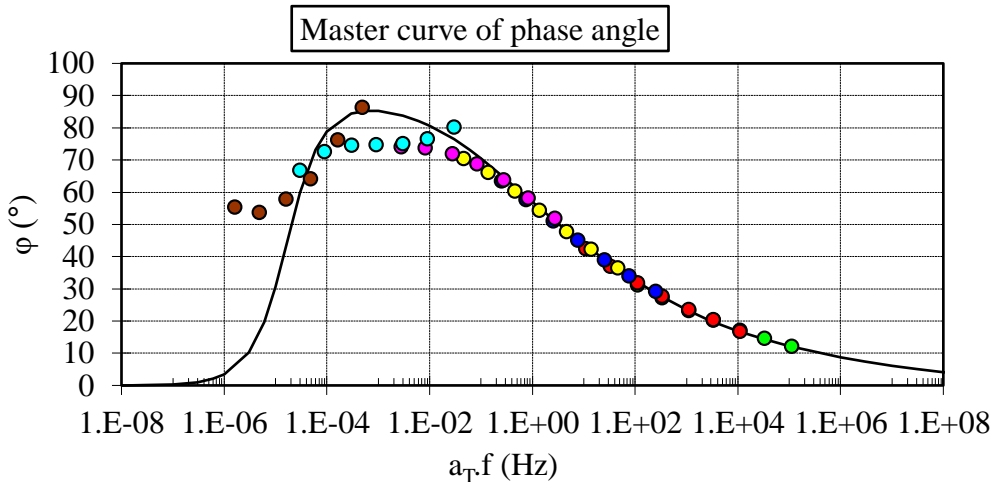
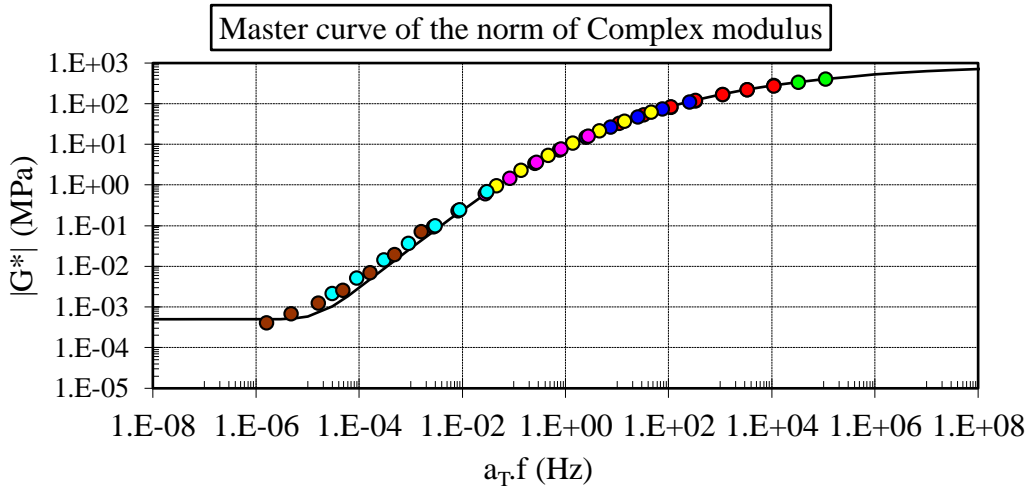
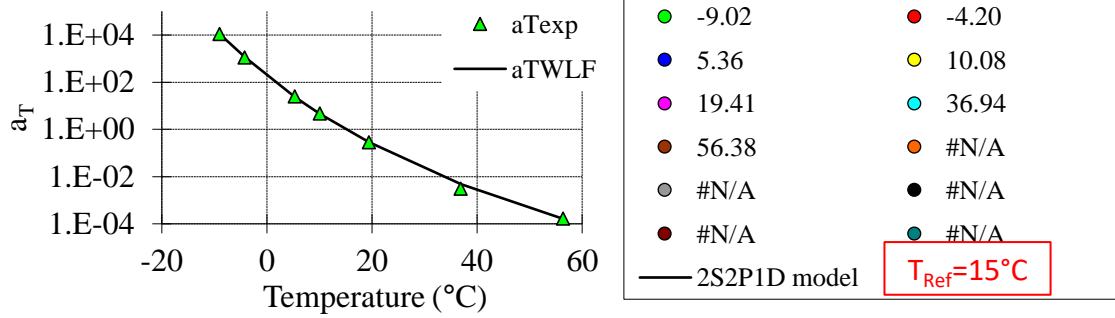
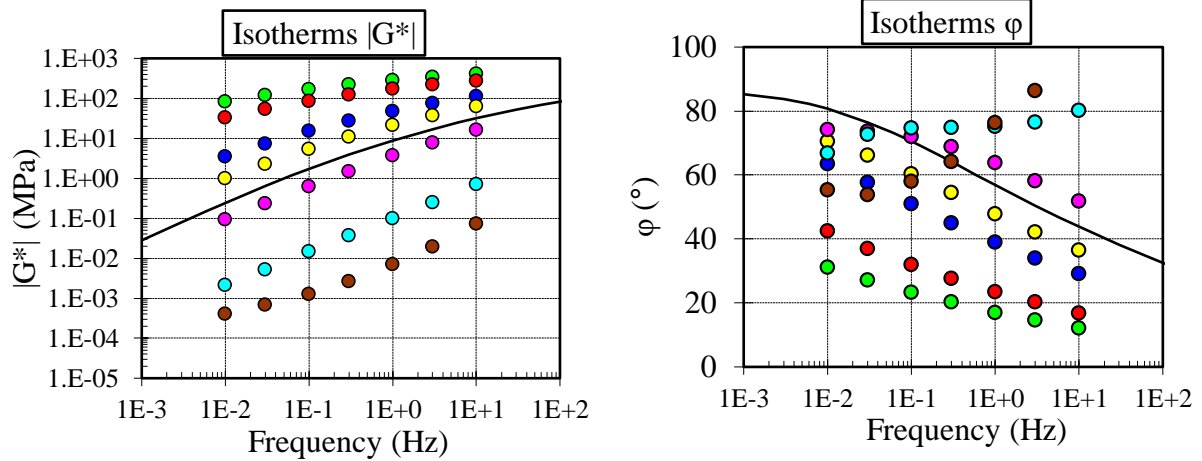
# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test



1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

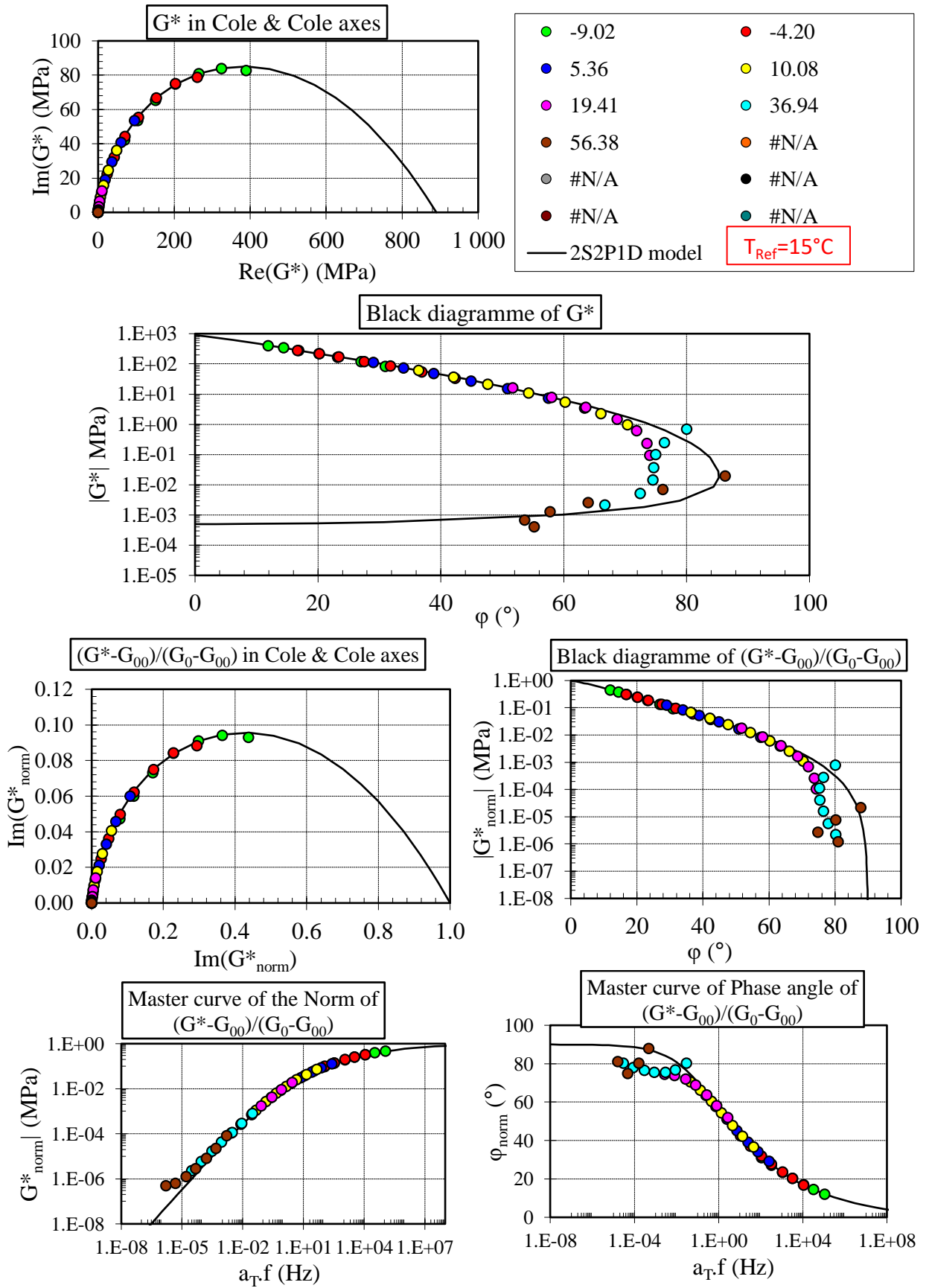
1.1.2.6. Sm\_ASR\_sp1





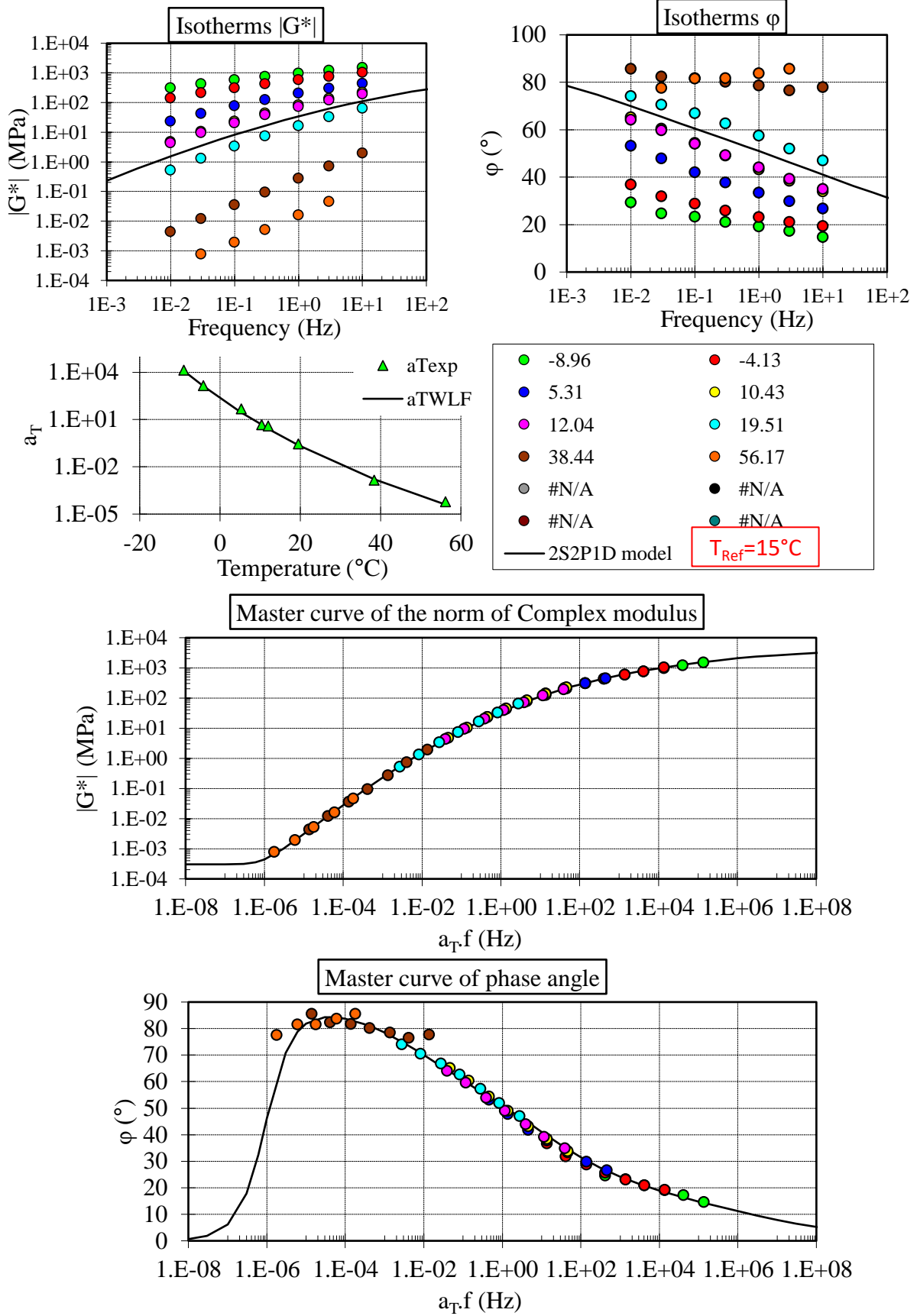
# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test



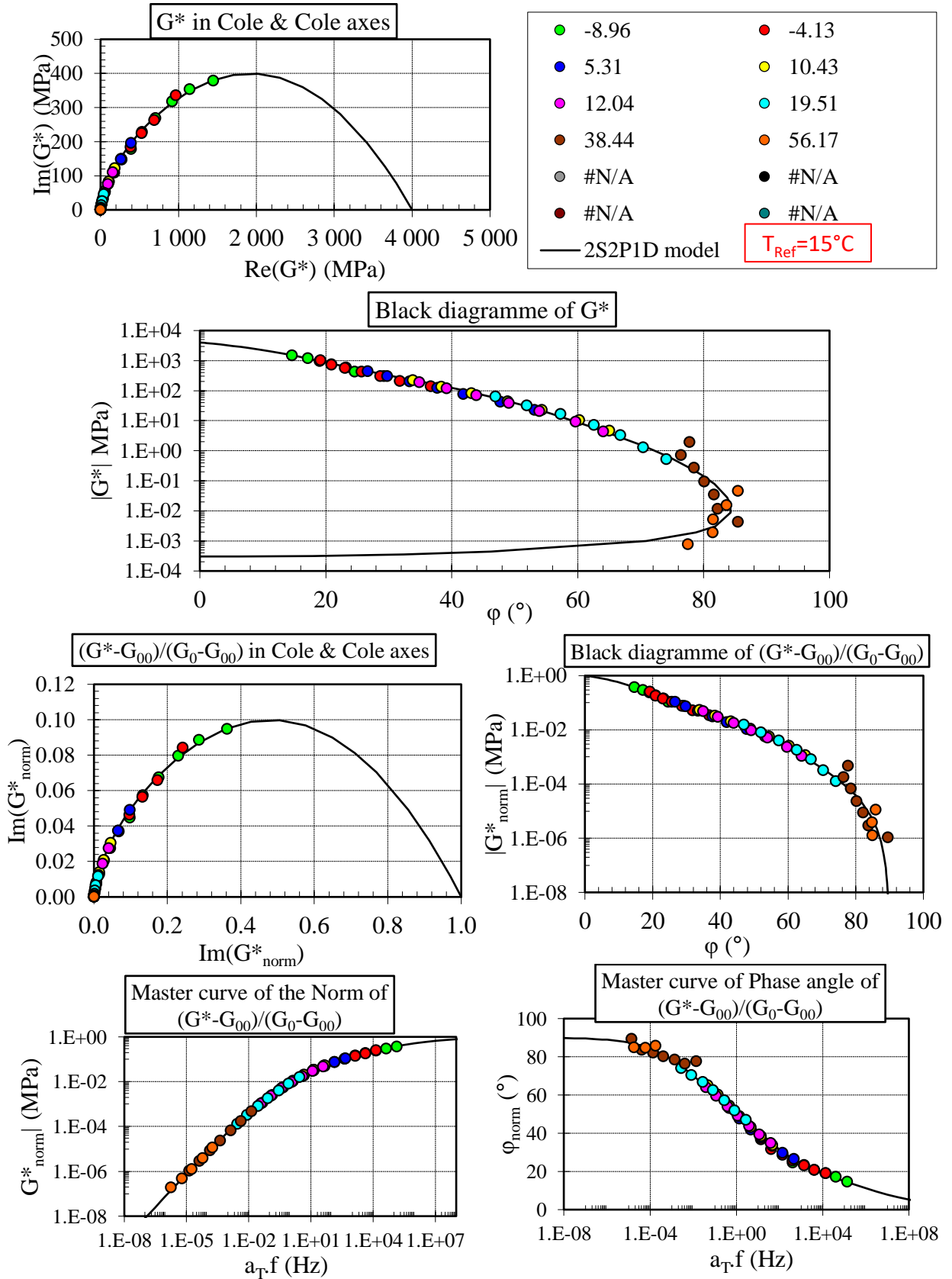
1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

1.1.2.7. B\_40%\_ASR\_sp1



# 1 Thermomechanical tests on bituminous binders

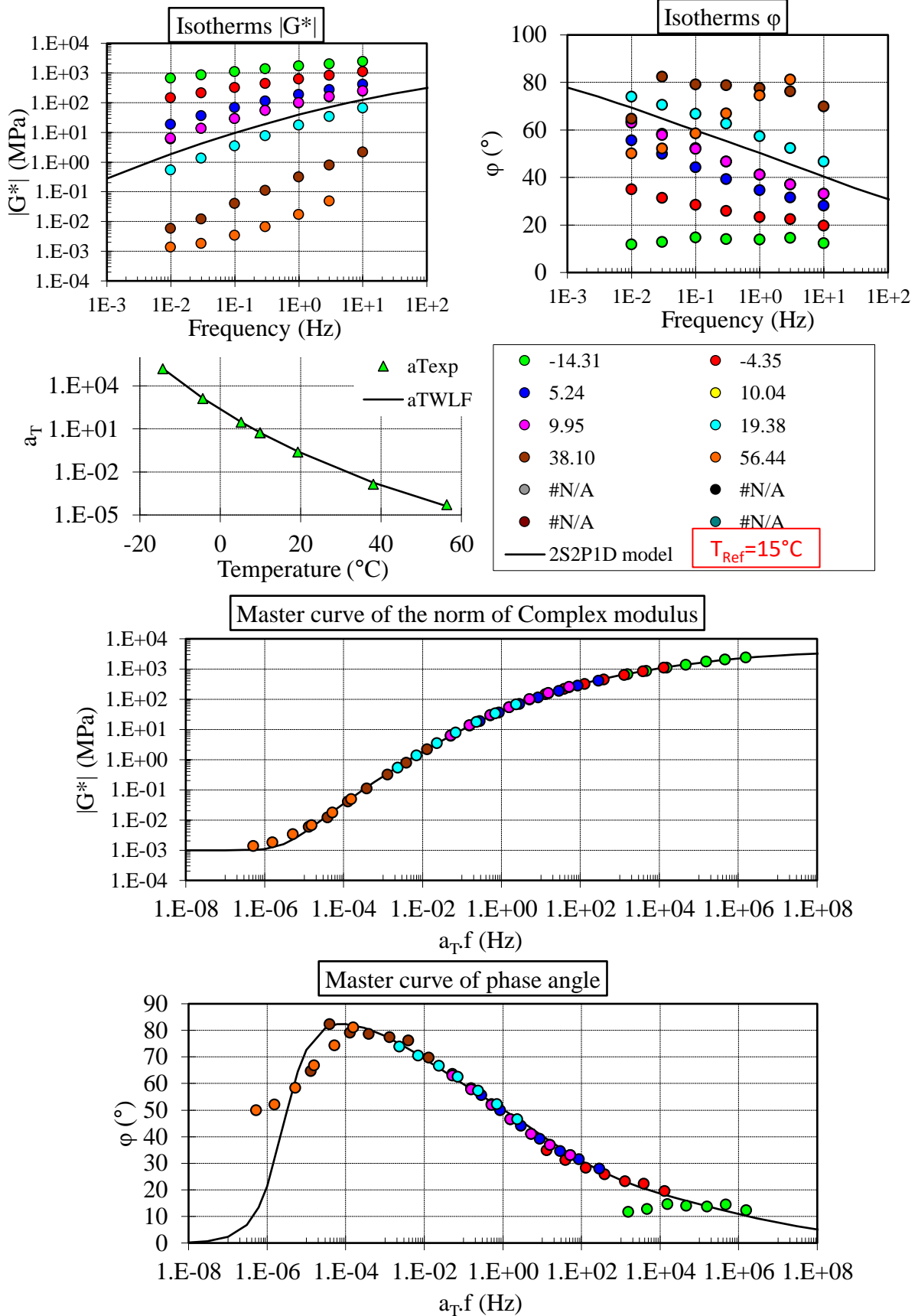
## 1.1 Complex shear modulus test



# 1 Thermomechanical tests on bituminous binders

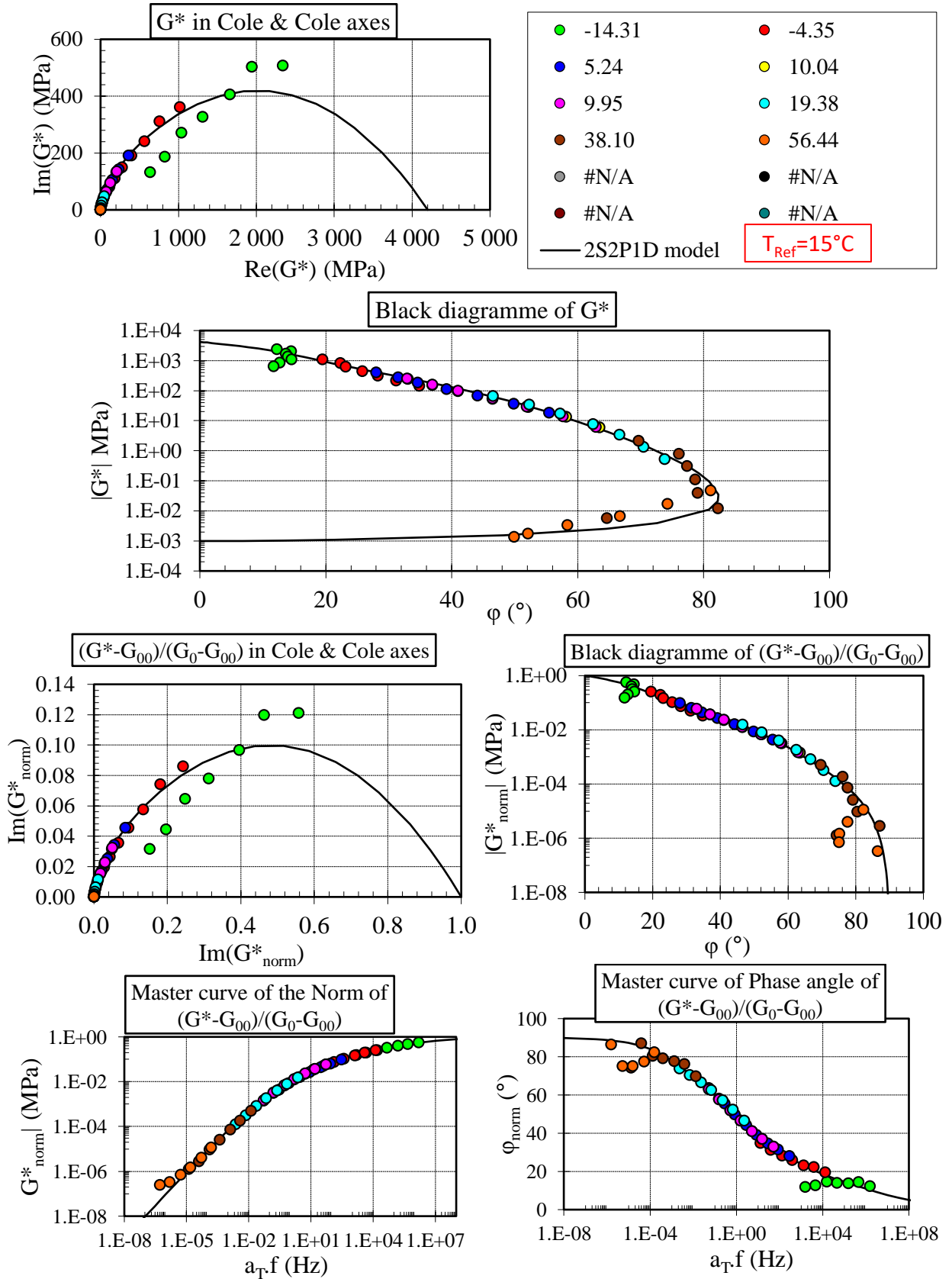
## 1.1 Complex shear modulus test

### 1.1.2.8. B\_40%(+)\_ASR\_sp2



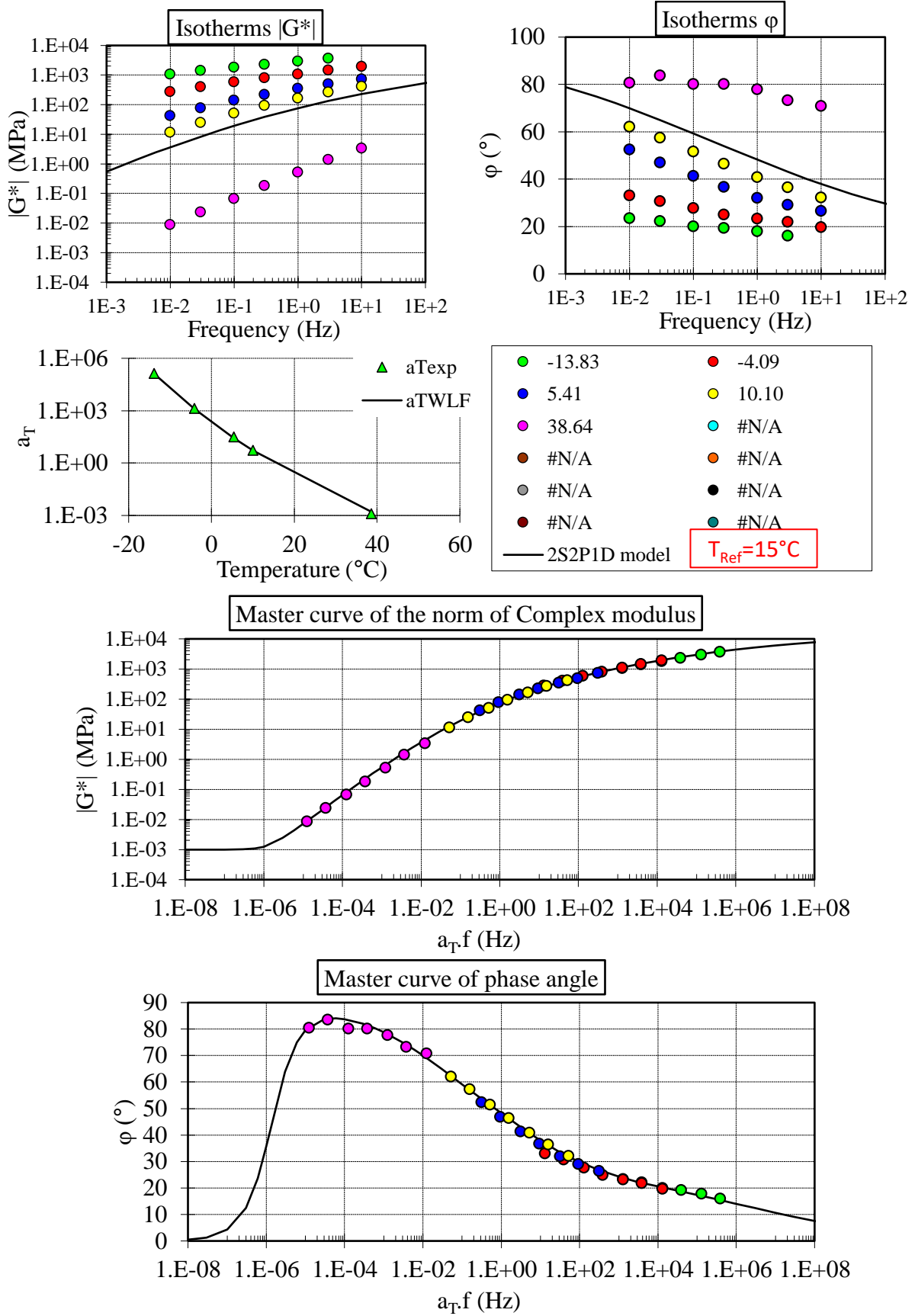
# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test



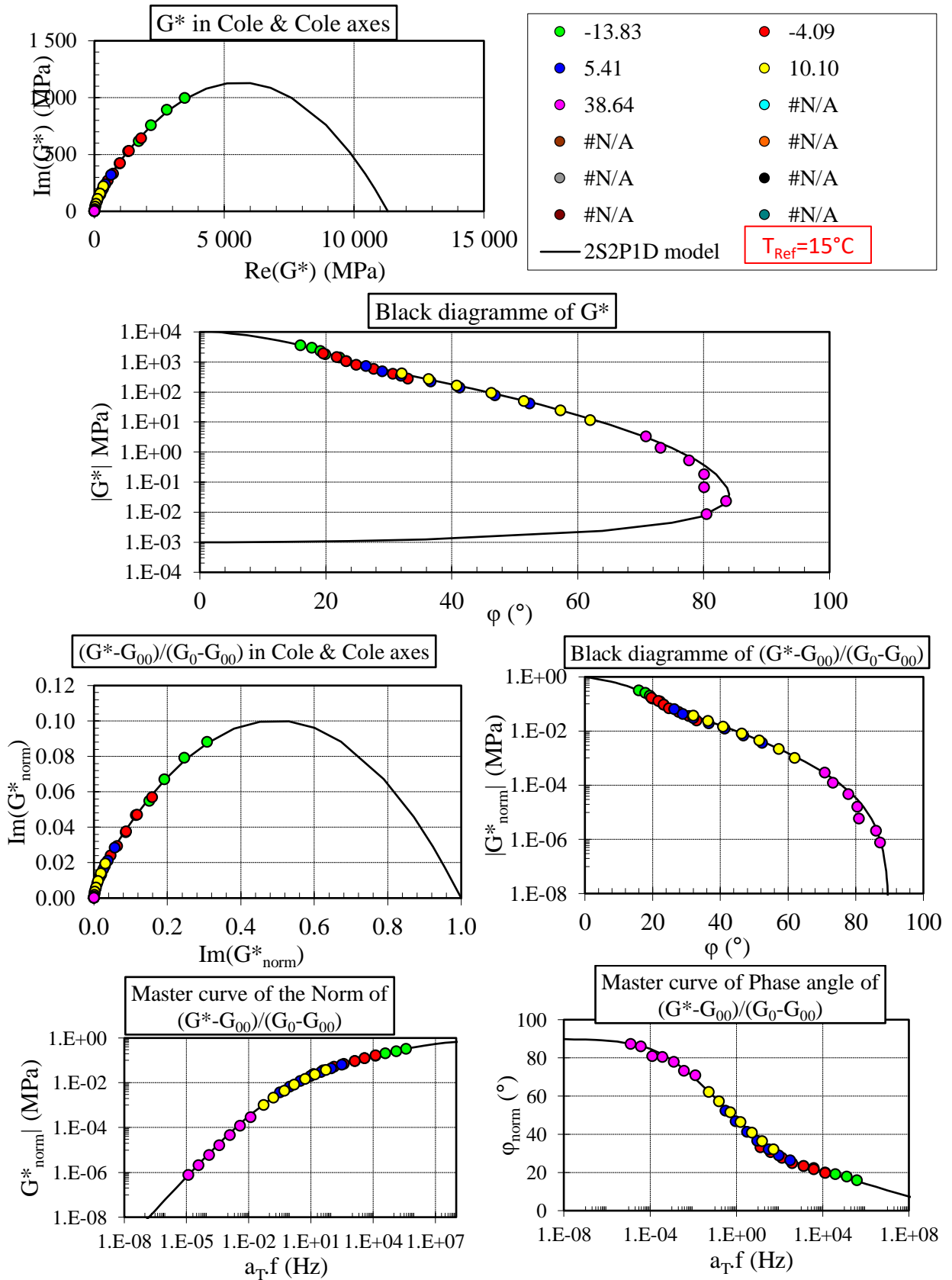
1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

1.1.2.9. B\_40%(-)\_ASR\_sp1



# 1 Thermomechanical tests on bituminous binders

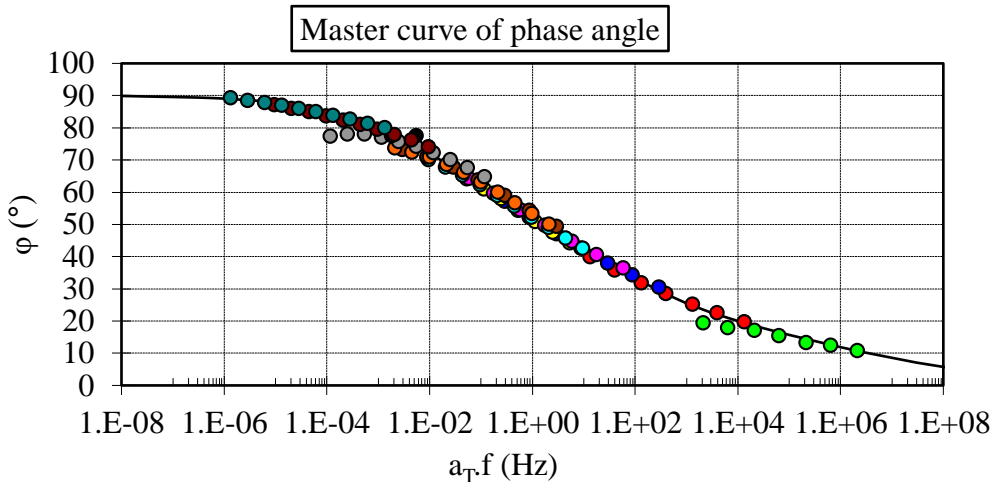
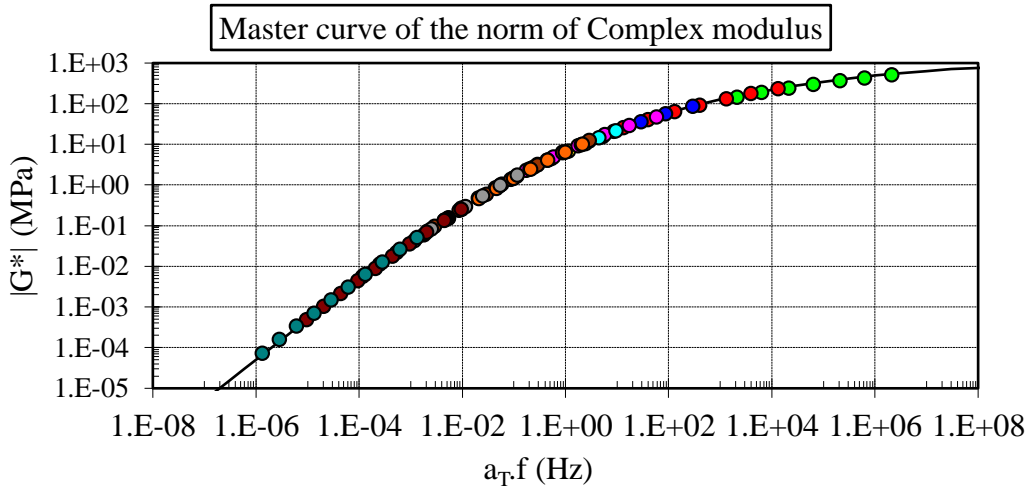
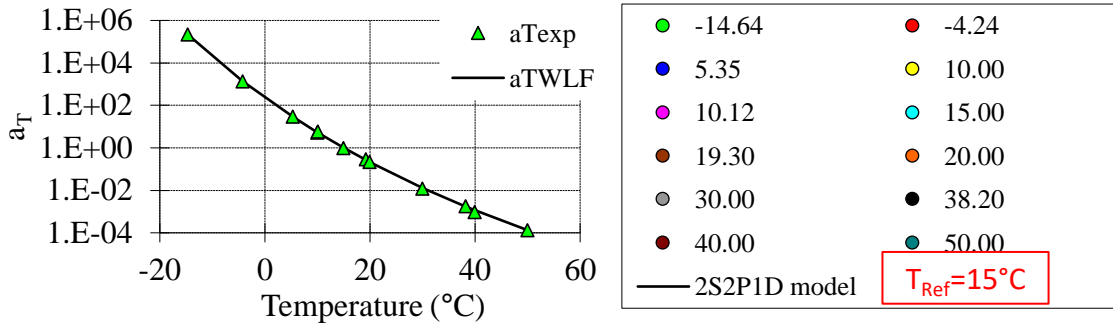
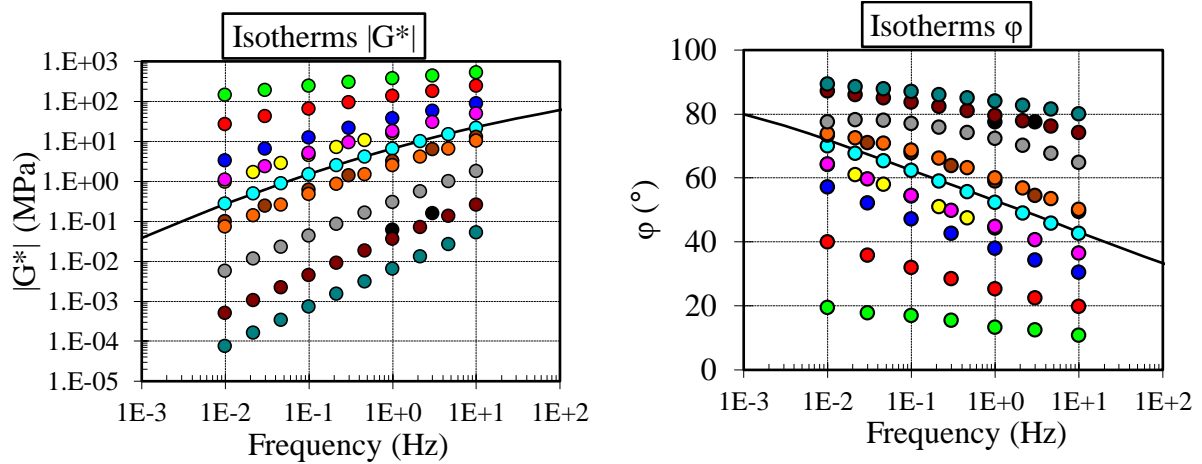
## 1.1 Complex shear modulus test



1.1.3.Unified ASR+DSR results

1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

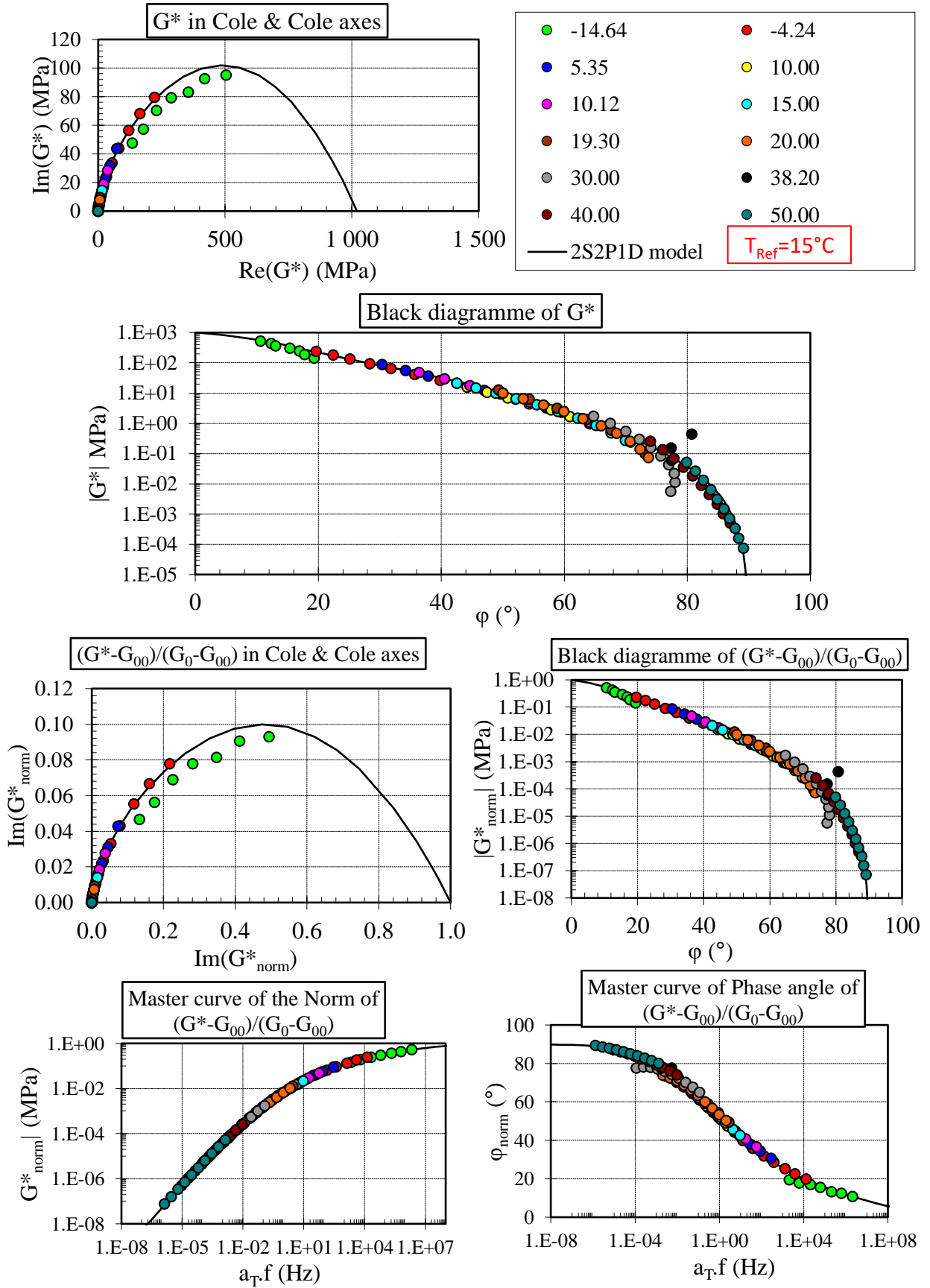
1.1.3.2. B\_ASR\_sp5+DSR





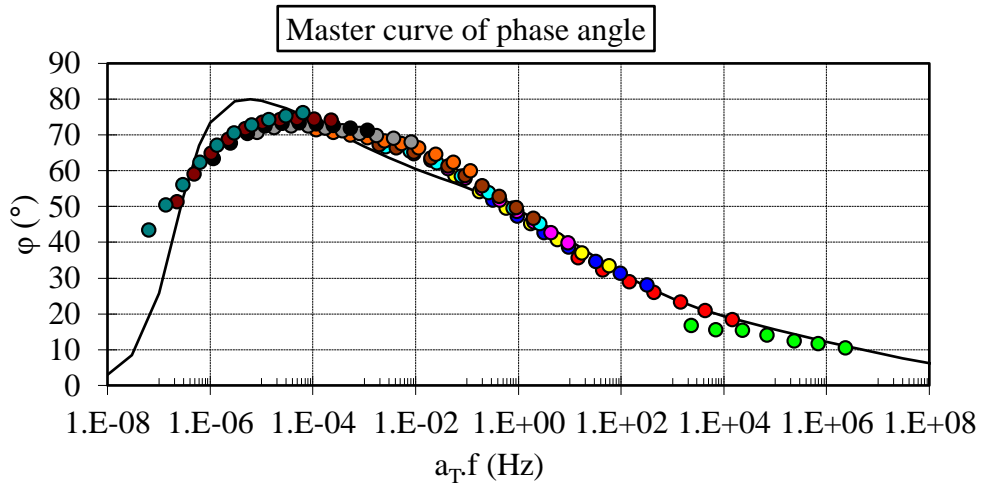
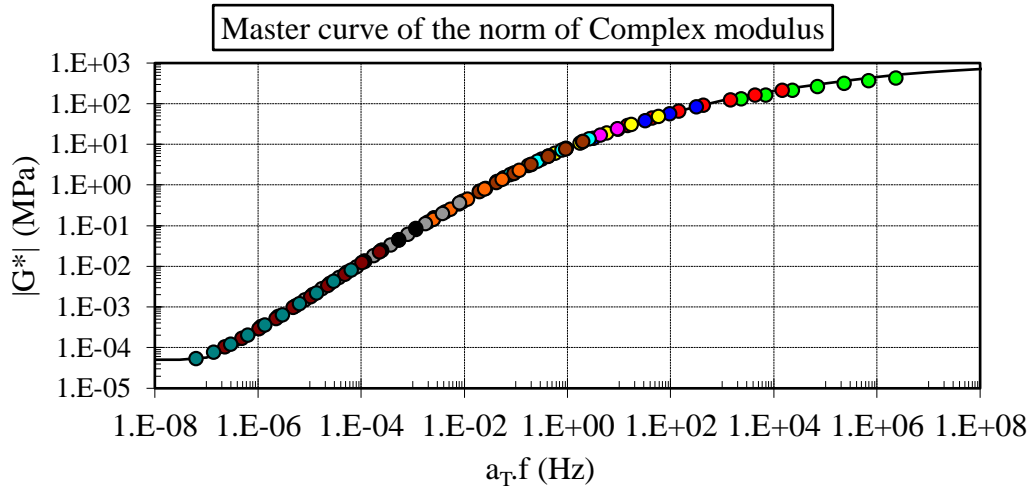
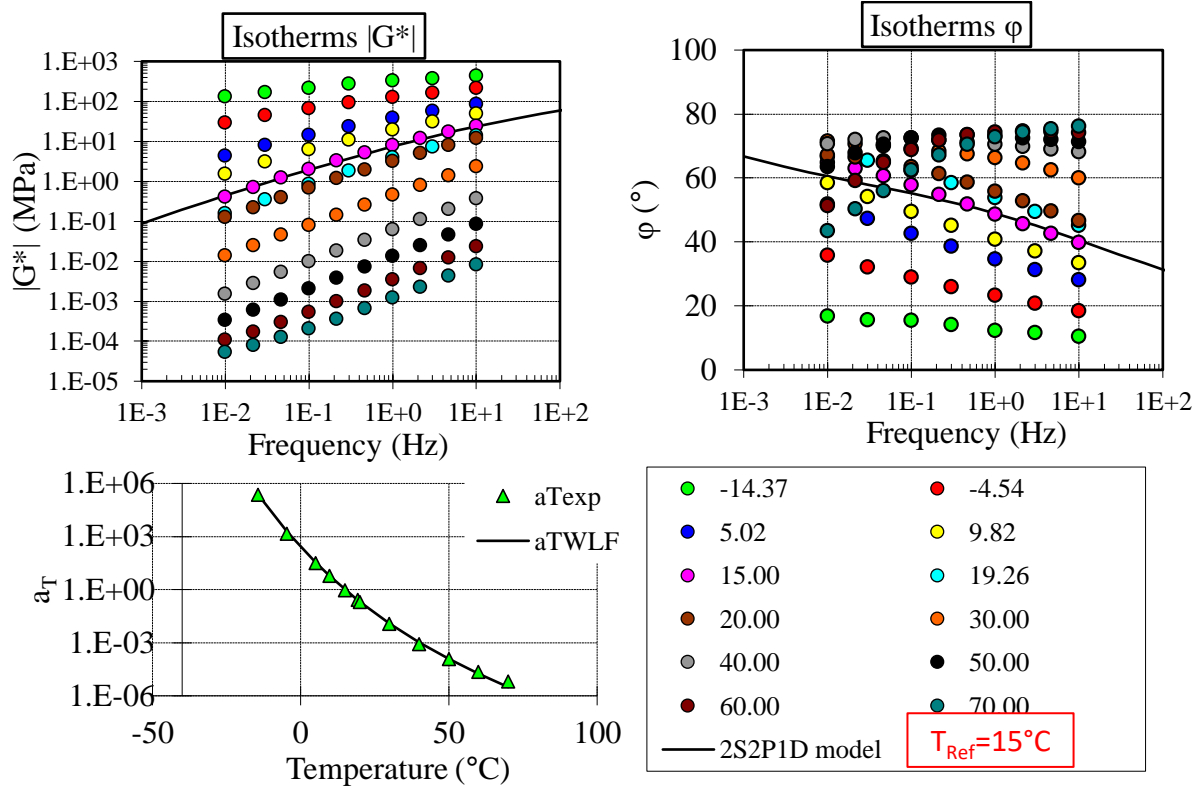
# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test



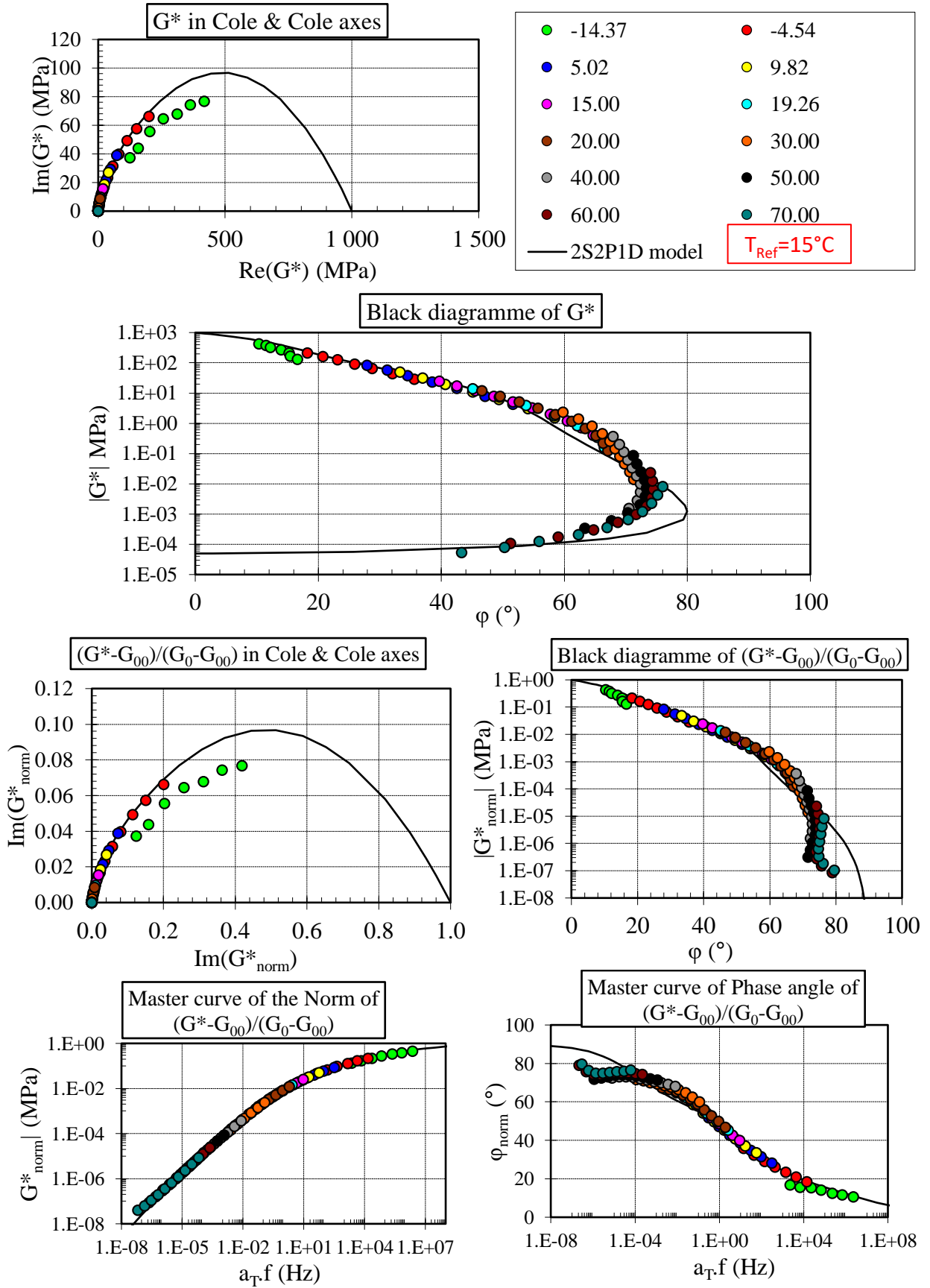
1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test

1.1.3.4. Bm\_ASR\_sp2+DSR



# 1 Thermomechanical tests on bituminous binders

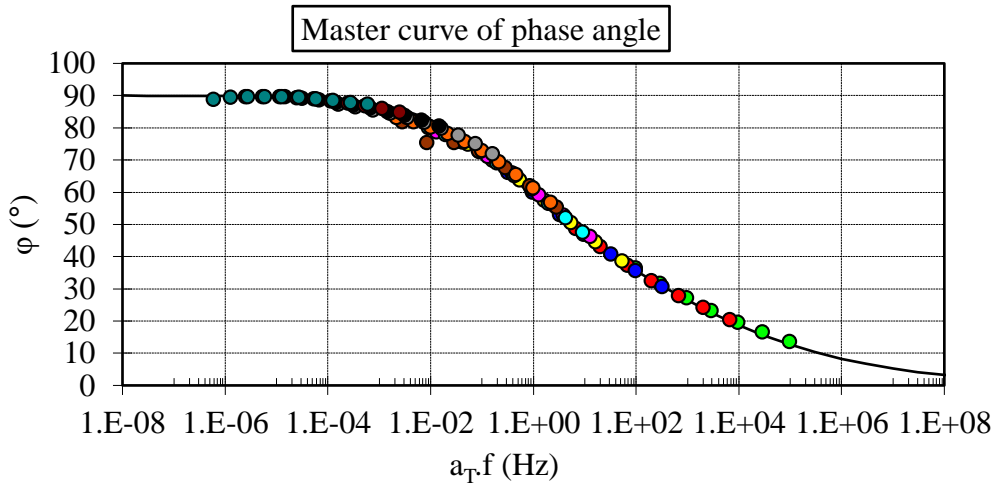
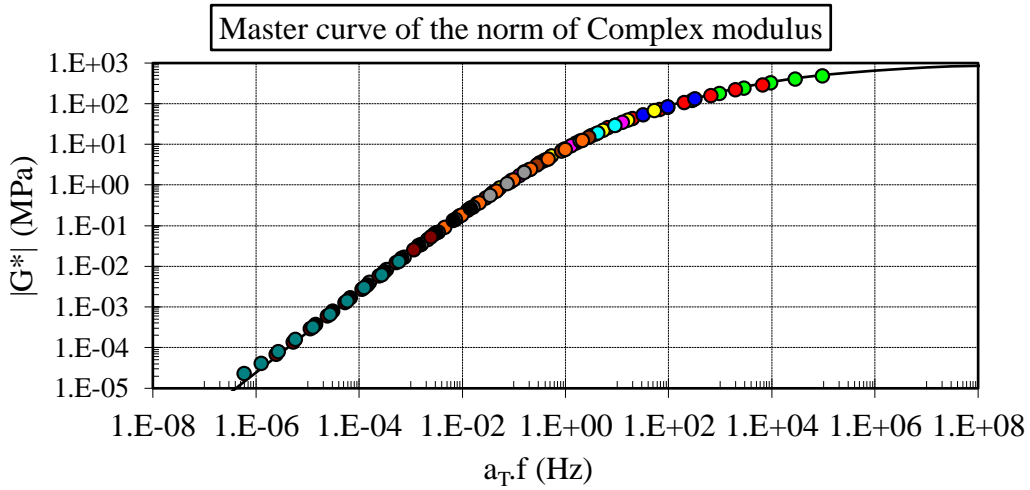
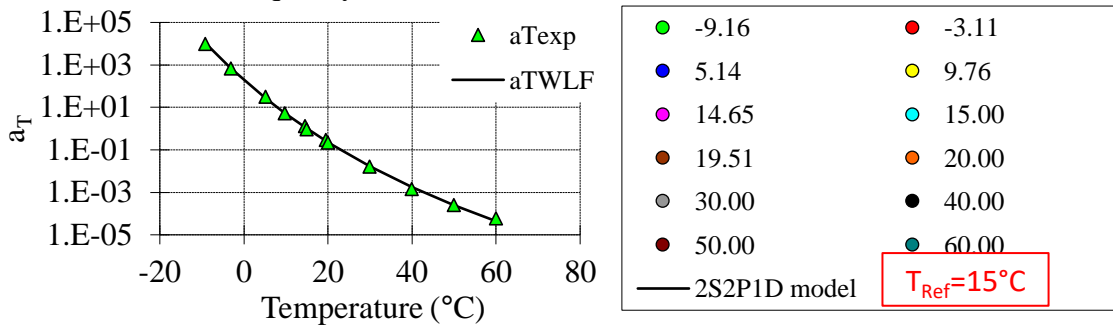
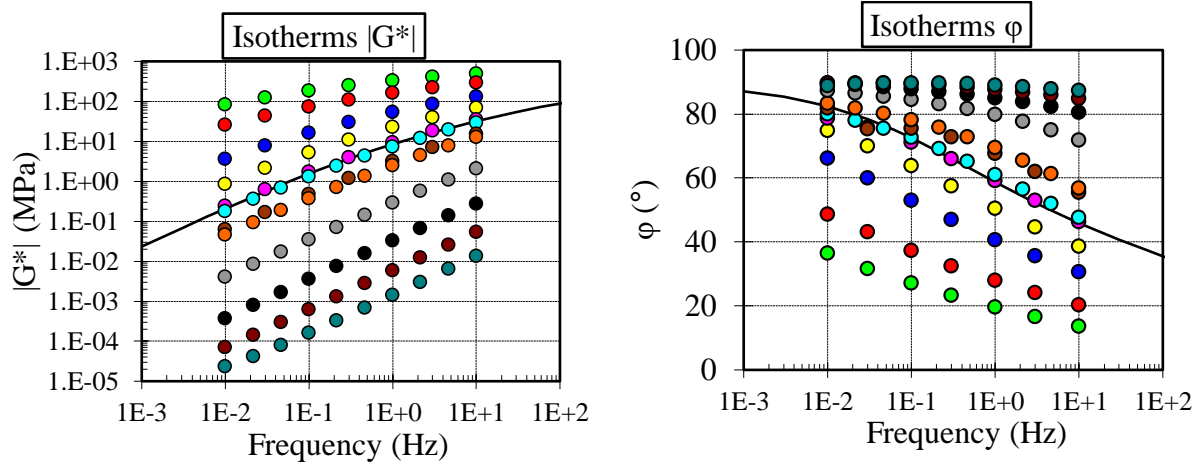
## 1.1 Complex shear modulus test



# 1 Thermomechanical tests on bituminous binders

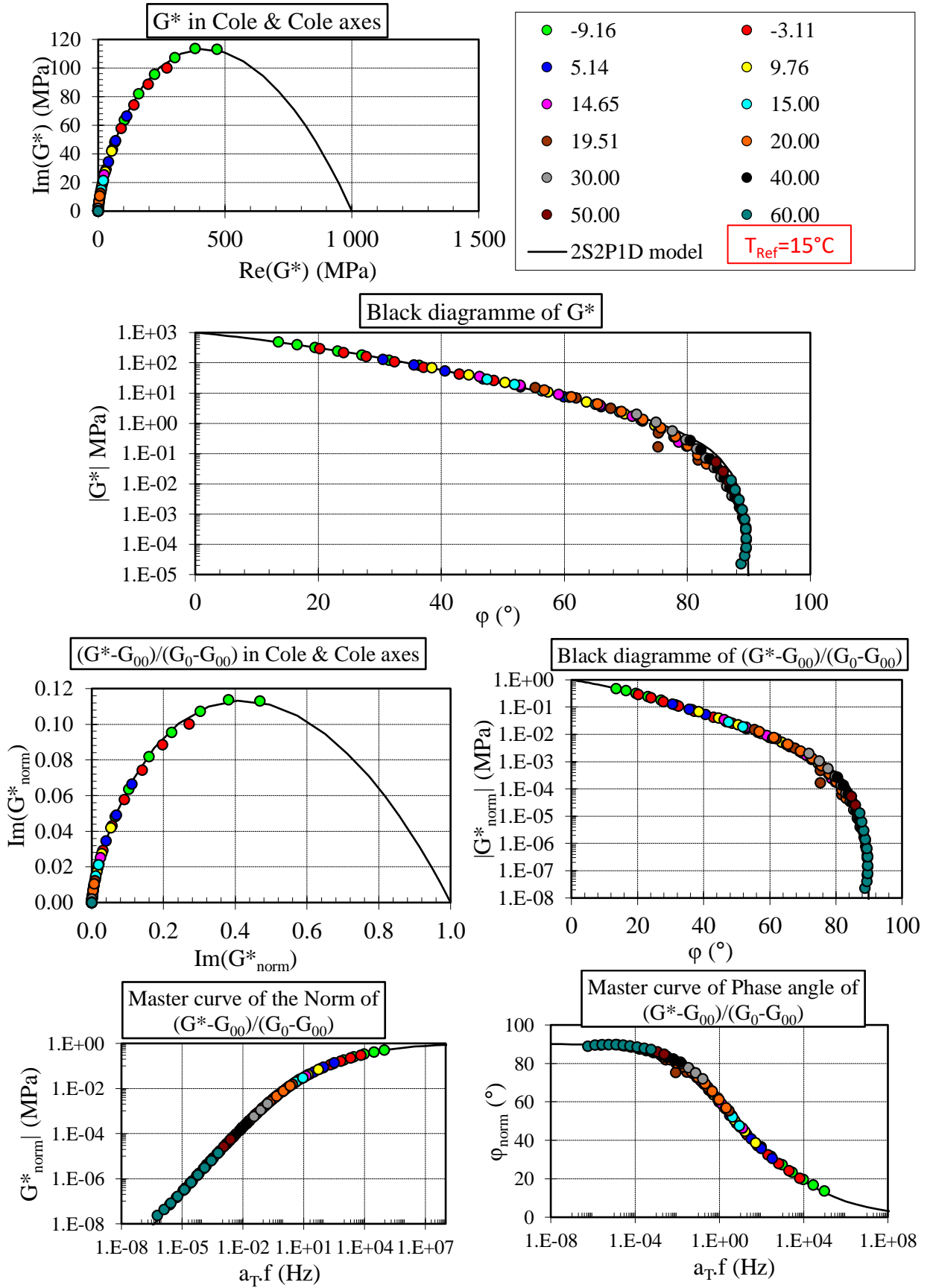
## 1.1 Complex shear modulus test

### 1.1.3.6. S\_ASR\_sp2+DSR



# 1 Thermomechanical tests on bituminous binders

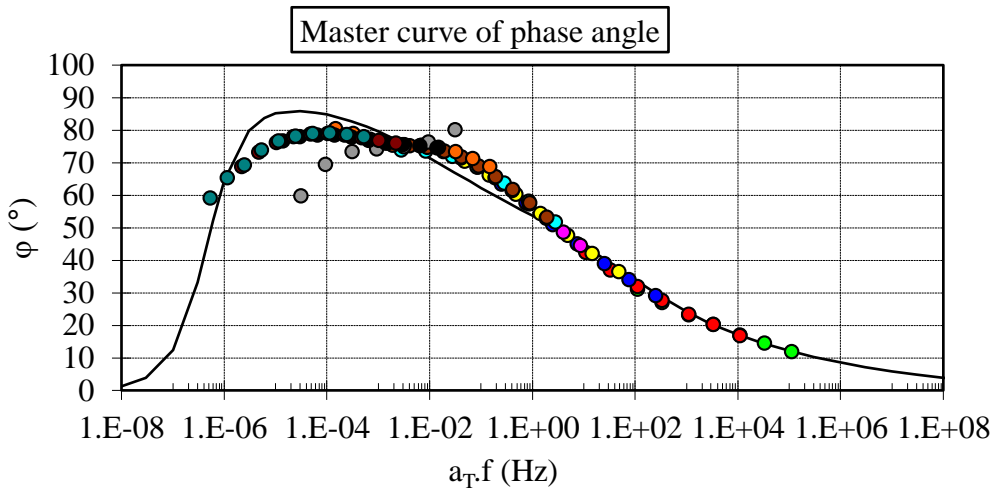
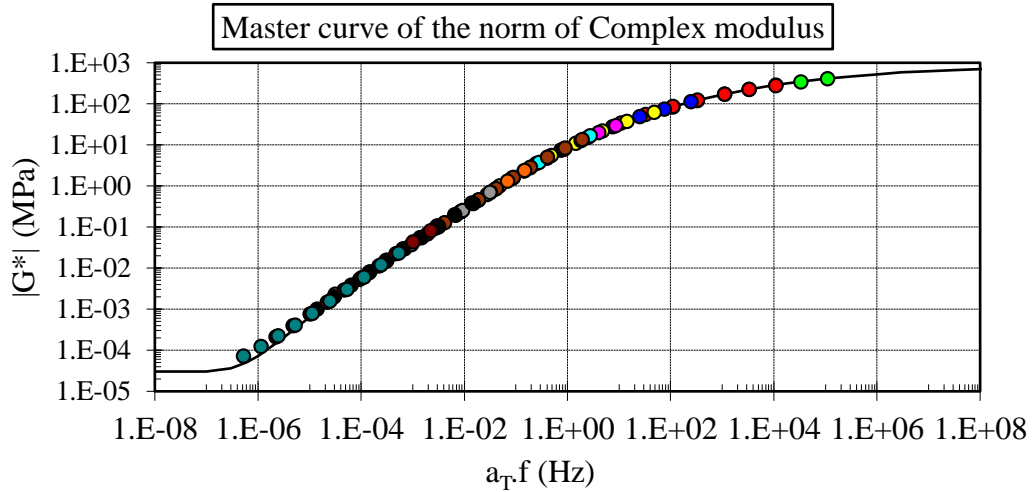
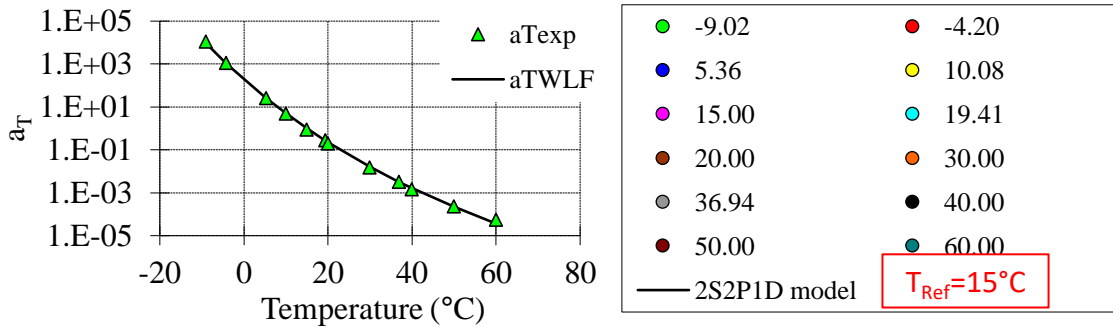
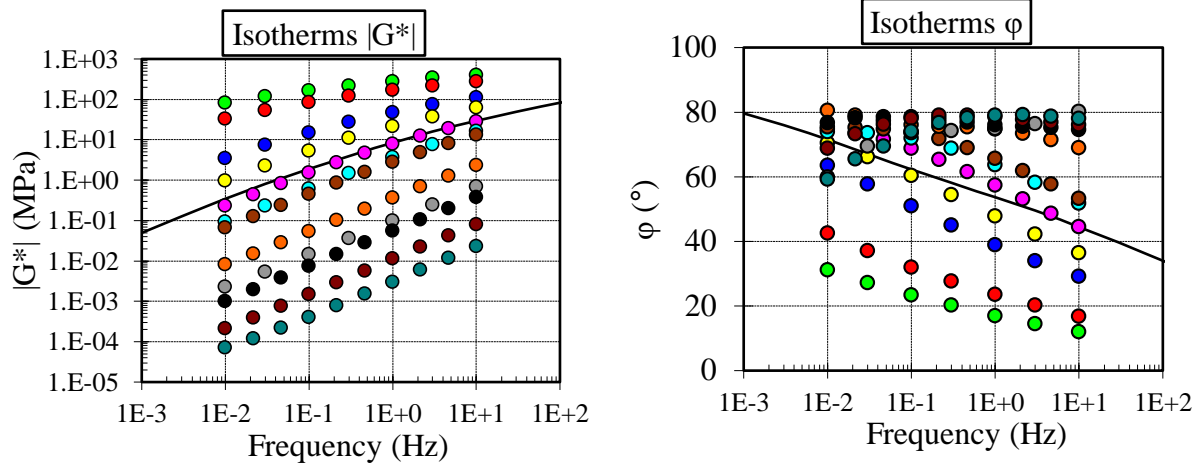
## 1.1 Complex shear modulus test



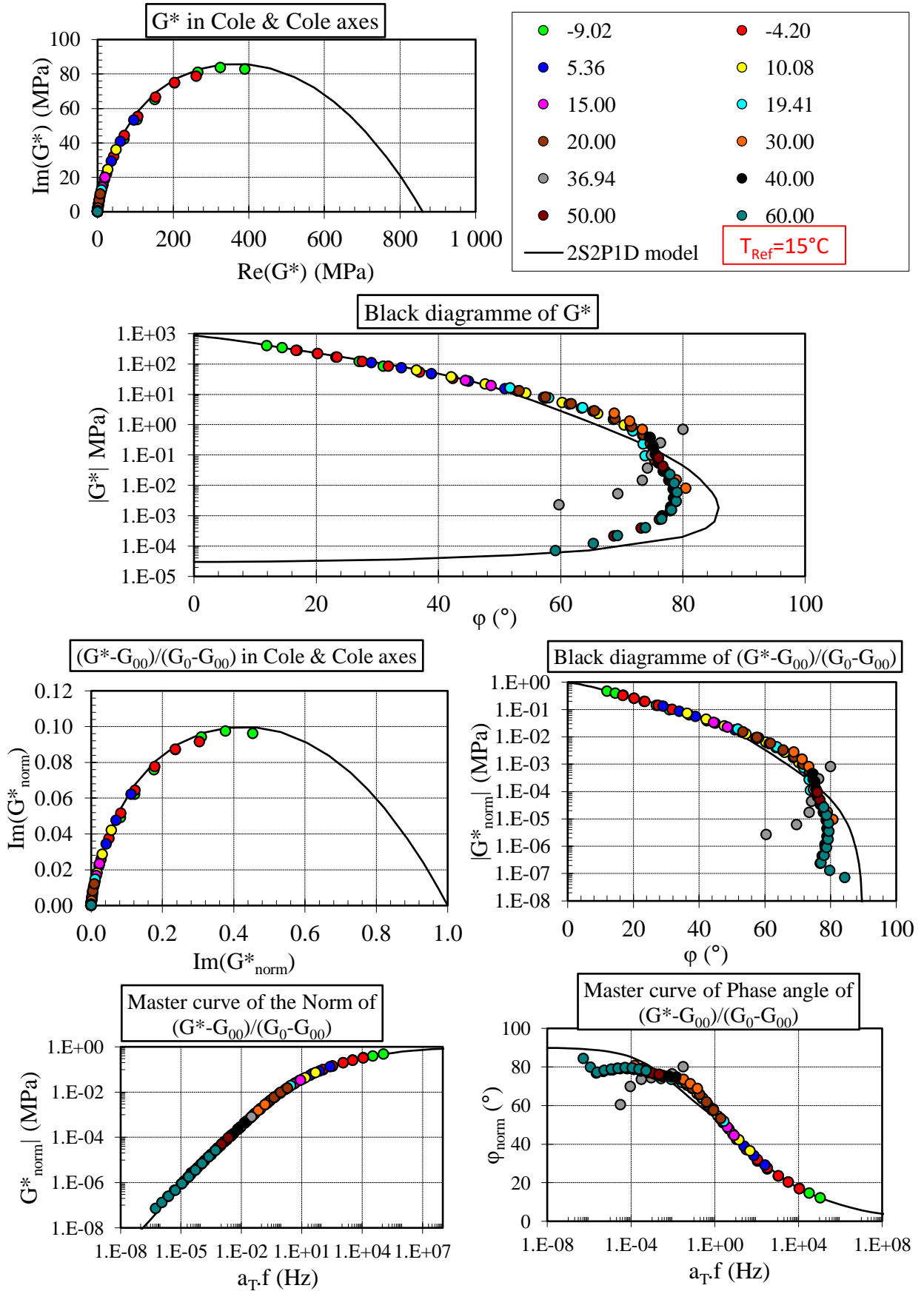
# 1 Thermomechanical tests on bituminous binders

## 1.1 Complex shear modulus test

### 1.1.3.8. Sm\_ASR\_sp1+DSR



1 Thermomechanical tests on bituminous binders  
 1.1 Complex shear modulus test



1.1.4.2S2P1D model constants and WLF parameters

1 Thermomechanical tests on bituminous binders  
1.1 Complex shear modulus test

		2S2P1D constants							WLF parameters		
		<b>G<sub>00</sub></b> <b>(MPa)</b>	<b>G<sub>0</sub></b> <b>(MPa)</b>	<b>k</b> -	<b>h</b> -	<b>δ</b> -	<b>τ<sub>0</sub></b> <b>(s)</b>	<b>β</b> -	<b>T<sub>ref</sub></b> <b>(°C)</b>	<b>C<sub>1</sub></b> -	<b>C<sub>2</sub></b> <b>(°C)</b>
ASR	B_ASR_sp1	0	1020	0.25	0.62	5.0	1.04E-04	100	15	20.4	151.5
	B_ASR_sp5	0	1020	0.25	0.62	5.0	9.75E-05	100	15	20.4	151.5
	Bm_ASR_sp2	0.0006	1000	0.23	0.58	5.4	8.01E-05	280	15	24.9	177.4
	S_ASR_sp2	0	1000	0.24	0.55	2.2	7.40E-05	60	15	20.4	151.8
	Sm_ASR_sp1	0.0005	890	0.22	0.57	3.0	1.08E-04	50	15	13.1	101.8
	B_40%_ASR_sp1	0.0003	4000	0.25	0.62	5.0	1.31E-04	100	15	18.6	133.3
	B_40%(+)_ASR_sp2	0.0004	4200	0.25	0.62	5.0	1.54E-04	100	15	18.6	133.7
	B_40%(-)_ASR_sp1	0.001	11300	0.25	0.62	8.0	1.06E-04	100	15	18.6	133.7
DSR	B_DSR	0	500	0.24	0.60	2.7	1.80E-04	110	15	28.0	203.3
	Bm_DSR	8E-05	800	0.15	0.47	2.0	1.20E-05	1000	15	21.2	158.1
	S_DSR	0	700	0.23	0.57	2.0	1.20E-04	40	15	17.8	136.7
	Sm_DSR	3E-05	580	0.23	0.57	2.2	2.00E-04	40	15	17.8	136.7
ASR + DSR	B_ASR_sp5+DSR	0	1020	0.25	0.62	5.0	8.08E-05	100	15	18.6	133.3
	Bm_ASR_sp2+DSR	5E-05	1000	0.24	0.63	5.8	1.03E-04	400	15	18.7	131.6
	S_ASR_sp2+DSR	0	1000	0.24	0.55	2.2	6.53E-05	60	15	16.0	120.1
	Sm_ASR_sp1+DSR	3E-05	860	0.23	0.61	3.0	1.24E-04	100	15	16.9	125.9

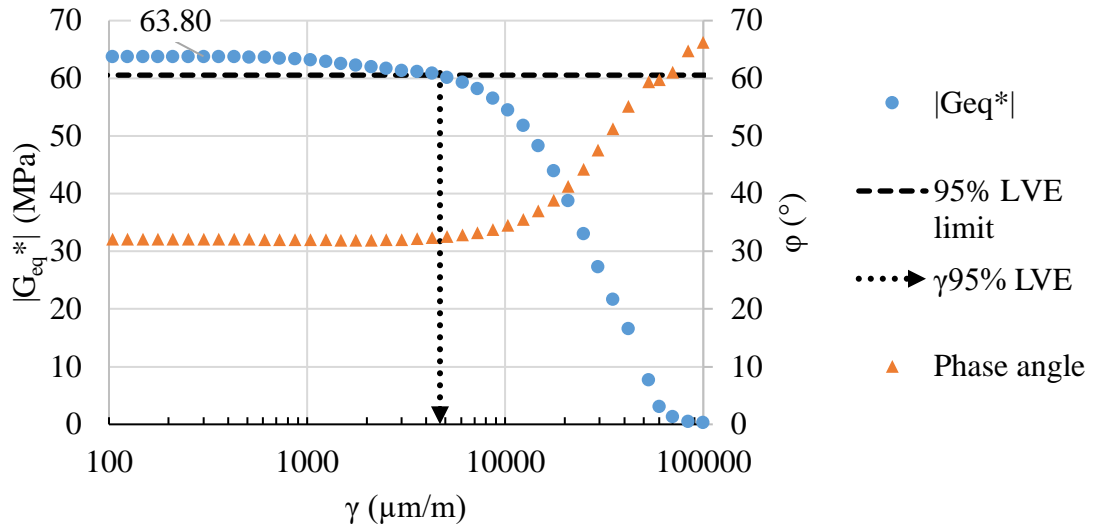


1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test

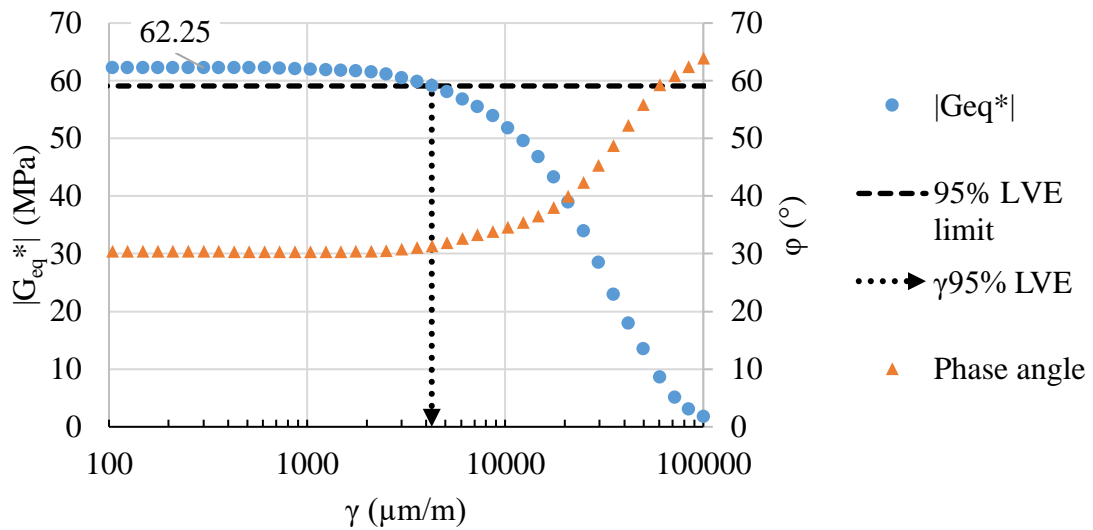
1.2. Strain Amplitude Sweep (SAS) test

1.2.1. SAS test with DSR at 10°C/25Hz

1.2.1.1. B\_DSR\_SAS

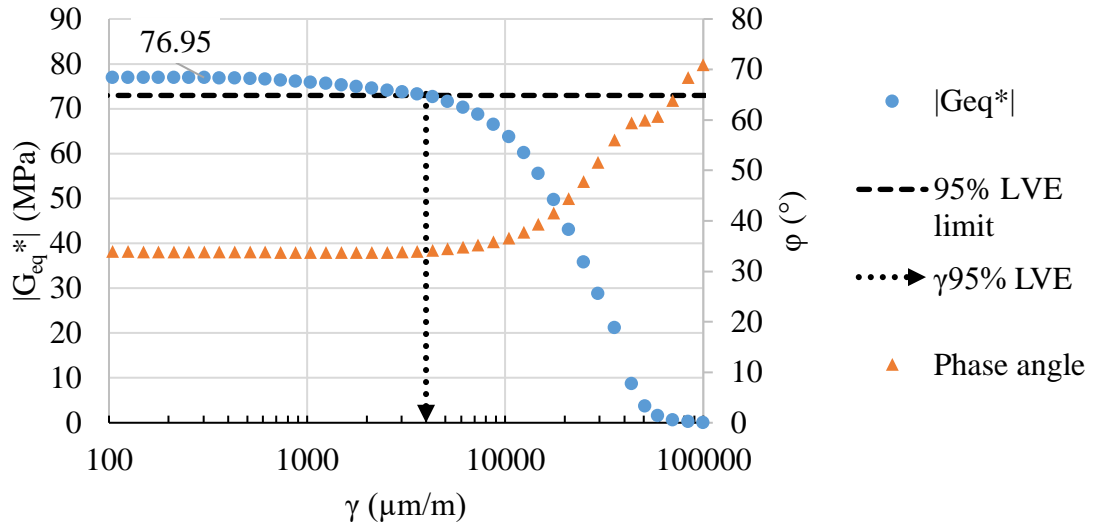


1.2.1.2. Bm\_DSR\_SAS

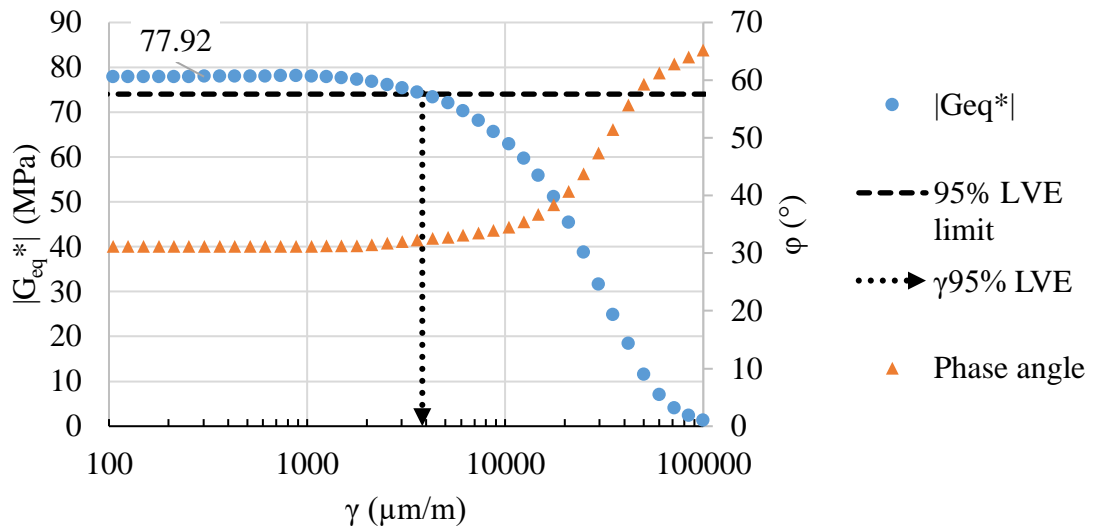


1.2.1.3. S\_DSR\_SAS

1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test



1.2.1.4. Sm\_DSR\_SAS



1.2.1.5. LVE limits with DSR

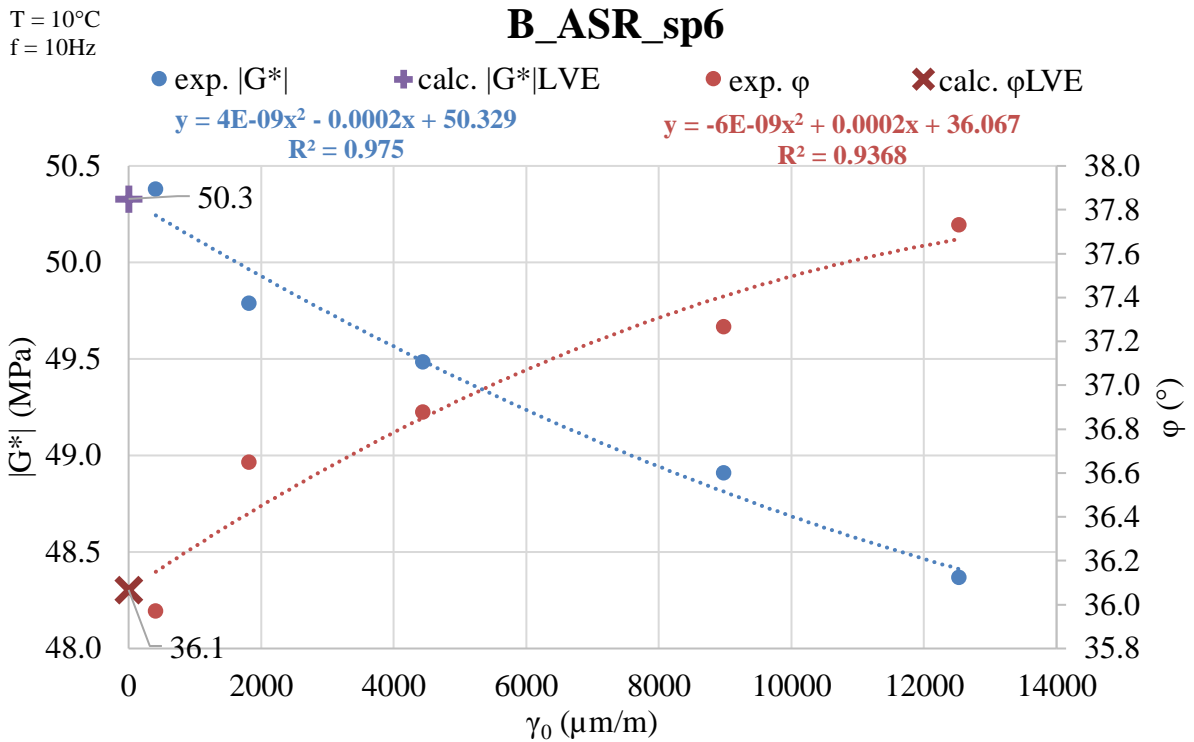
	Asymptotic $ G^* $ (MPa)	Asymptotic $\phi$ (°)	$\gamma_{95\% \text{ LVE}}$ ( $\mu\text{m}/\text{m}$ )
B	63.7	32.1	4687
Bm	62.2	30.4	4258
S	76.8	33.9	3984
Sm	77.9	31.1	3816

1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test

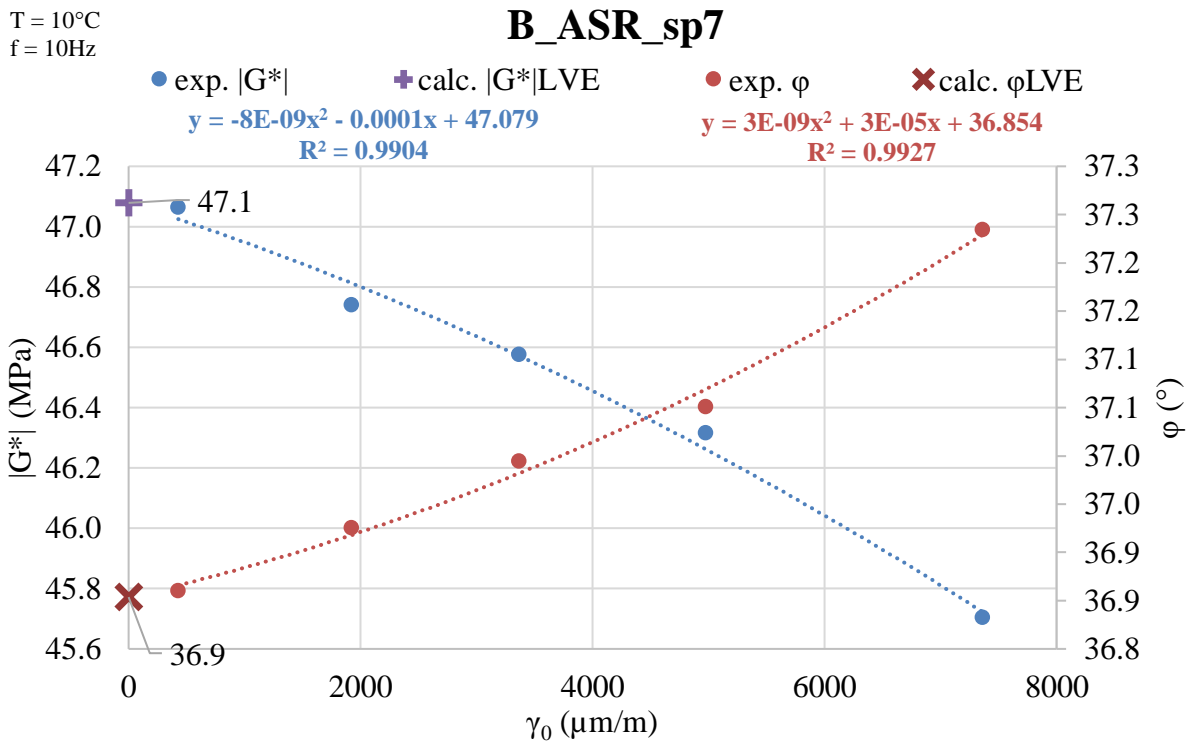
1.2.2.SAS test with ASR at 10°C/10Hz

1.2.2.1. B\_ASR

T = 10°C  
 f = 10Hz



T = 10°C  
 f = 10Hz

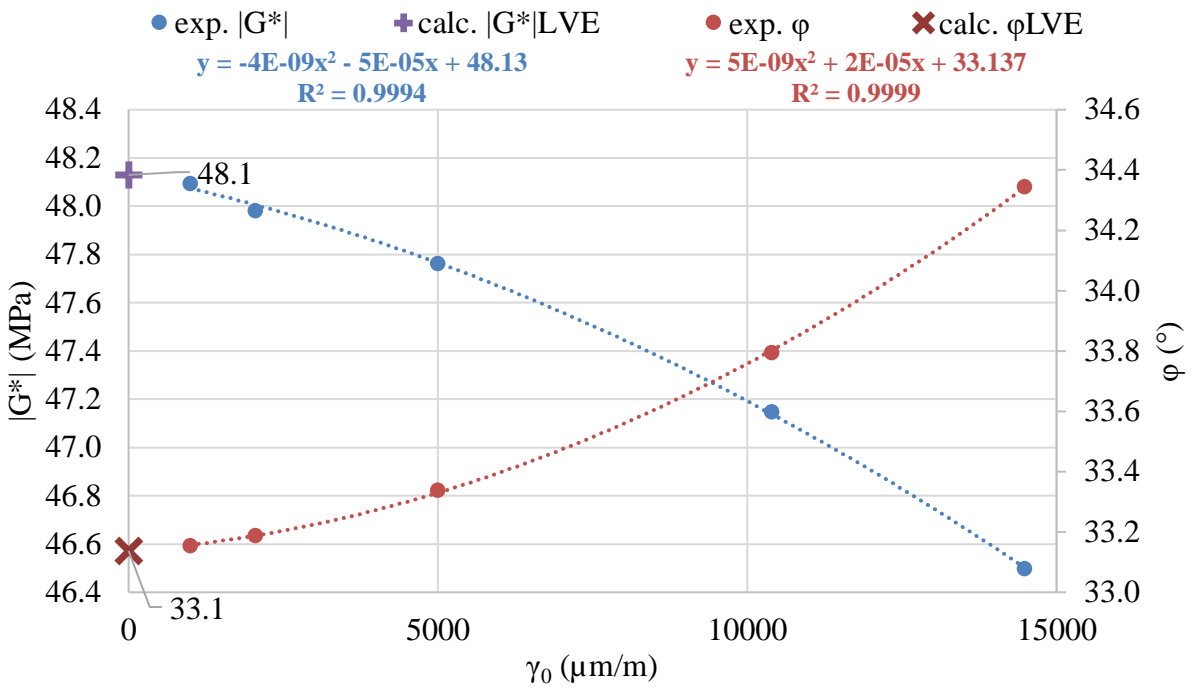


1.2.2.2. Bm\_ASR

1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test

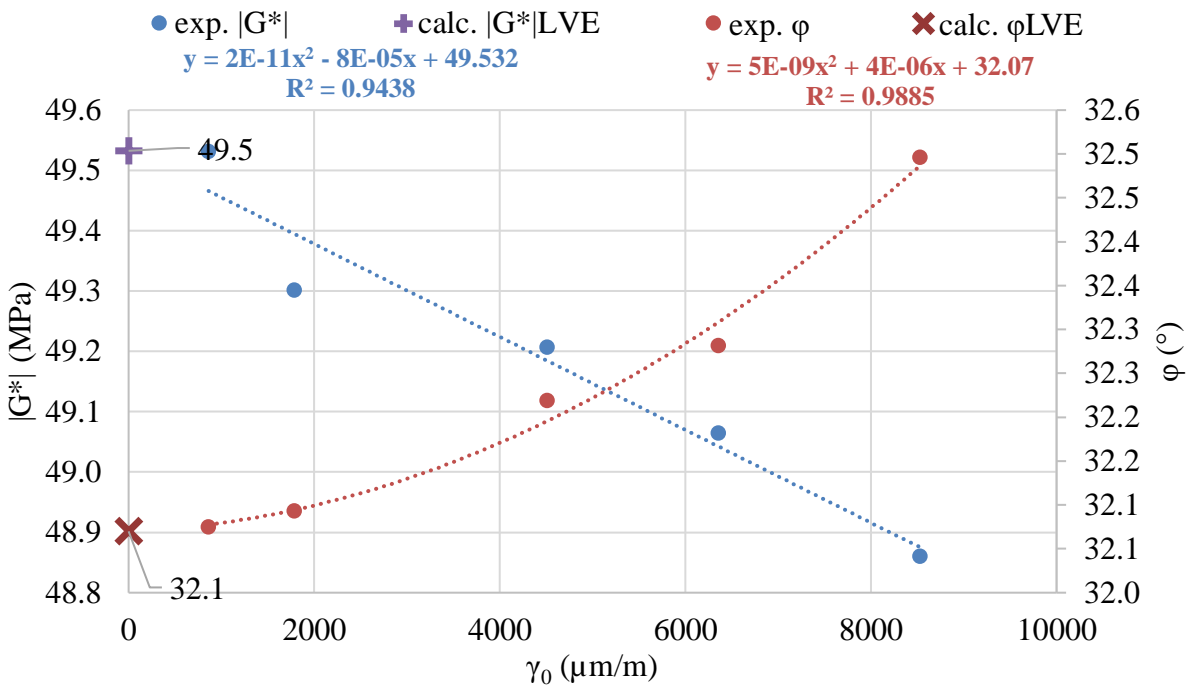
T = 10°C  
 f = 10Hz

**Bm\_ASR\_sp2**



T = 10°C  
 f = 10Hz

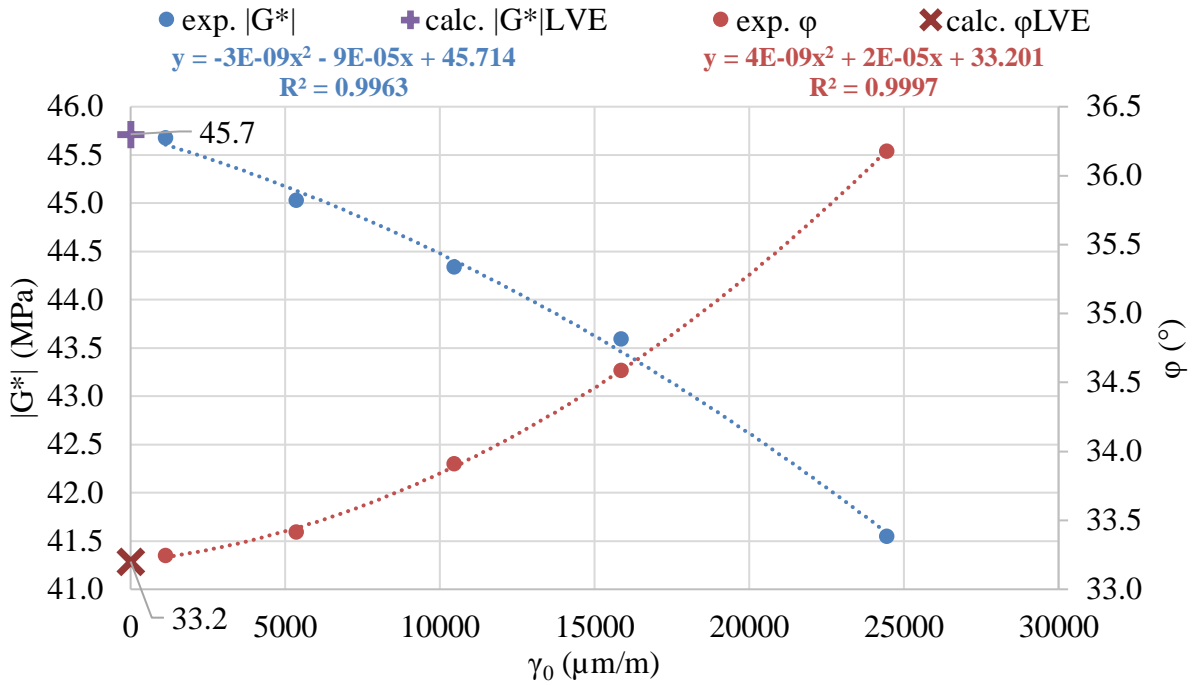
**Bm\_ASR\_sp3**



1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test

T = 10°C  
 f = 10Hz

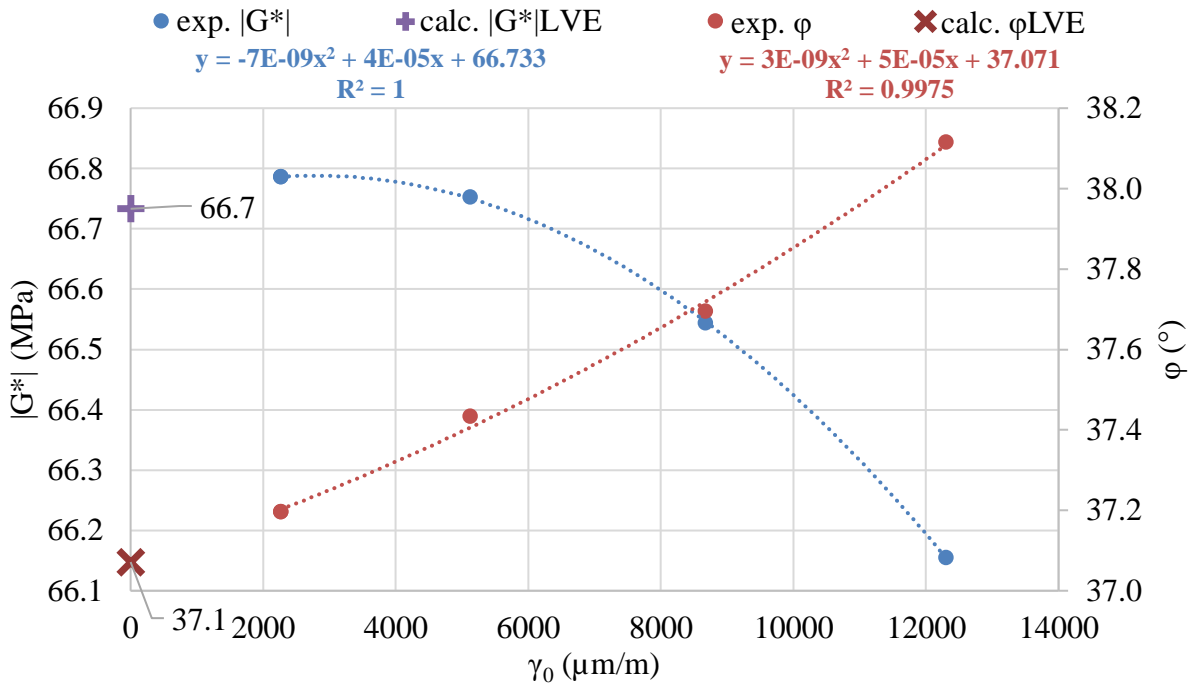
**Bm\_ASR\_sp4**



1.2.2.3. S\_ASR

T = 10°C  
 f = 10Hz

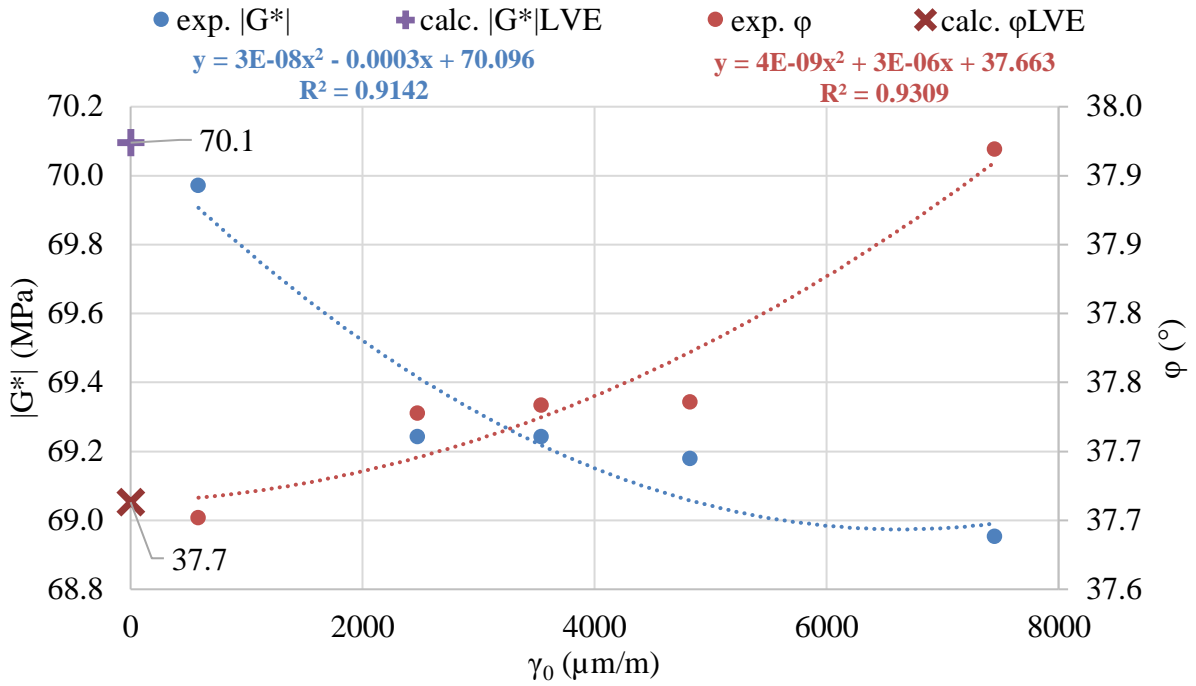
**S\_ASR\_sp5**



1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test

T = 10°C  
 f = 10Hz

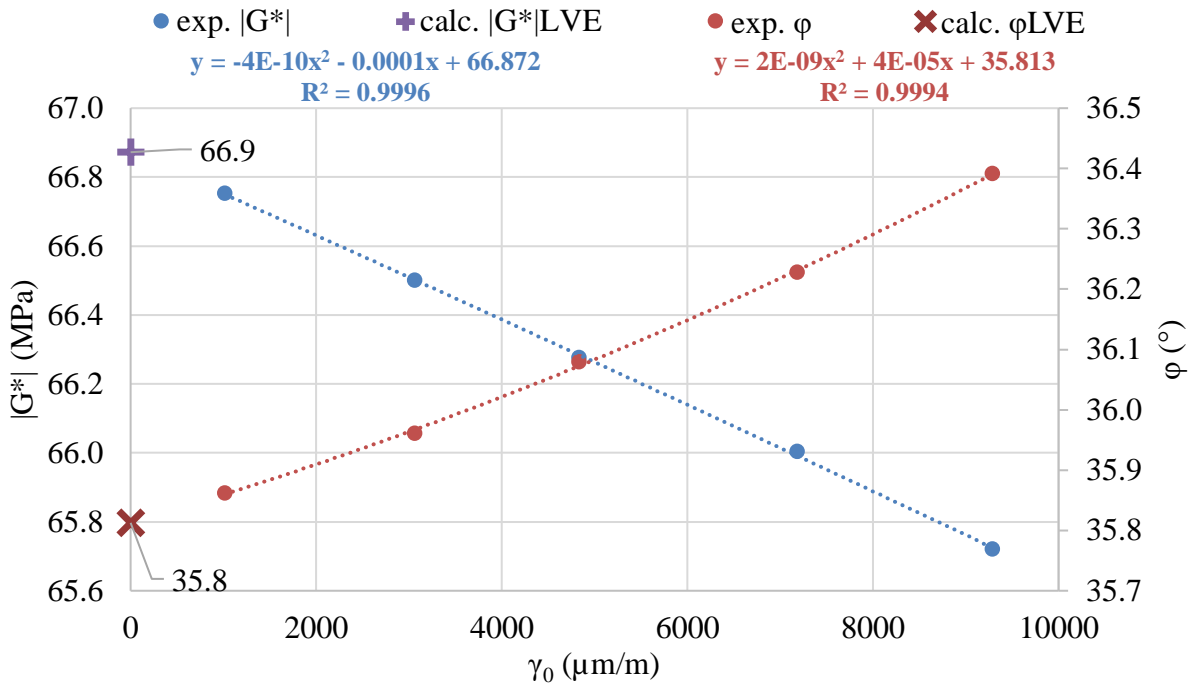
**S\_ASR\_sp6**



1.2.2.4. Sm\_ASR

T = 10°C  
 f = 10Hz

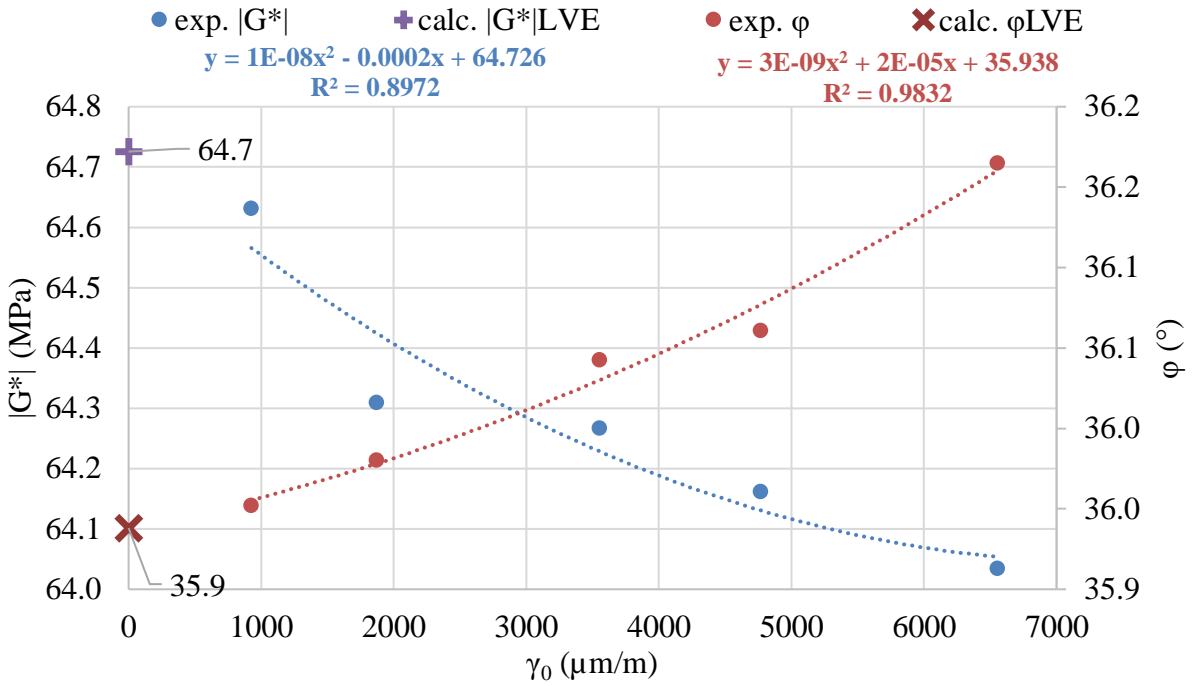
**Sm\_ASR\_sp2**



1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test

T = 10°C  
 f = 10Hz

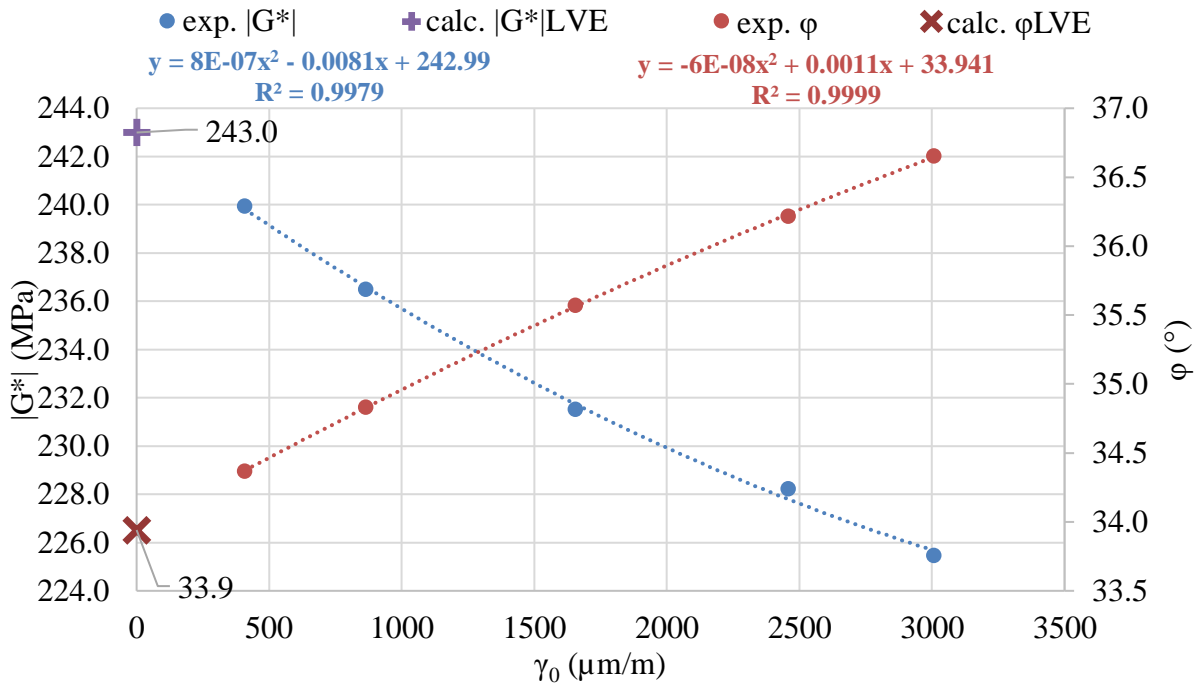
**Sm\_ASR\_sp4**



1.2.2.5. B\_40%\_ASR

T = 10°C  
 f = 10Hz

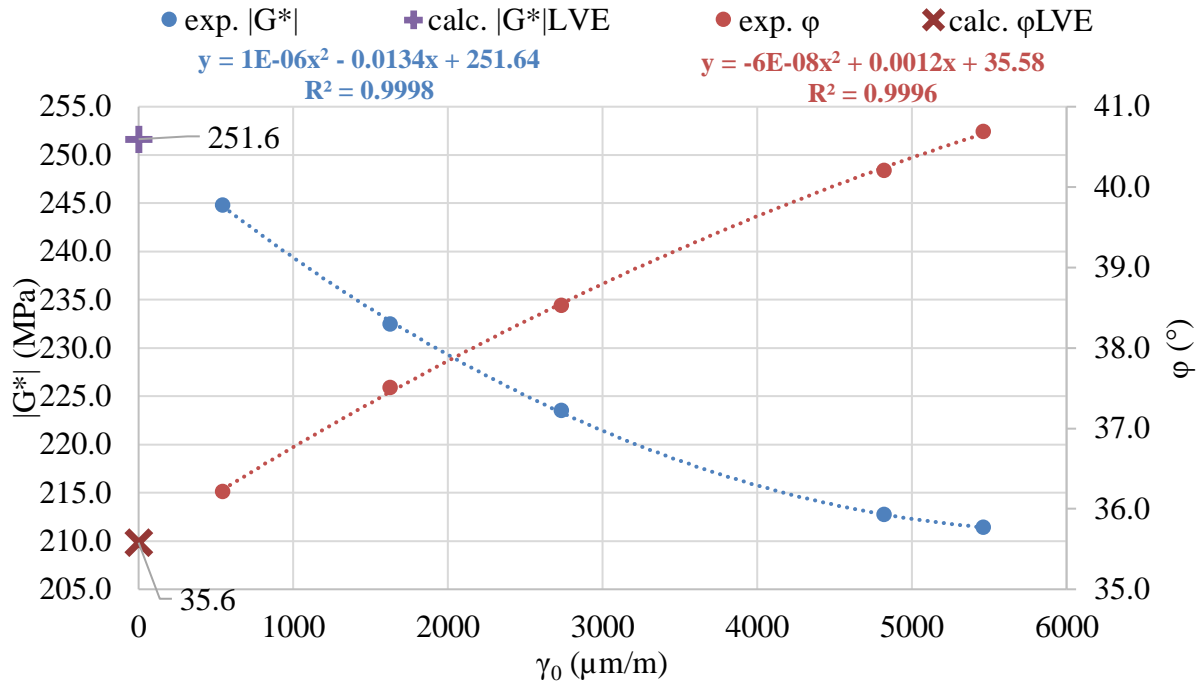
**B\_40%\_ASR\_sp5**



1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test

T = 10°C  
 f = 10Hz

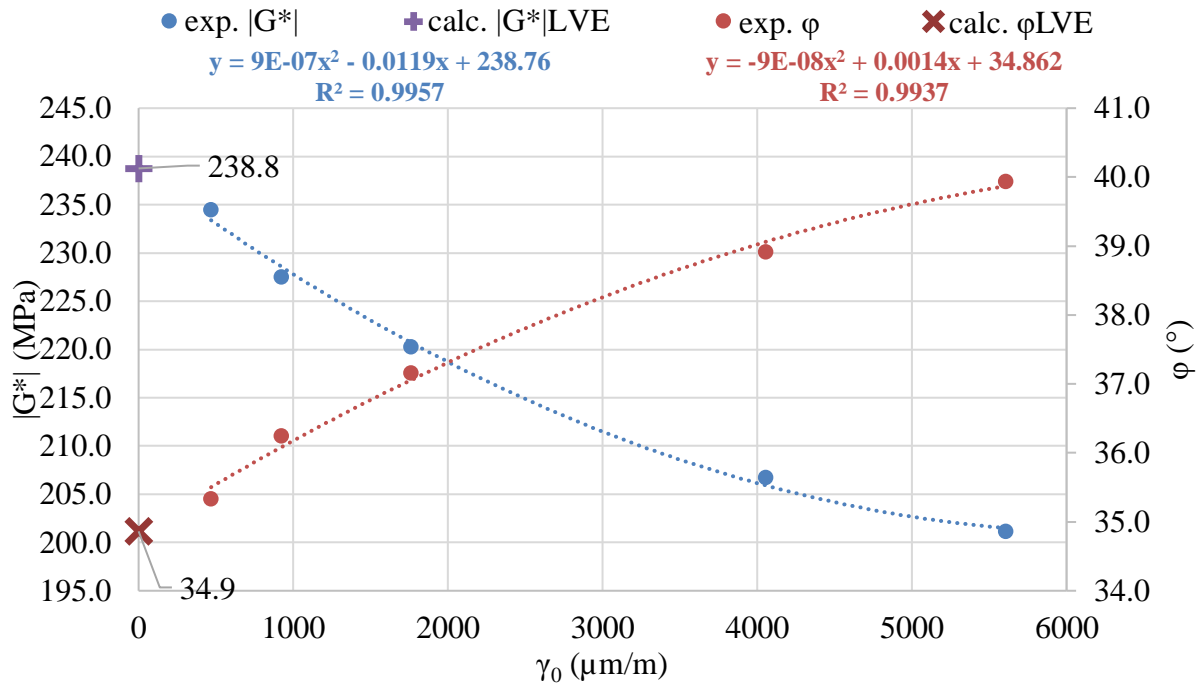
**B\_40%\_ASR\_sp6**



1.2.2.6. B\_40%(+)\_ASR

T = 10°C  
 f = 10Hz

**B\_40%(+)\_ASR\_sp1**

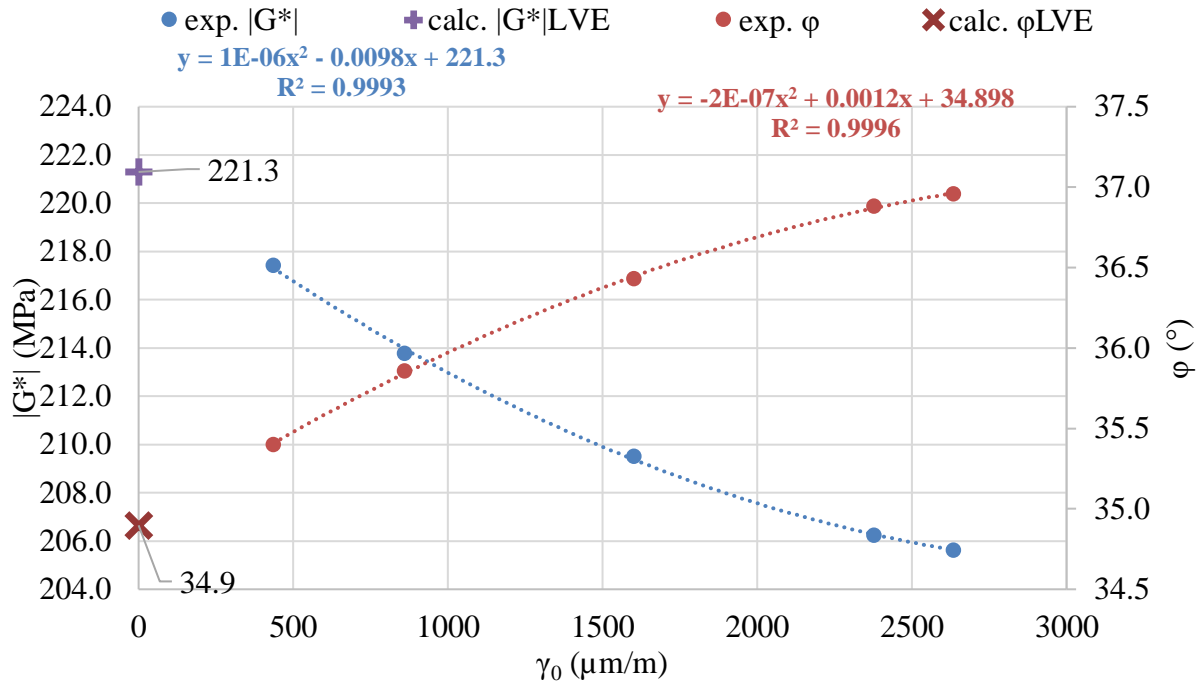




1 Thermomechanical tests on bituminous binders  
 1.2 Strain Amplitude Sweep (SAS) test

T = 10°C  
 f = 10Hz

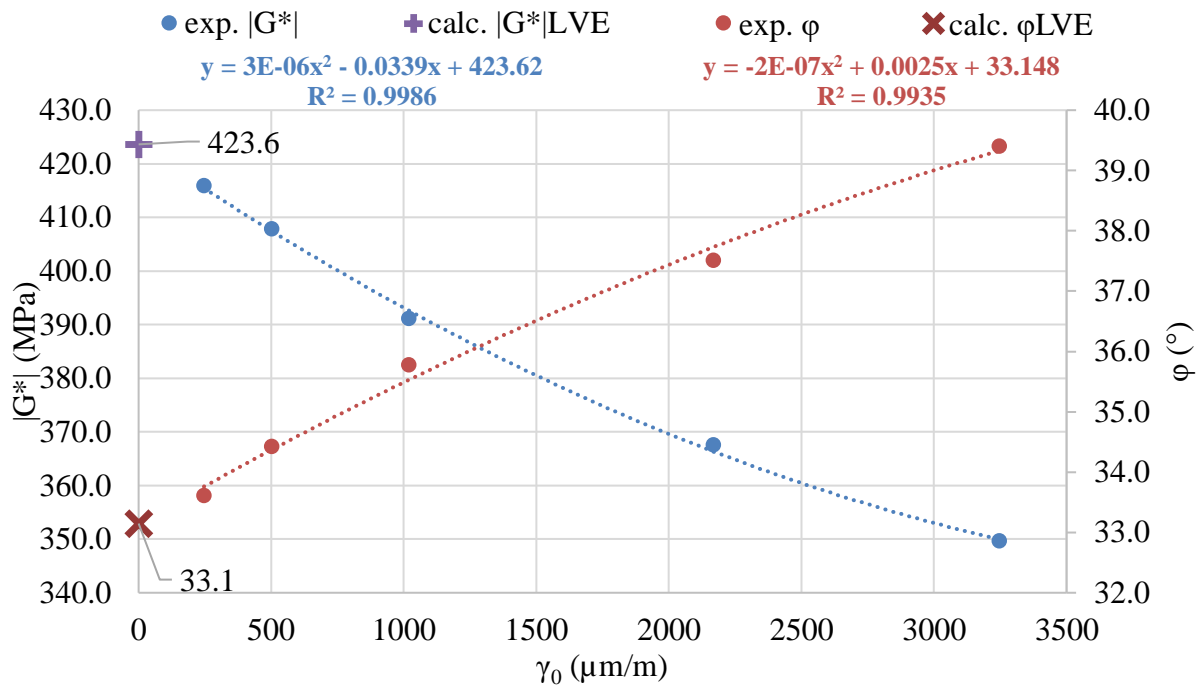
**B\_40%(+)\_ASR\_sp3**



1.2.2.7. B\_40%(-)\_ASR

T = 10°C  
 f = 10Hz

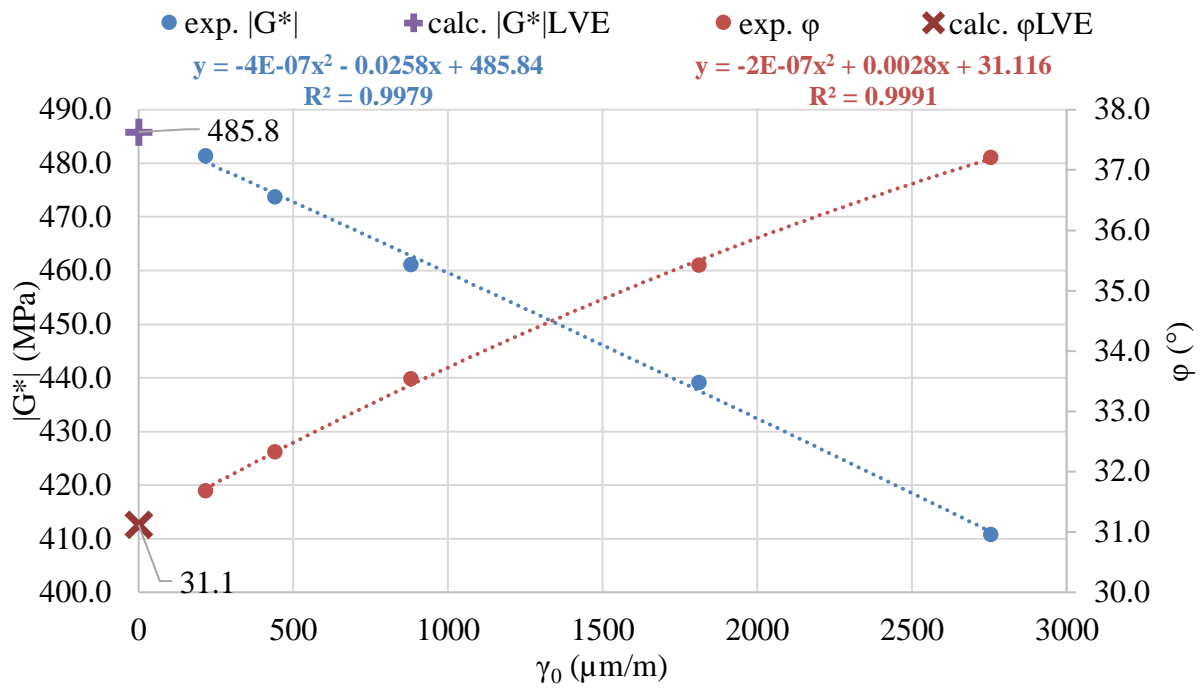
**B\_40%(-)\_ASR\_sp3**



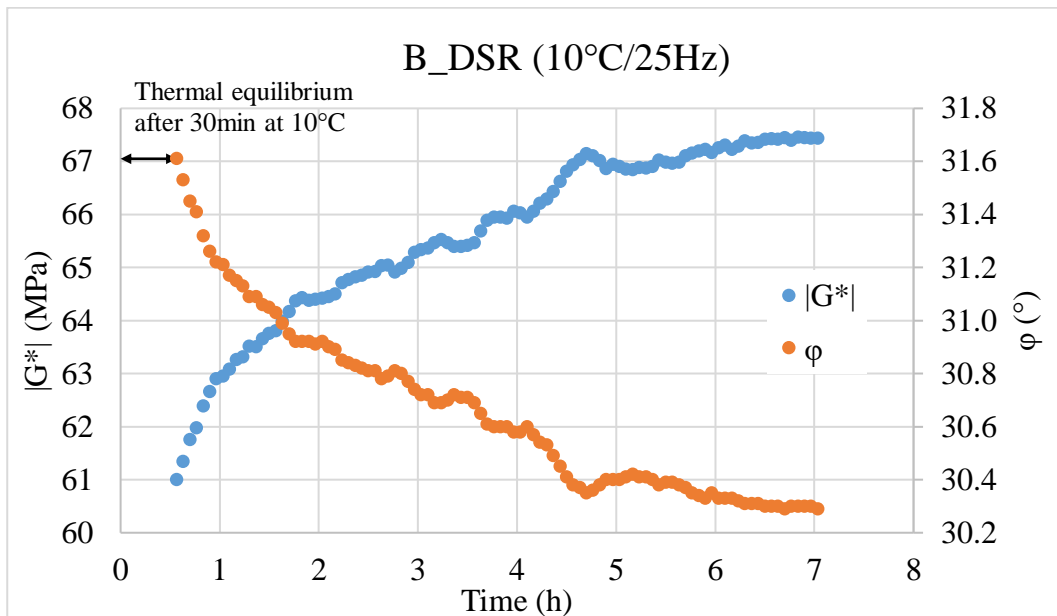
1 Thermomechanical tests on bituminous binders  
 1.3 Steric hardening identification test with DSR at 10 C/25Hz

T = 10°C  
 f = 10Hz

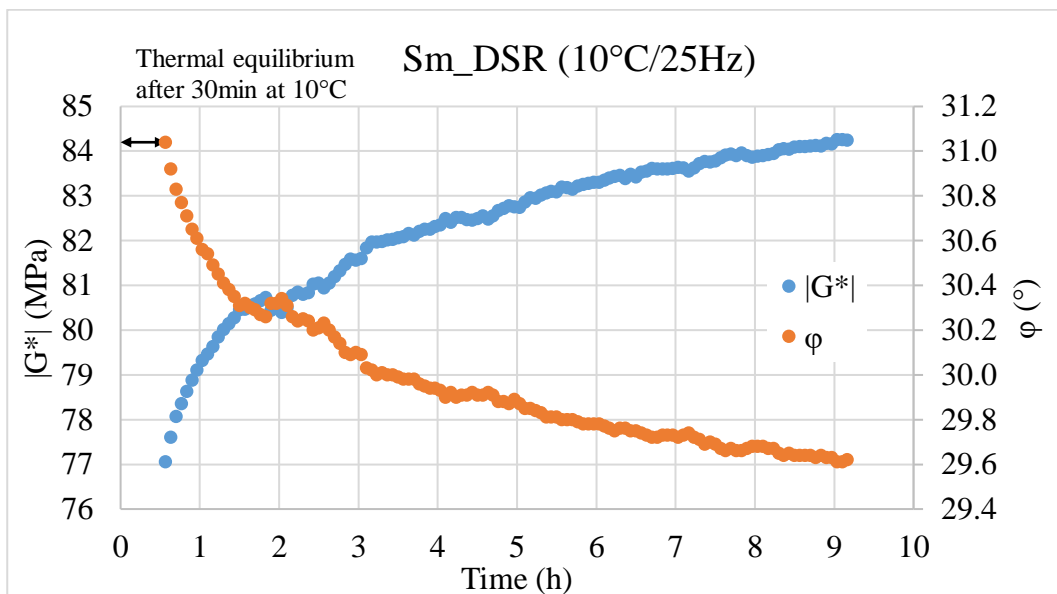
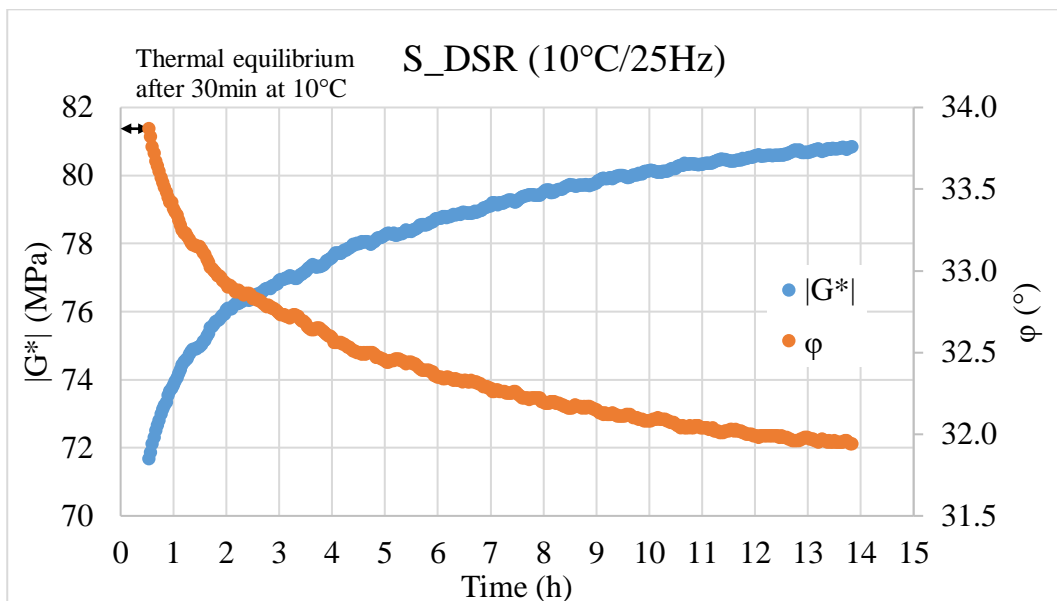
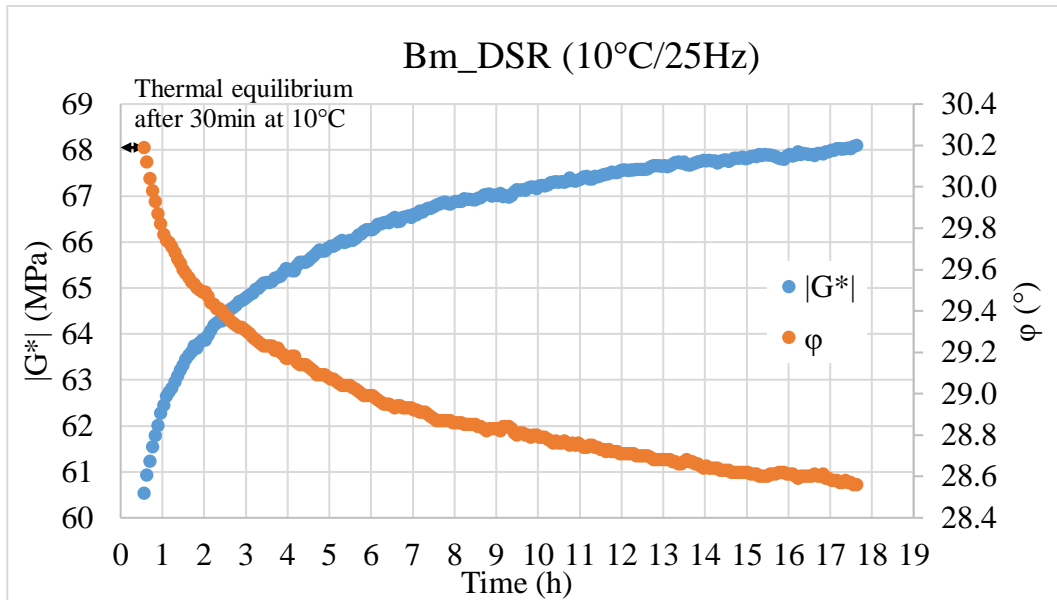
**B\_40%(-)\_ASR\_sp4**



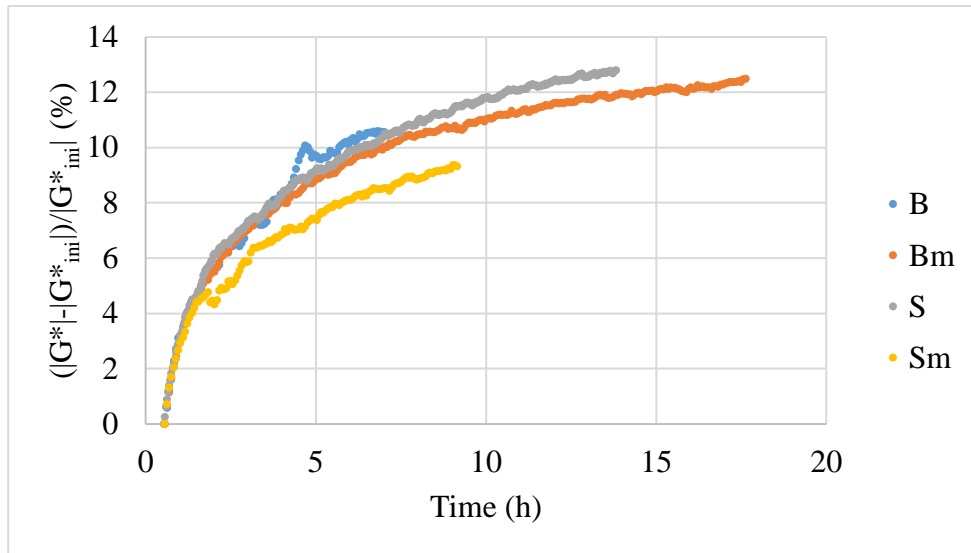
1.3. Steric hardening identification test with DSR at 10°C/25Hz



1 Thermomechanical tests on bituminous binders  
 1.3 Steric hardening identification test with DSR at 10 C/25Hz



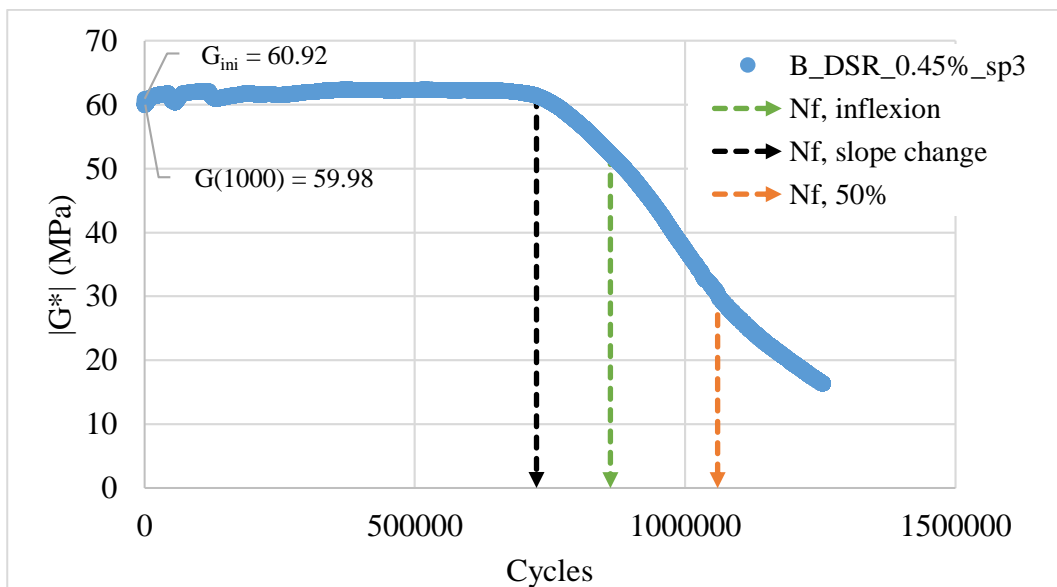
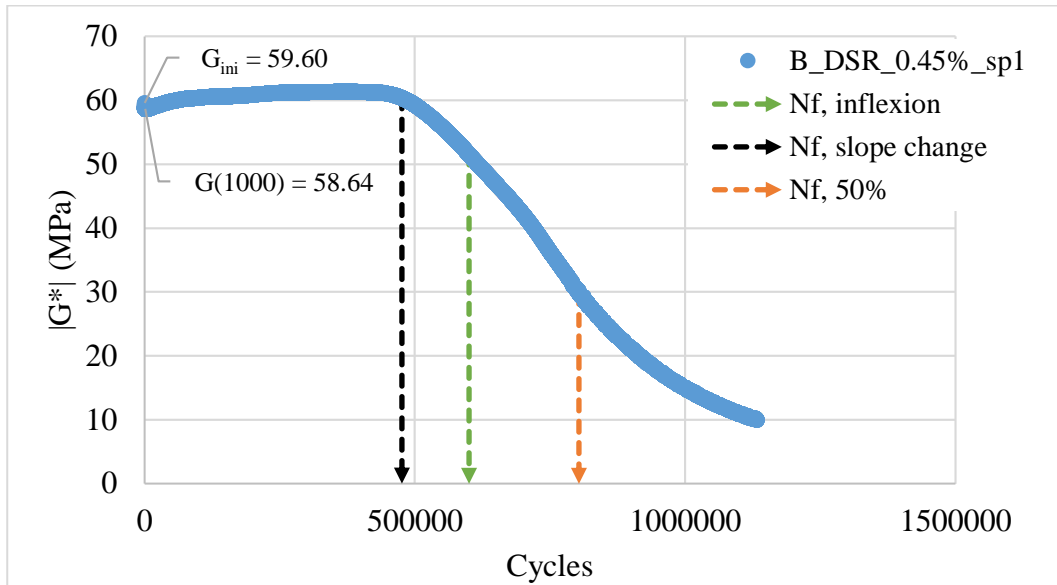
1 Thermomechanical tests on bituminous binders  
1.3 Steric hardening identification test with DSR at 10 C/25Hz



1 Thermomechanical tests on bituminous binders  
1.4 Continuous fatigue test with DSR at 10 C/25Hz

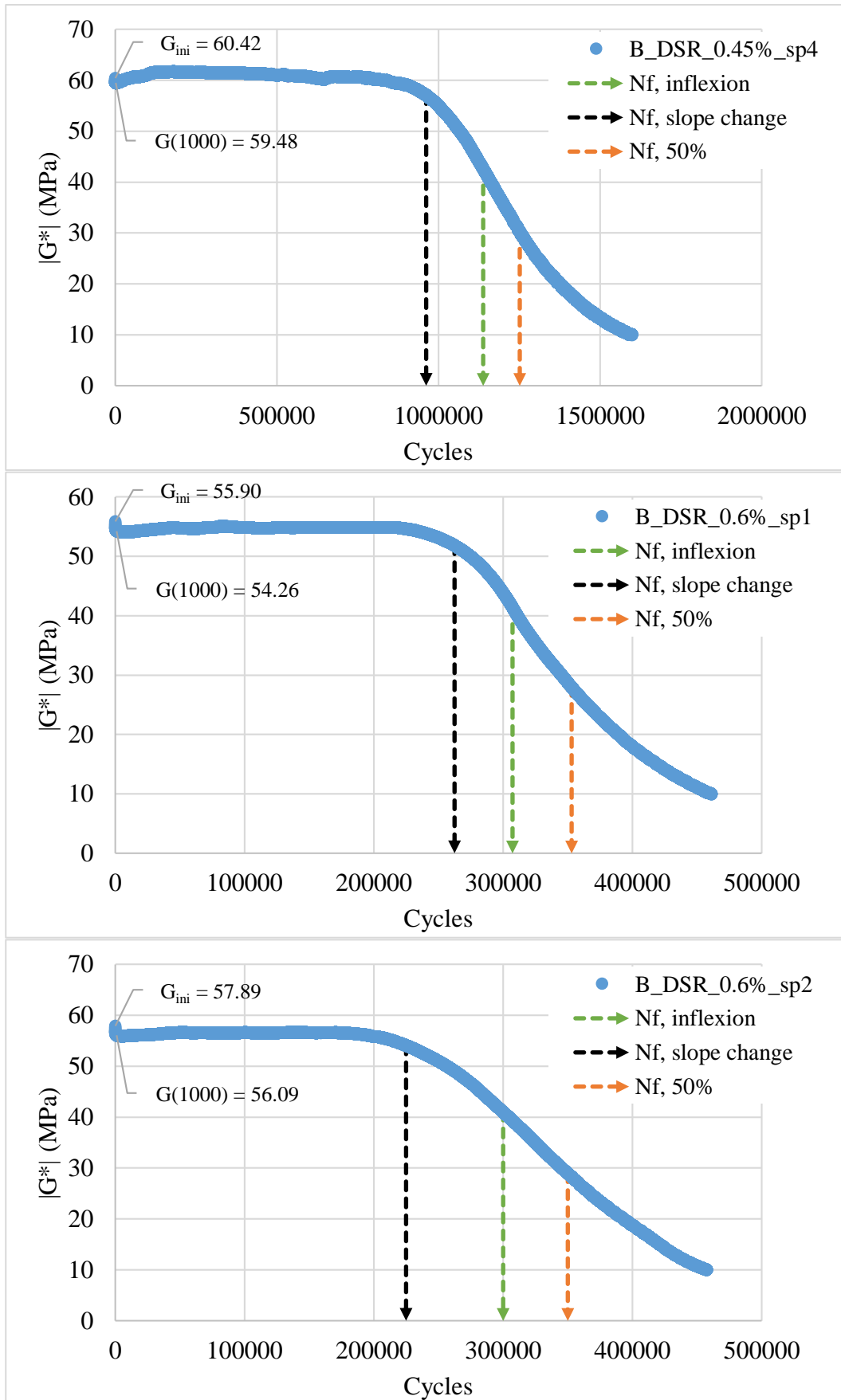
1.4. Continuous fatigue test with DSR at 10°C/25Hz

1.4.1.B\_DSR



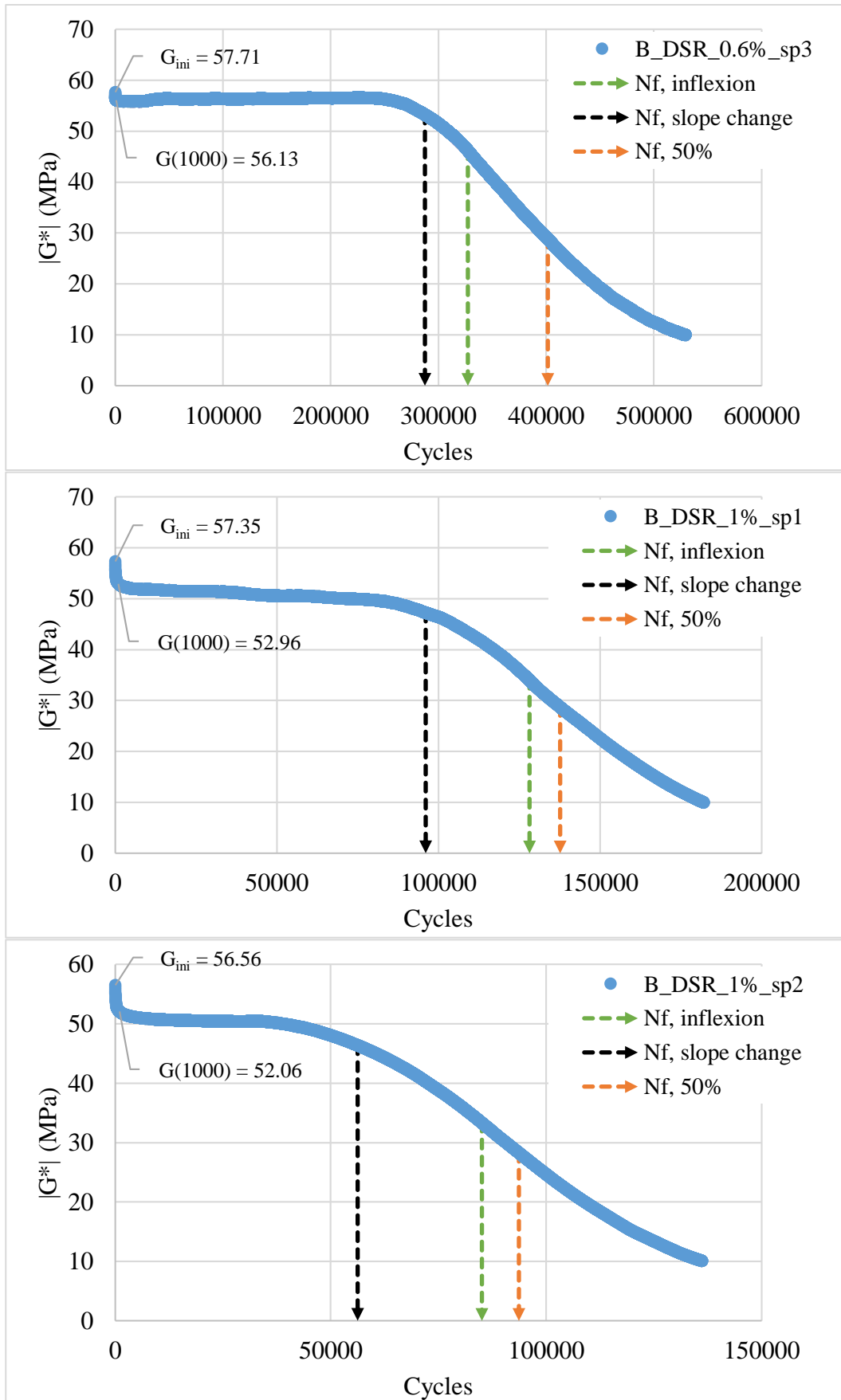
# 1 Thermomechanical tests on bituminous binders

## 1.4 Continuous fatigue test with DSR at 10 C/25Hz

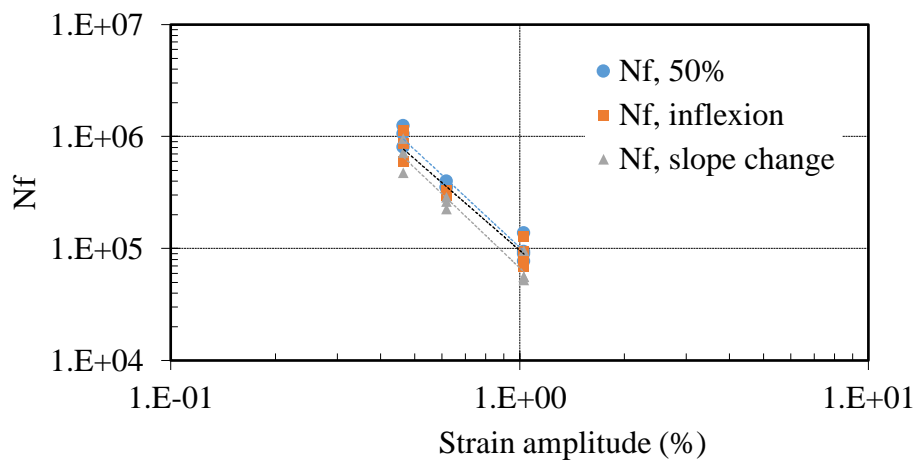
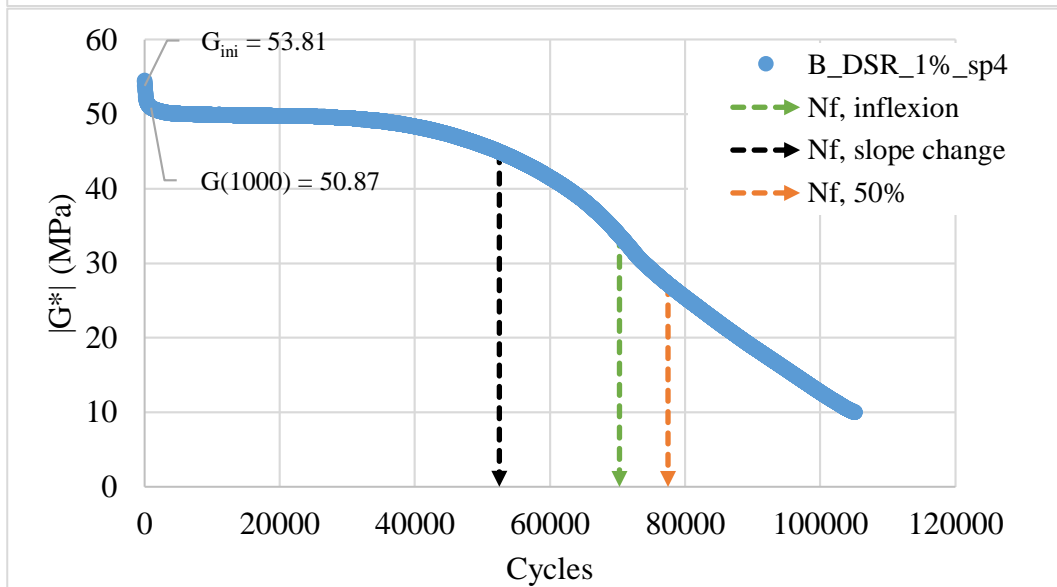
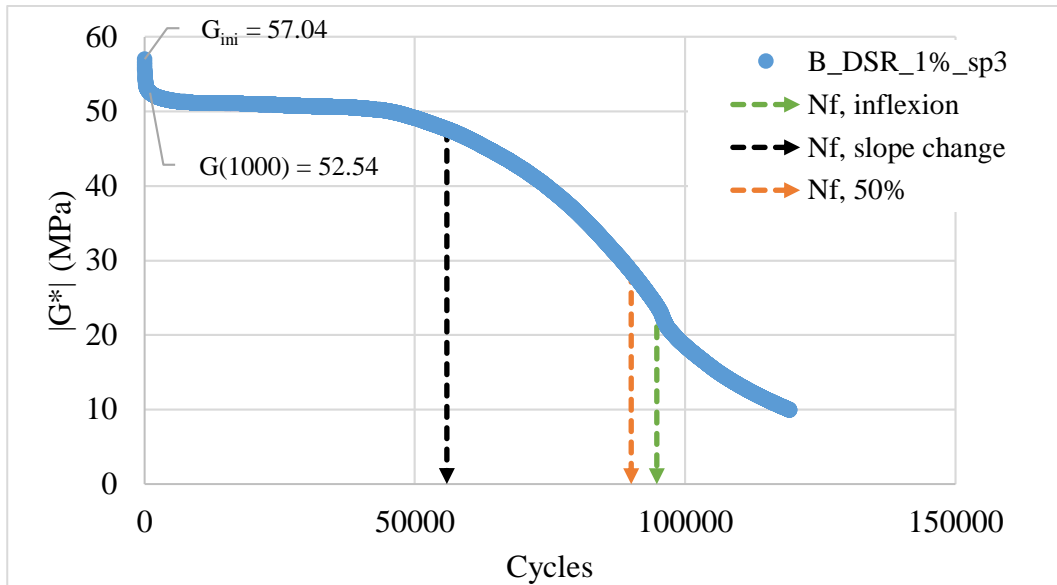


# 1 Thermomechanical tests on bituminous binders

## 1.4 Continuous fatigue test with DSR at 10 C/25Hz

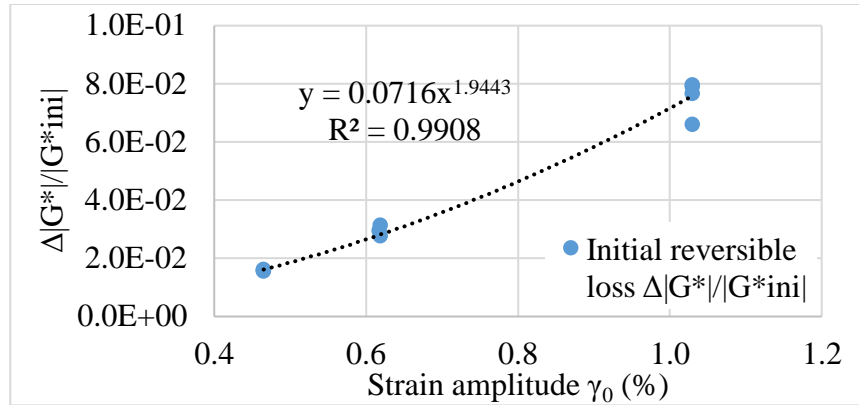


1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz





1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz



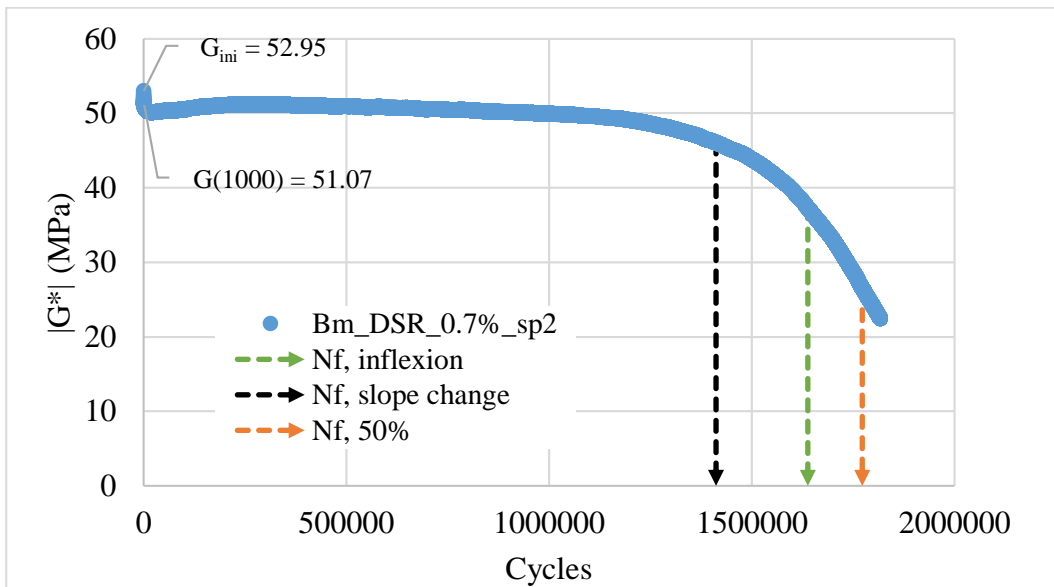
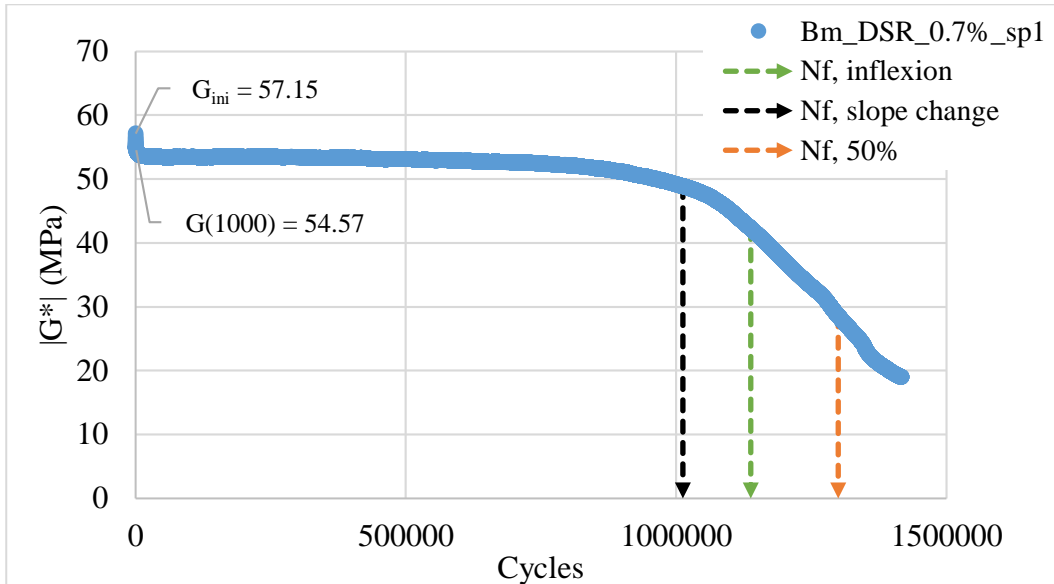
	$\gamma_0$ (%)	$ G^*_{ini} $ (MPa)	$N_{f, 50\%}$	$N_{f, inflexion}$	$N_{f, slope change}$	Initial reversible loss $\Delta G^* / G^*_{ini} $
B_DSR_0.45%_sp1	0.465	59.60	803563	600000	476000	1.61E-02
B_DSR_0.45%_sp3	0.465	60.92	1060213	862000	725000	1.55E-02
B_DSR_0.45%_sp4	0.465	60.42	1252163	1138000	962000	1.56E-02
B_DSR_0.6%_sp1	0.618	55.90	353063	307347	262450	2.94E-02
B_DSR_0.6%_sp2	0.619	57.89	350088	299950	224950	3.12E-02
B_DSR_0.6%_sp3	0.619	57.71	401463	327412	287450	2.75E-02
B_DSR_1%_sp1	1.030	57.35	137700	128122	96050	7.65E-02
B_DSR_1%_sp2	1.030	56.56	93663	85112	56250	7.95E-02
B_DSR_1%_sp3	1.030	57.04	90050	94725	55912	7.89E-02
B_DSR_1%_sp4	1.030	54.45	77438	70262	52500	6.58E-02

$$\text{Log}(Nf) = a + \frac{\text{Log}(\gamma)}{b}$$

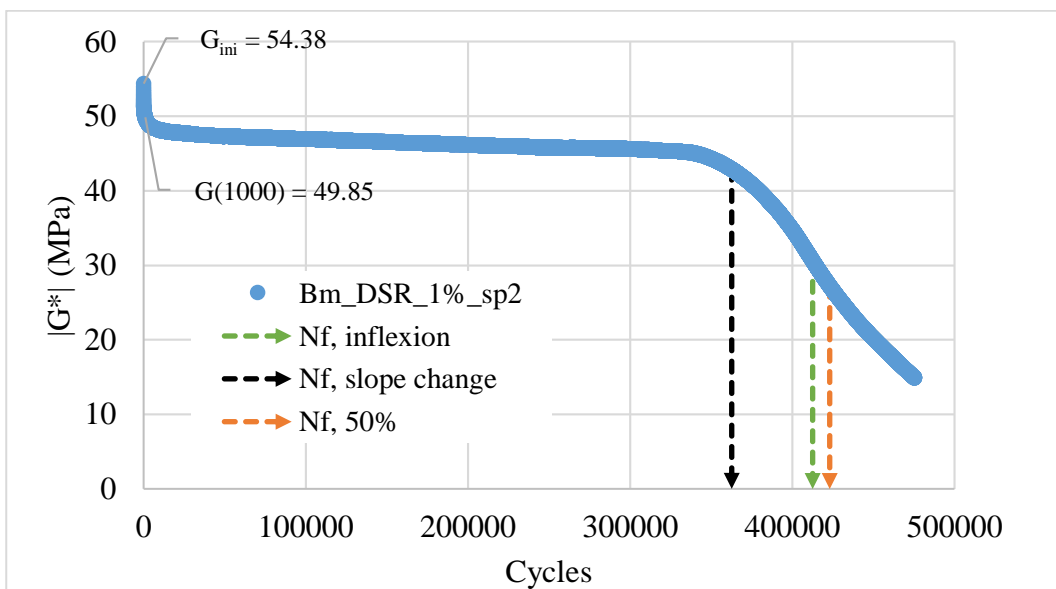
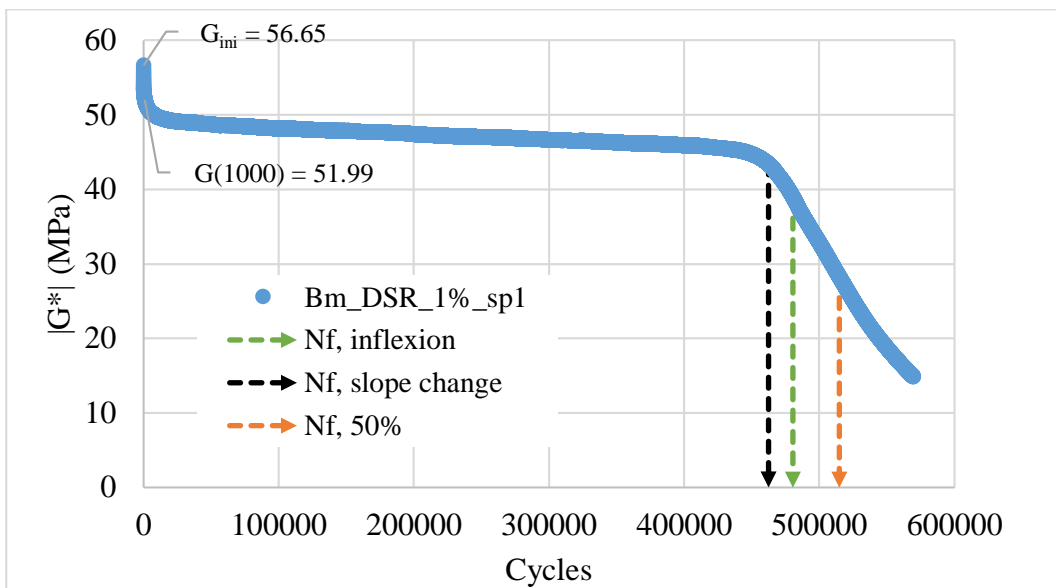
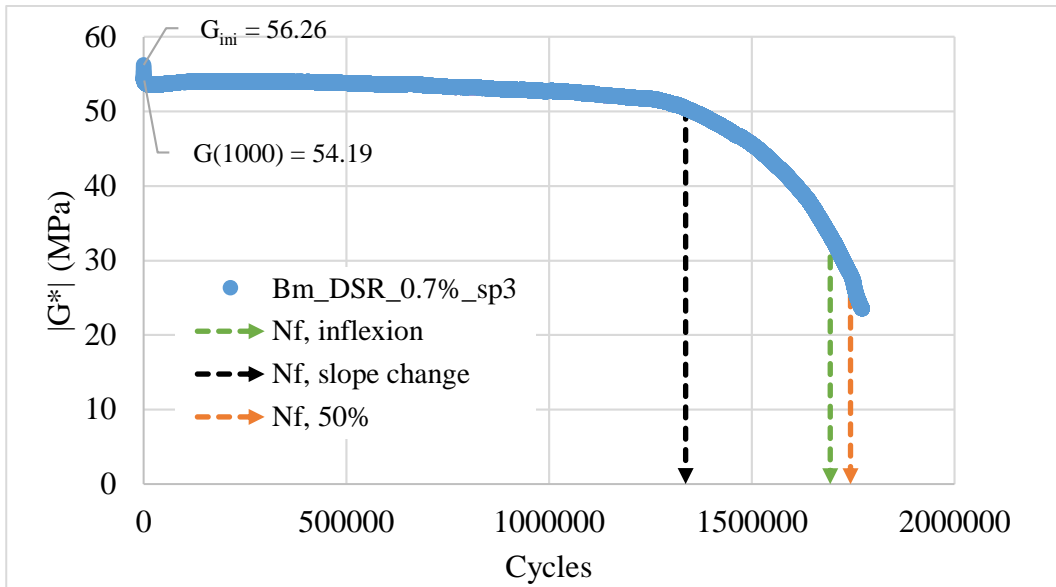
	$N_{f, 50\%}$	$N_{f, inflexion}$	$N_{f, slope change}$
<b>1/b</b>	<b>-2.90</b>	<b>-2.71</b>	<b>-2.97</b>
a	5.01	4.98	4.83
$\gamma_6$ (%)	<b>0.456</b>	<b>0.422</b>	<b>0.403</b>

1 Thermomechanical tests on bituminous binders  
1.4 Continuous fatigue test with DSR at 10 C/25Hz

1.4.2.Bm\_DSR

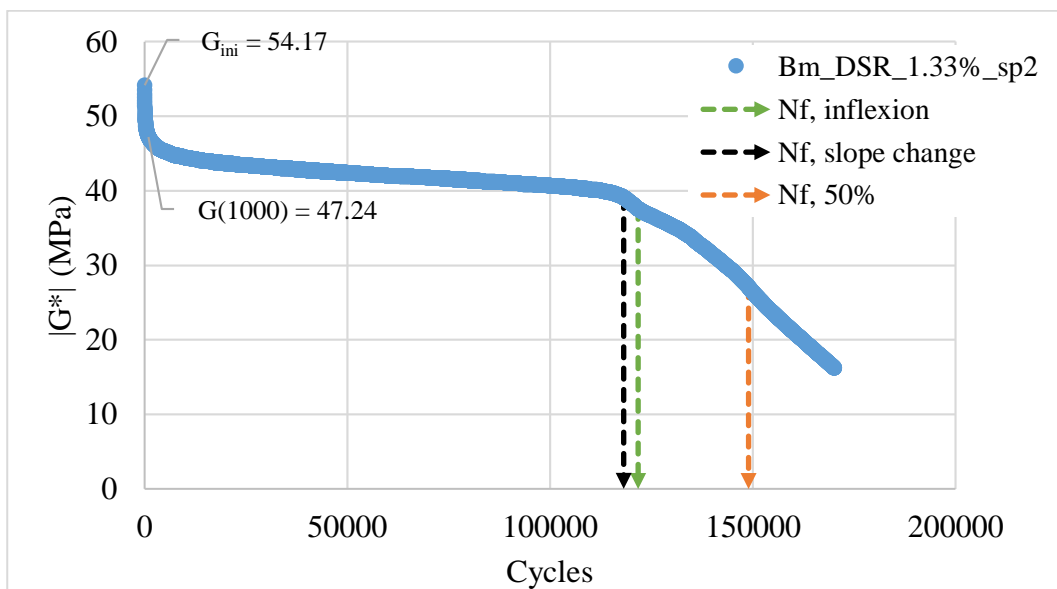
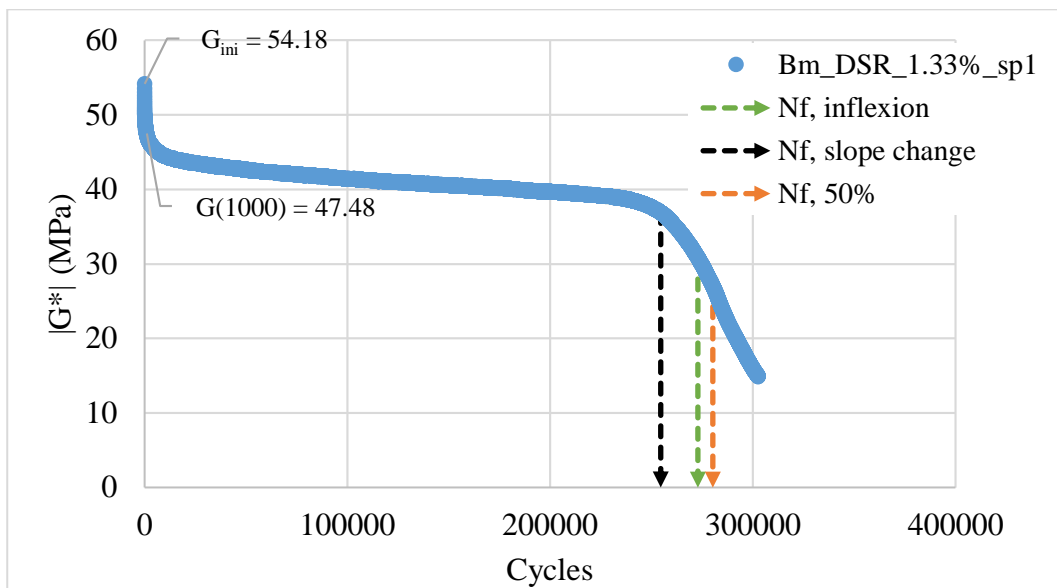
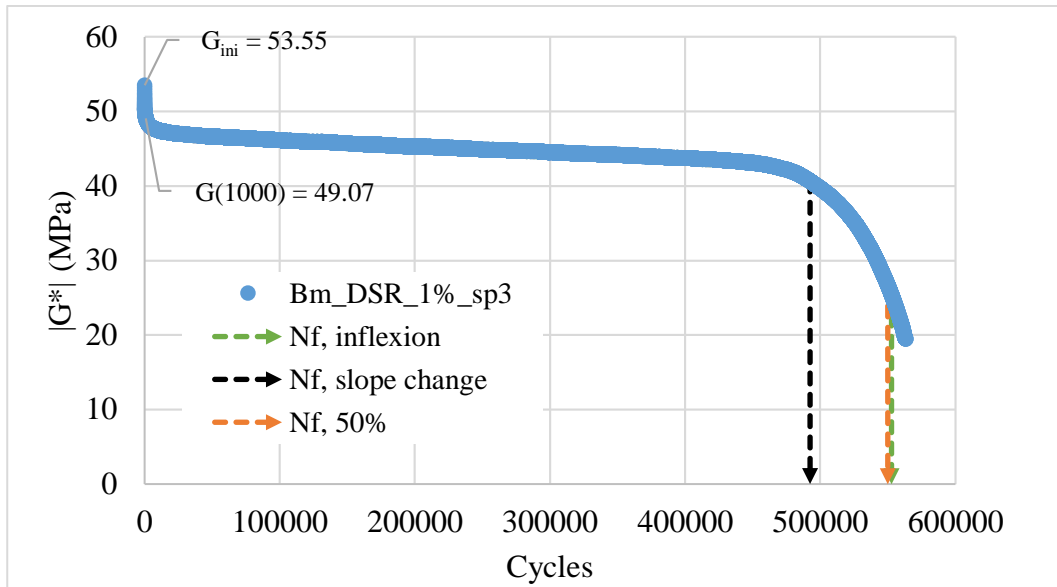


1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz

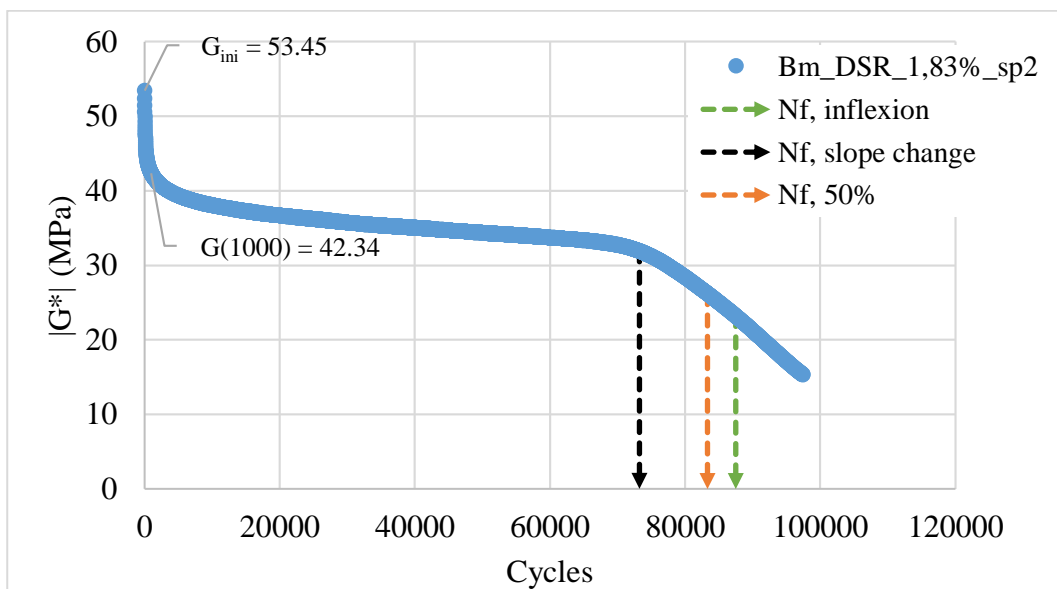
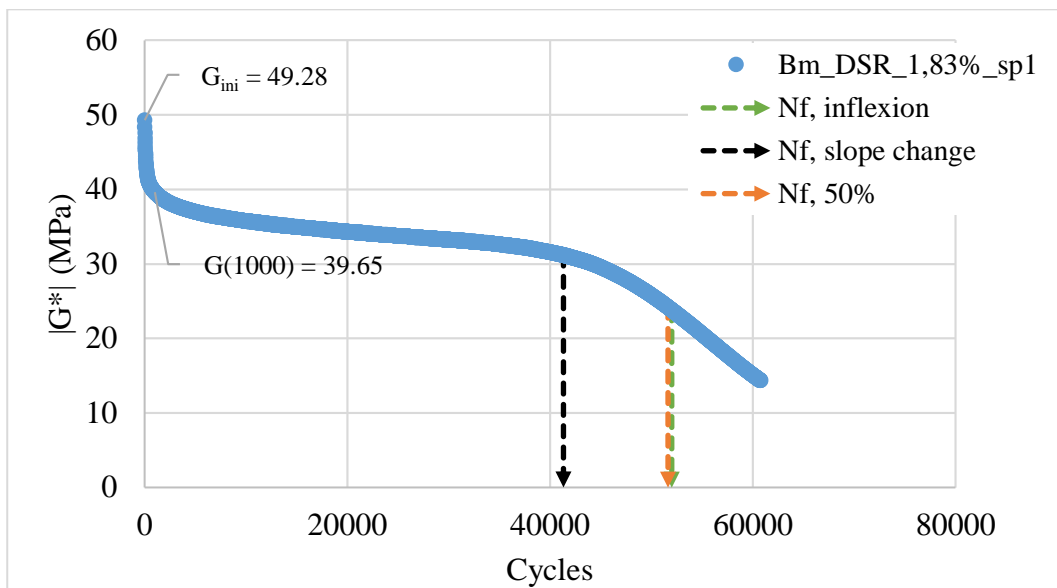
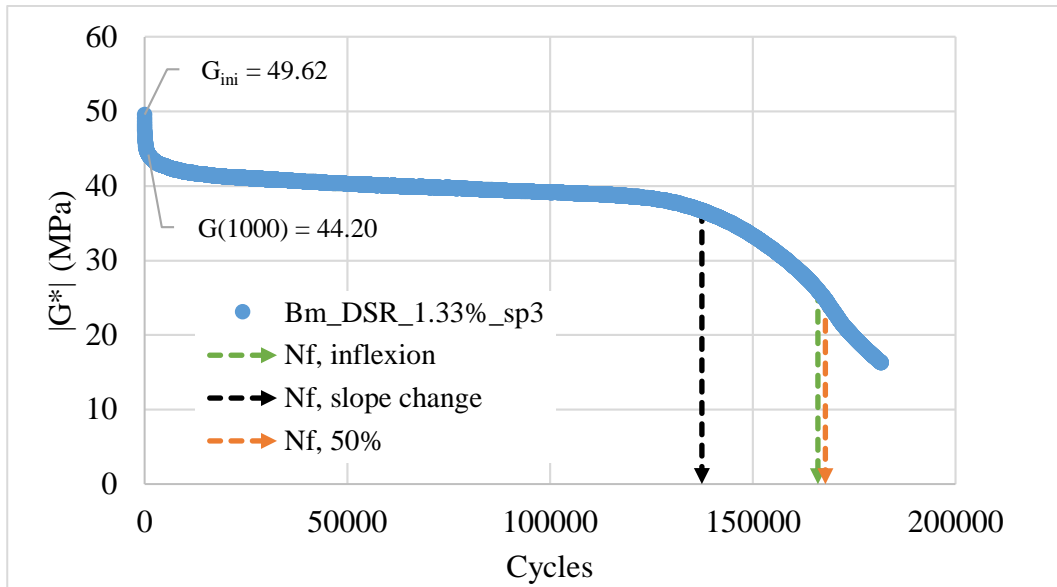


# 1 Thermomechanical tests on bituminous binders

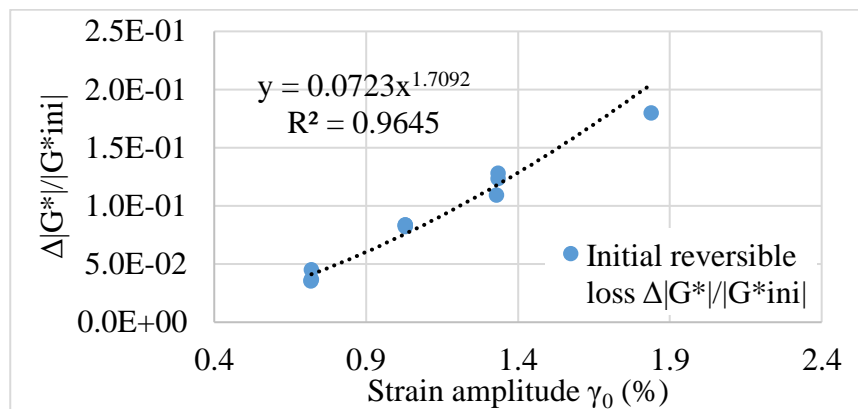
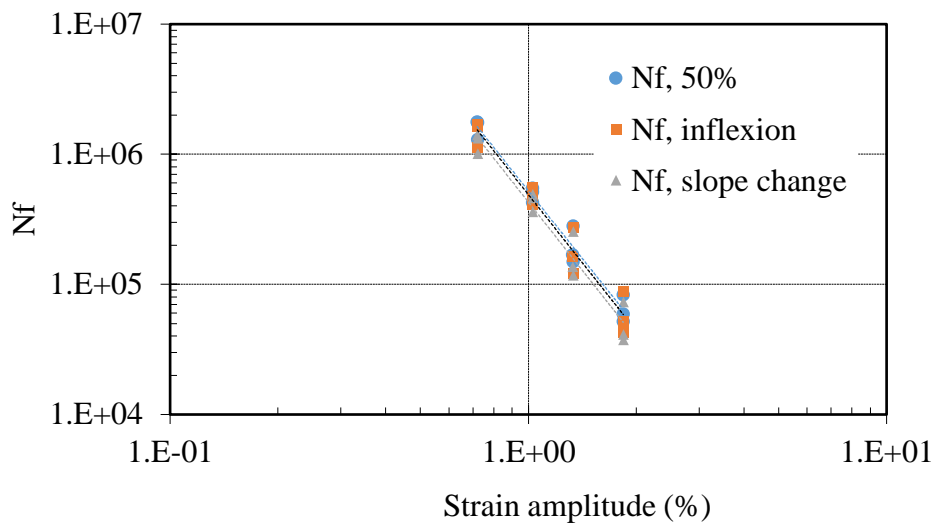
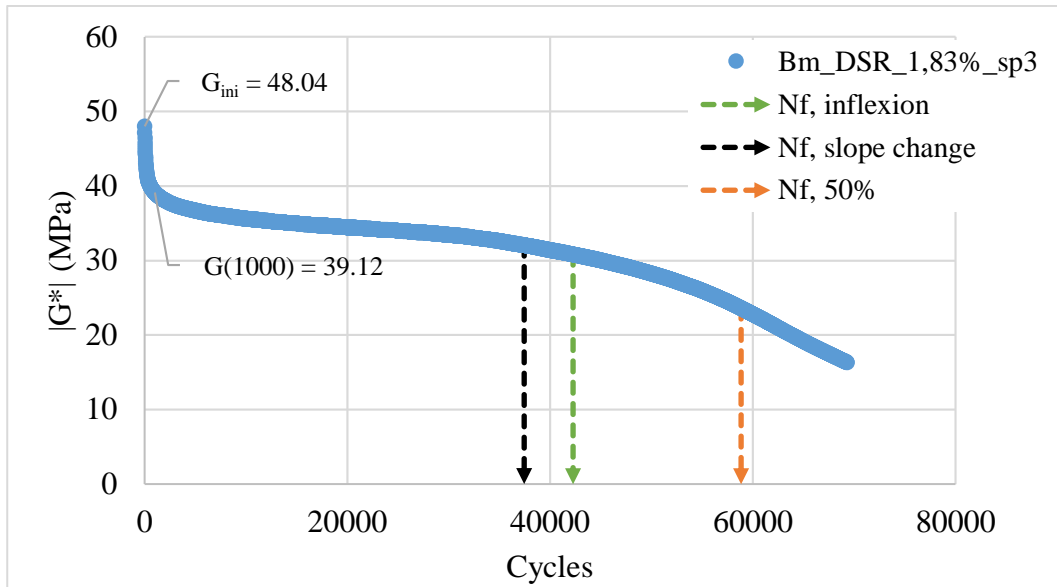
## 1.4 Continuous fatigue test with DSR at 10 C/25Hz



1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz



1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz



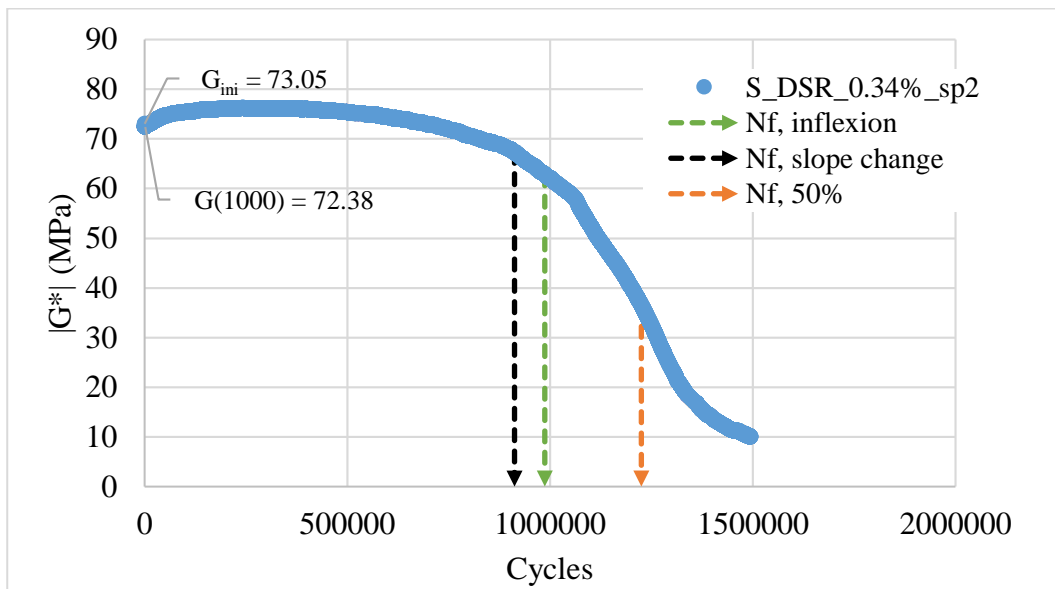
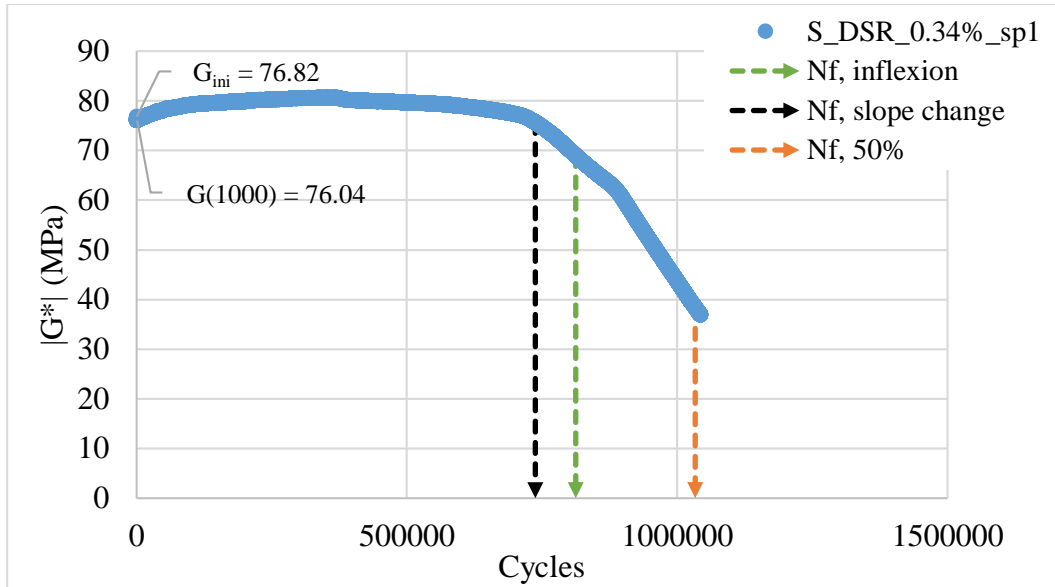
1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz

	$\gamma_0$ (%)	$ G^*_{ini} $ (MPa)	$N_{f, 50\%}$	$N_{f, inflexion}$	$N_{f, slope\ change}$	Initial reversible loss $\Delta G^* / G^*_{ini} $
Bm_DSR_0.7%_sp1	0.722	57.15	1299563	1138000	1012462	4.52E-02
Bm_DSR_0.7%_sp2	0.720	52.95	1772688	1638000	1412000	3.54E-02
Bm_DSR_0.7%_sp3	0.722	56.26	1744063	1694000	1337000	3.69E-02
Bm_DSR_1%_sp1	1.030	56.65	514688	480587	462462	8.23E-02
Bm_DSR_1%_sp2	1.030	54.38	423213	412462	362662	8.33E-02
Bm_DSR_1%_sp3	1.030	53.55	549813	552612	492437	8.37E-02
Bm_DSR_1.33%_sp1	1.335	54.18	280238	273000	254612	1.24E-01
Bm_DSR_1.33%_sp2	1.335	54.17	148963	121687	118172	1.28E-01
Bm_DSR_1.33%_sp3	1.330	49.62	167888	166112	137462	1.09E-01
Bm_DSR_1.83%_sp1	1.840	48.35	51663	52000	41325	1.80E-01
Bm_DSR_1.83%_sp2	1.842	52.34	83338	87462	73237	19.11%
Bm_DSR_1.83%_sp3	1.840	47.17	58875	42275	37450	17.05%

	$N_{f, 50\%}$	$N_{f, inflexion}$	$N_{f, slope\ change}$
$Log(Nf) = a + \frac{Log(\gamma)}{b}$			
<b>1/b</b>	<b>-3.46</b>	<b>-3.48</b>	<b>-3.49</b>
a	5.72	5.69	5.63
<b><math>\gamma_6</math> (%)</b>	<b>0.830</b>	<b>0.815</b>	<b>0.785</b>

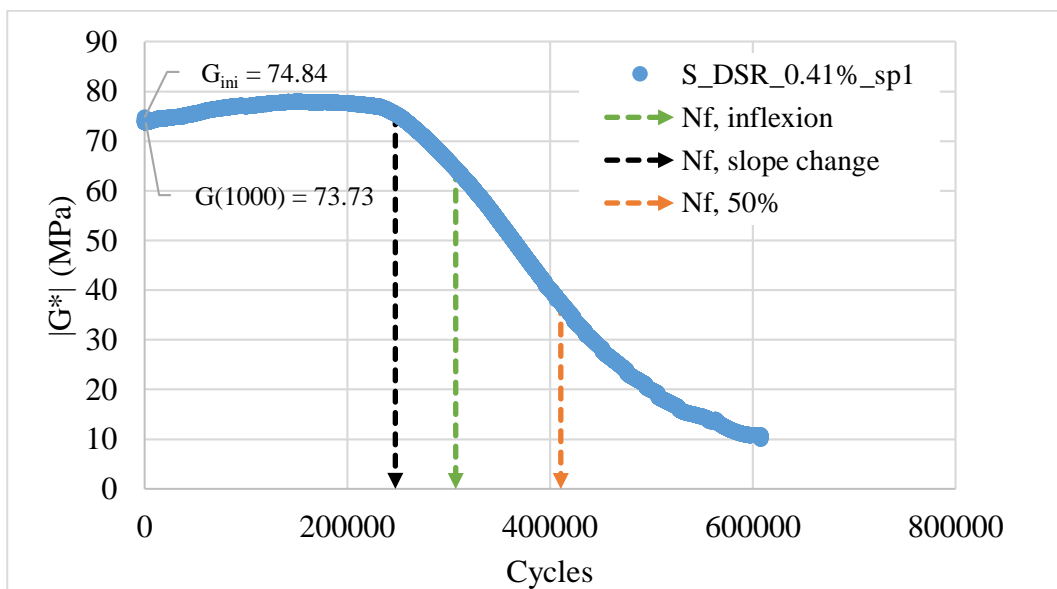
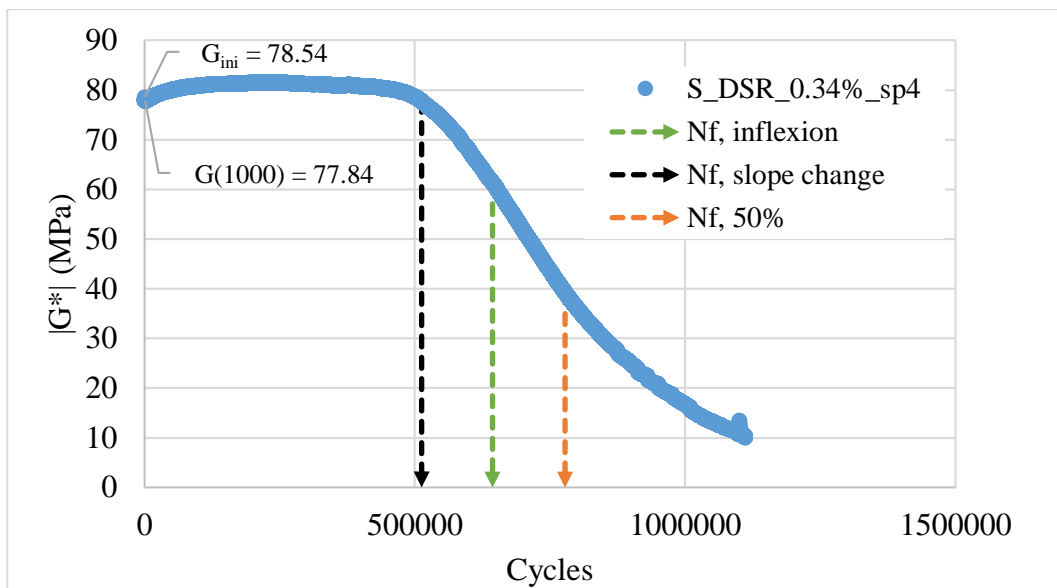
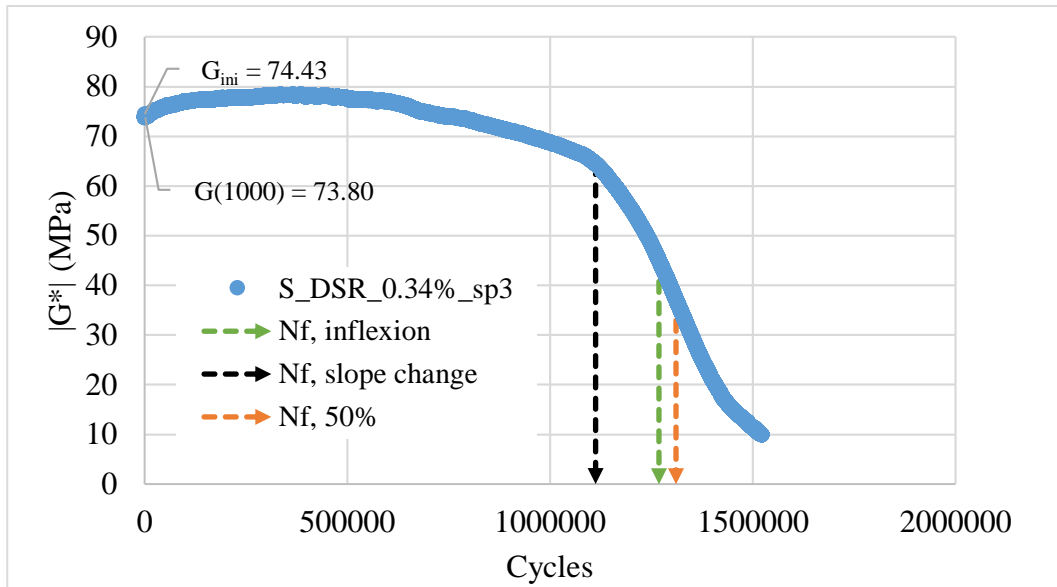
1 Thermomechanical tests on bituminous binders  
1.4 Continuous fatigue test with DSR at 10 C/25Hz

1.4.3.S\_DSR

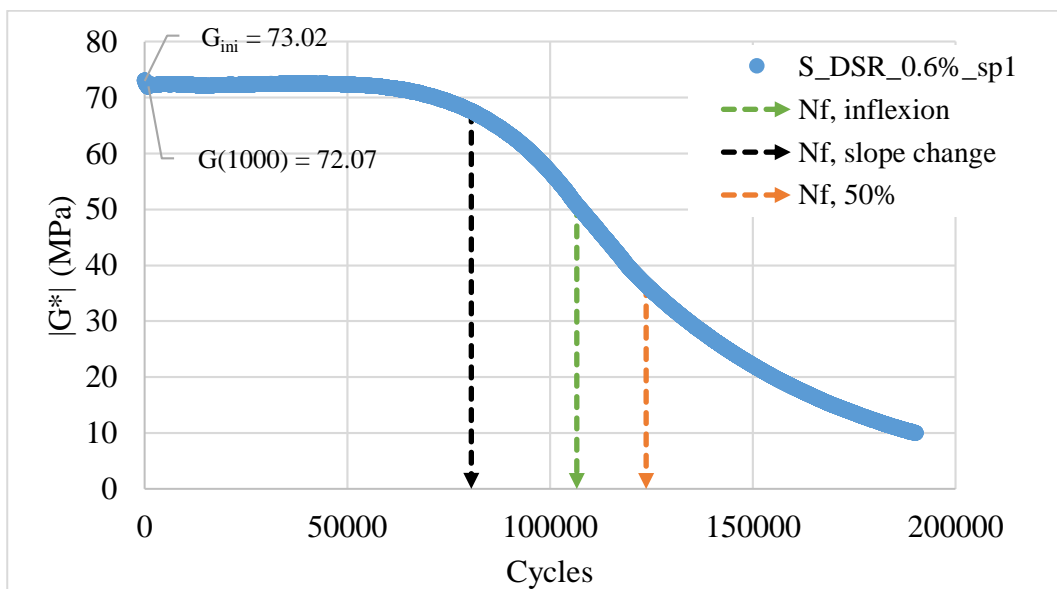
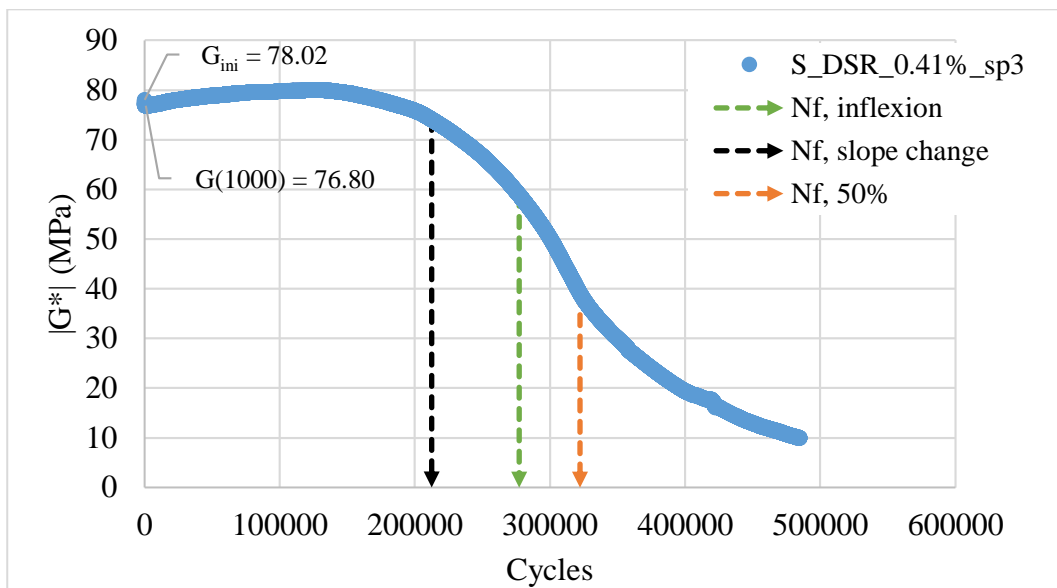
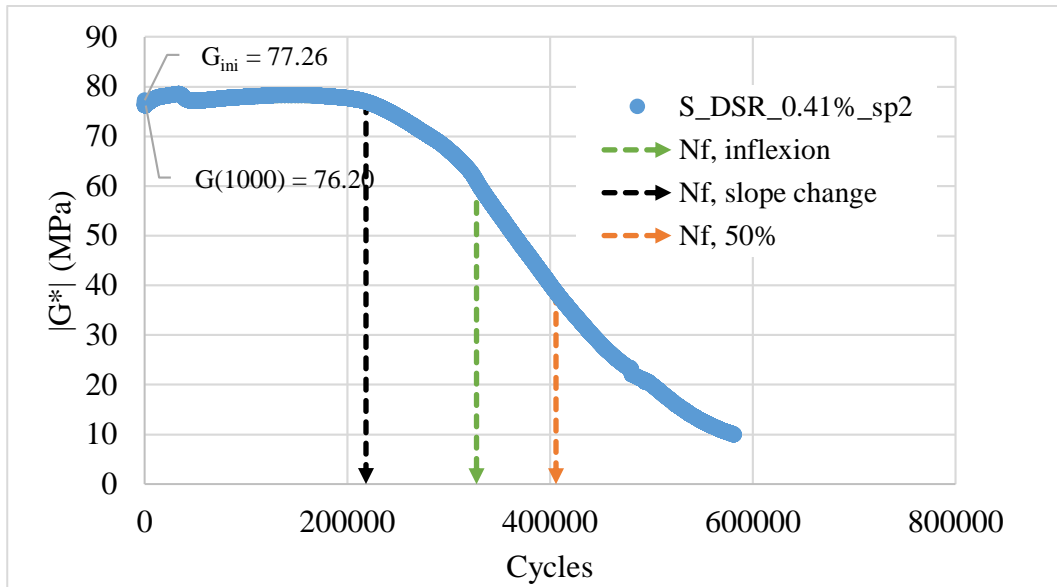




1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz

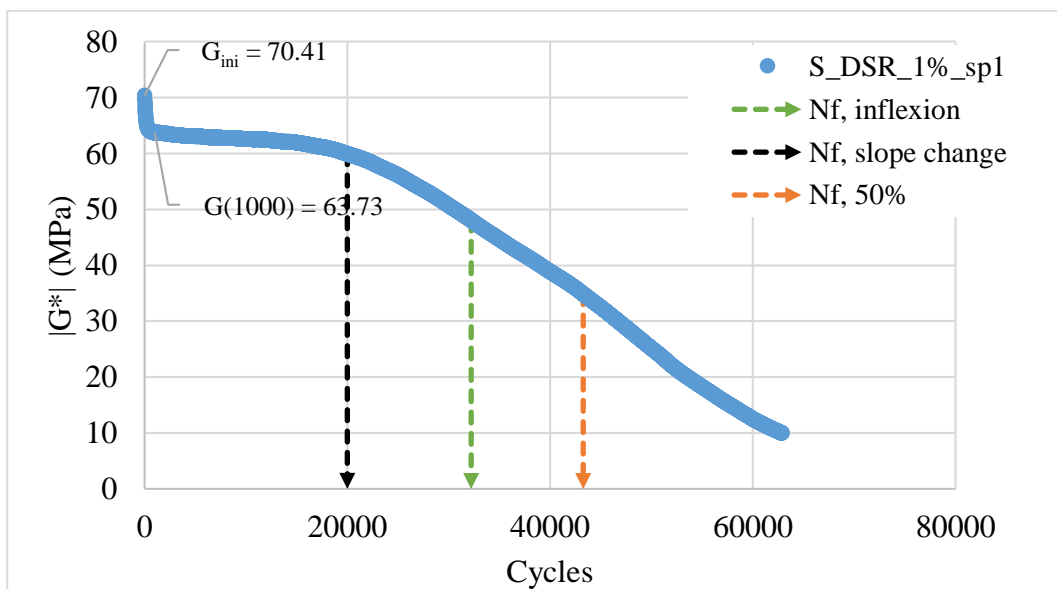
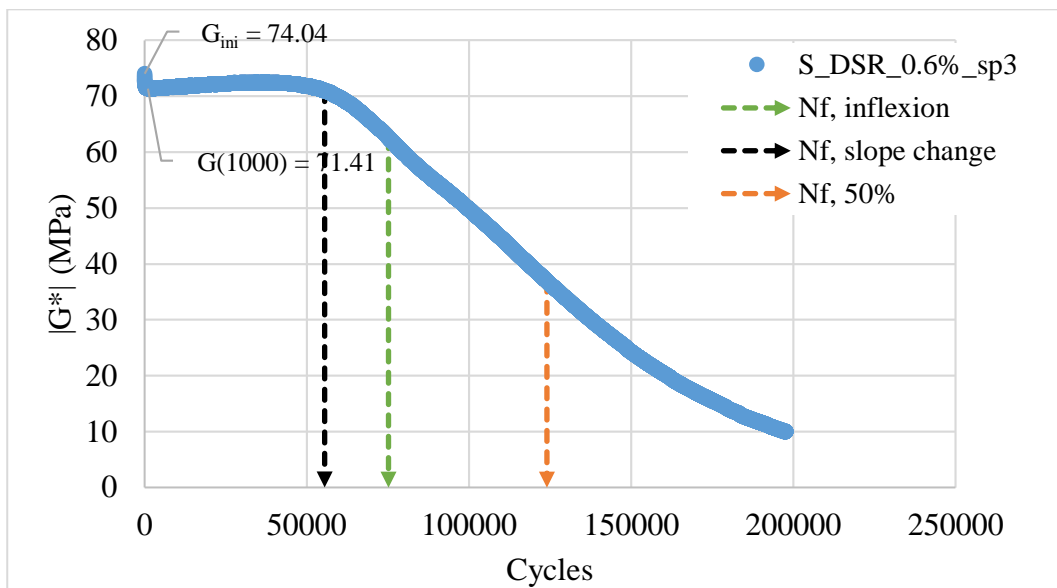
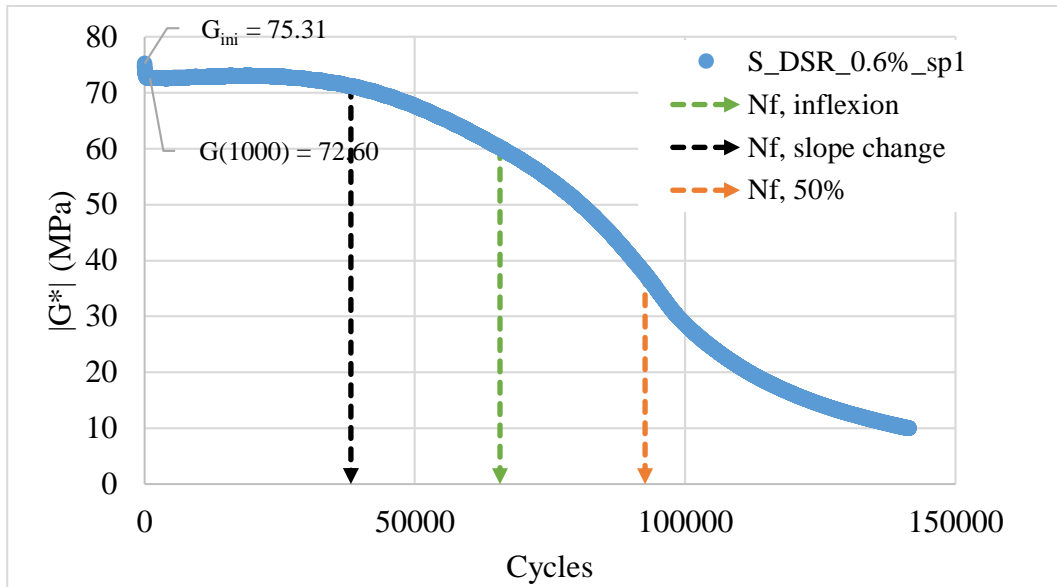


1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz



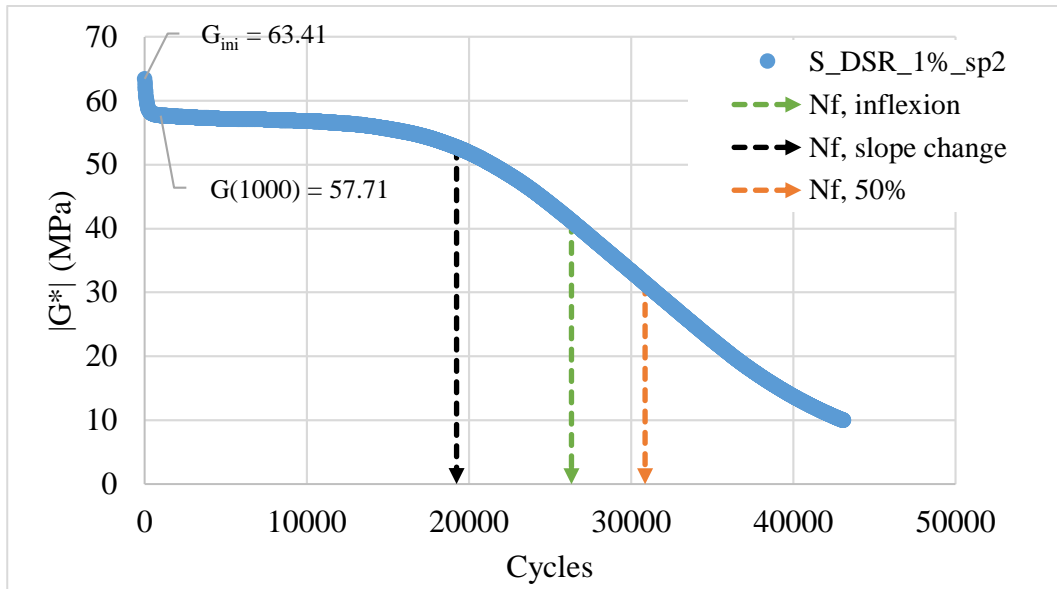
# 1 Thermomechanical tests on bituminous binders

## 1.4 Continuous fatigue test with DSR at 10 C/25Hz

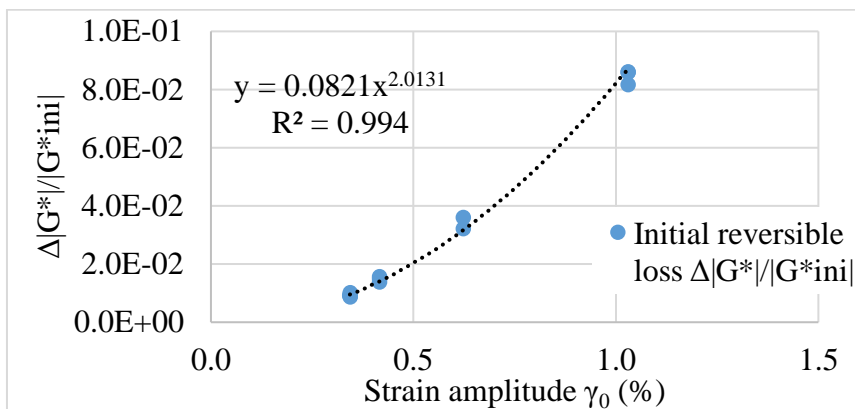
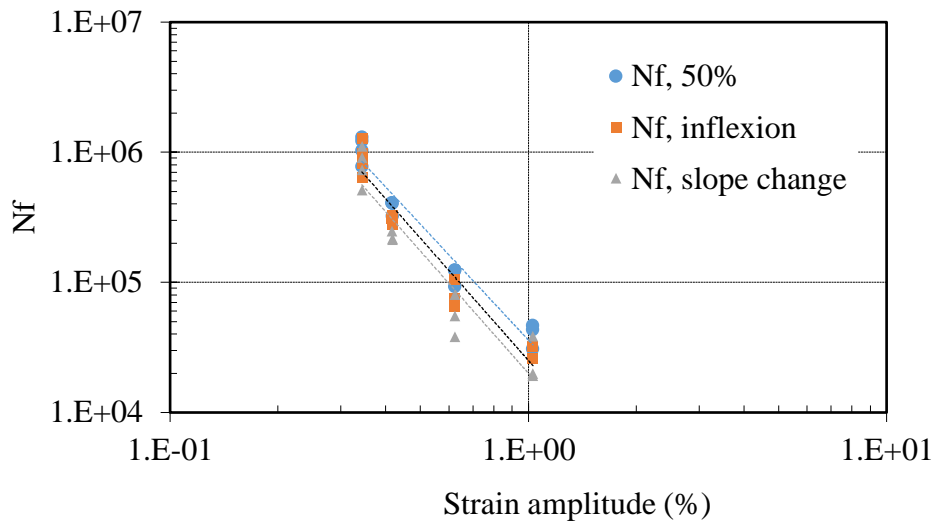
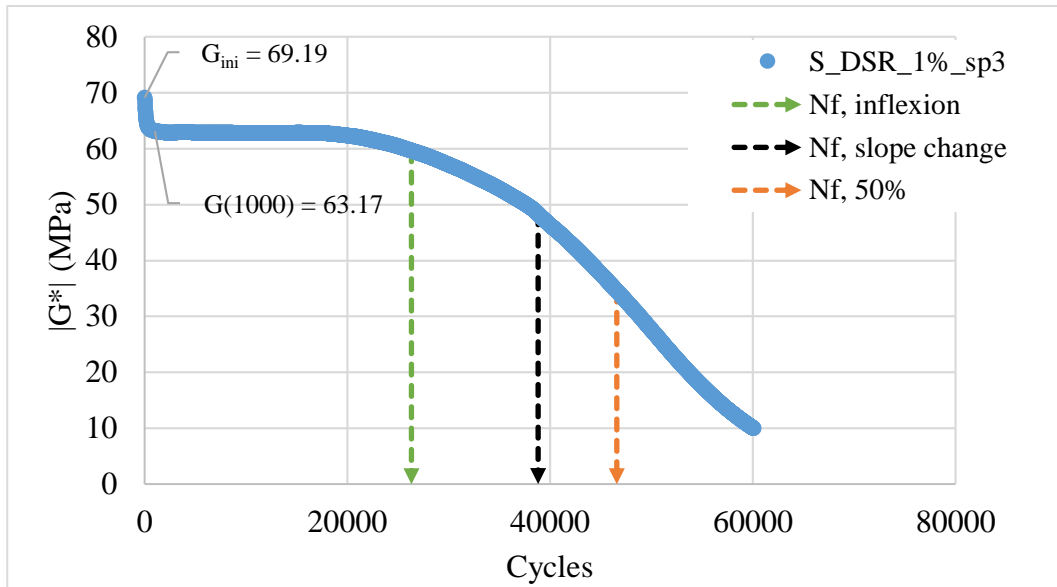


# 1 Thermomechanical tests on bituminous binders

## 1.4 Continuous fatigue test with DSR at 10 C/25Hz



1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz



# 1 Thermomechanical tests on bituminous binders

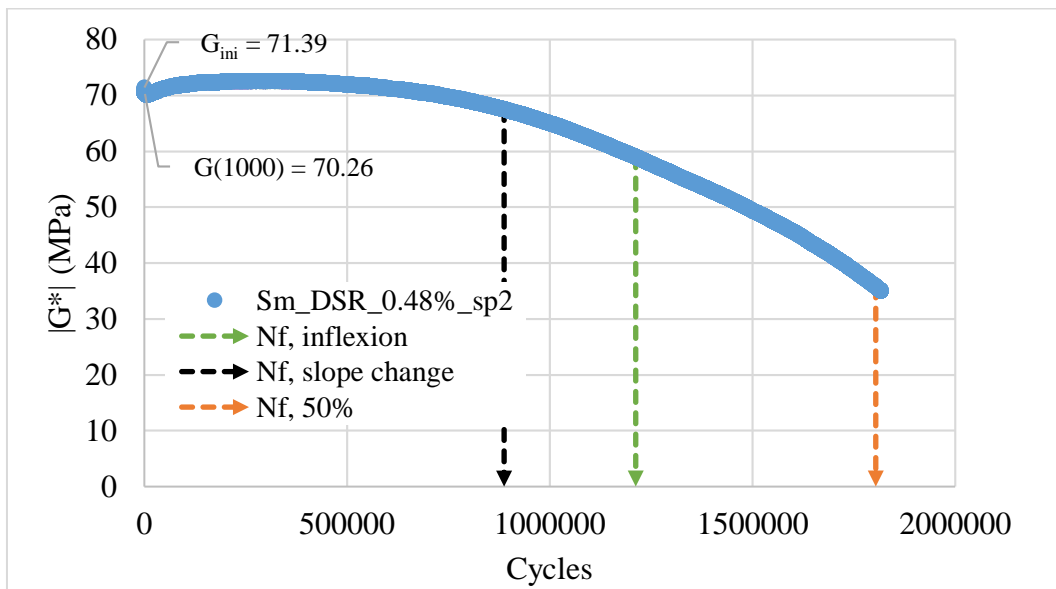
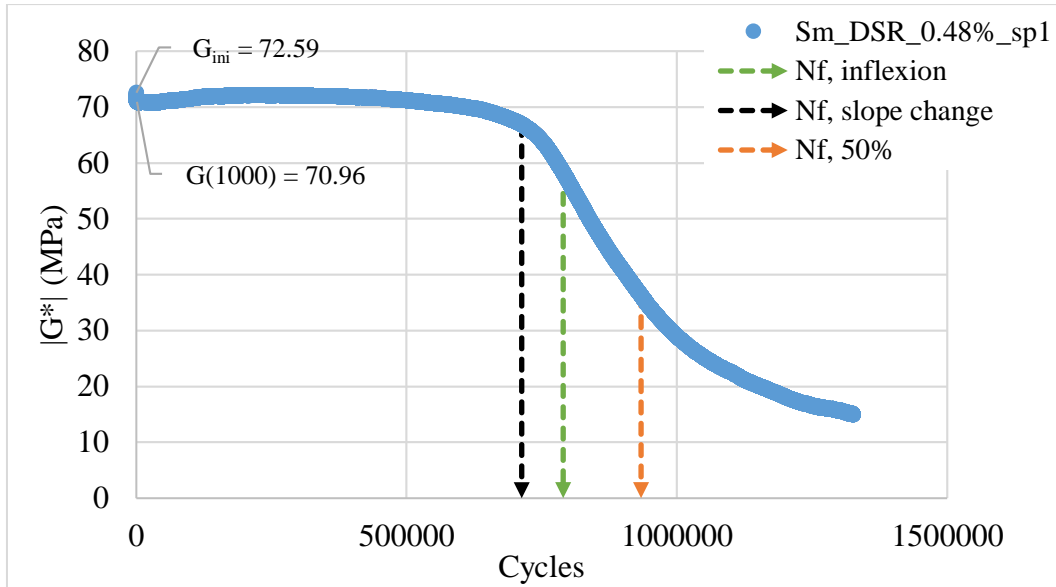
## 1.4 Continuous fatigue test with DSR at 10 C/25Hz

	$\gamma_0$ (%)	$ G^*_{ini} $ (MPa)	$N_{f, 50\%}$	$N_{f, inflexion}$	$N_{f, slope\ change}$	Initial reversible loss $\Delta G^* / G^*_{ini} $
S_DSR_0.34%_sp1	0.344	76.82	1033138	812642	737637	1.01E-02
S_DSR_0.34%_sp2	0.343	73.05	1225138	987462	912462	9.16E-03
S_DSR_0.34%_sp3	0.344	74.43	1310688	1268563	1112462	8.56E-03
S_DSR_0.34%_sp4	0.344	78.54	777363	643887	512462	8.98E-03
S_DSR_0.41%_sp1	0.417	74.84	410888	307000	247362	1.48E-02
S_DSR_0.41%_sp2	0.417	77.26	405913	327612	218412	1.37E-02
S_DSR_0.41%_sp3	0.417	78.02	322363	277362	212432	1.57E-02
S_DSR_0.6%_sp1	0.624	73.02	123663	106575	80587	
S_DSR_0.6%_sp1	0.624	75.31	92550	65767	38162	3.60E-02
S_DSR_0.6%_sp3	0.624	73.77	124113	75250	55512	3.21E-02
S_DSR_1%_sp1	1.030	69.72	43275	32237	20000	8.59E-02
S_DSR_1%_sp2	1.030	62.84	30863	26327	19237	8.16E-02
S_DSR_1%_sp3	1.030	69.11	46588	26327	38825	8.60E-02

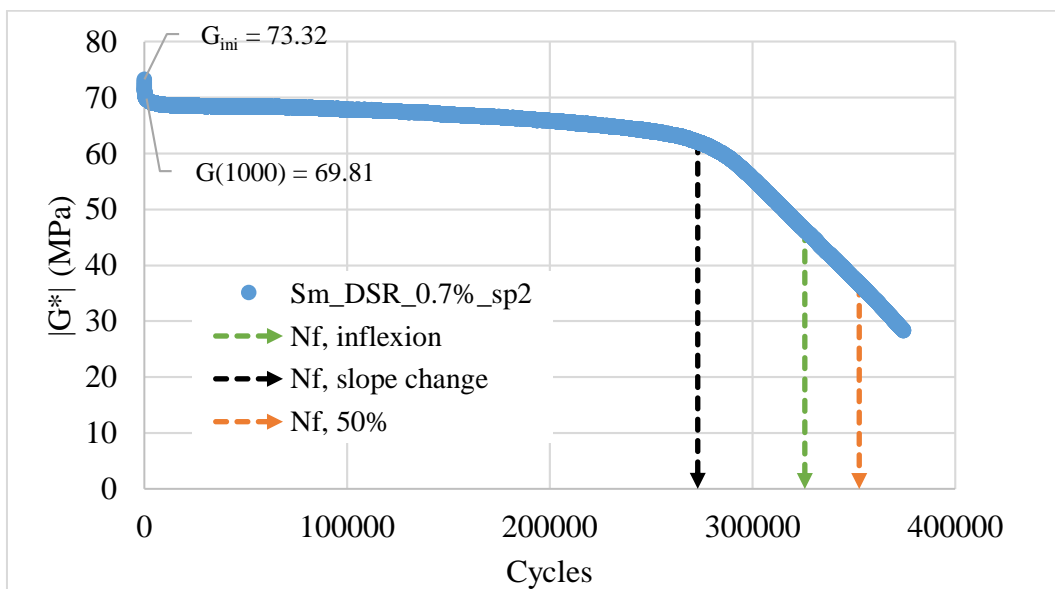
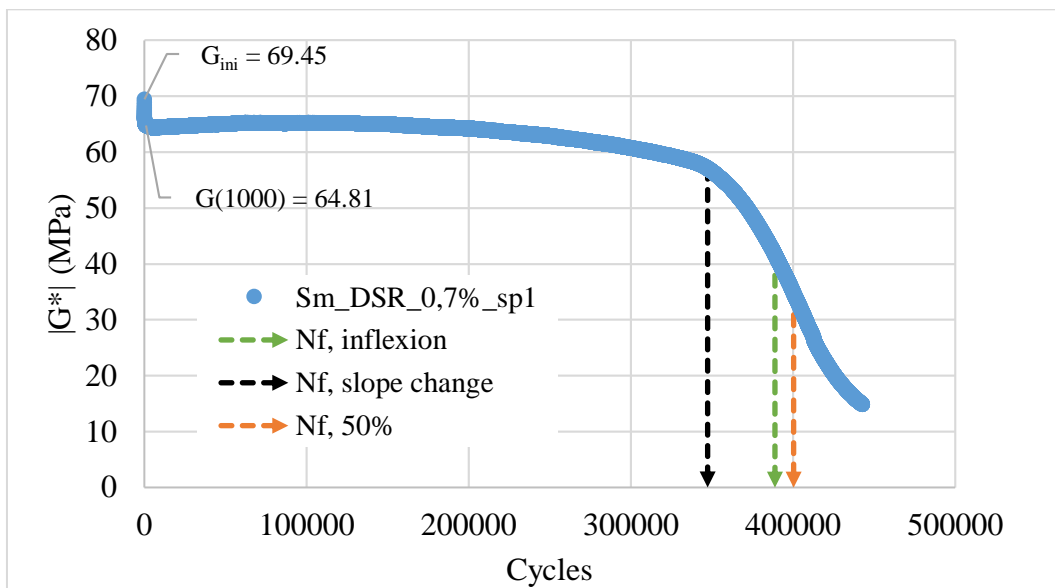
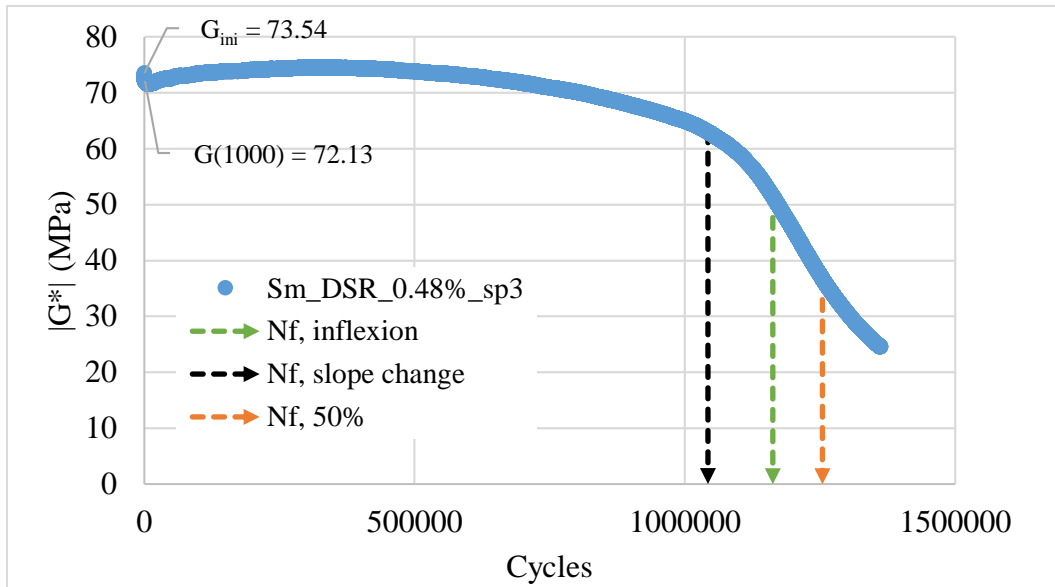
	$N_{f, 50\%}$	$N_{f, inflexion}$	$N_{f, slope\ change}$
$Log(Nf) = a + \frac{Log(\gamma)}{b}$			
<b>1/b</b>	<b>-2.95</b>	<b>-3.12</b>	<b>-3.12</b>
<b>a</b>	<b>4.56</b>	<b>4.40</b>	<b>4.30</b>
<b><math>\gamma_6</math> (%)</b>	<b>0.325</b>	<b>0.307</b>	<b>0.285</b>

1 Thermomechanical tests on bituminous binders  
1.4 Continuous fatigue test with DSR at 10 C/25Hz

1.4.4.Sm\_DSR

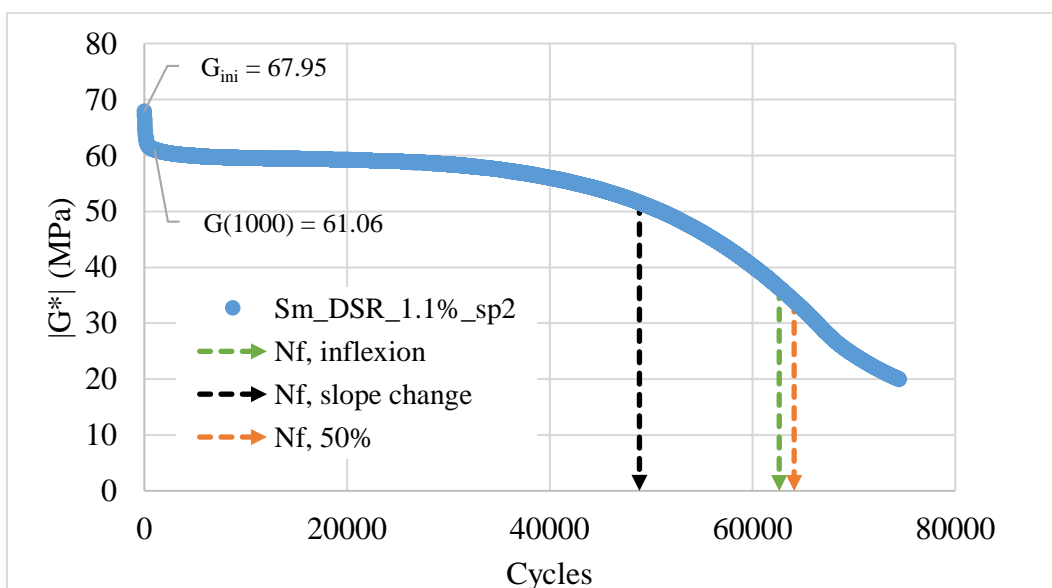
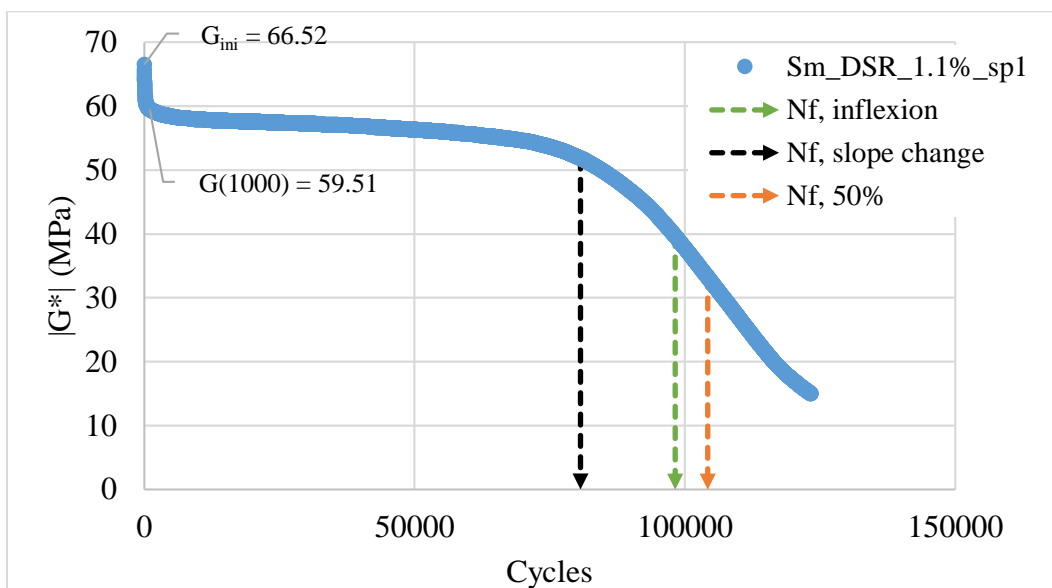
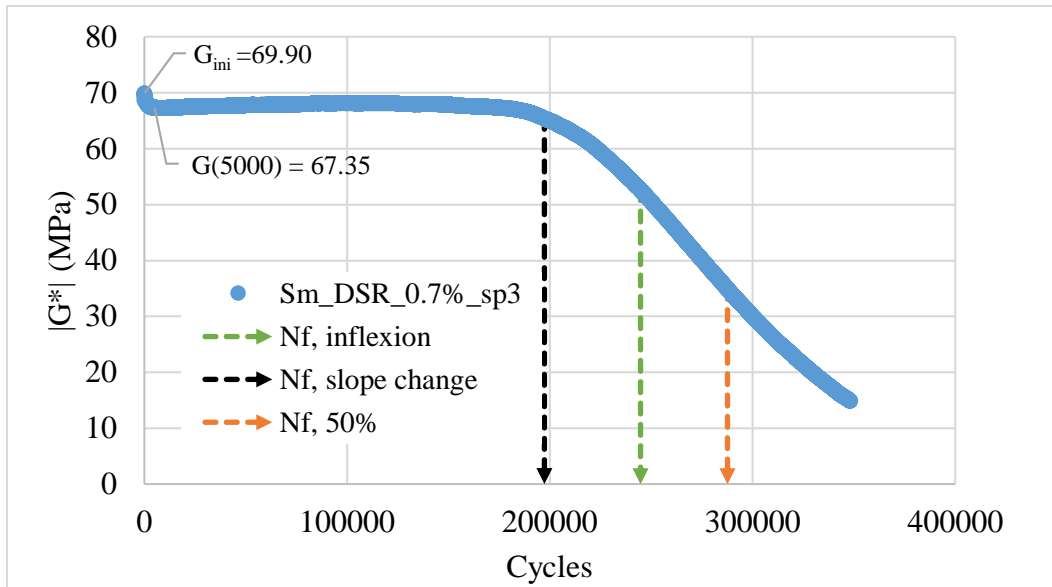


1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz

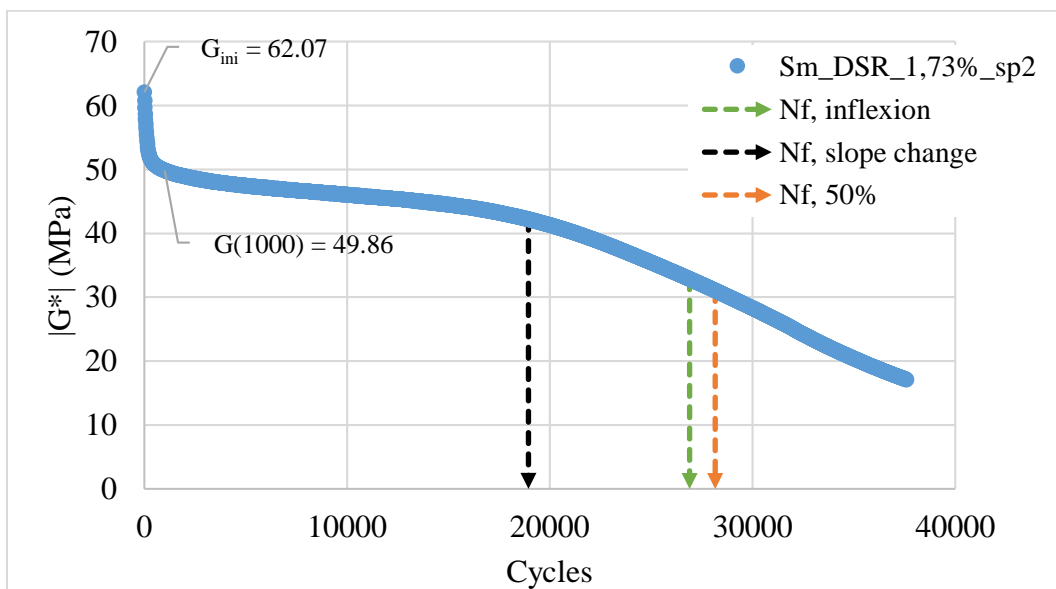
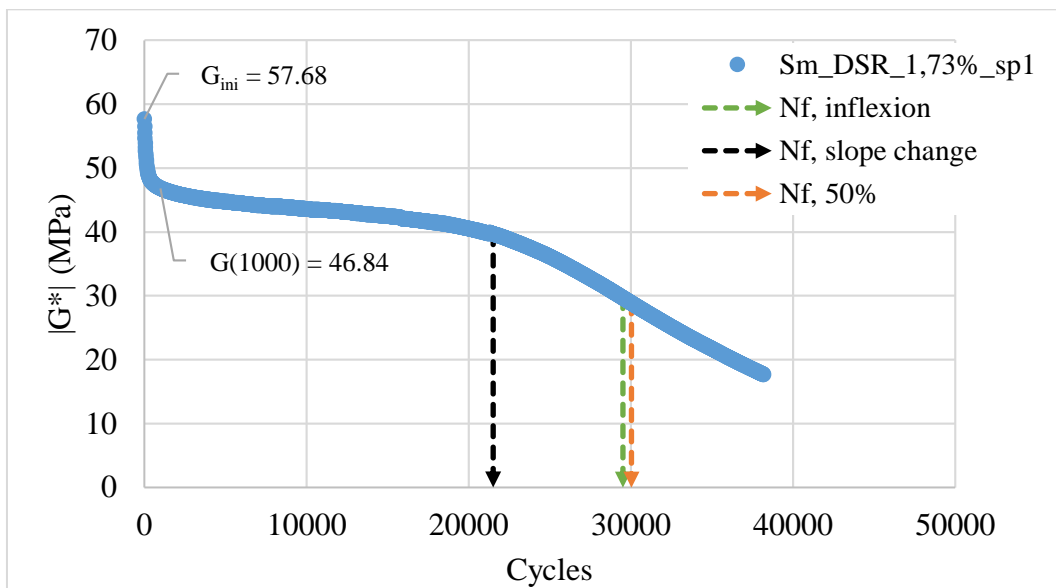
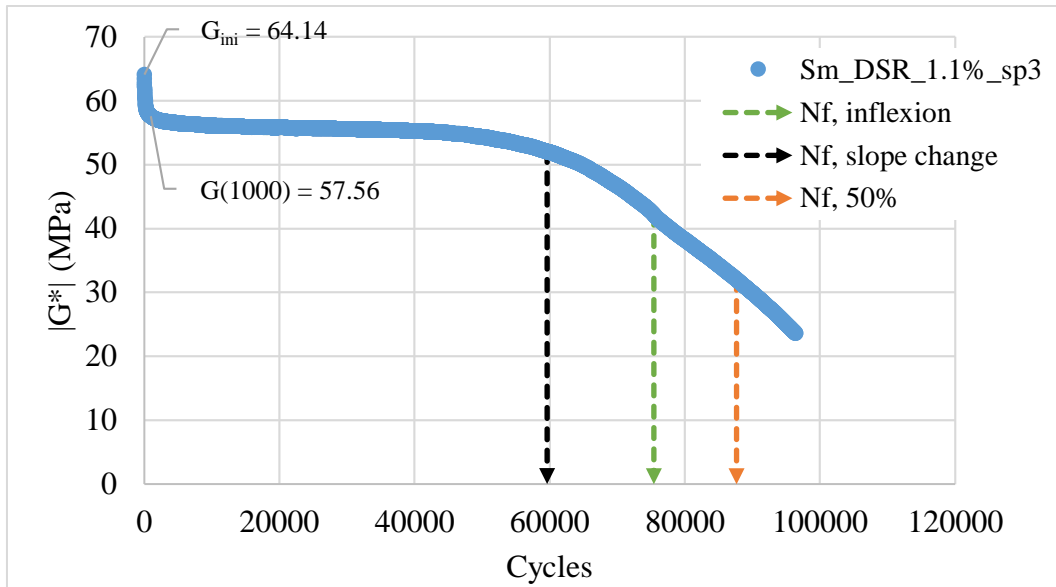




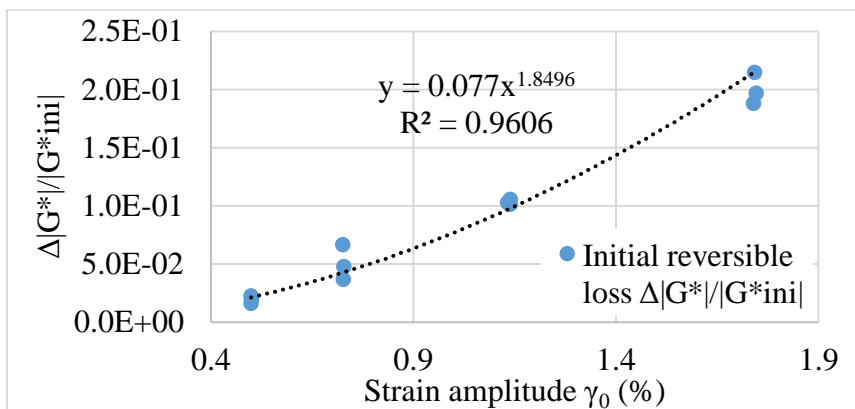
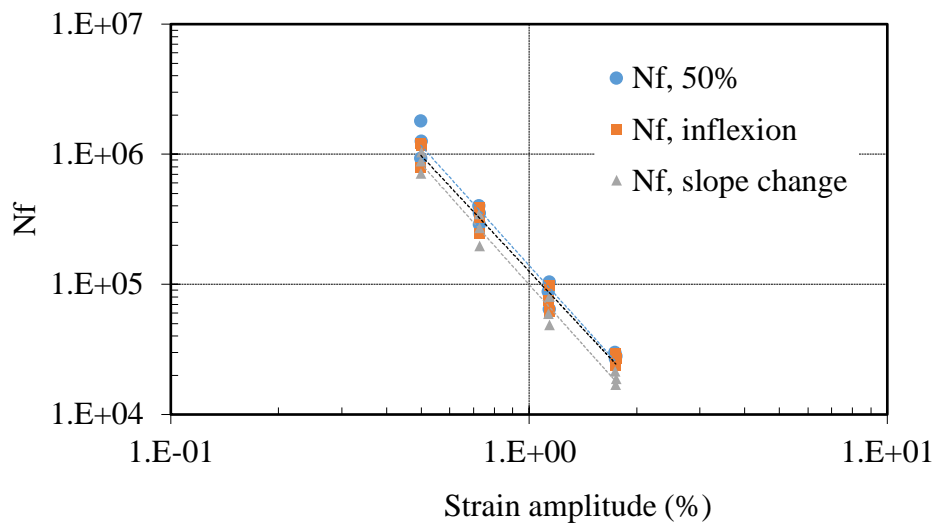
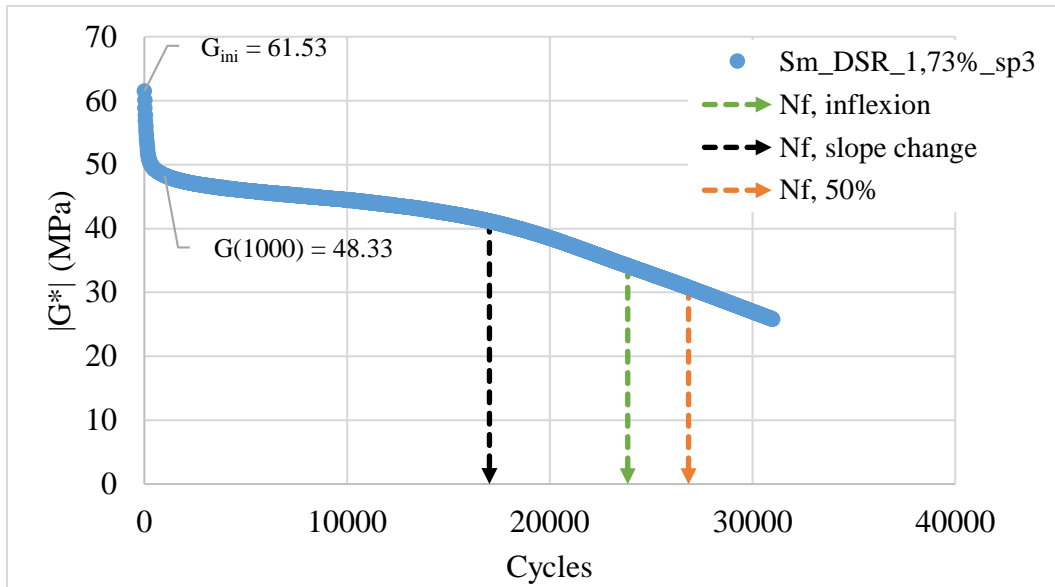
1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz



1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz



1 Thermomechanical tests on bituminous binders  
 1.4 Continuous fatigue test with DSR at 10 C/25Hz



# 1 Thermomechanical tests on bituminous binders

## 1.4 Continuous fatigue test with DSR at 10 C/25Hz

	$\gamma_0$ (%)	$ G^*_{ini} $ (MPa)	$N_f, 50\%$	$N_f, inflexion$	$N_f, slope\ change$	Initial reversible loss $\Delta G^* / G^*_{ini} $
Sm_DSR_0.48%_sp1	0.500	72.59	933313	789437	712962	2.25E-02
Sm_DSR_0.48%_sp2	0.499	71.39	1804863	1212462	887462	1.60E-02
Sm_DSR_0.48%_sp3	0.500	73.54	1254338	1162462	1042712	1.92E-02
Sm_DSR_0.7%_sp1	0.725	69.45	400488	388812	347362	6.67E-02
Sm_DSR_0.7%_sp2	0.728	73.32	352763	325787	273012	4.78E-02
Sm_DSR_0.7%_sp3	0.727	69.90	287613	244737	197362	3.67E-02
Sm_DSR_1.1%_sp1	1.140	66.52	104188	98187	80687	1.05E-01
Sm_DSR_1.1%_sp2	1.140	67.95	64113	62625	48850	1.01E-01
Sm_DSR_1.1%_sp3	1.133	64.14	87613	75412	59612	1.03E-01
Sm_DSR_1.73%_sp1	1.740	57.68	30050	29512	21512	1.88E-01
Sm_DSR_1.73%_sp2	1.747	62.07	28163	26912	18950	1.97E-01
Sm_DSR_1.73%_sp3	1.743	61.53	26838	23850	17025	2.15E-01

$$\text{Log}(Nf) = a + \frac{\text{Log}(\gamma)}{b}$$

	$N_f, 50\%$	$N_f, inflexion$	$N_f, slope\ change$
<b>1/b</b>	<b>-3.06</b>	<b>-2.95</b>	<b>-3.08</b>
a	5.15	5.10	5.00
<b><math>\gamma_0</math> (%)</b>	<b>0.526</b>	<b>0.496</b>	<b>0.473</b>

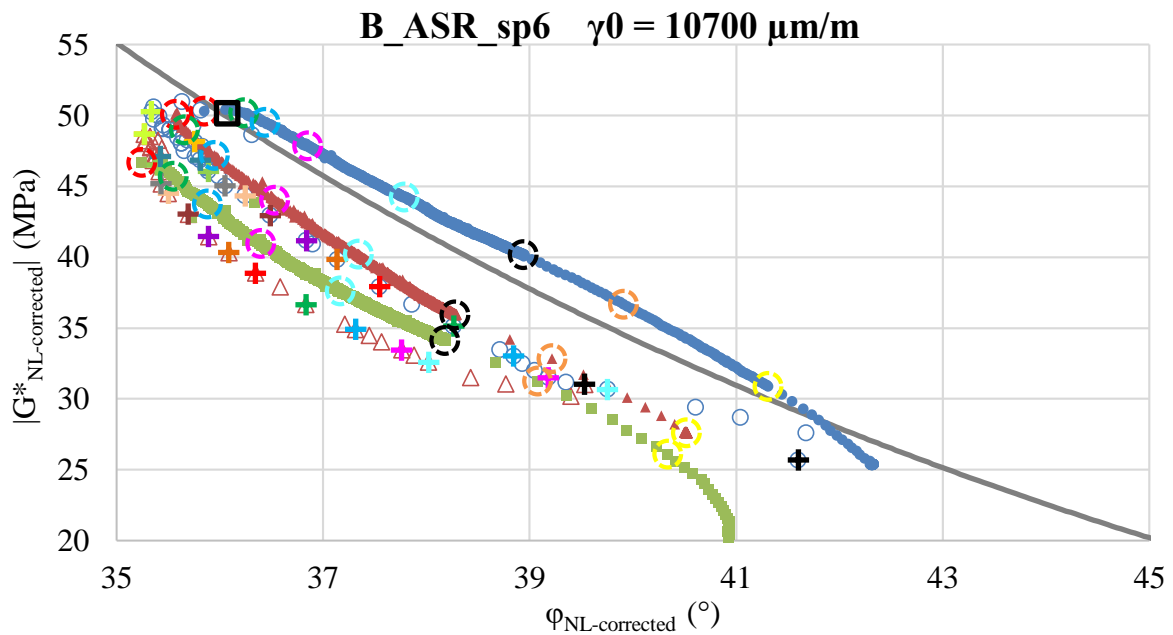
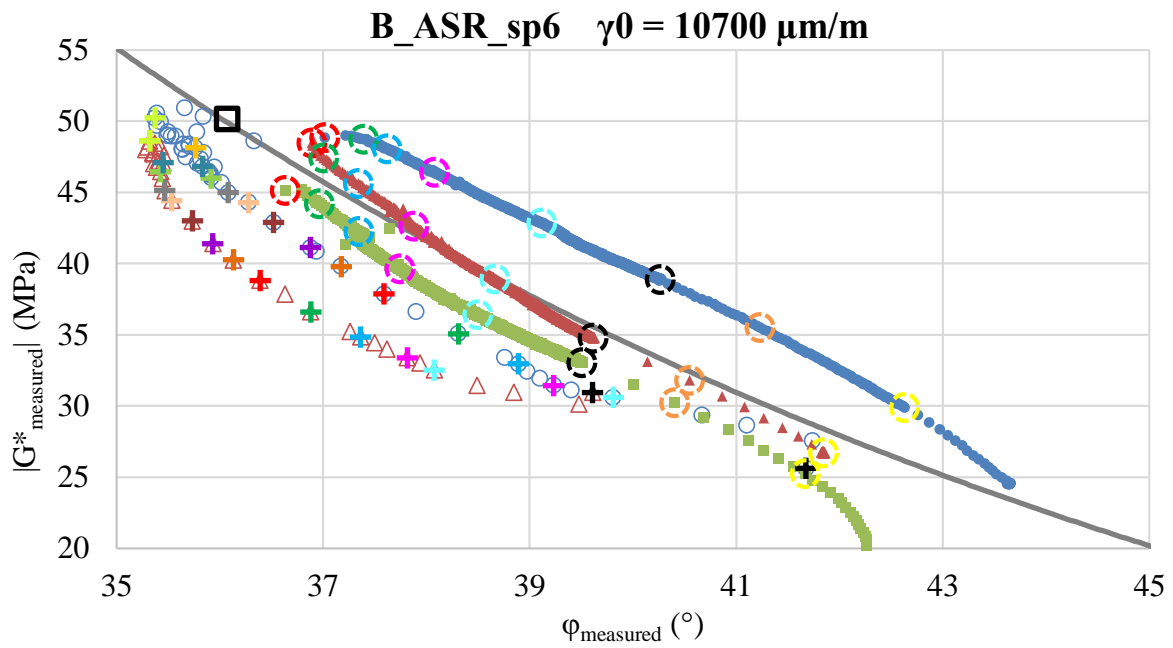
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

1.5. Load and Rest Periods (LRP) tests with ASR at 10°C/10Hz

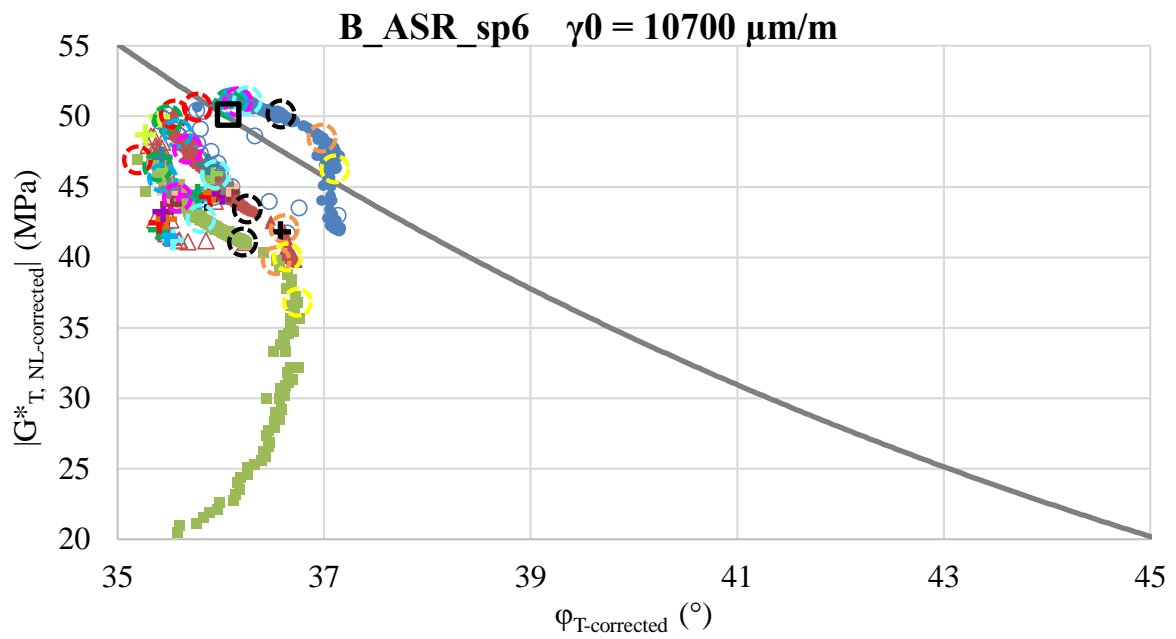
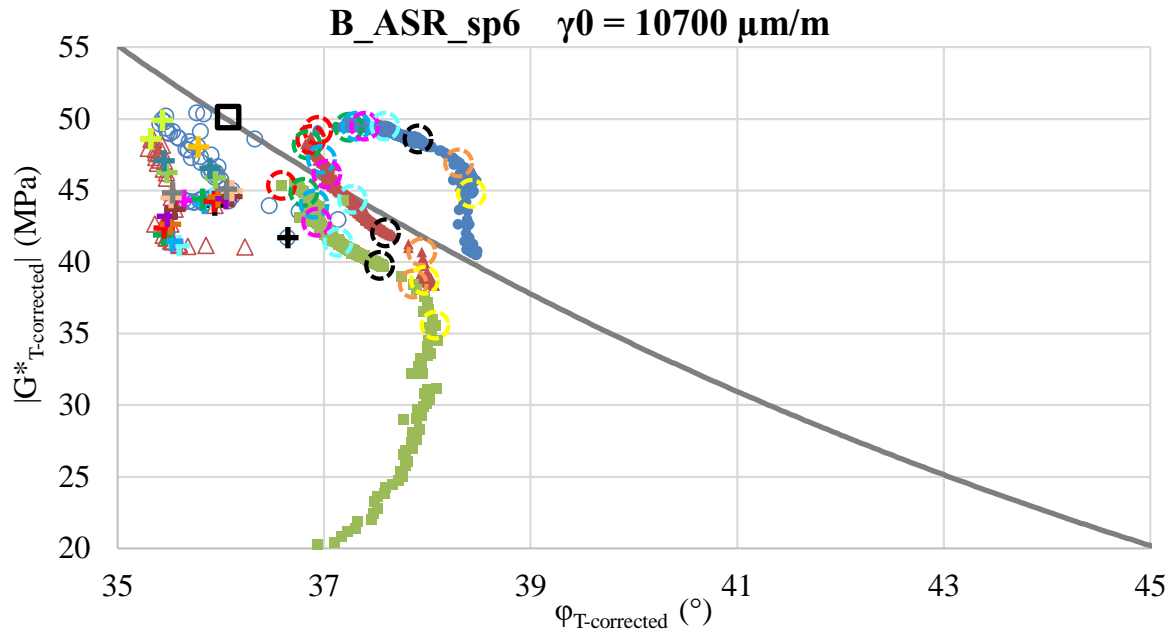
1.5.1.B\_ASR

1.5.1.1. B\_ASR\_sp6 (10700 $\mu\text{m}/\text{m}$ )

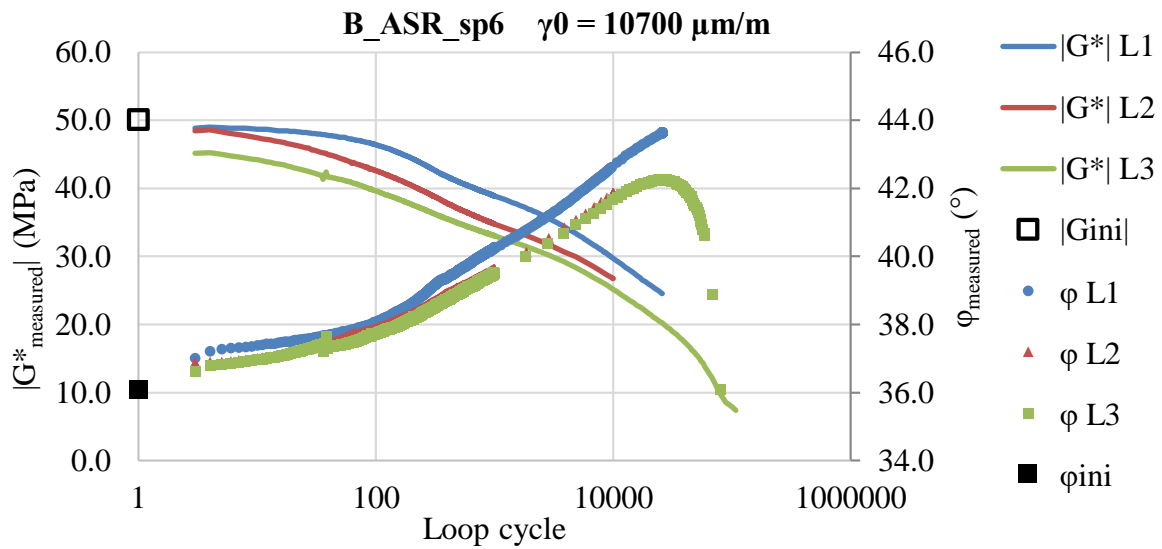
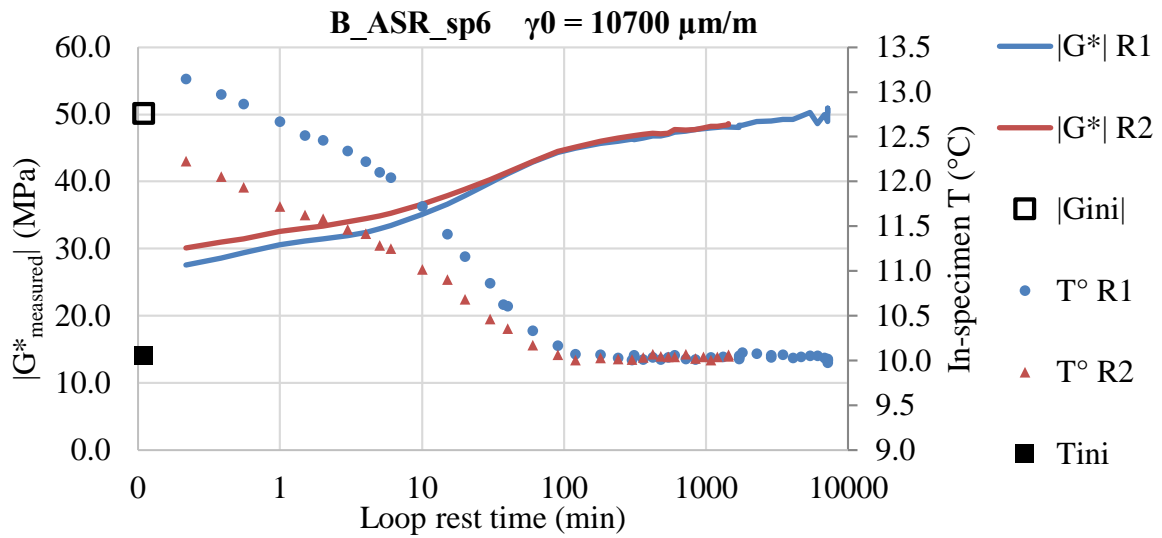
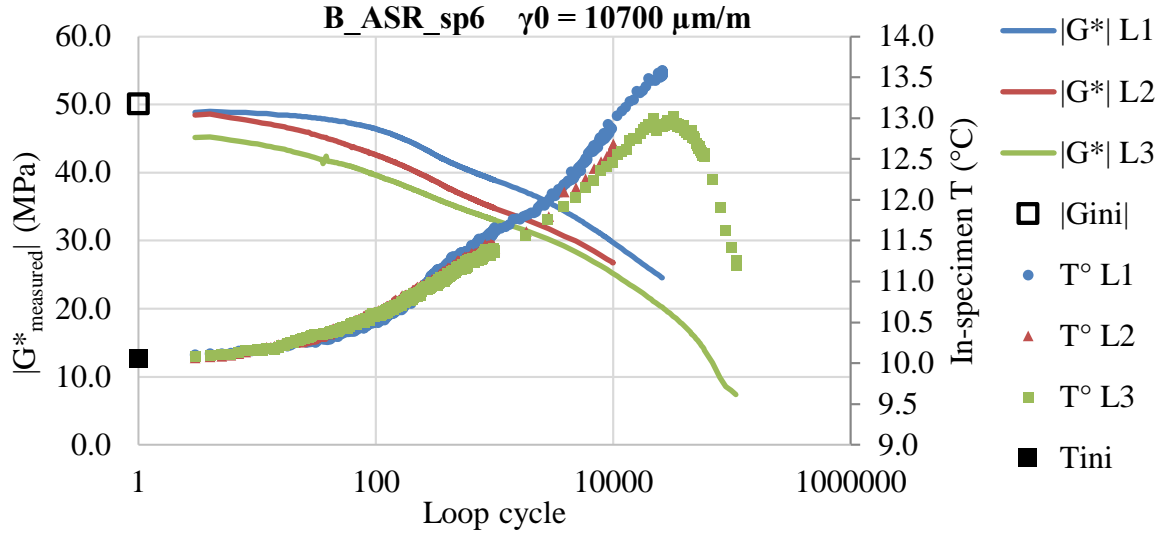
- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | ◻ G*ini        | — 2S2P1D        |



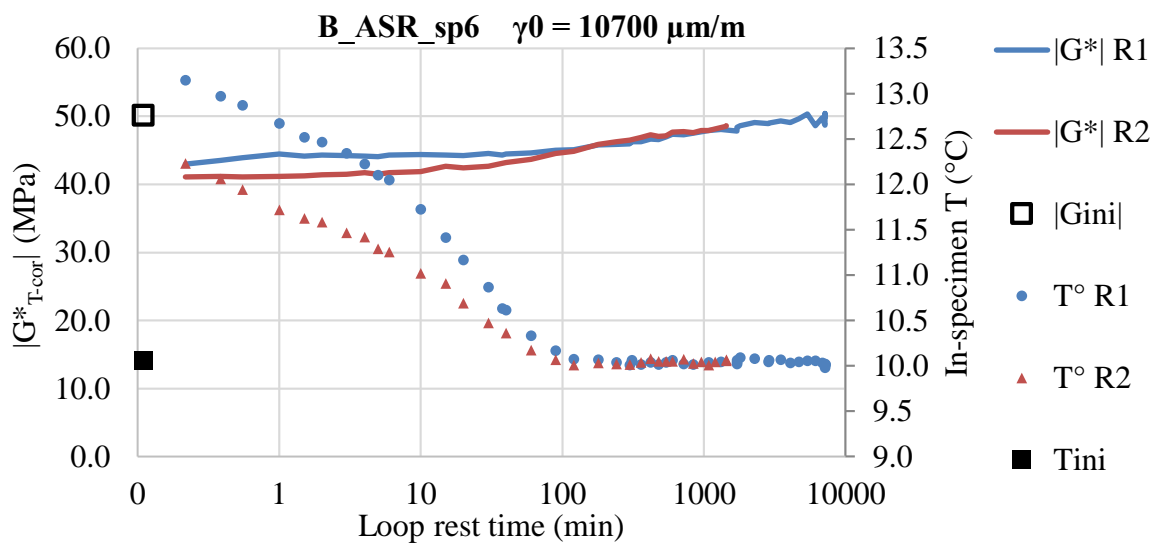
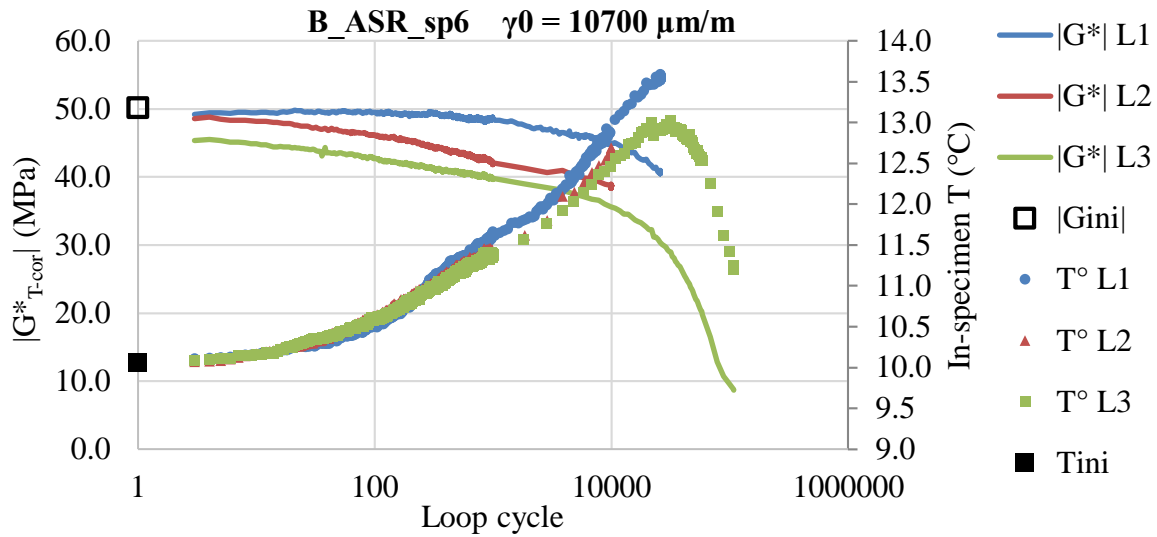
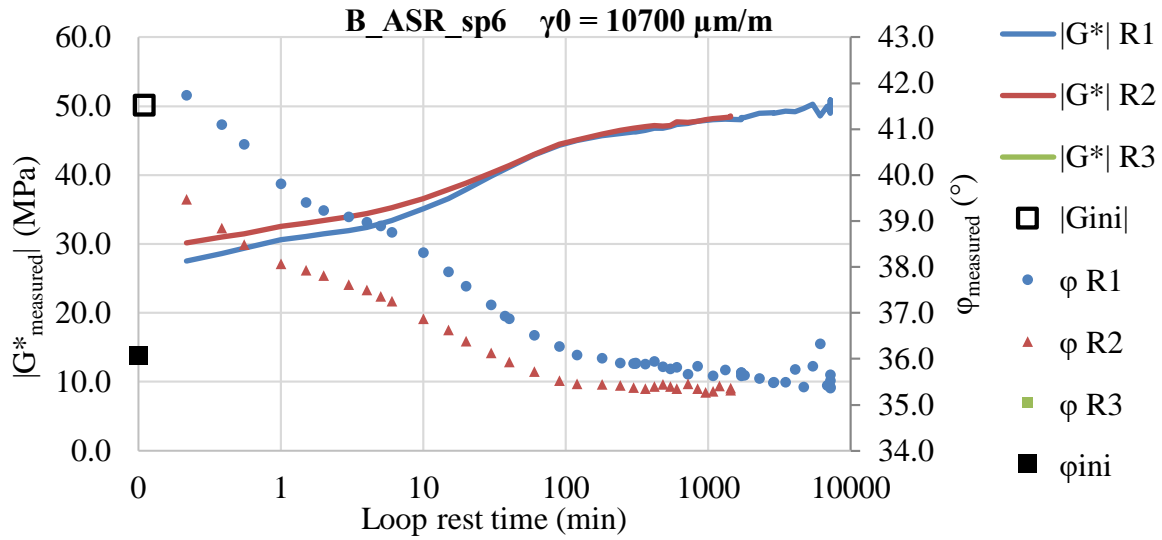
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

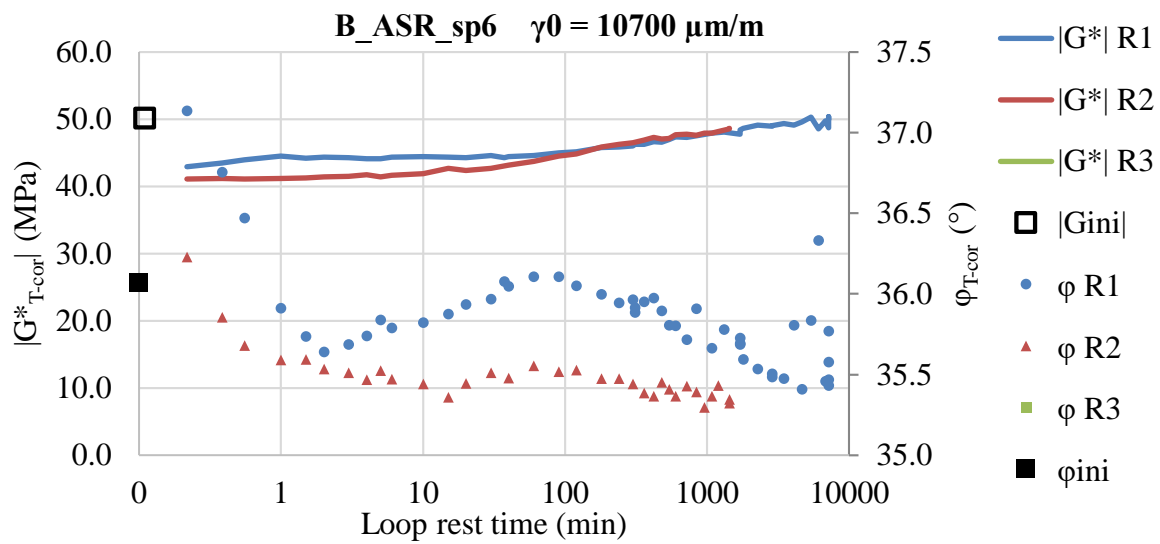
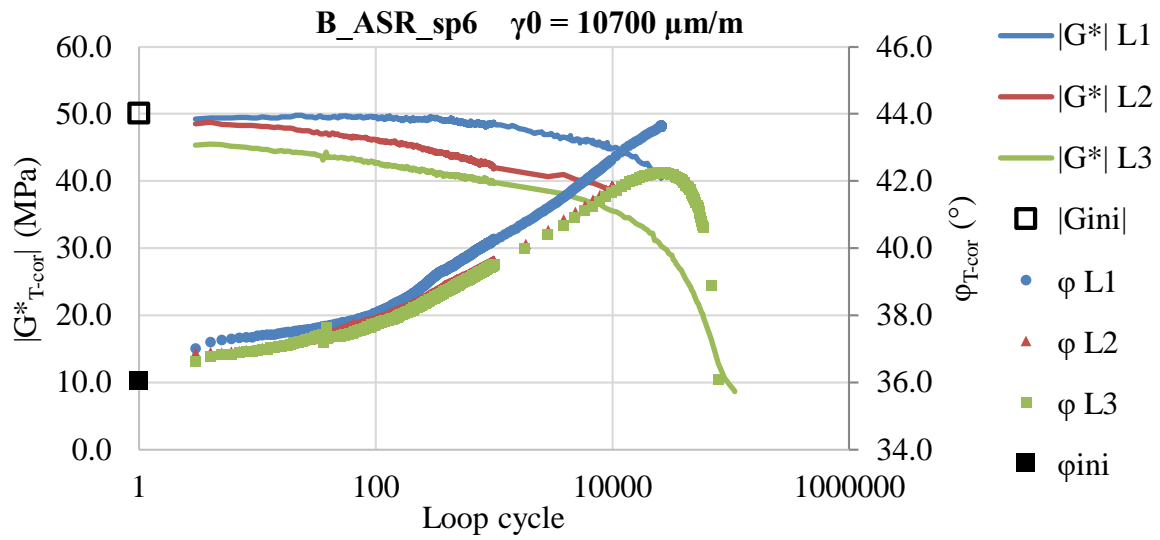


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

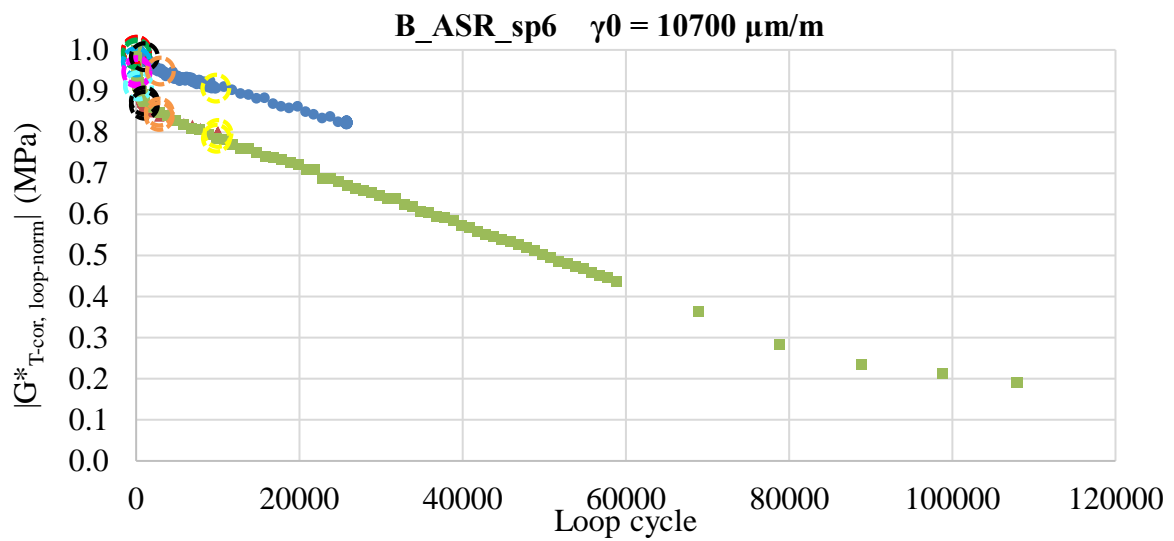
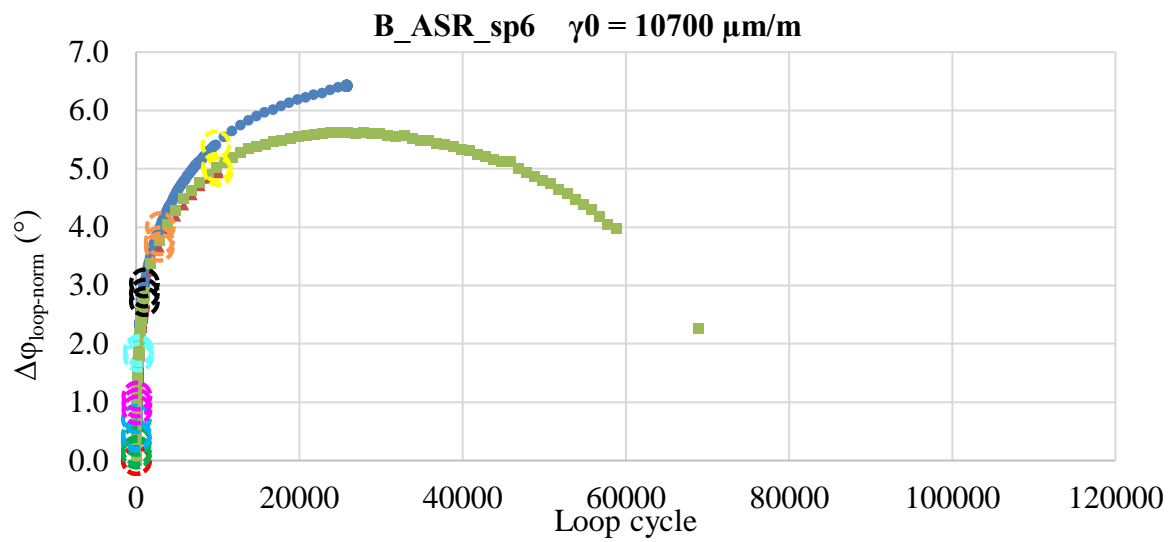
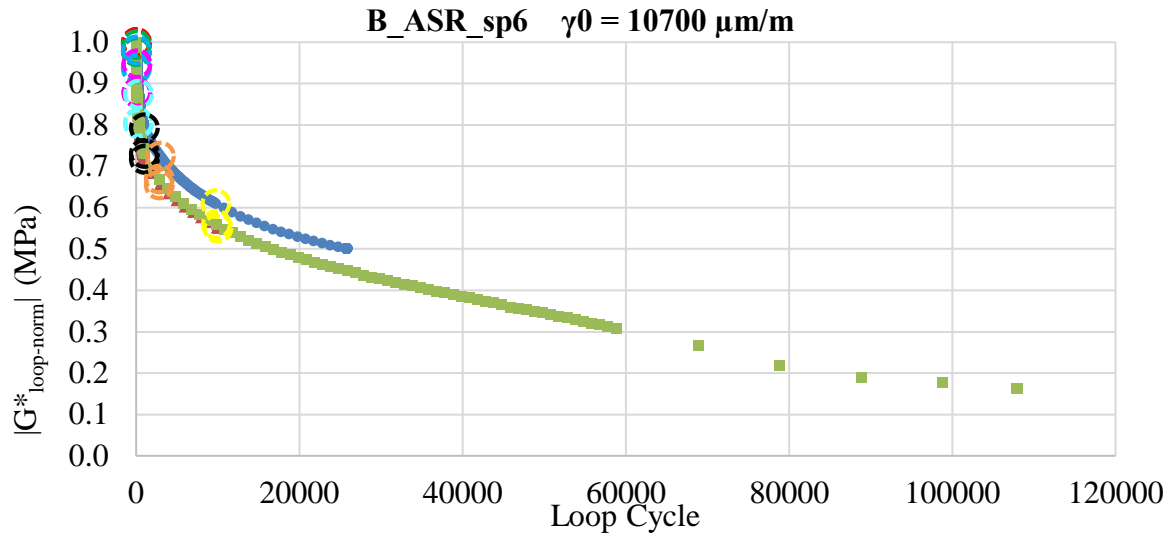




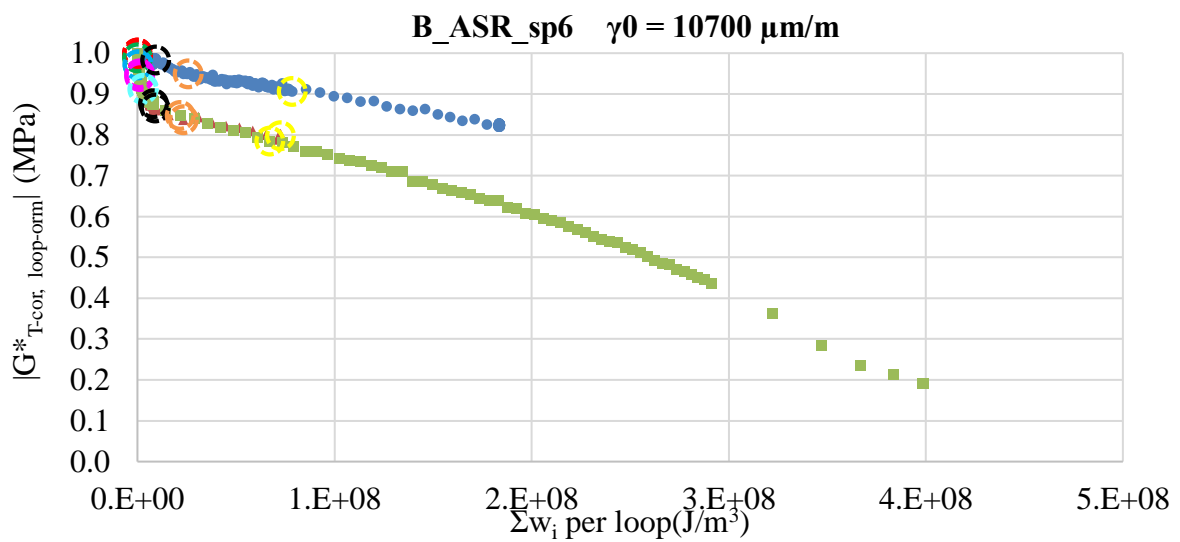
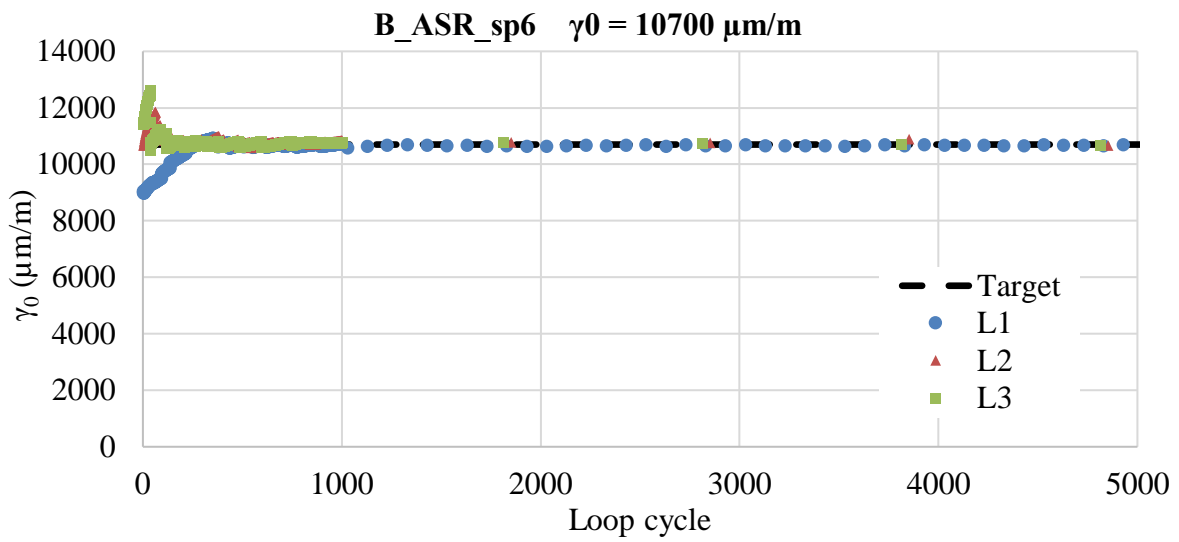
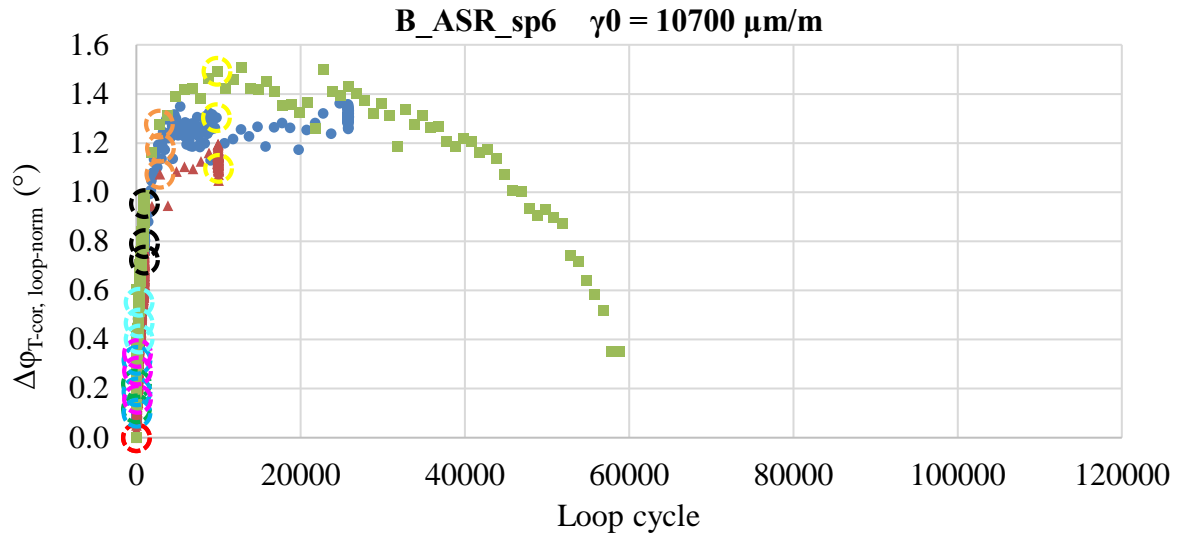
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



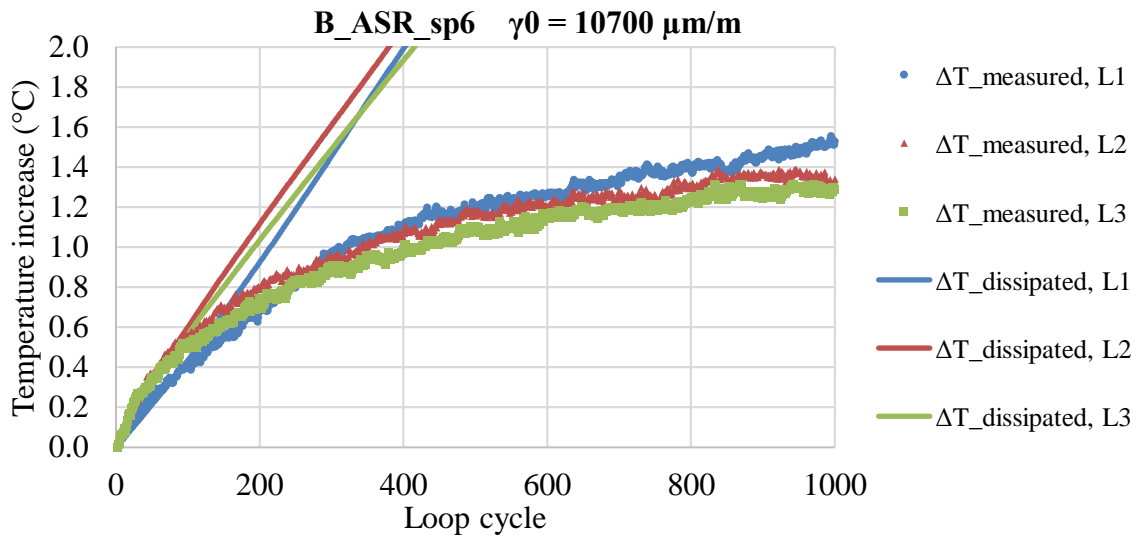
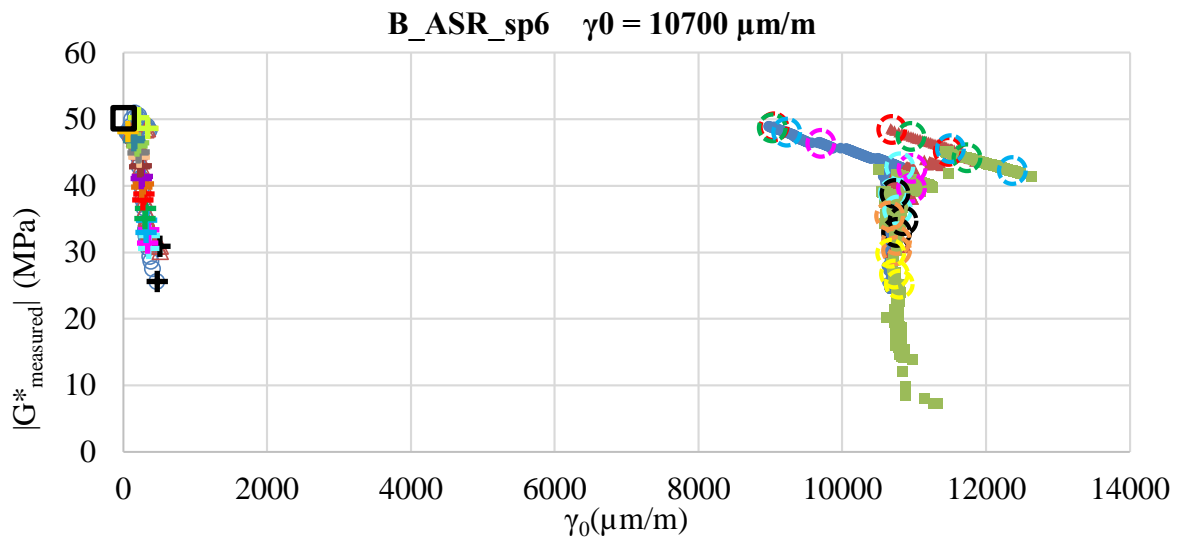
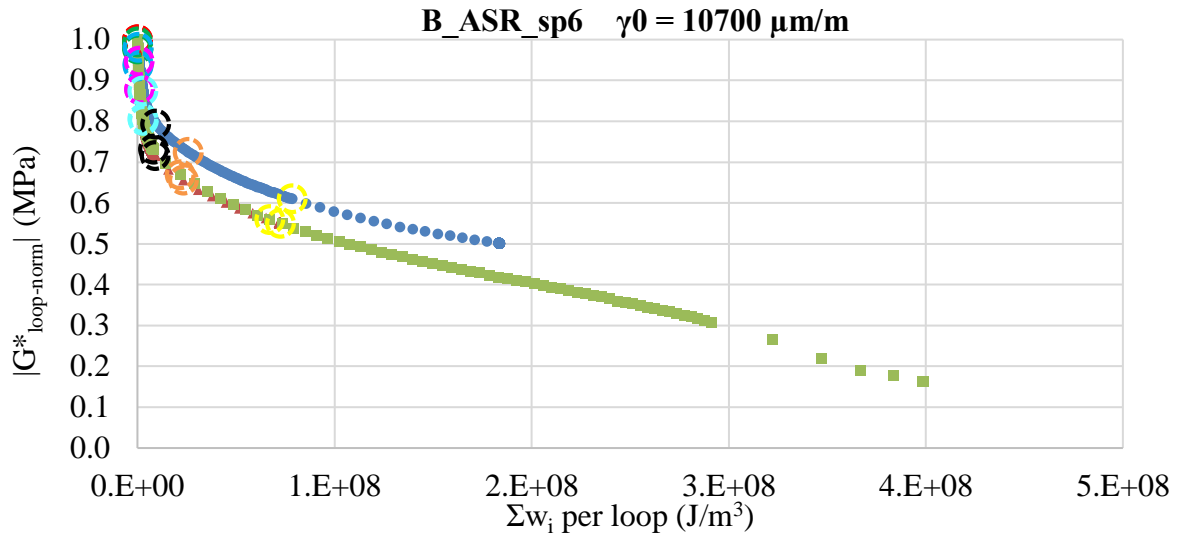
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



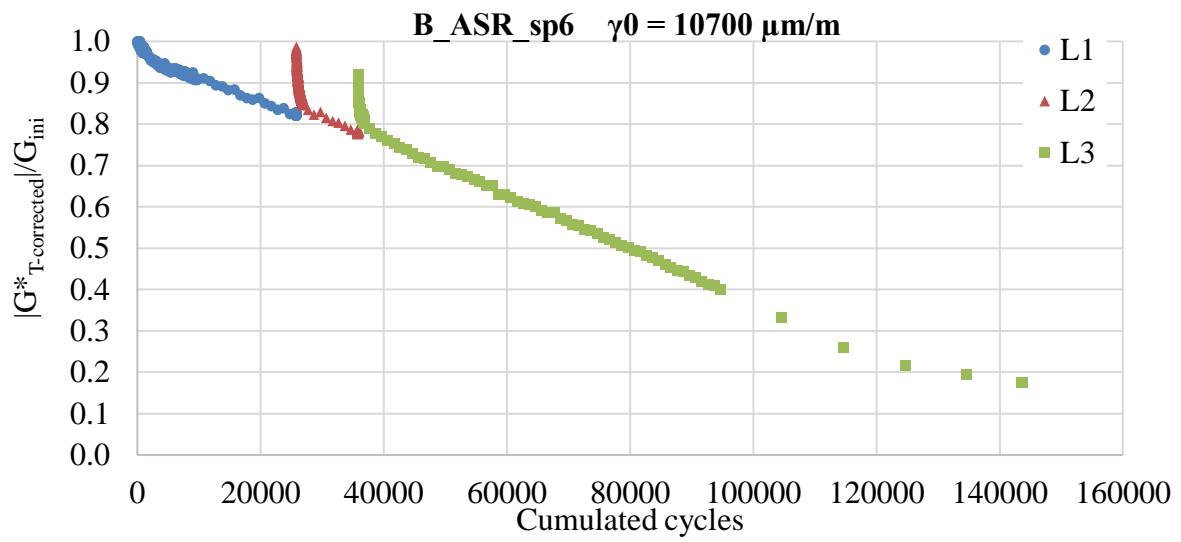
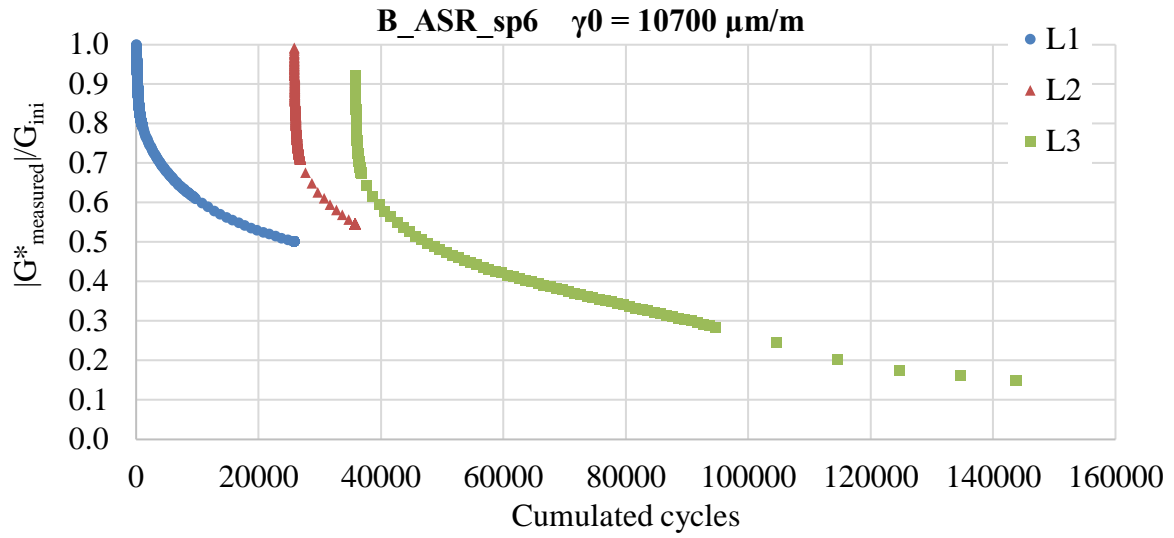
1 Thermomechanical tests on bituminous binders  
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1 Thermomechanical tests on bituminous binders  
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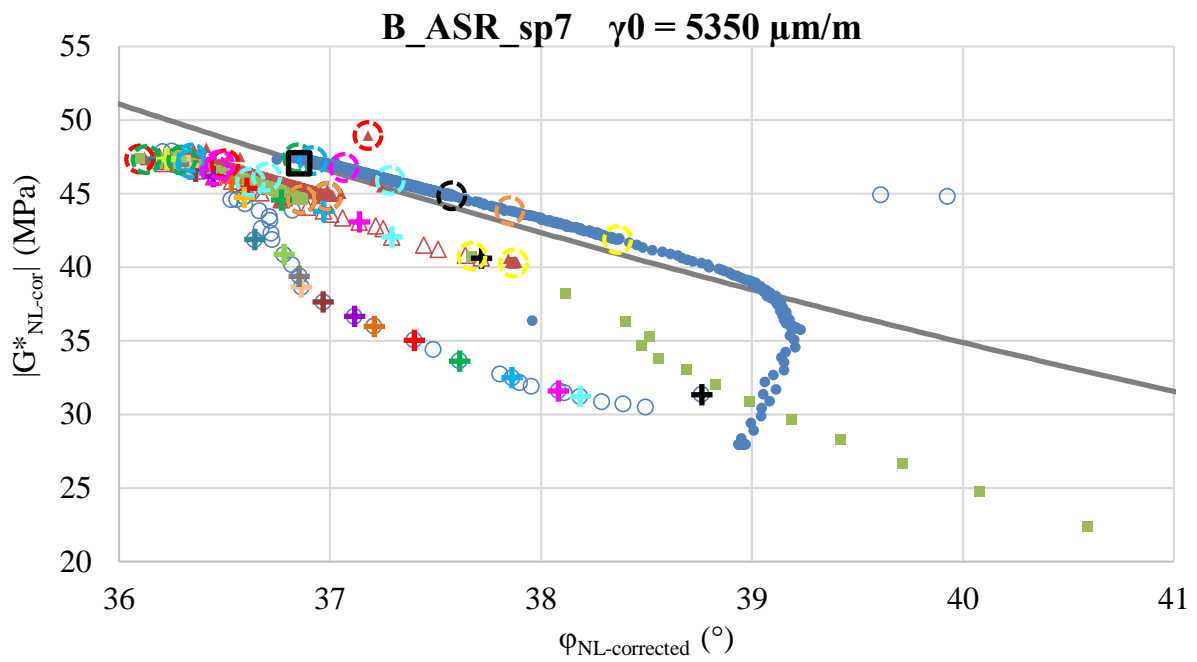
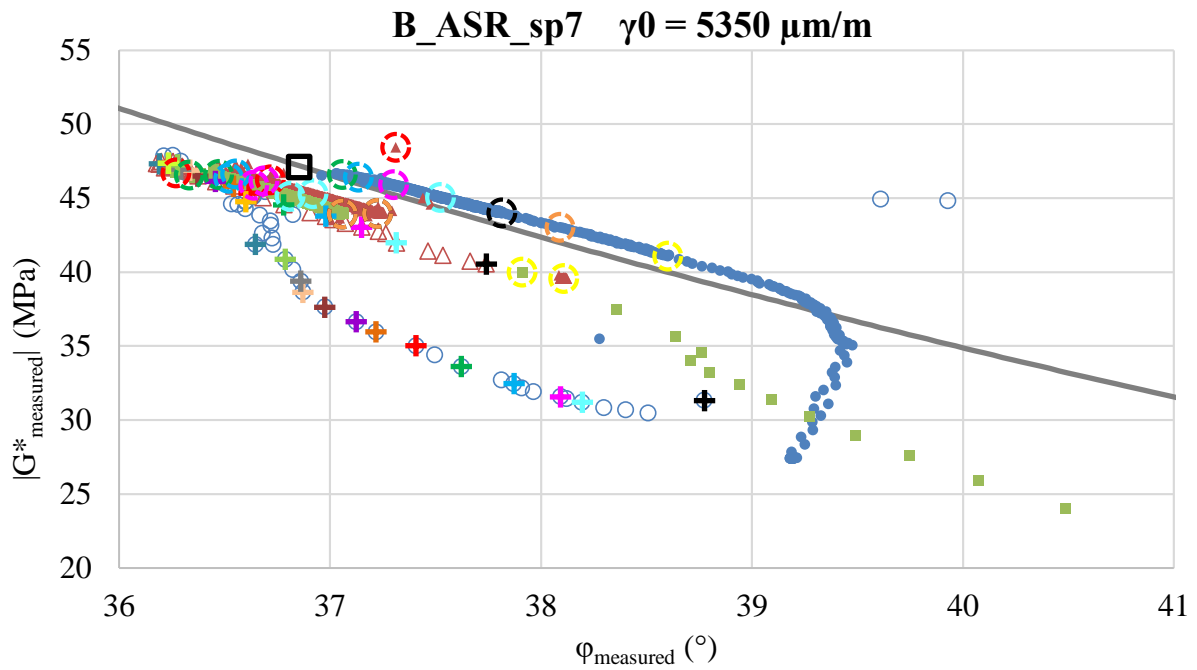
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



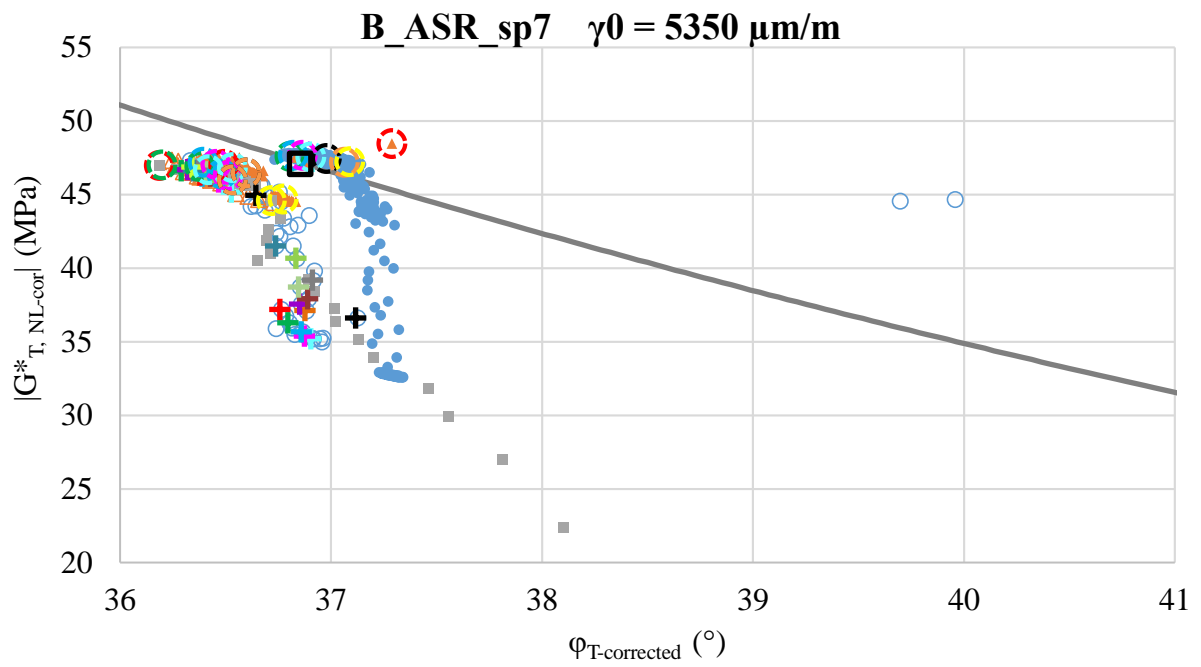
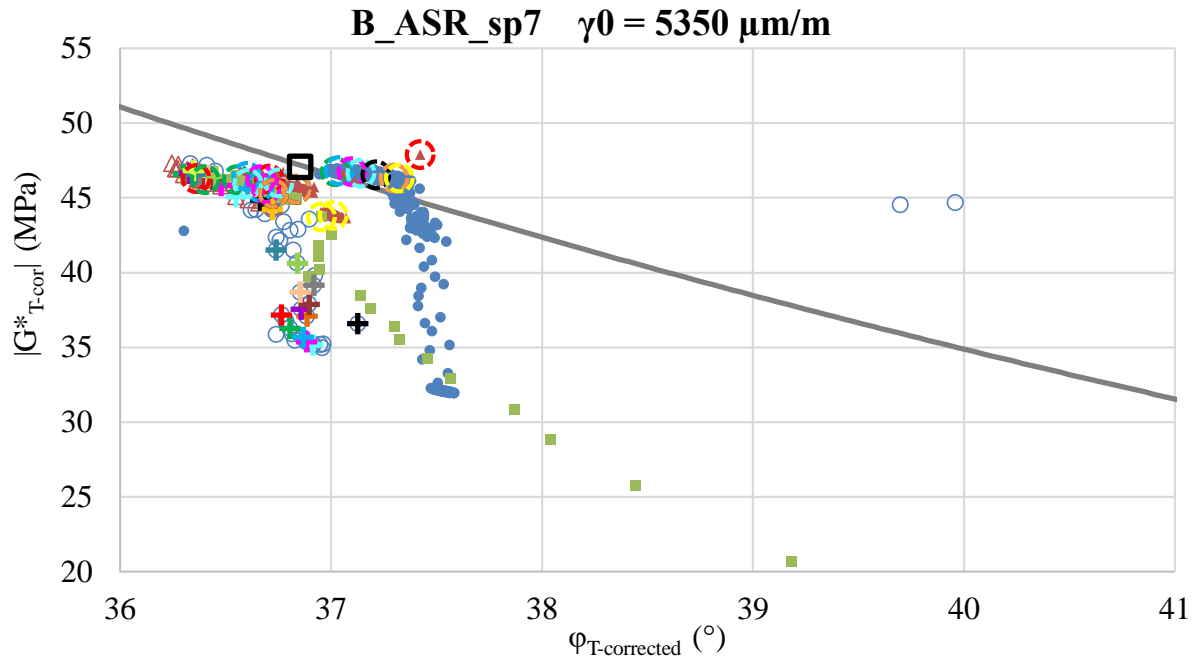
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

1.5.1.2. B\_ASR\_sp7 (5350 $\mu\text{m}/\text{m}$ )

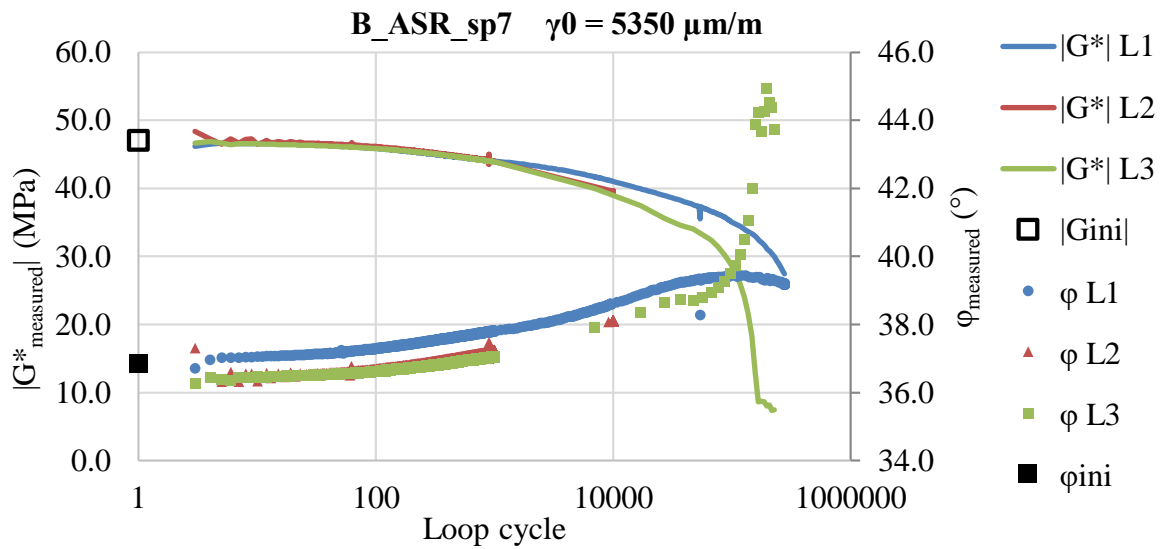
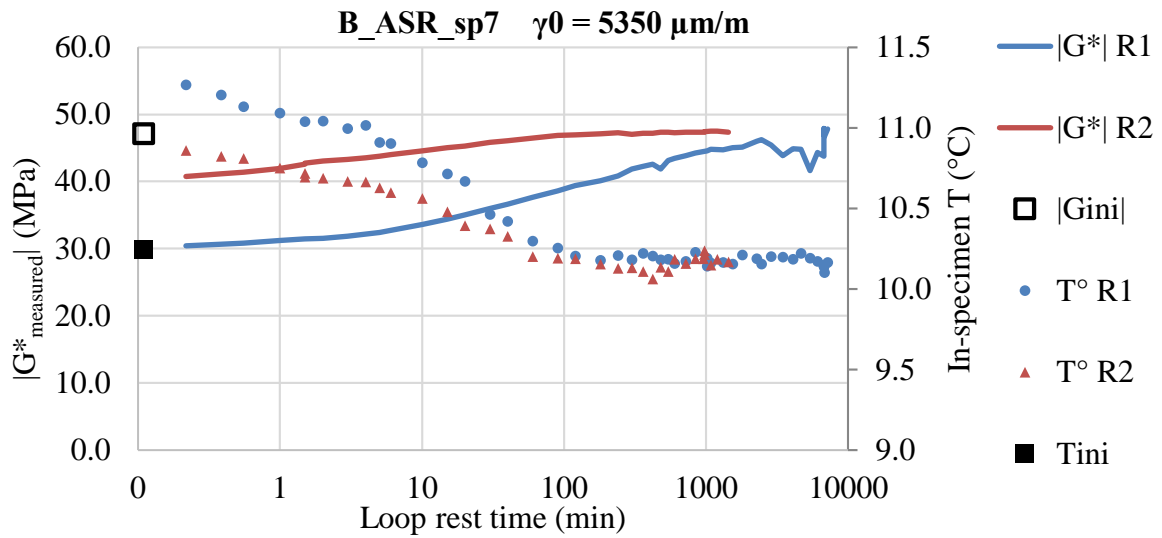
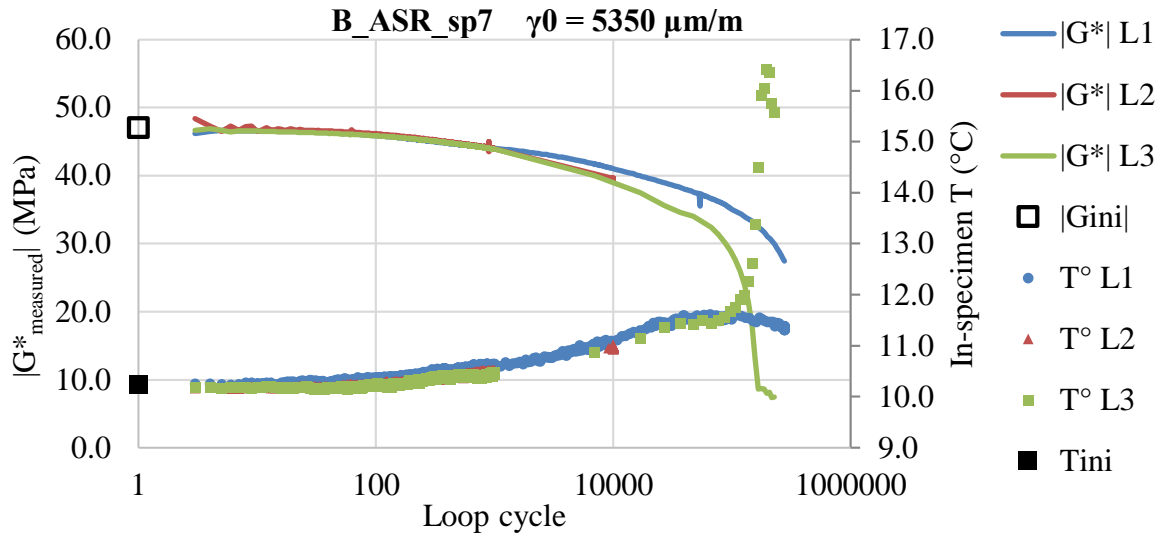
- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | ■ G*ini        | — 2S2P1D        |



1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

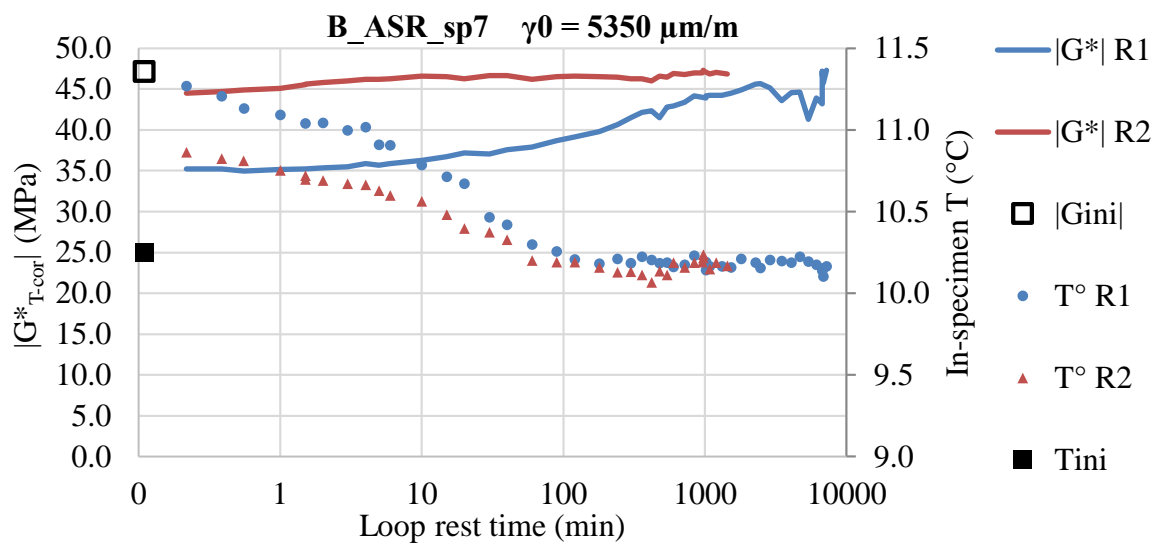
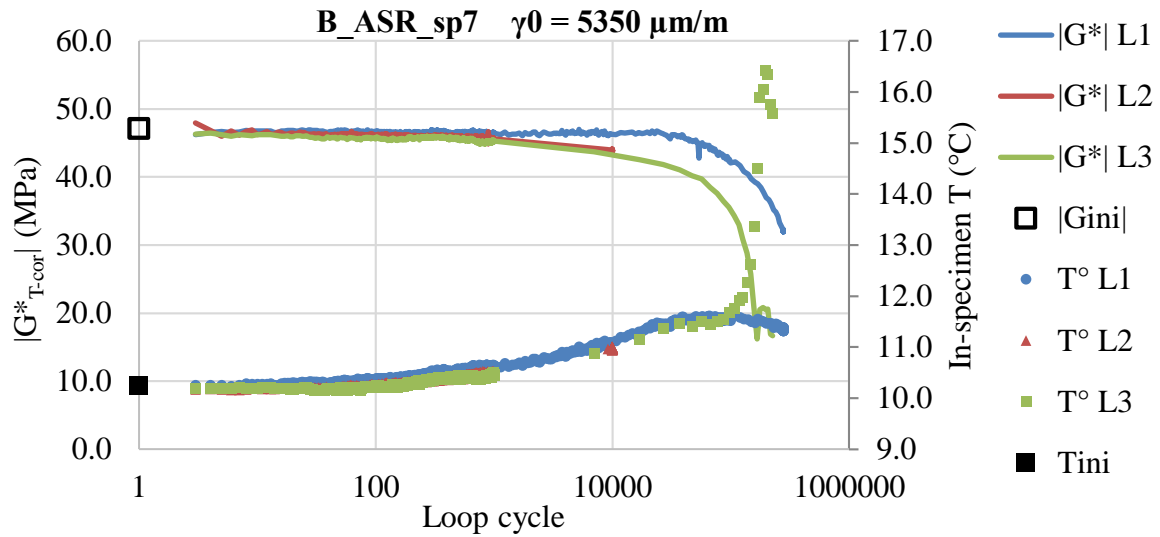
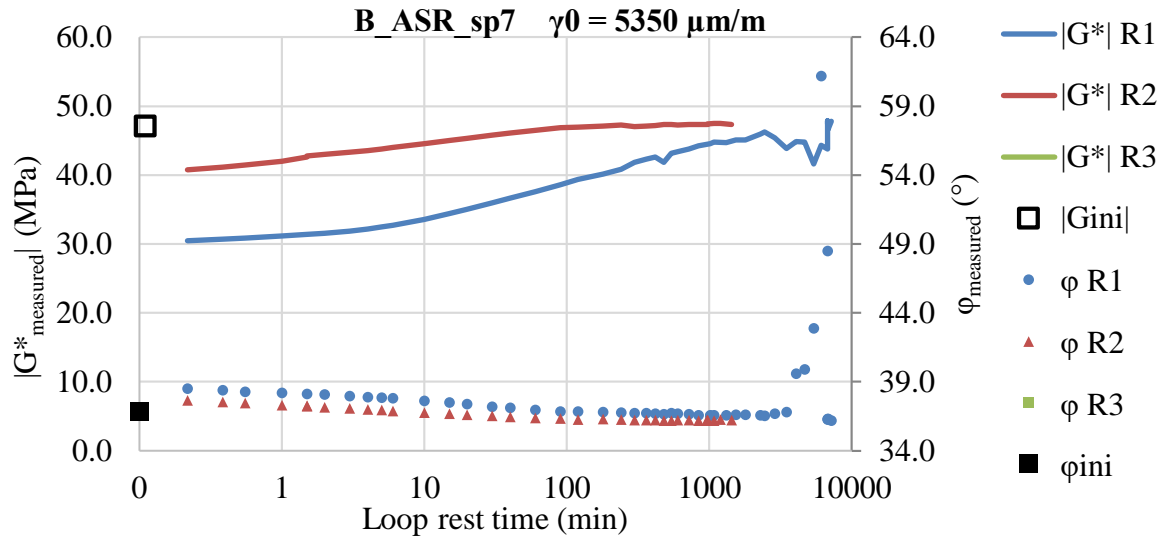


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

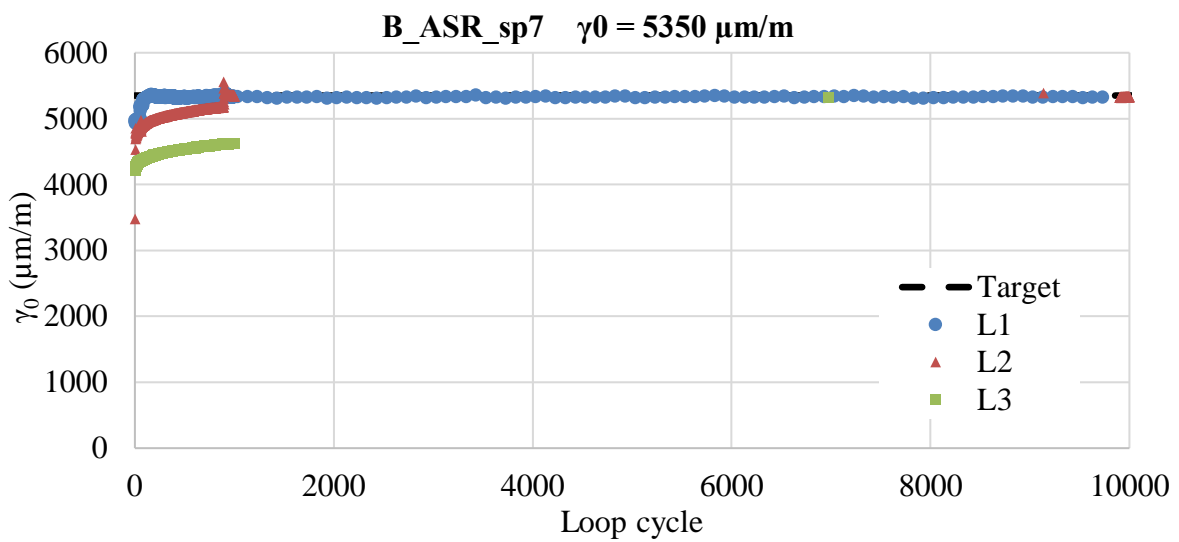
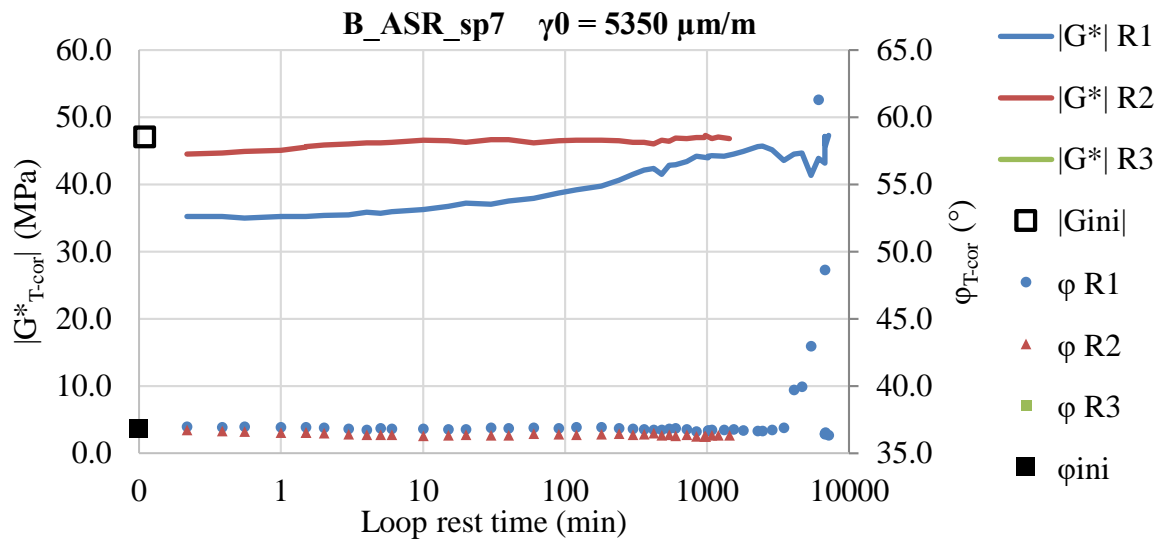
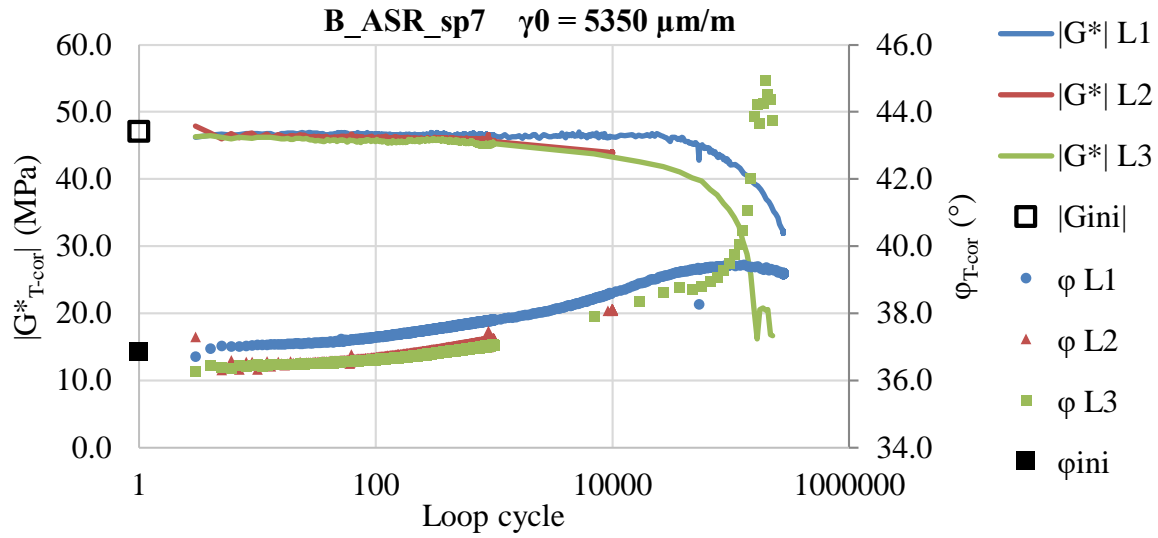




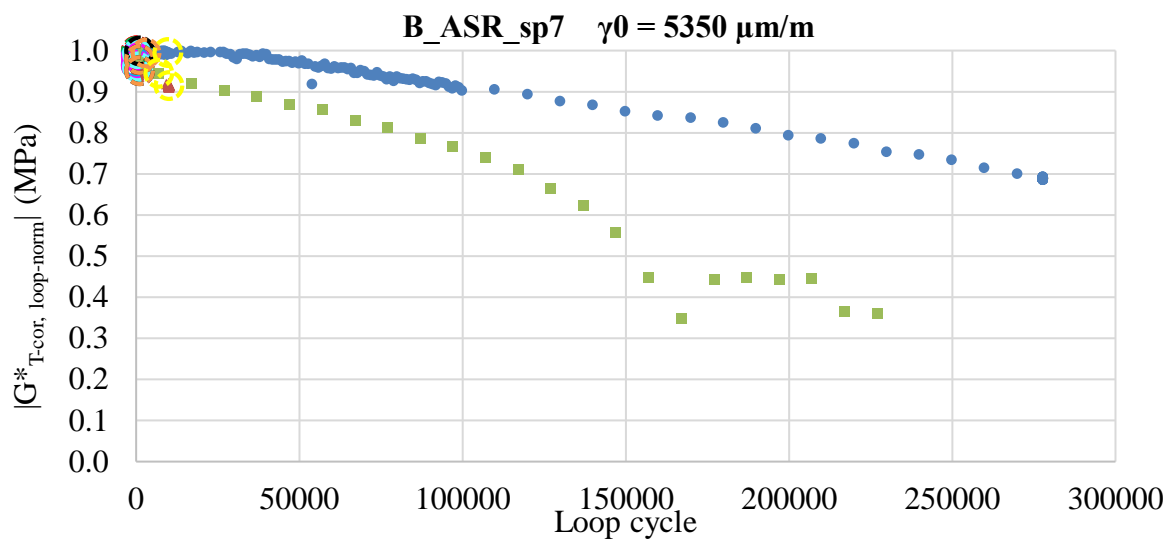
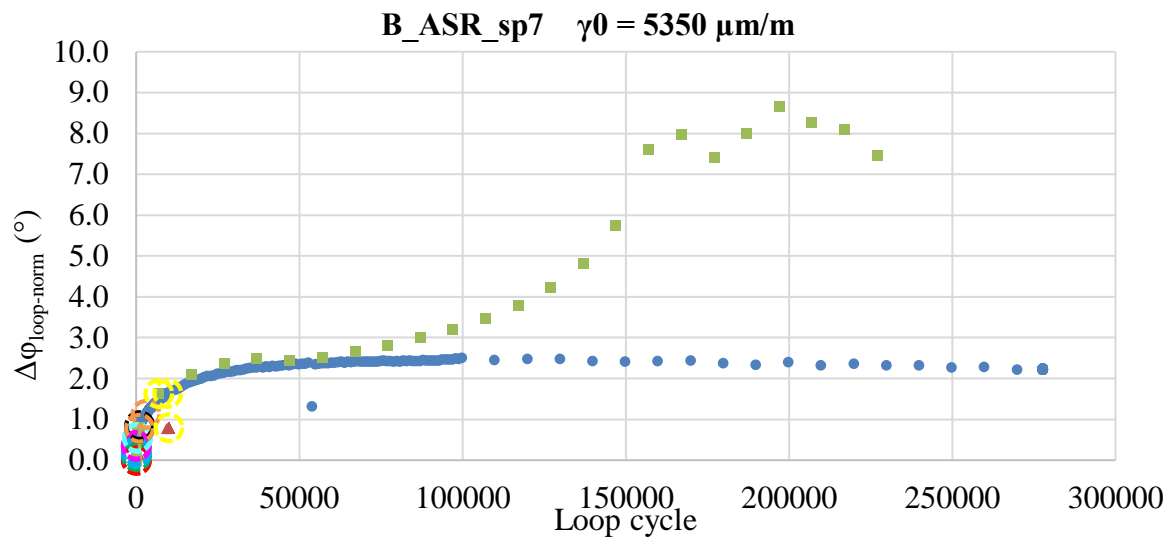
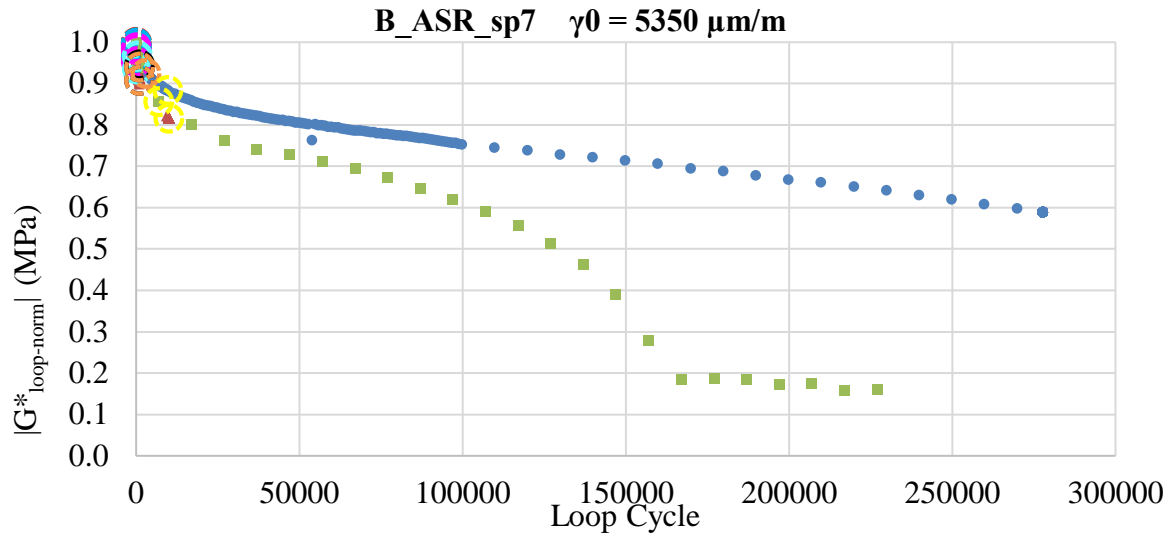
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



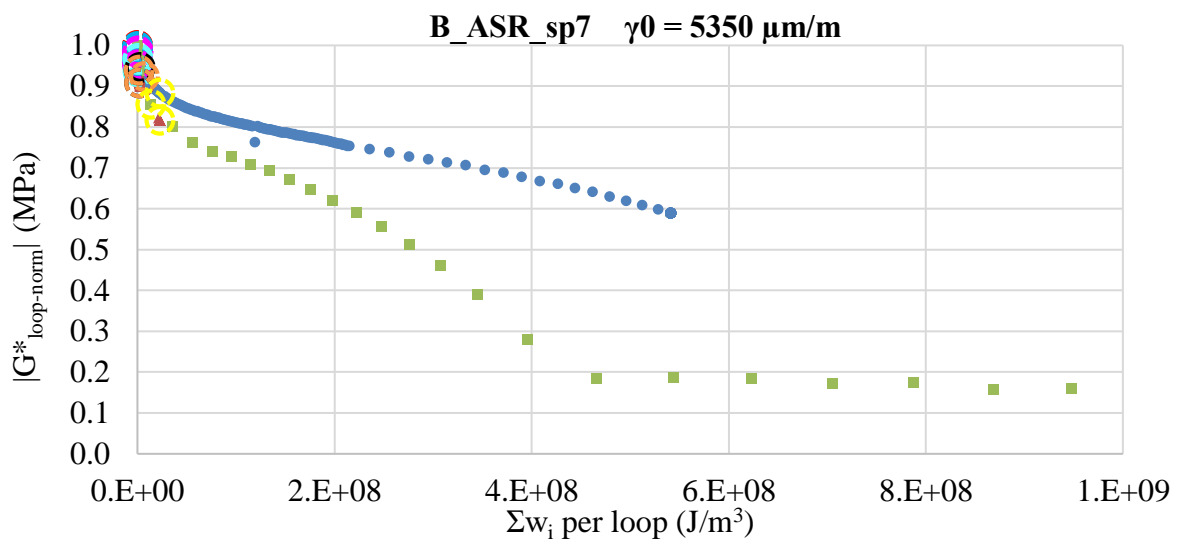
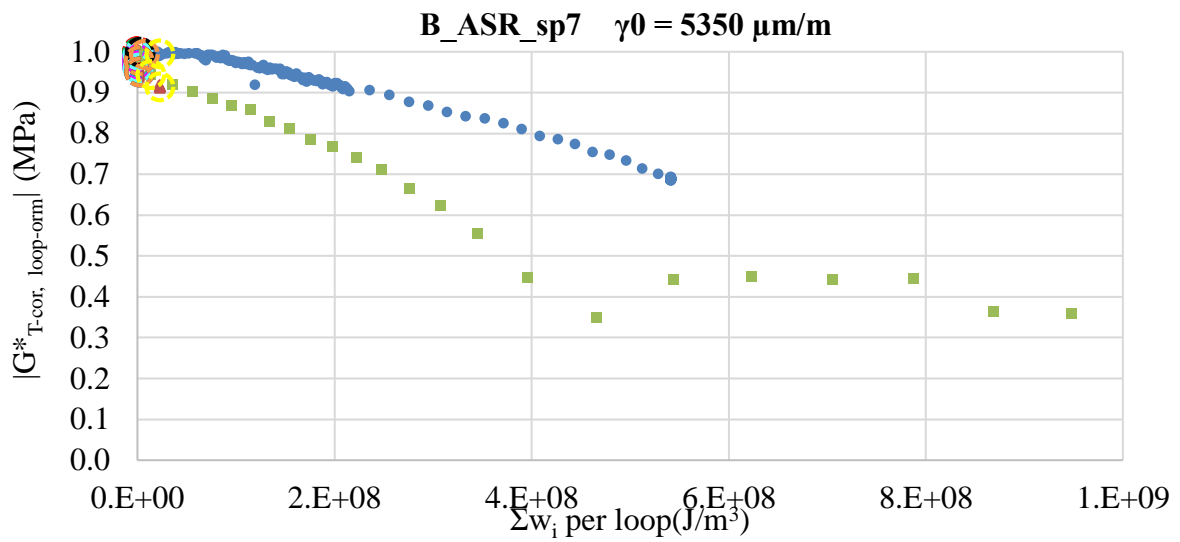
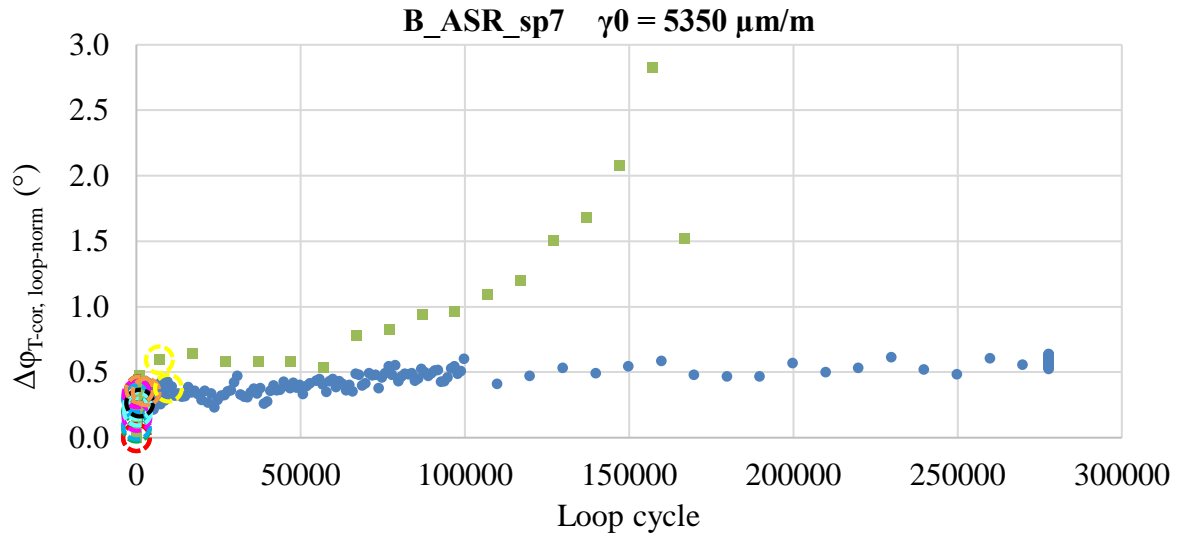
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



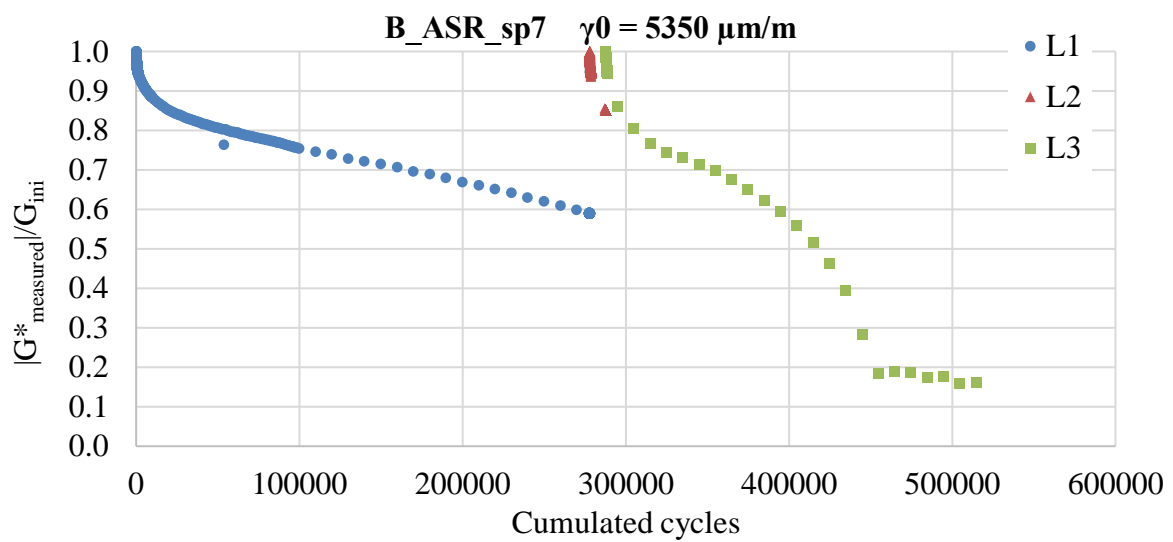
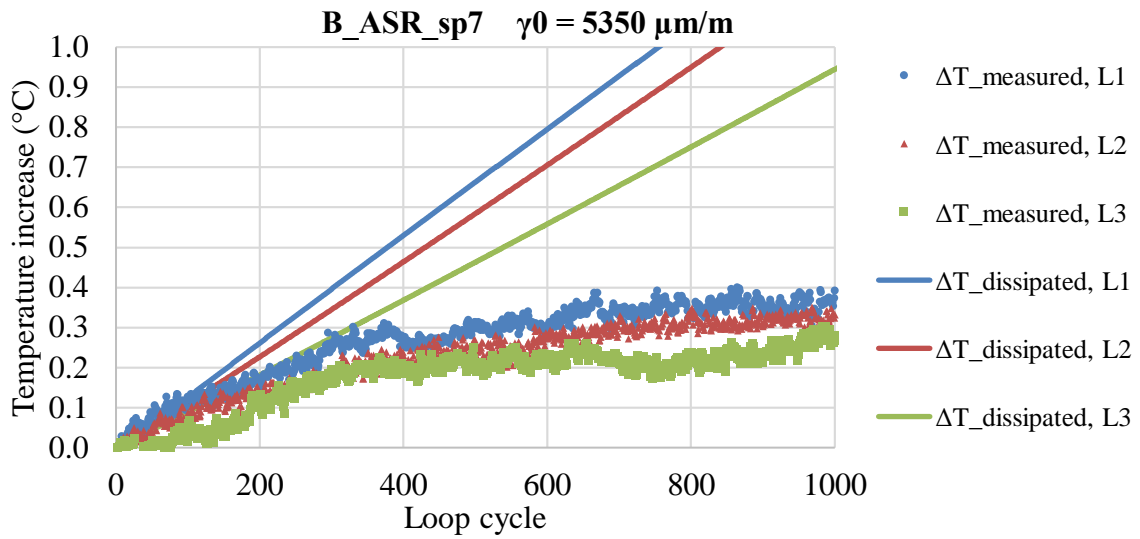
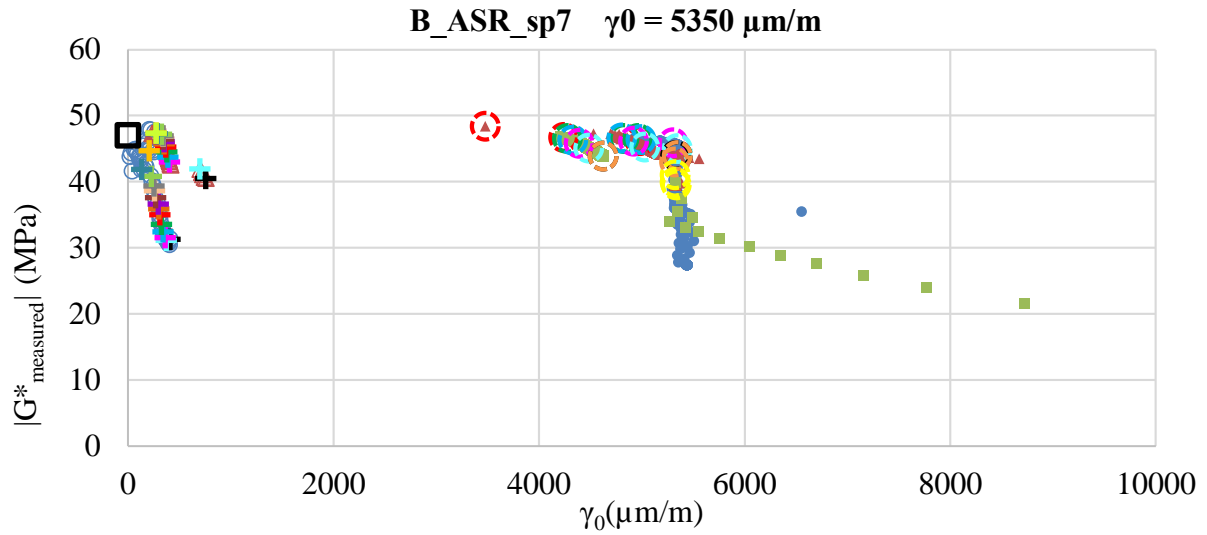
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



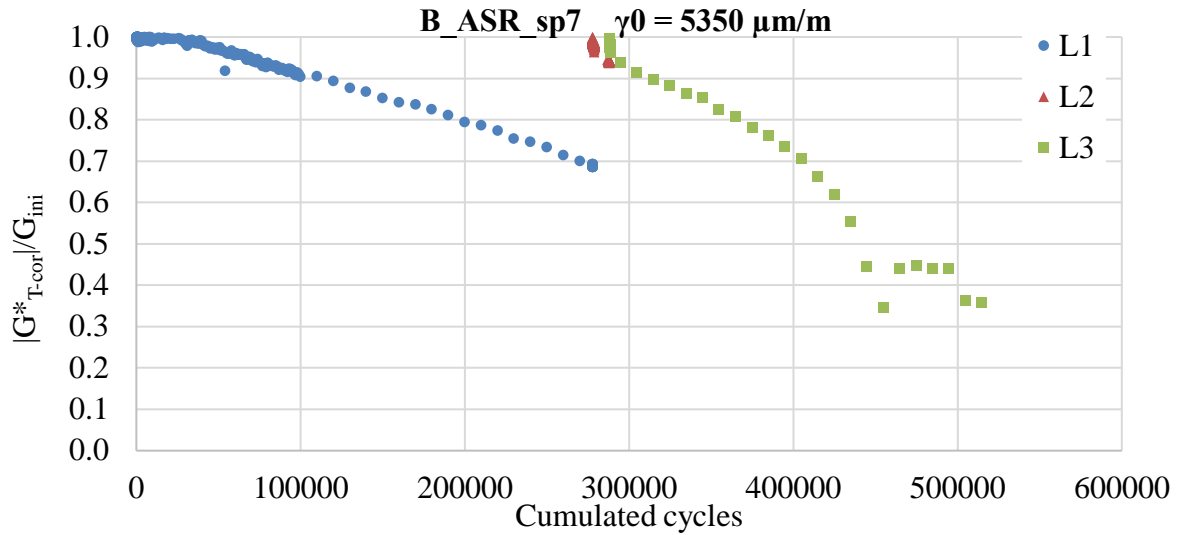
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



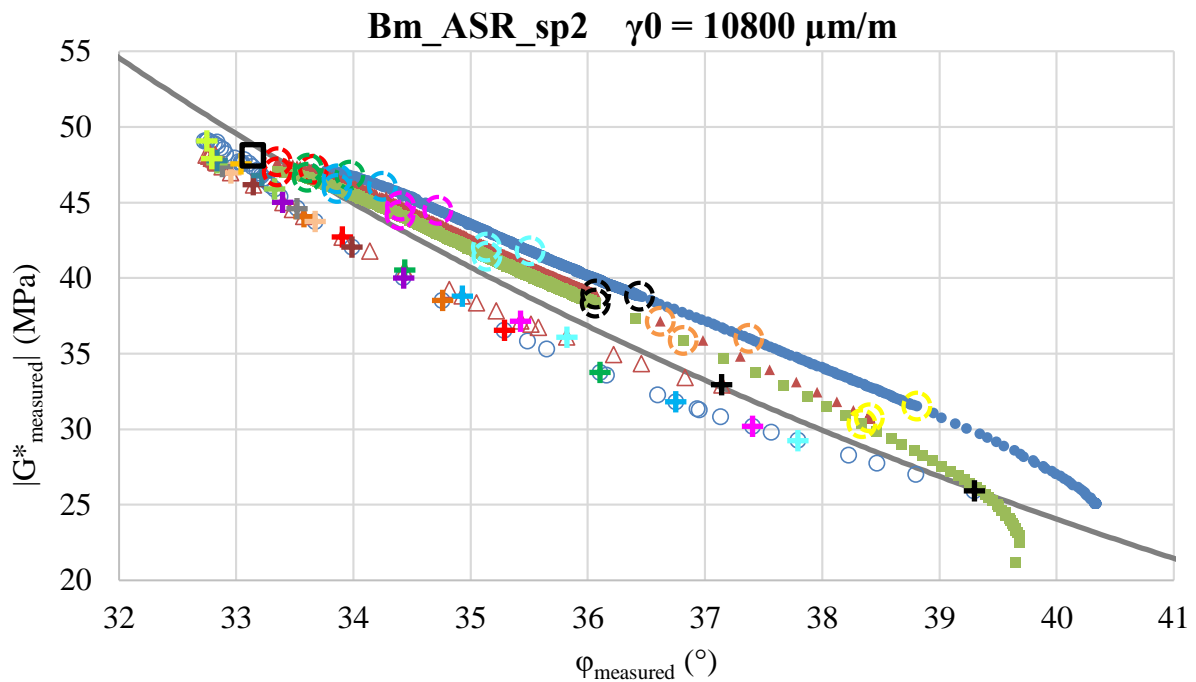
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



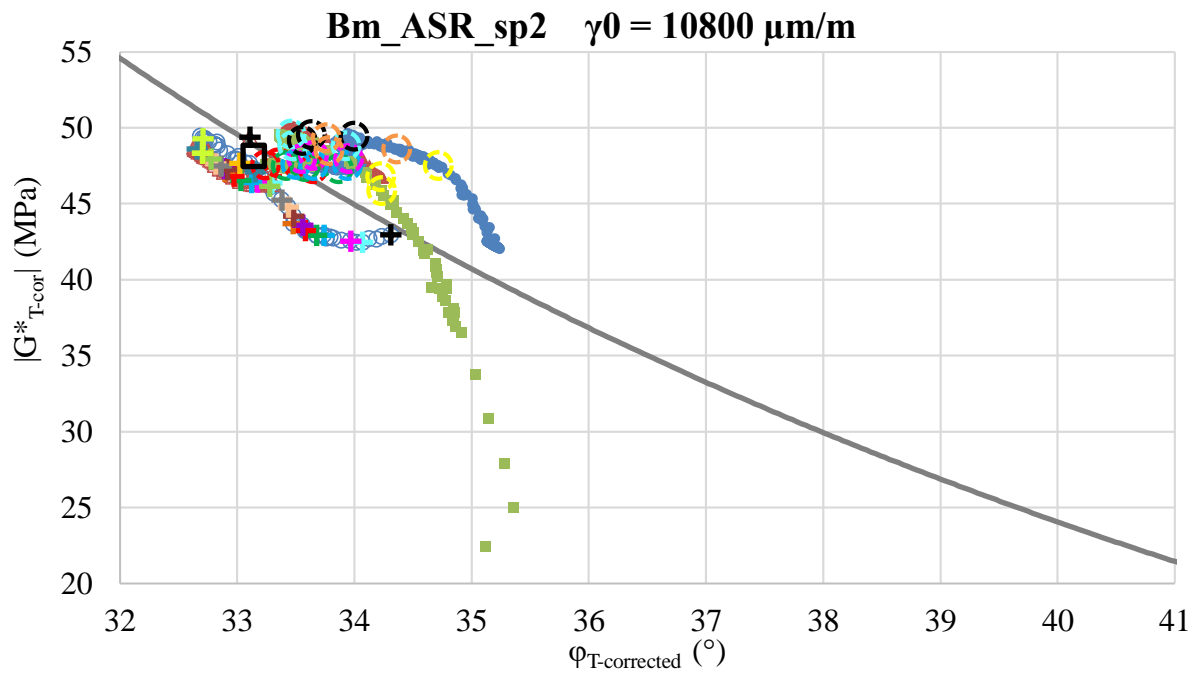
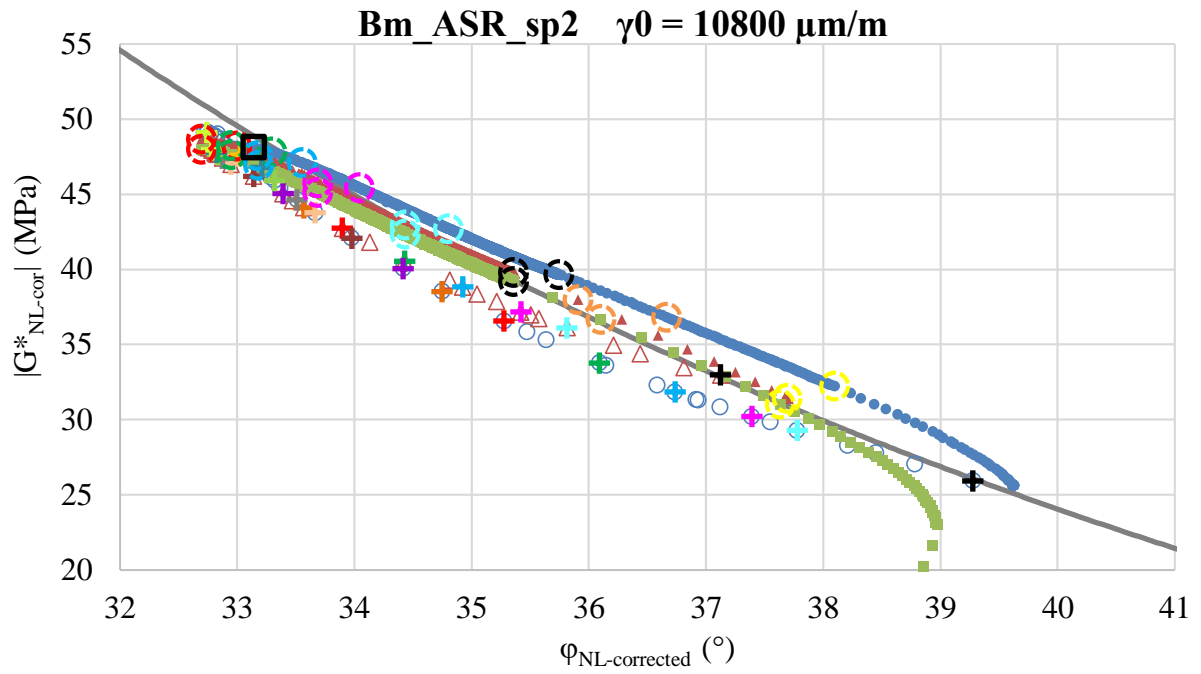
1.5.2. Bm\_ASR

1.5.2.1. Bm\_ASR\_sp2 (10800 $\mu\text{m/m}$ )

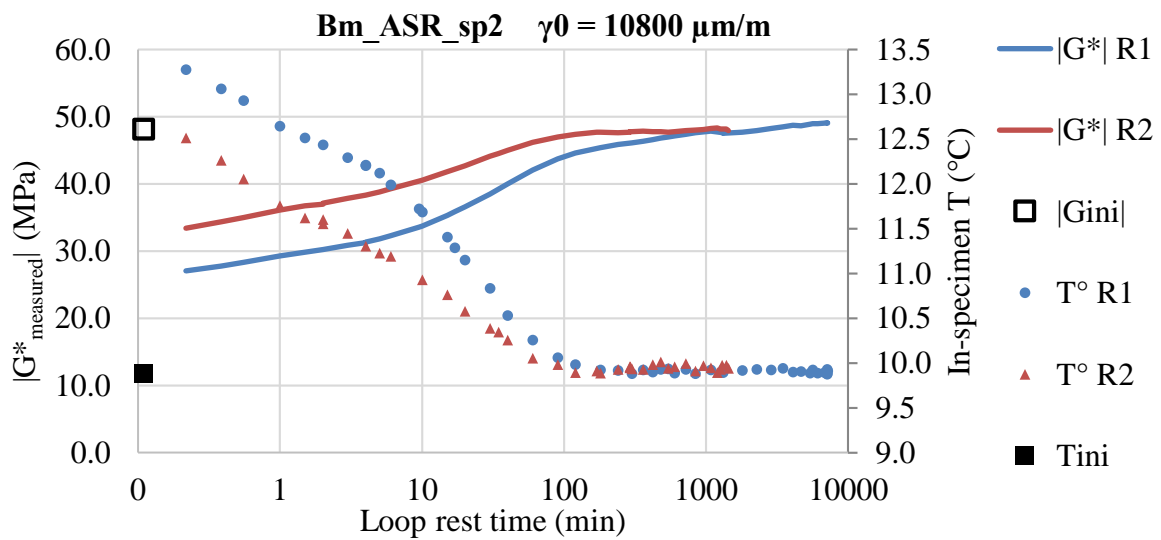
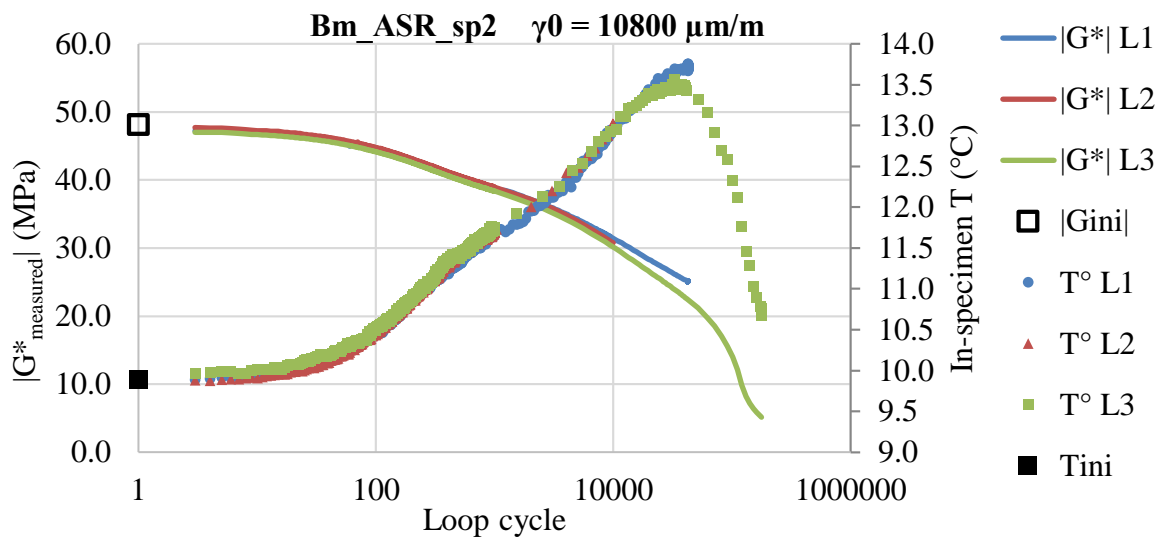
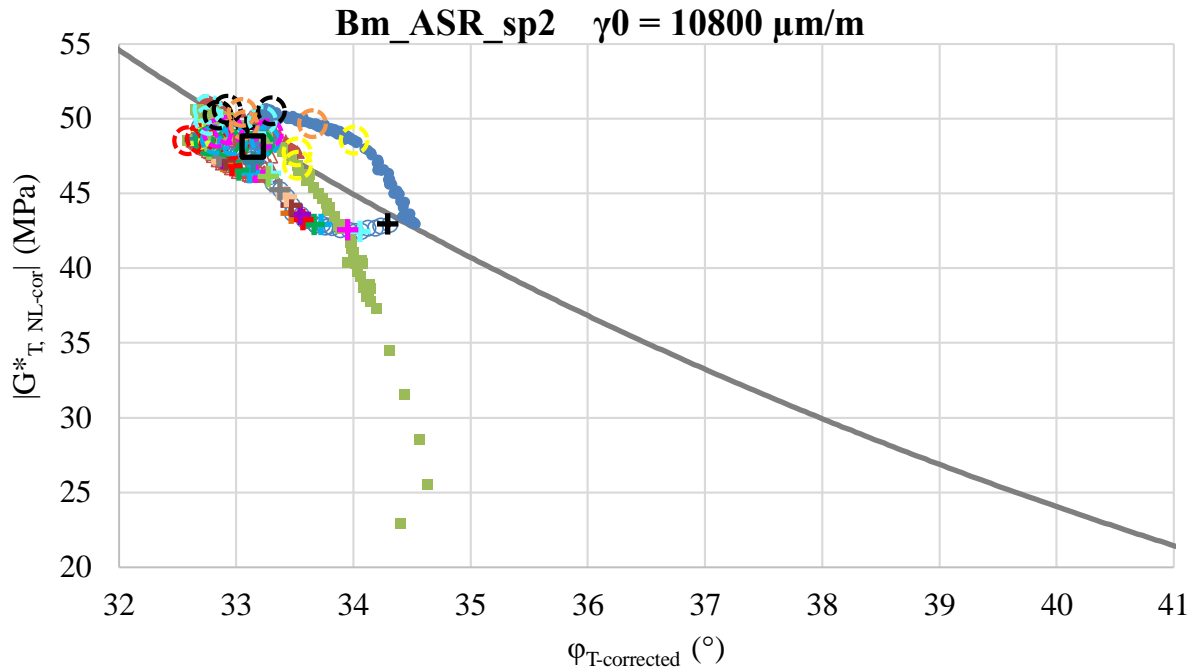
- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | ■ G*ini        | — 2S2P1D        |



1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

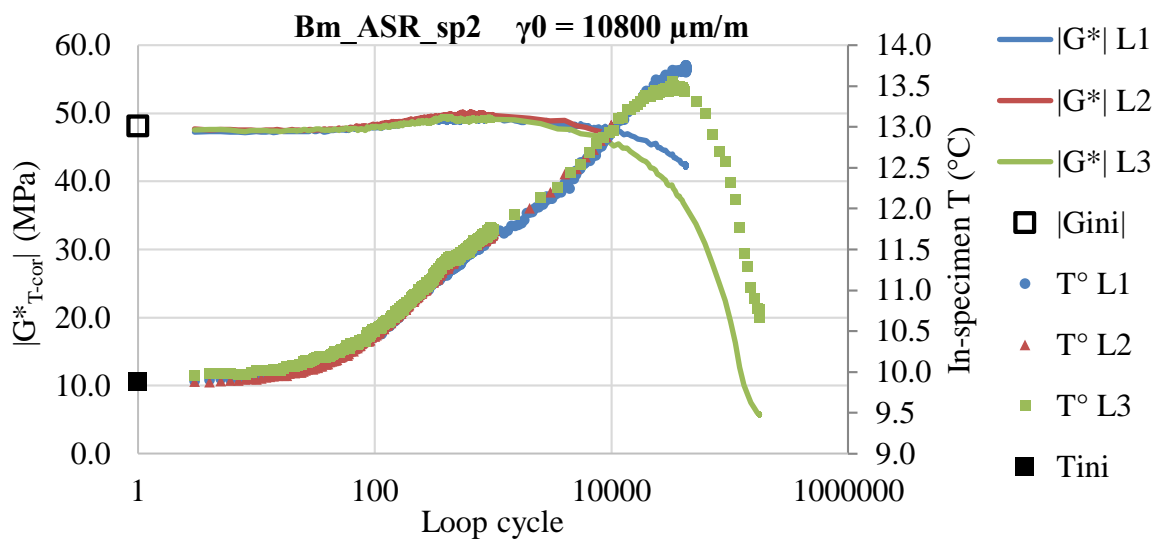
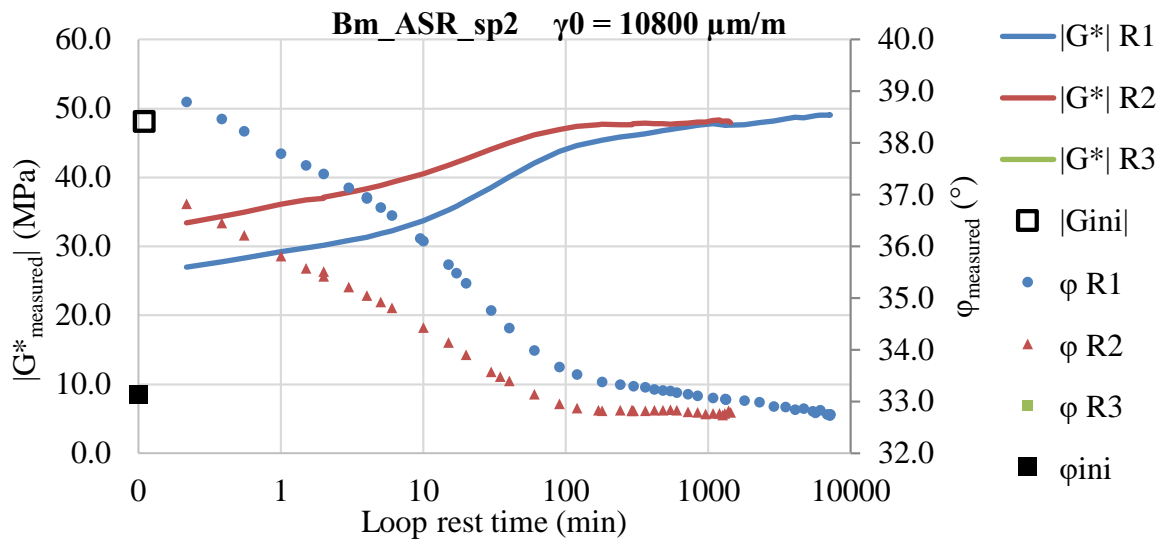
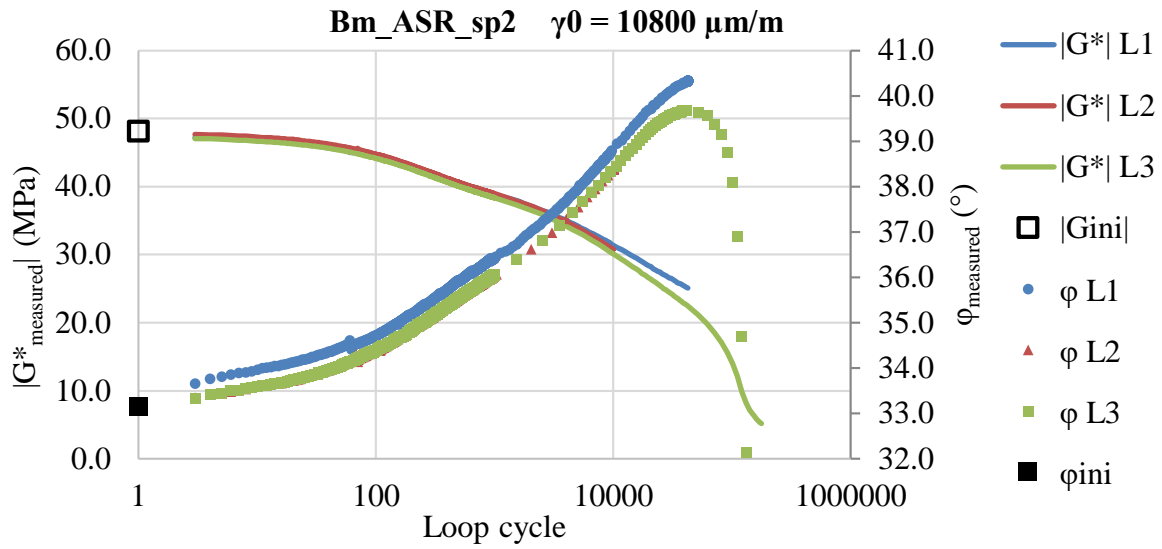


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

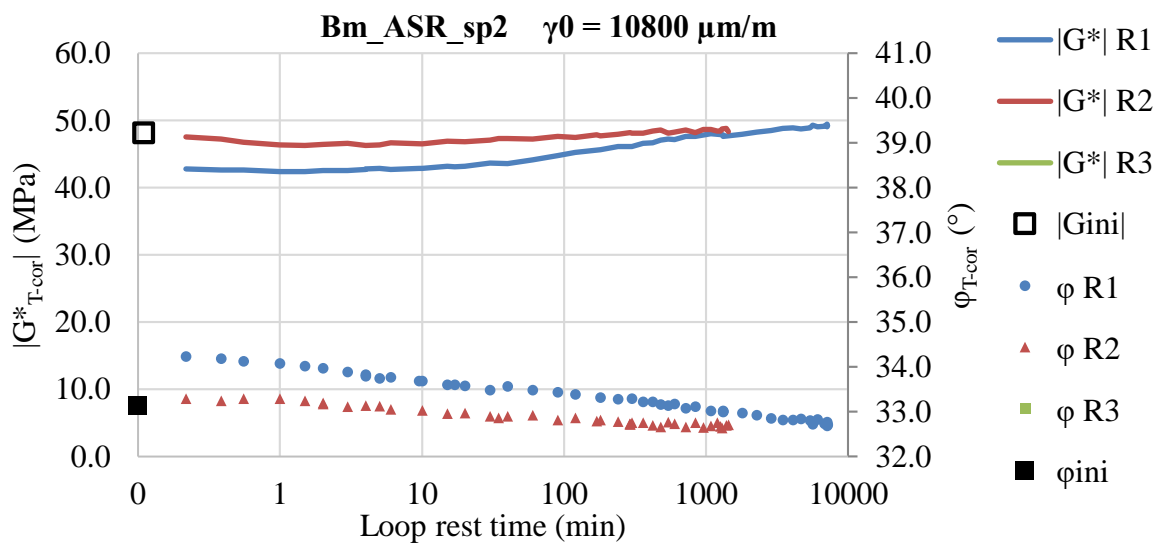
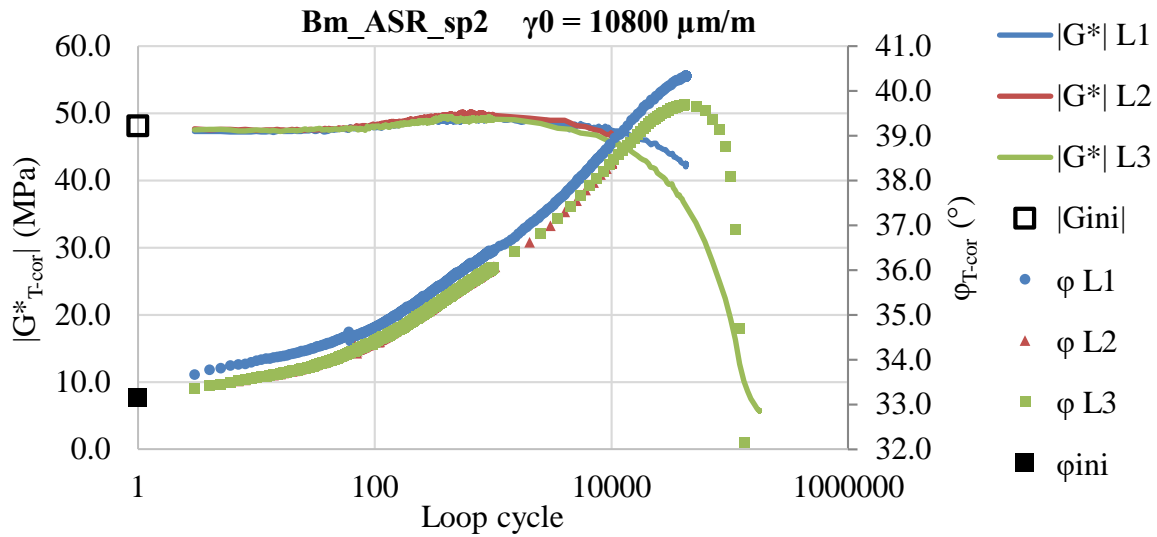
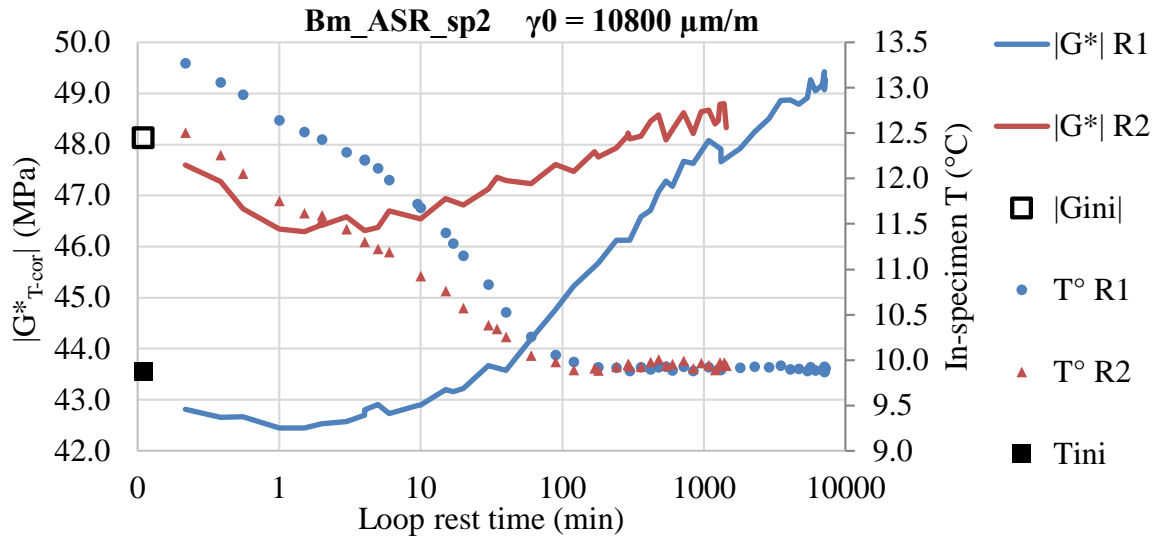




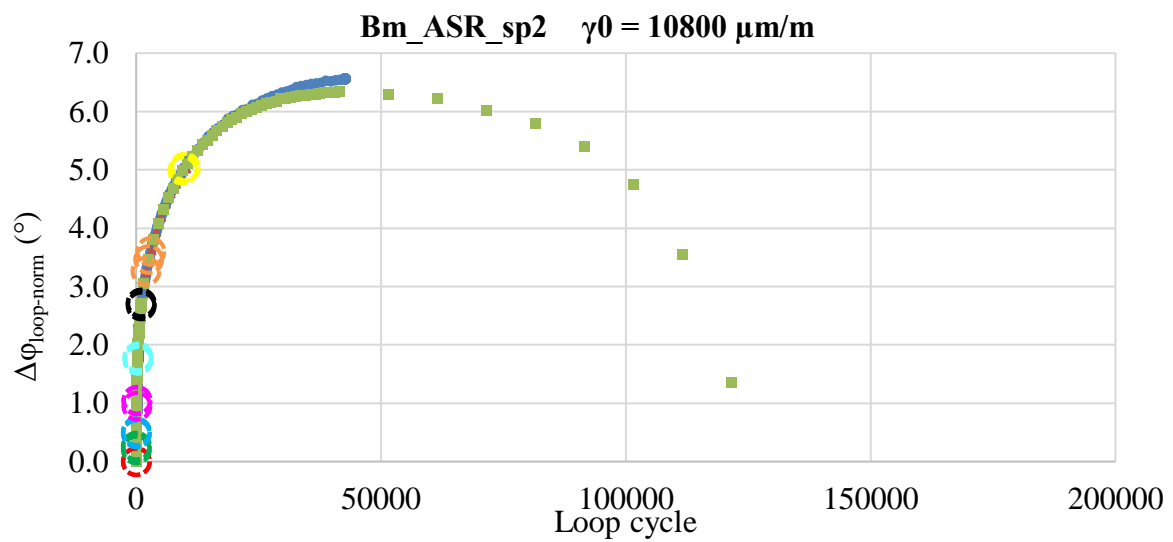
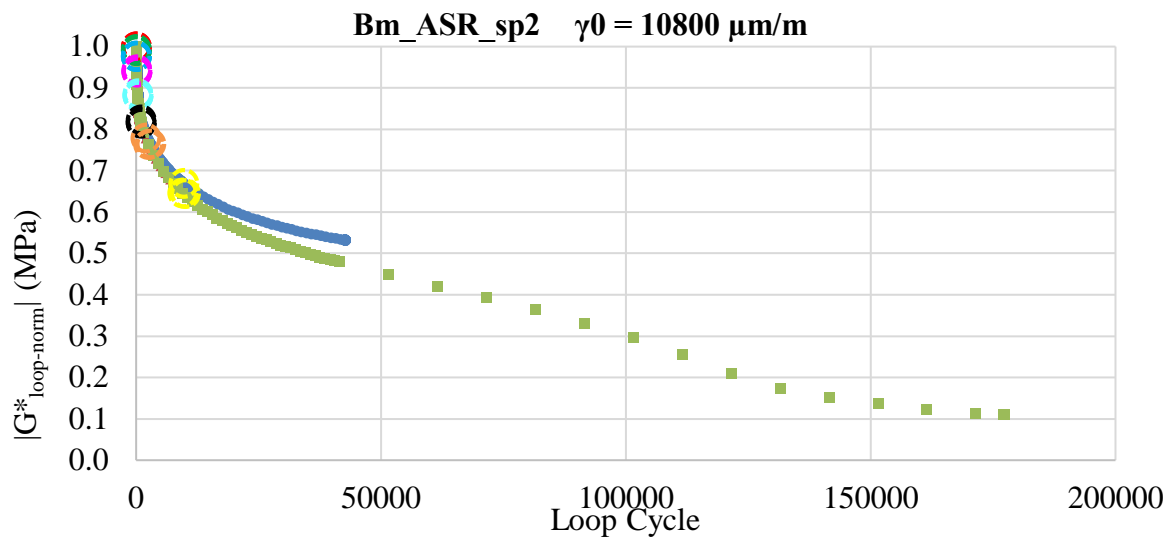
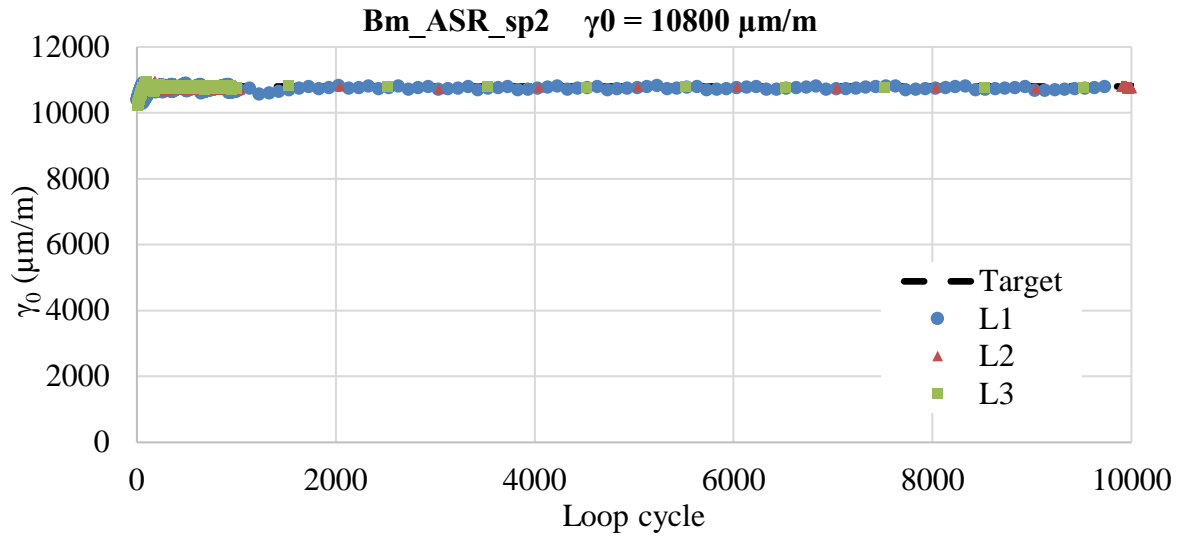
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



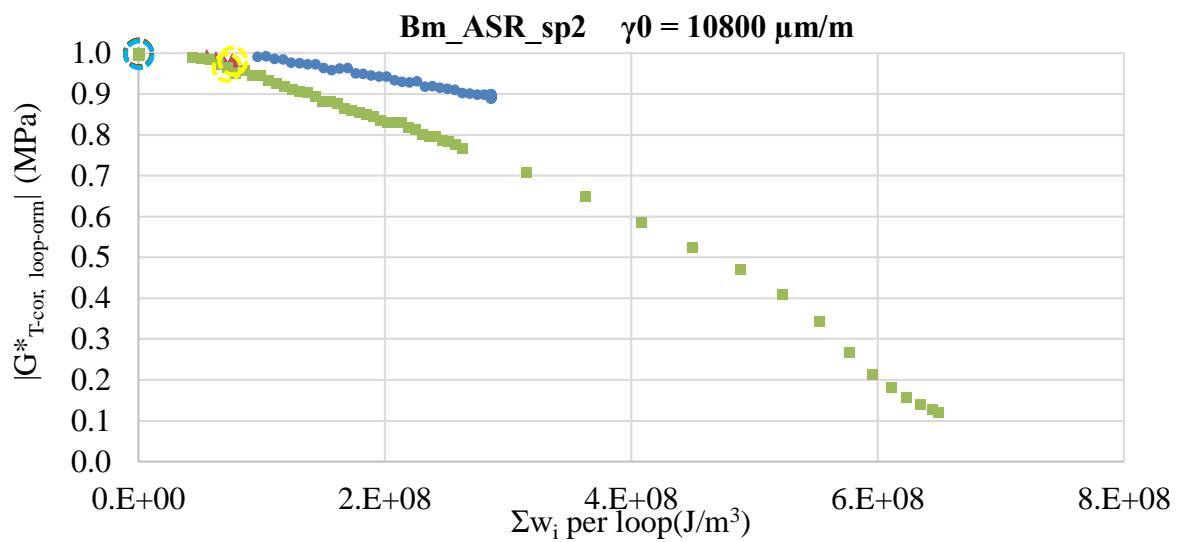
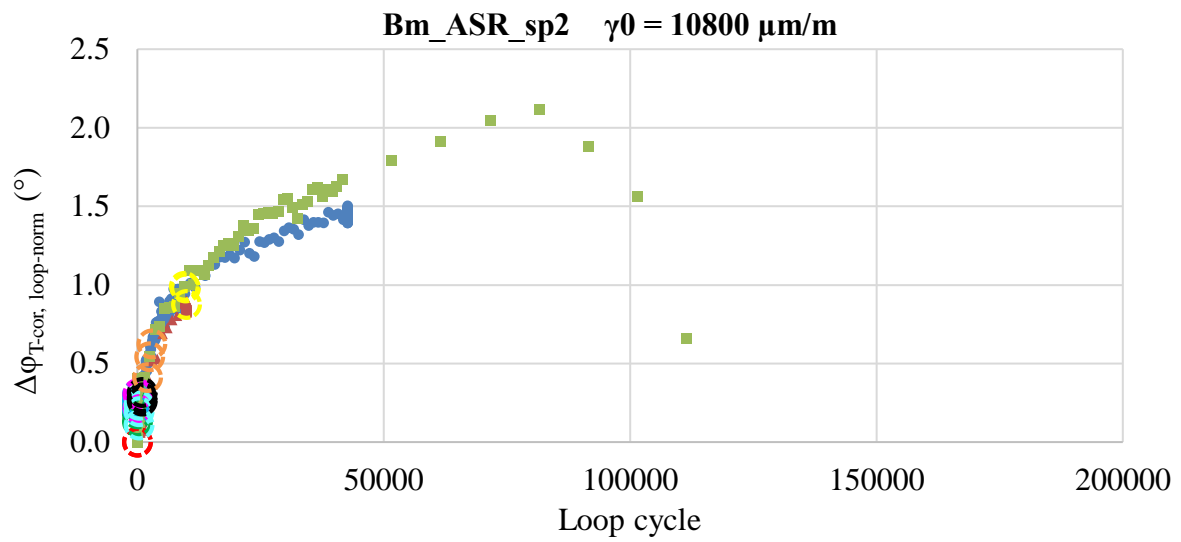
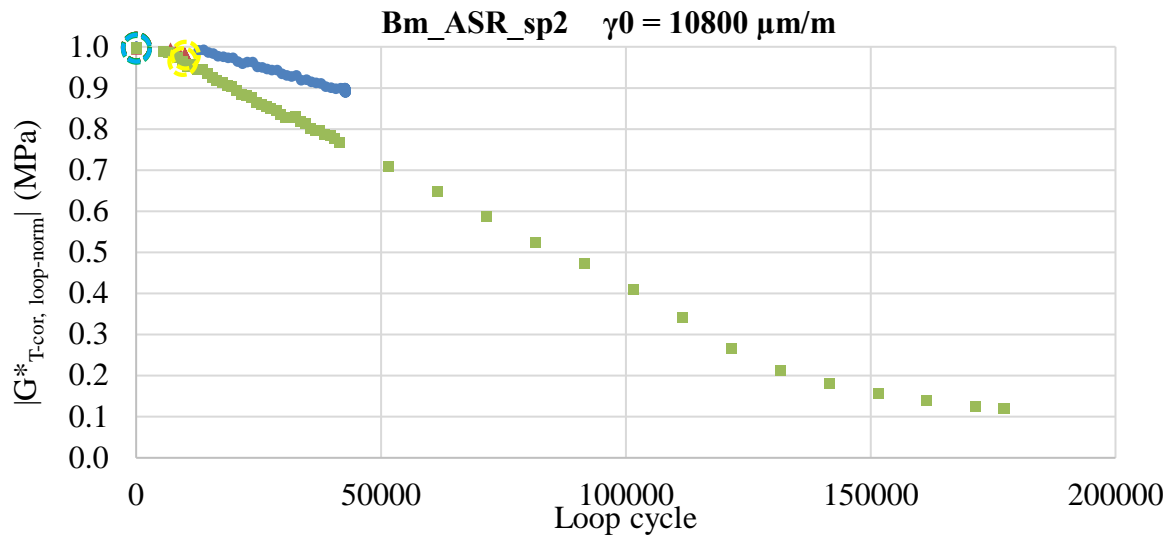
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



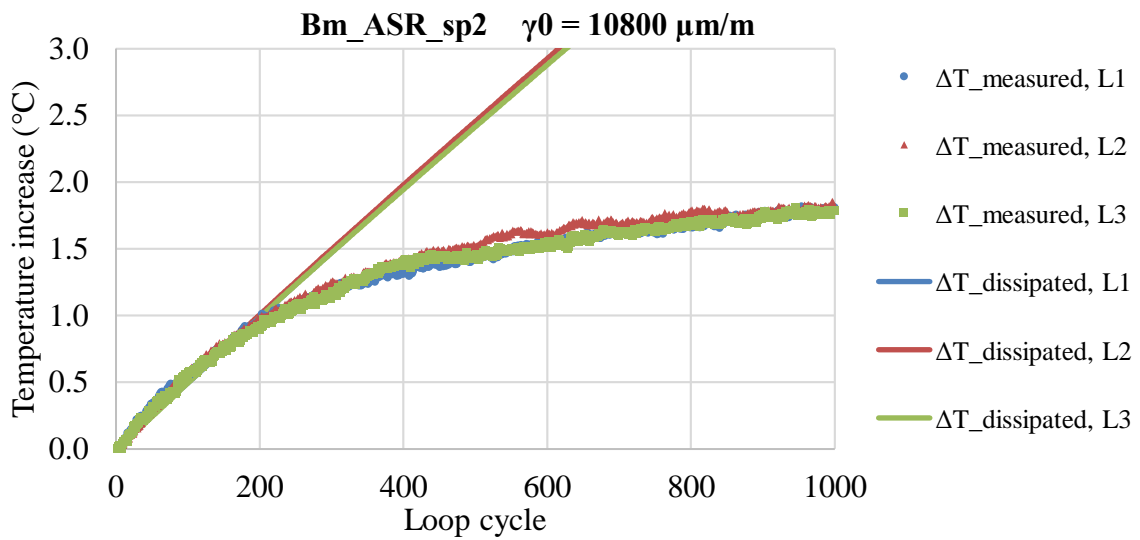
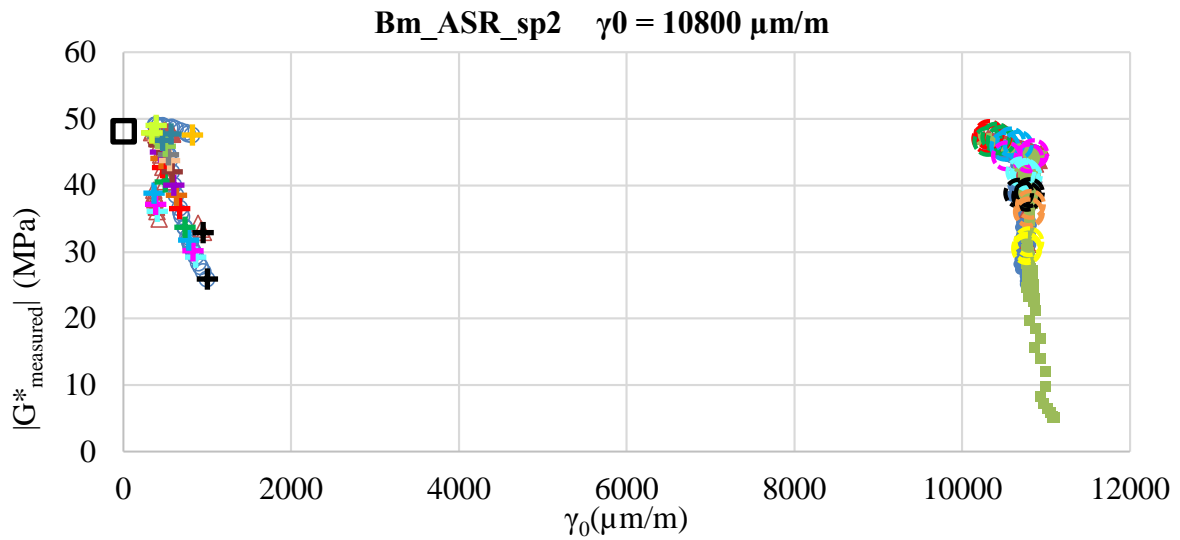
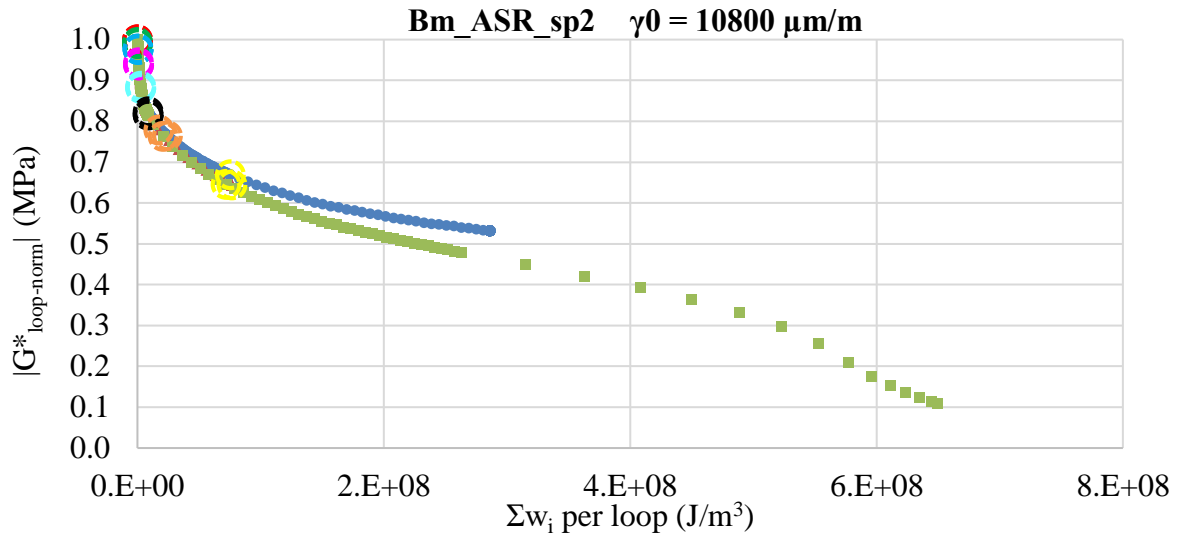
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



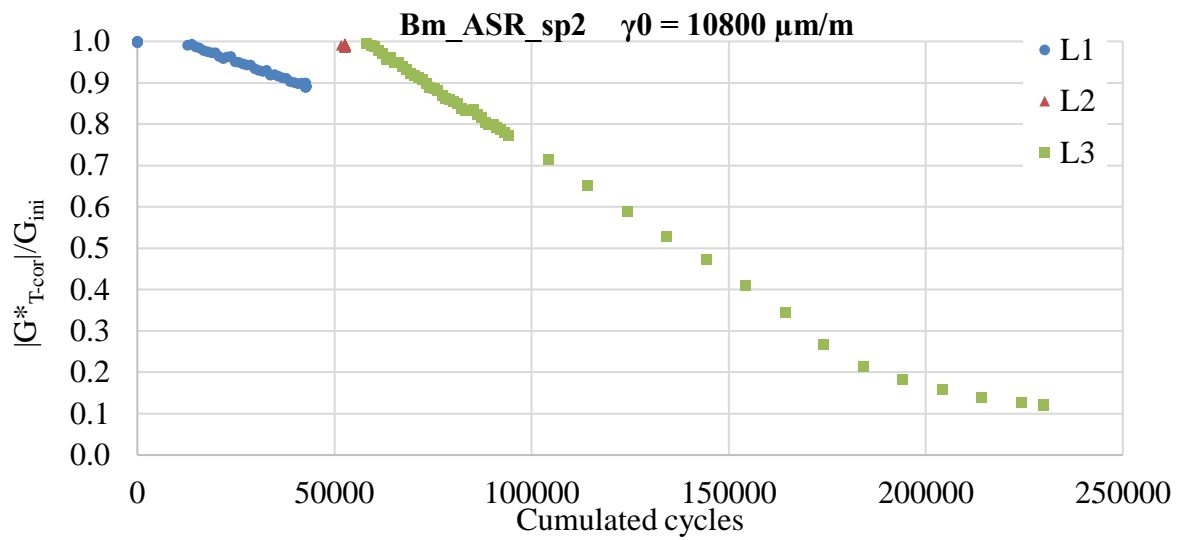
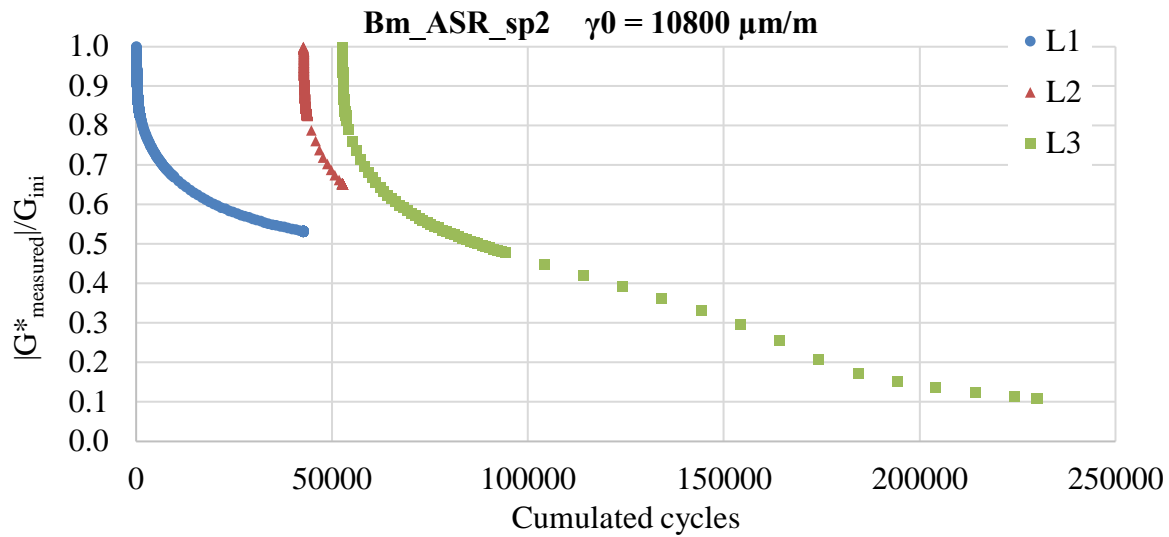
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



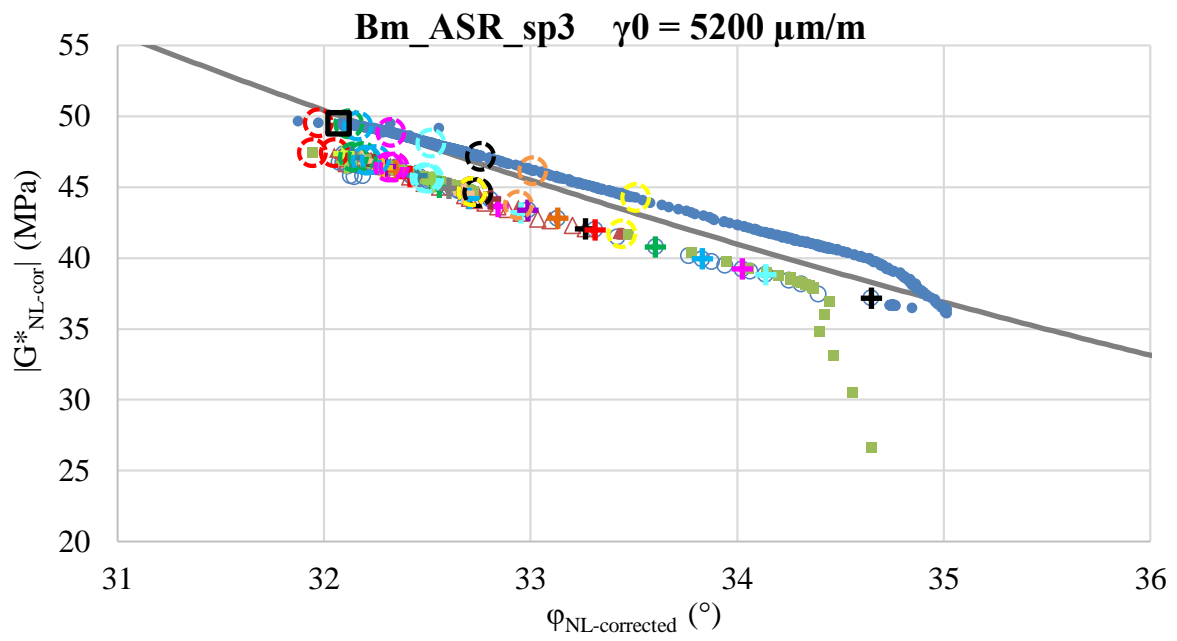
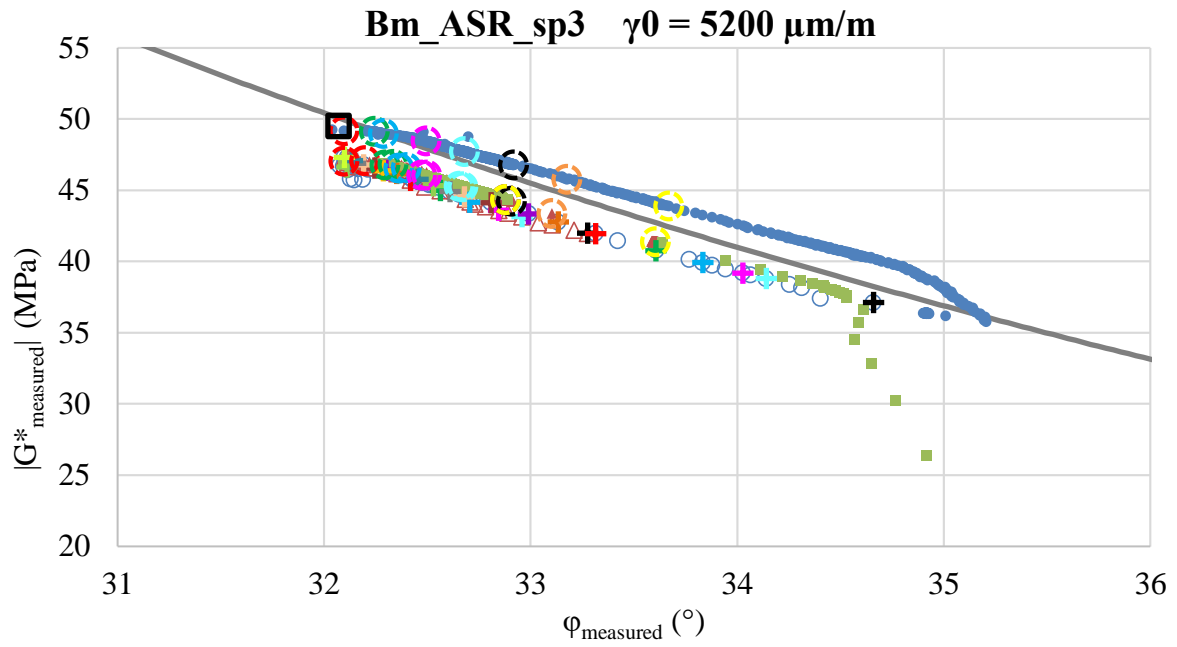
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



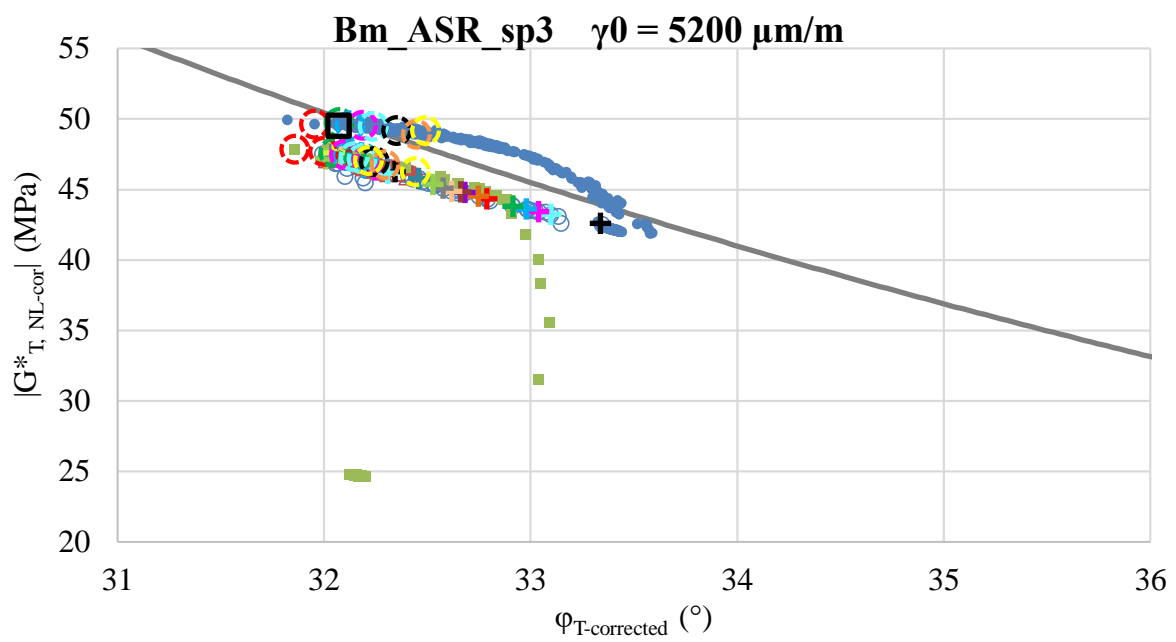
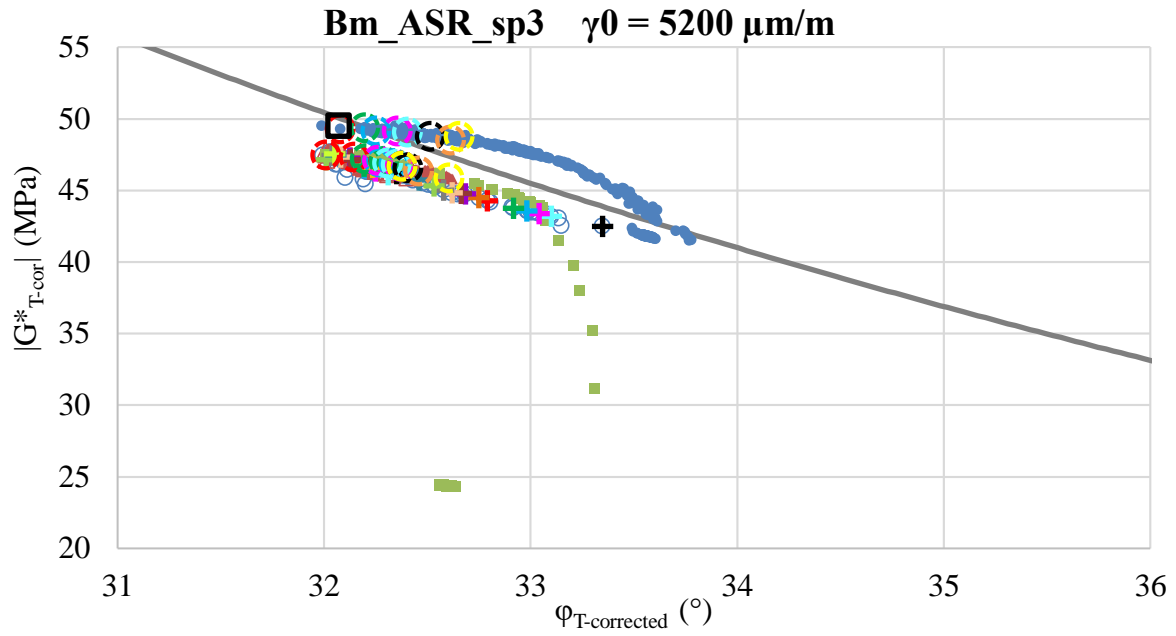
1.5.2.2. Bm\_ASR\_sp3 (5200 $\mu$ m/m)

- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G*ini        | — 2S2P1D        |

1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

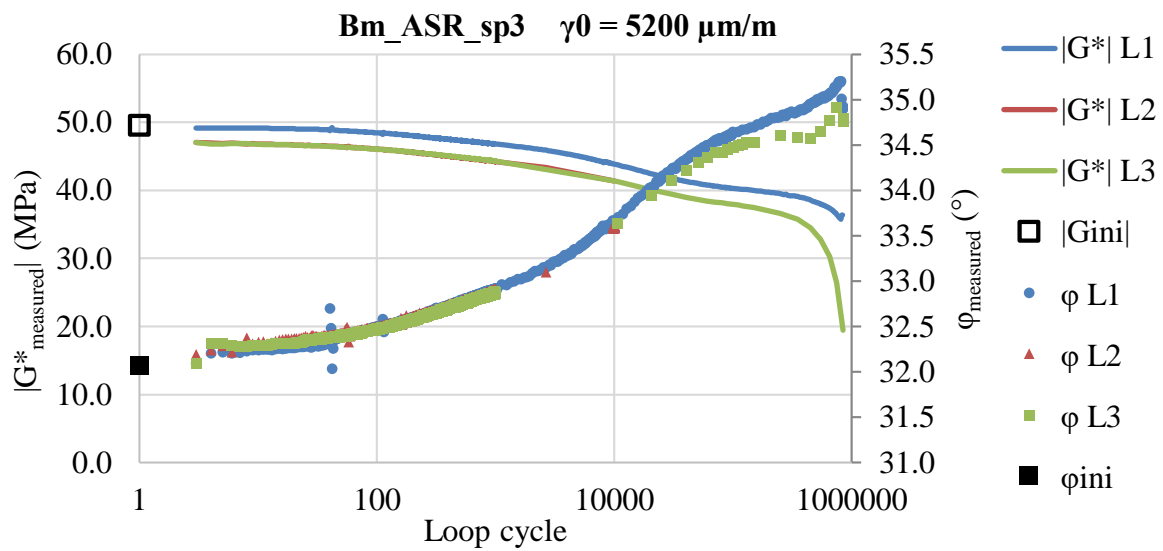
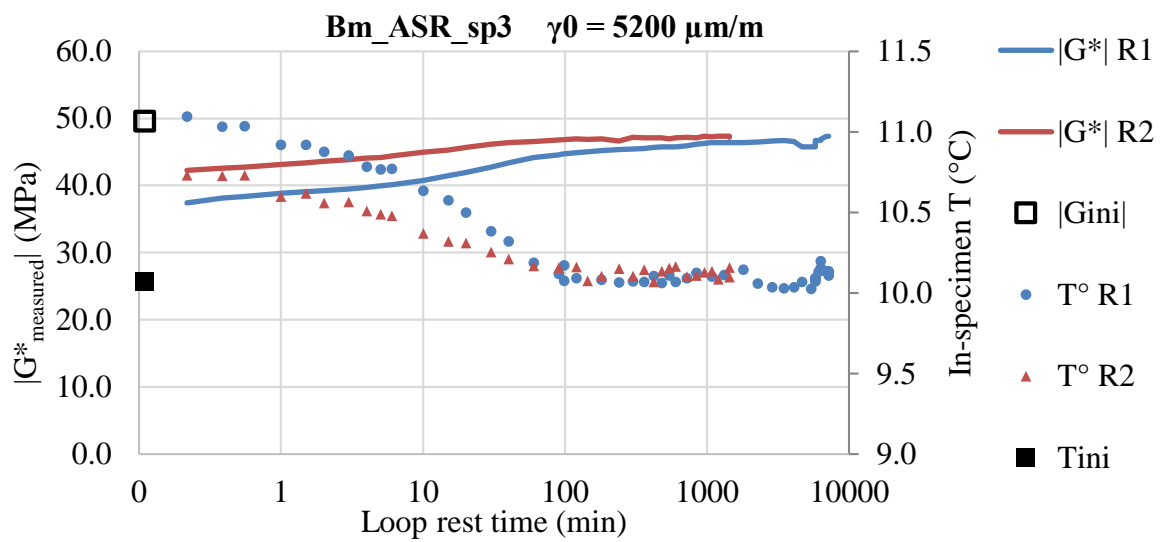
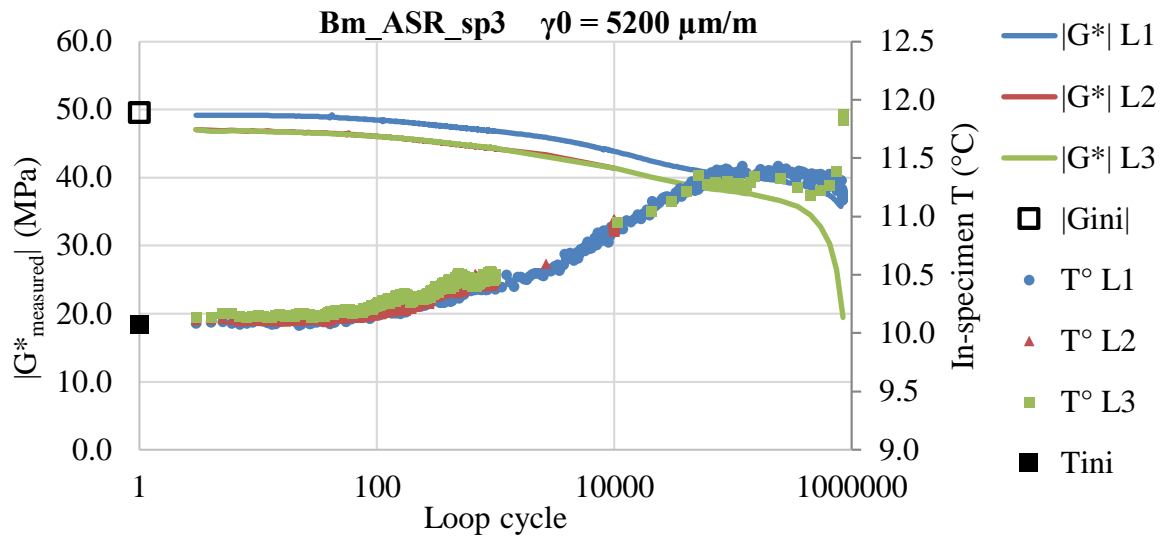


1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

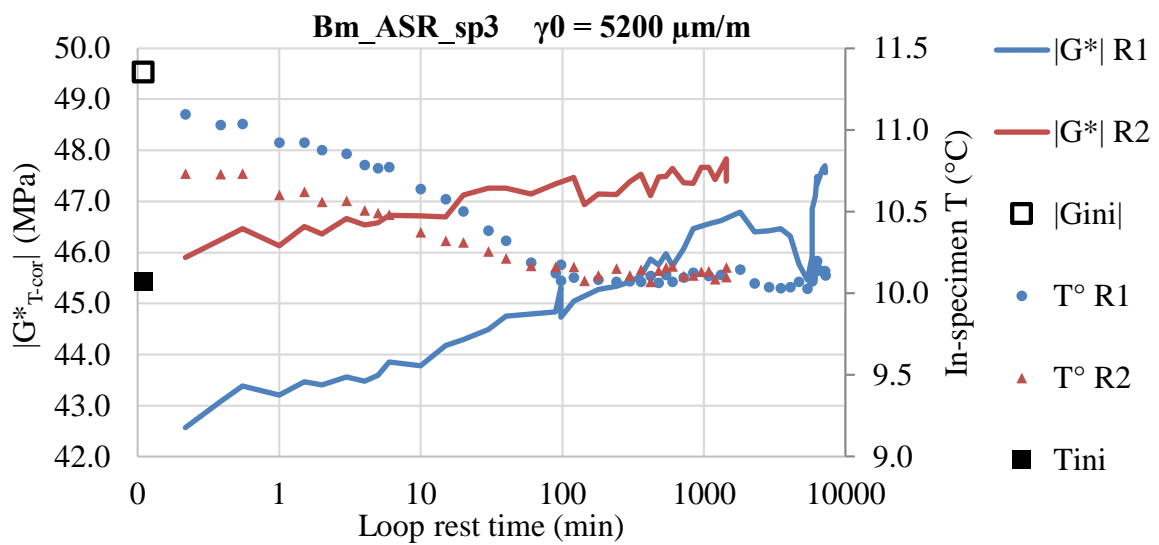
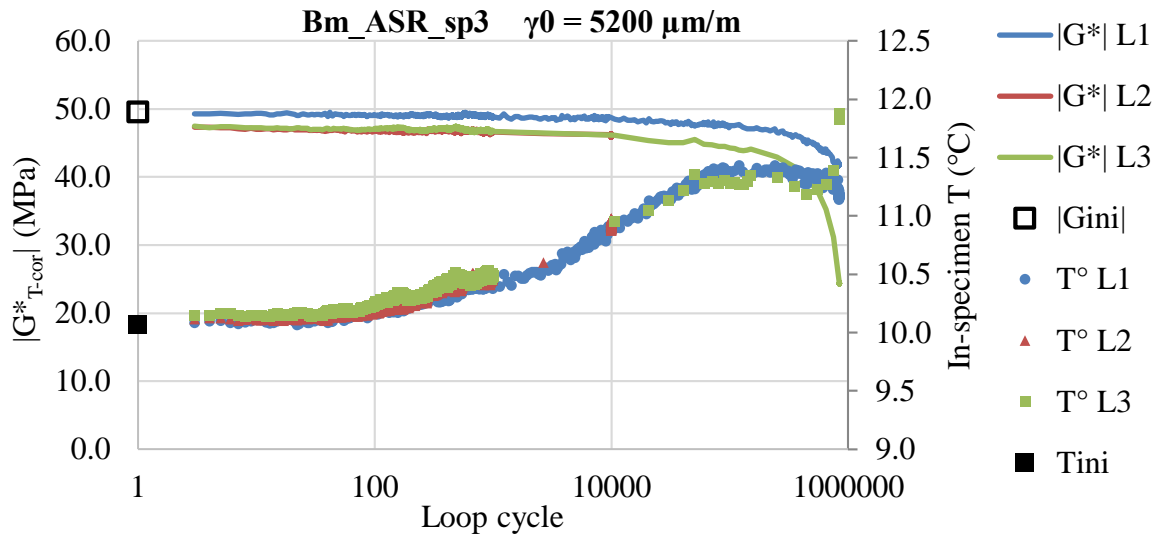
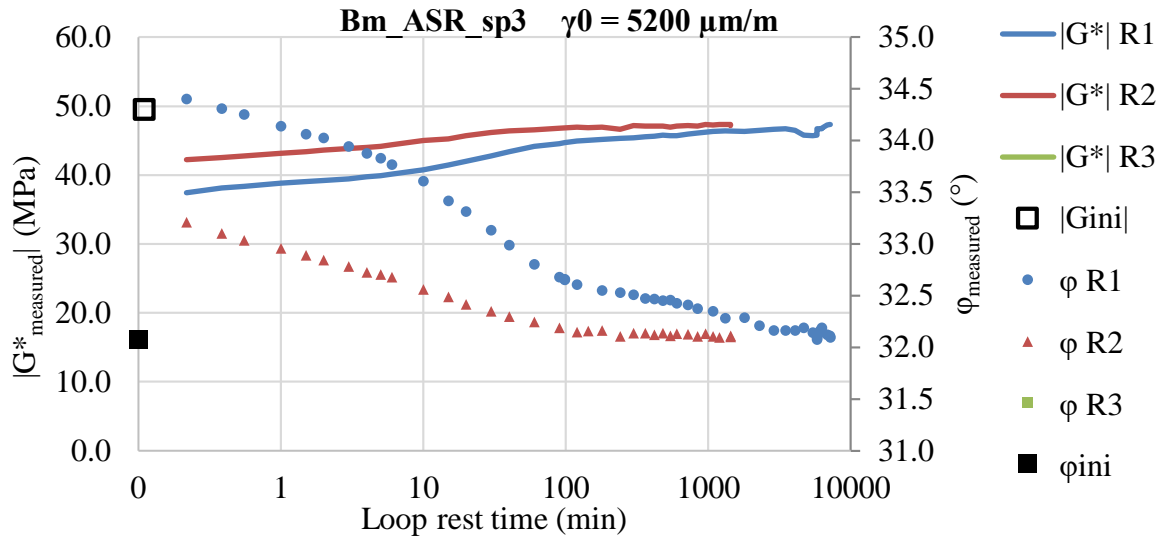




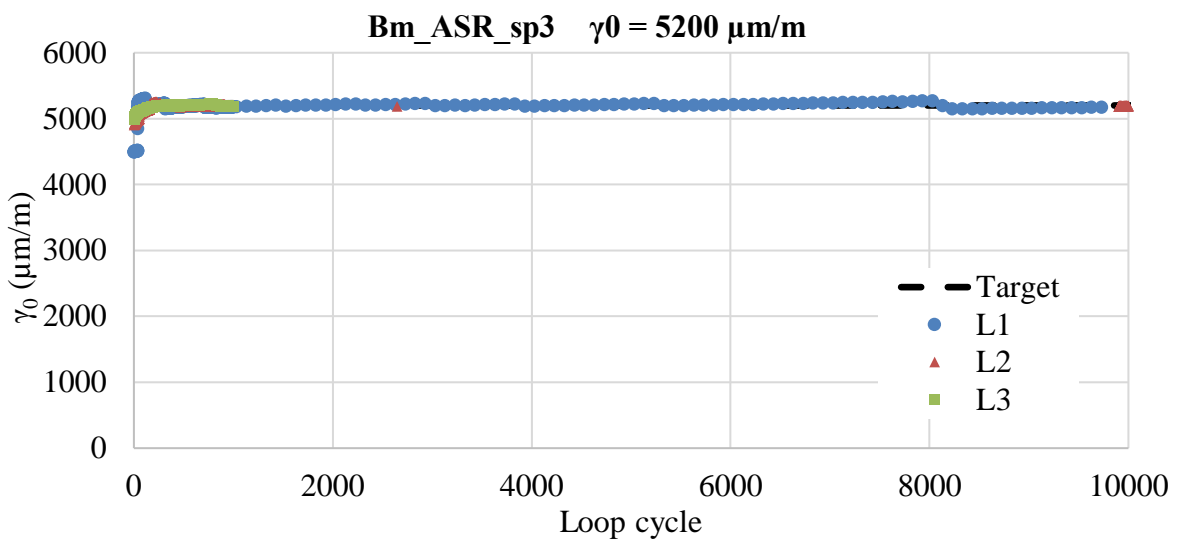
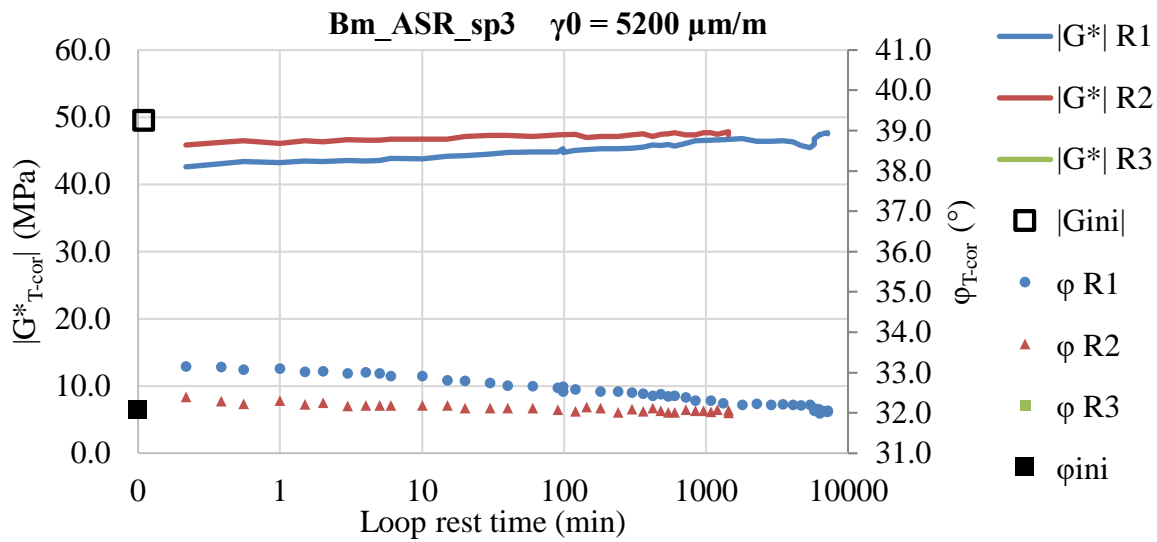
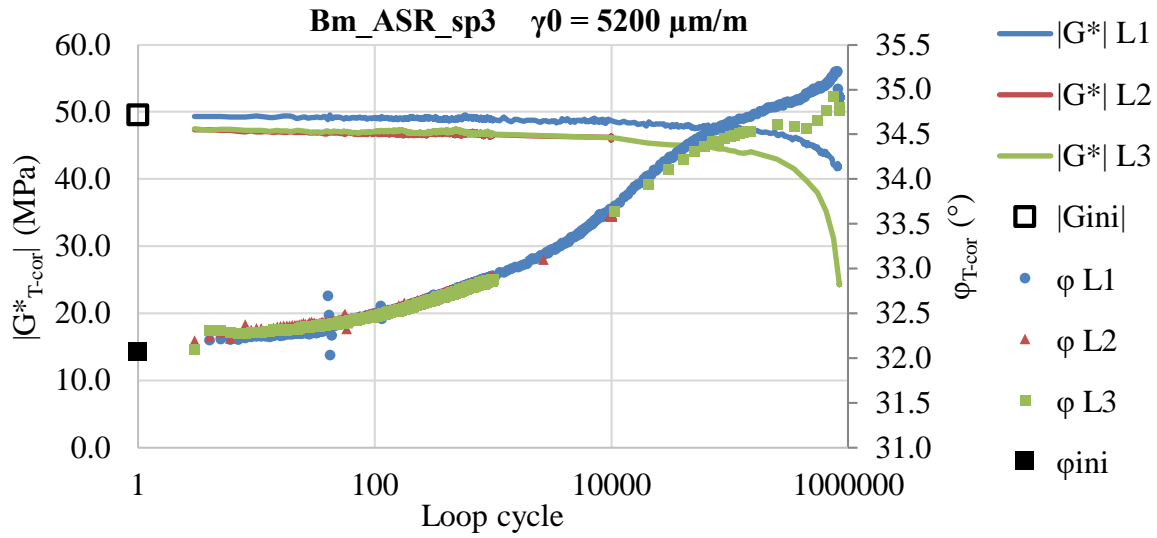
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



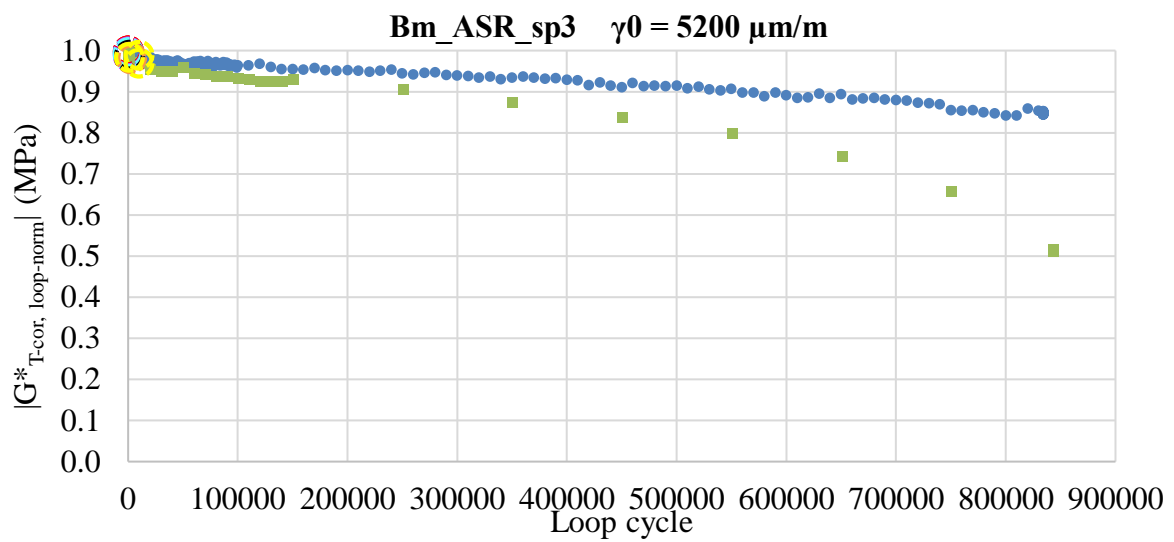
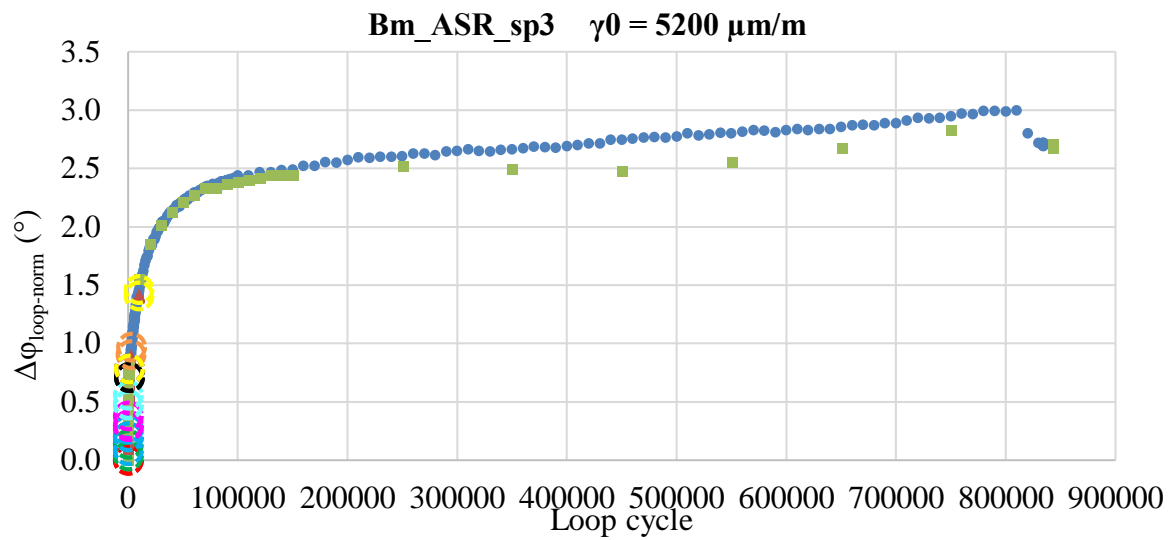
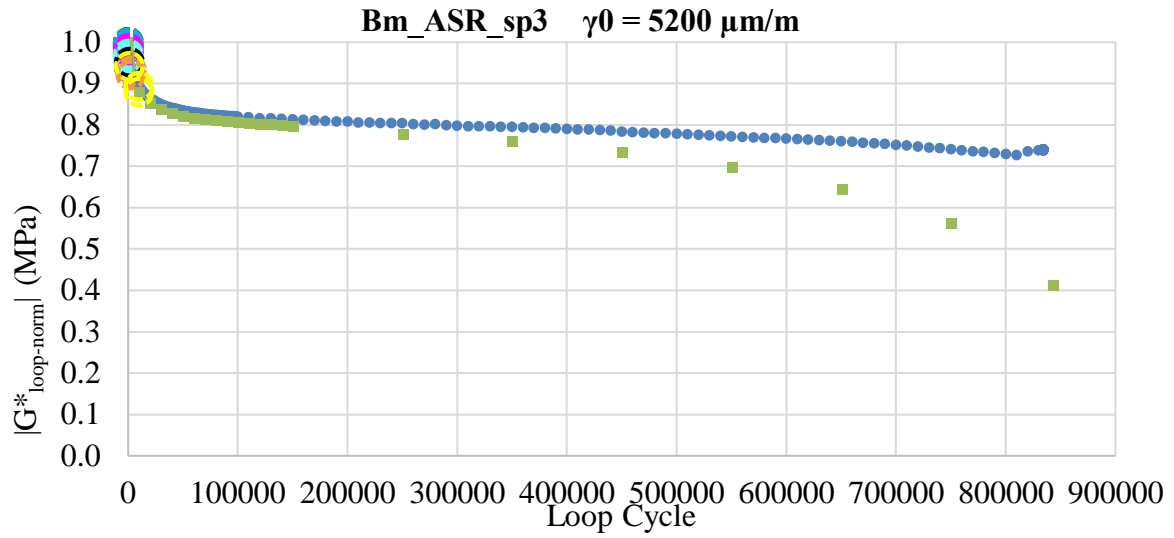
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



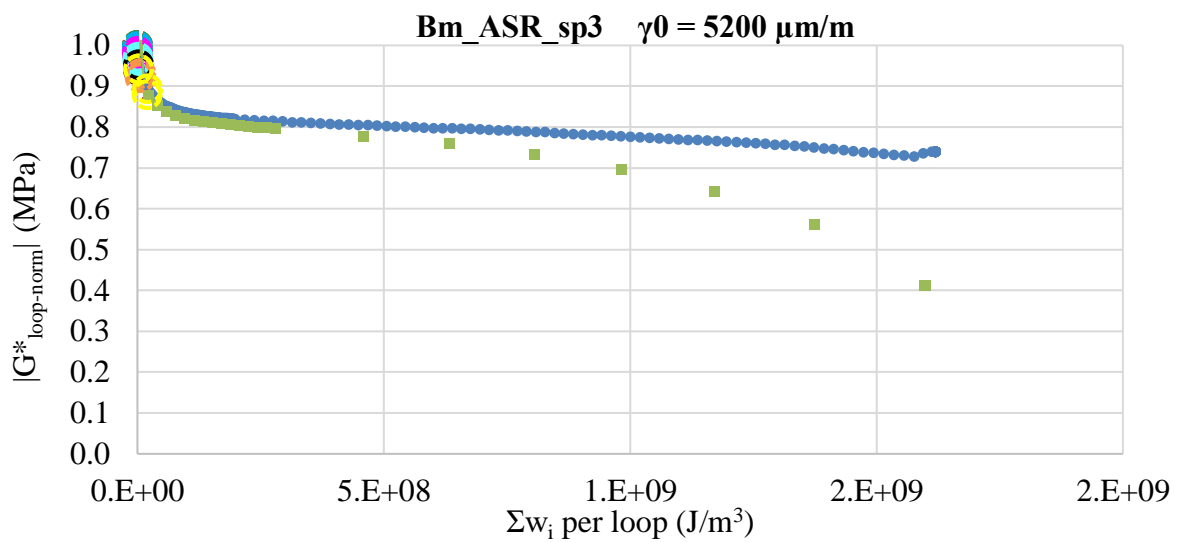
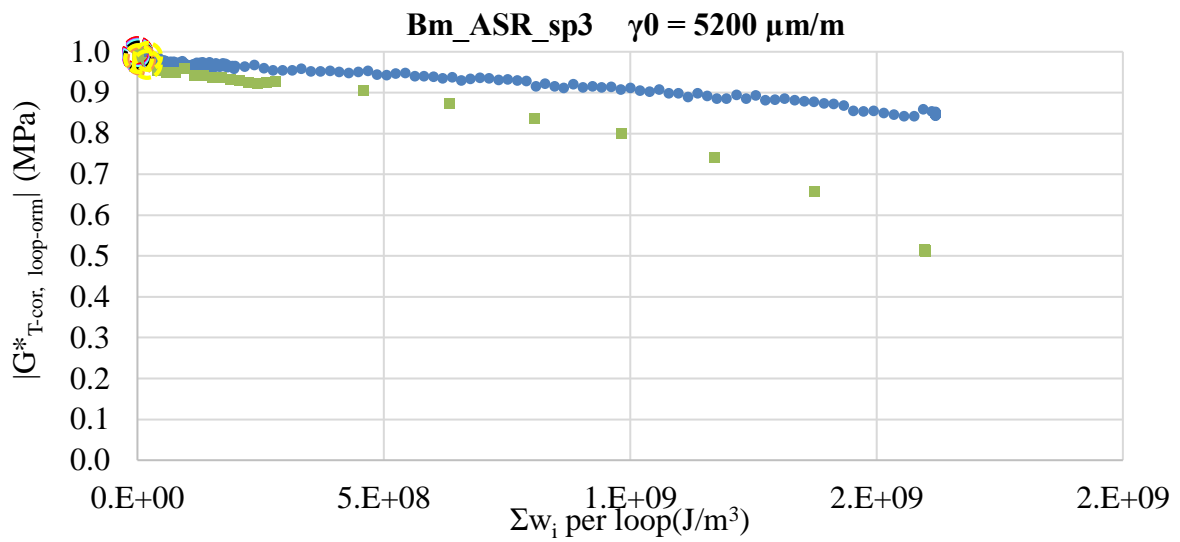
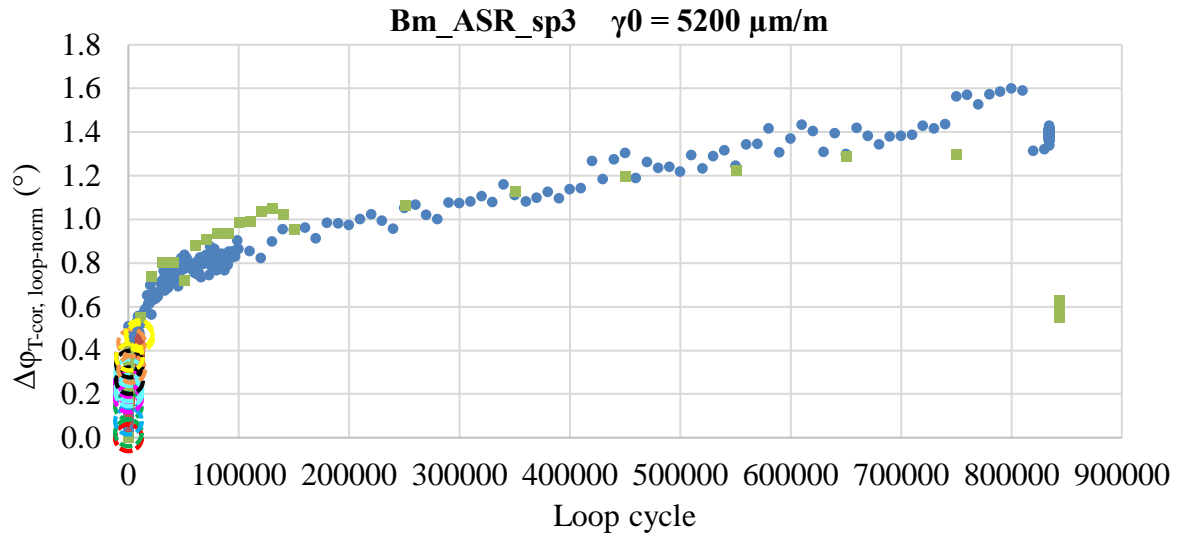
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



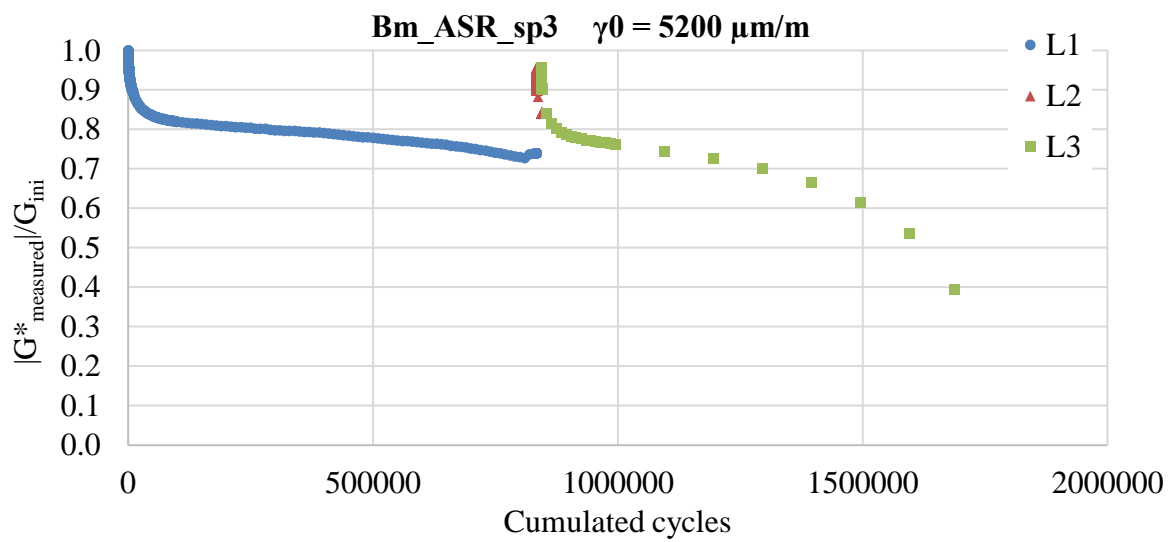
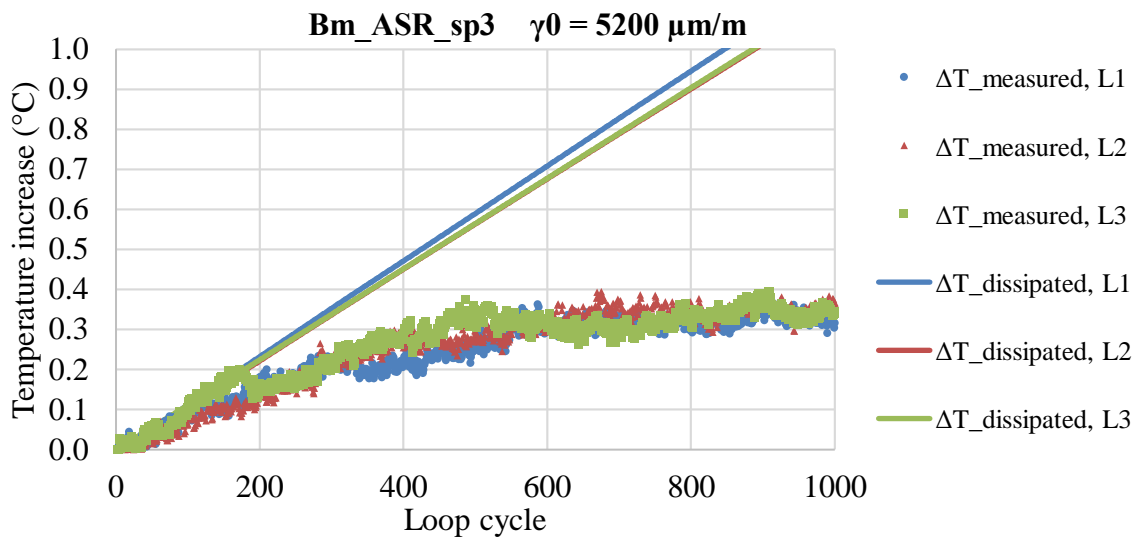
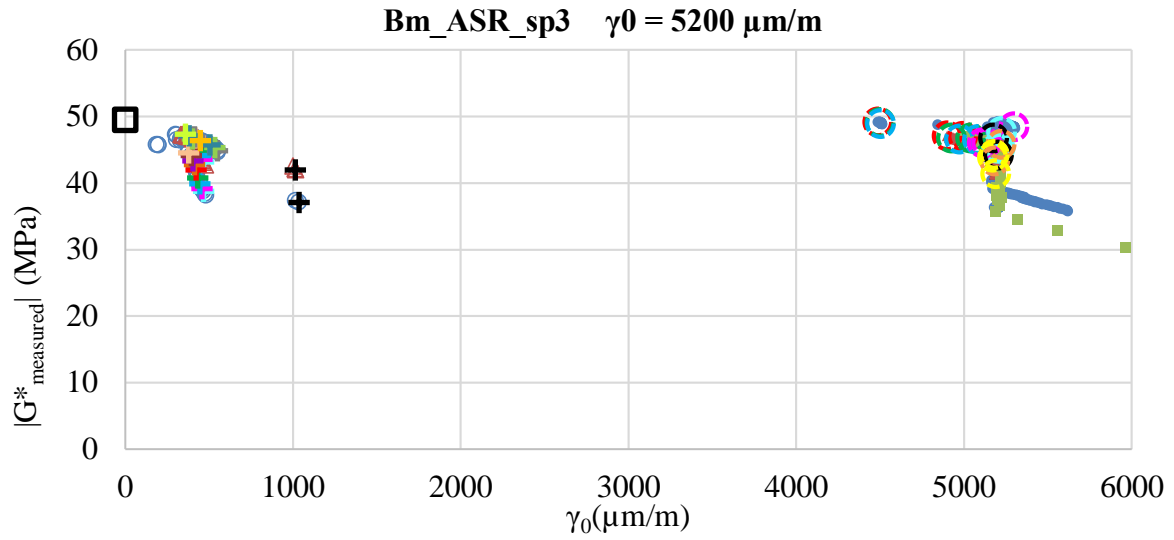
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



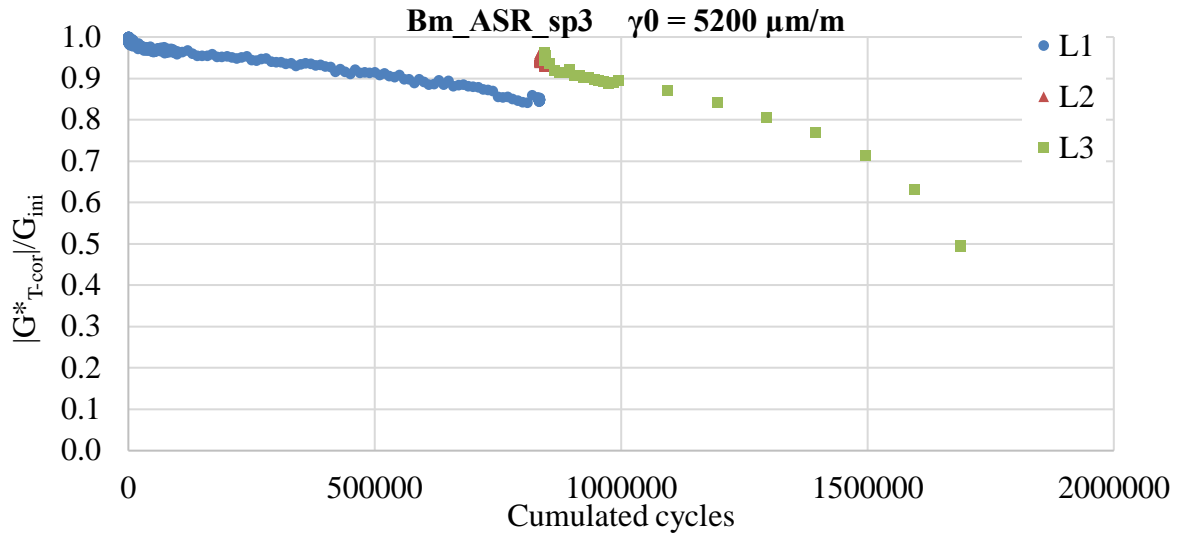
1 Thermomechanical tests on bituminous binders  
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1 Thermomechanical tests on bituminous binders  
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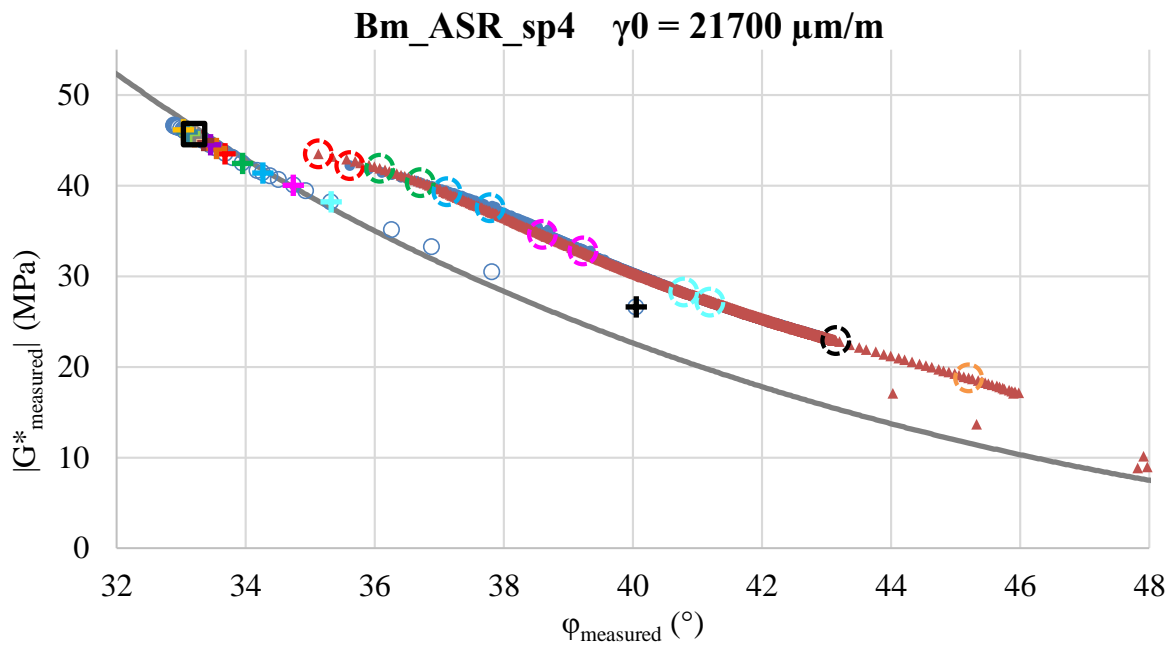


1 Thermomechanical tests on bituminous binders  
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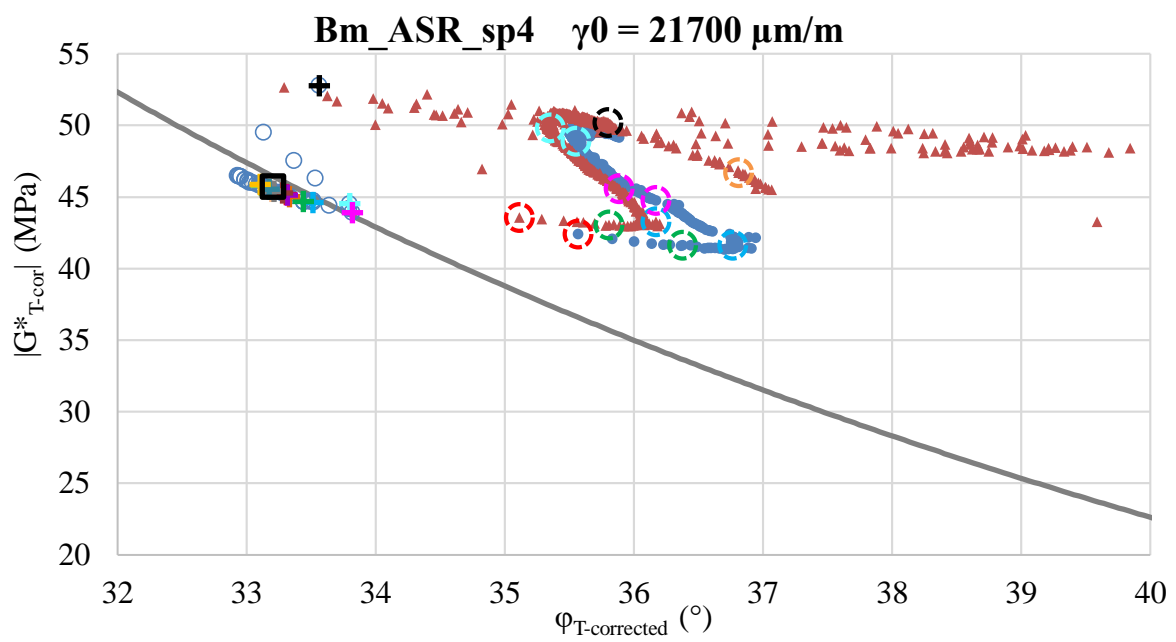
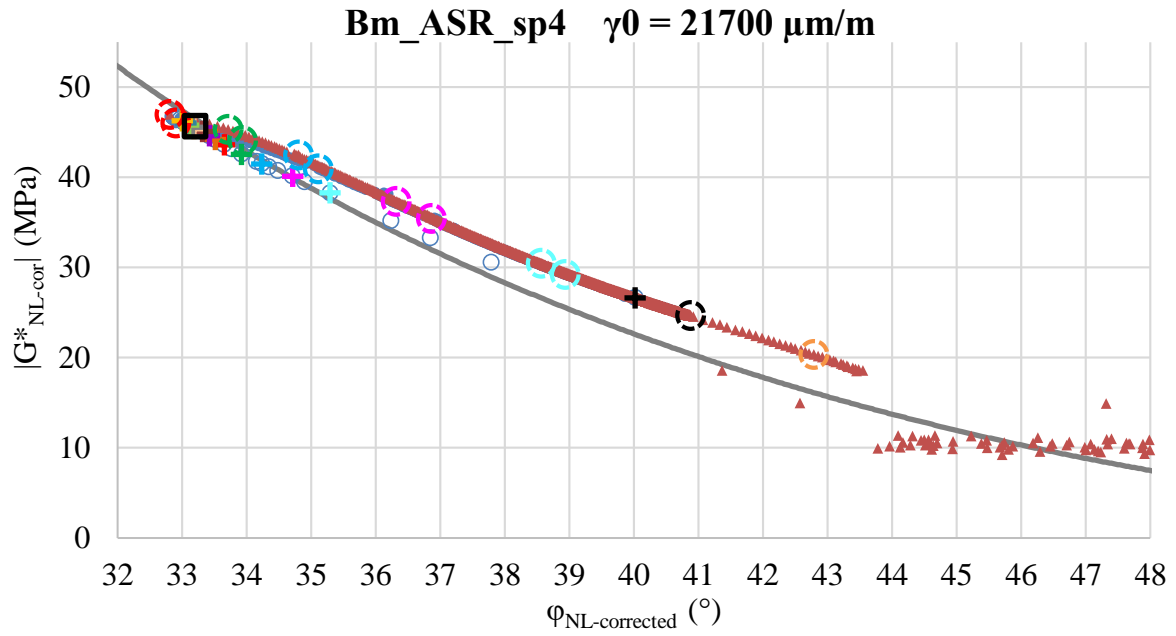


1.5.2.3. Bm\_ASR\_sp4 (21700 $\mu\text{m/m}$ )

- |                 |                 |                 |                     |                 |
|-----------------|-----------------|-----------------|---------------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2                | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min       | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min      | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day      | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100         | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G* <sub>ini</sub> | — 2S2P1D        |

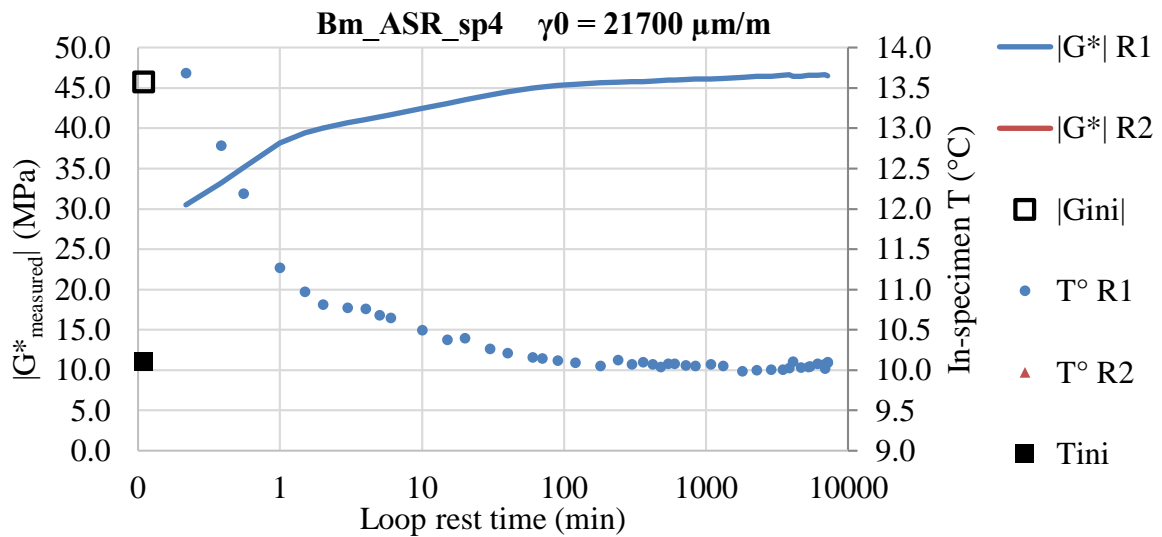
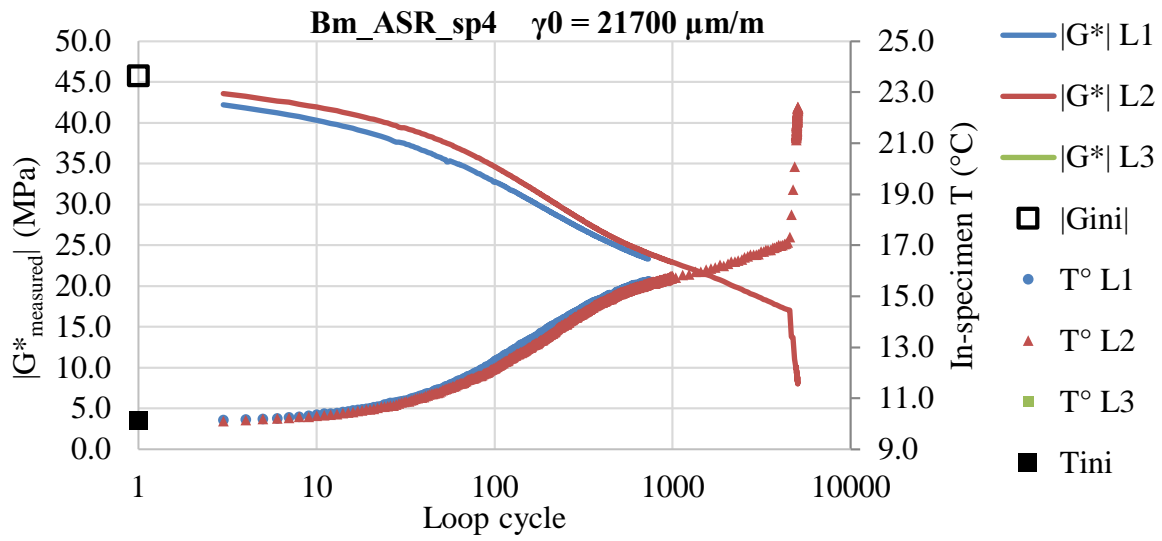
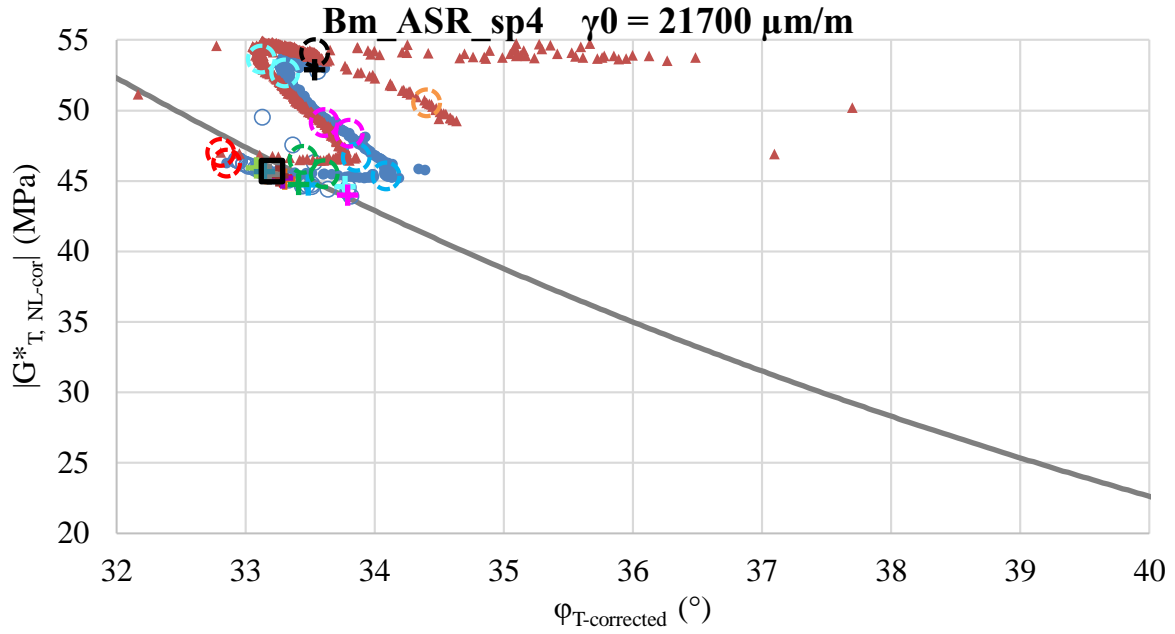


1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

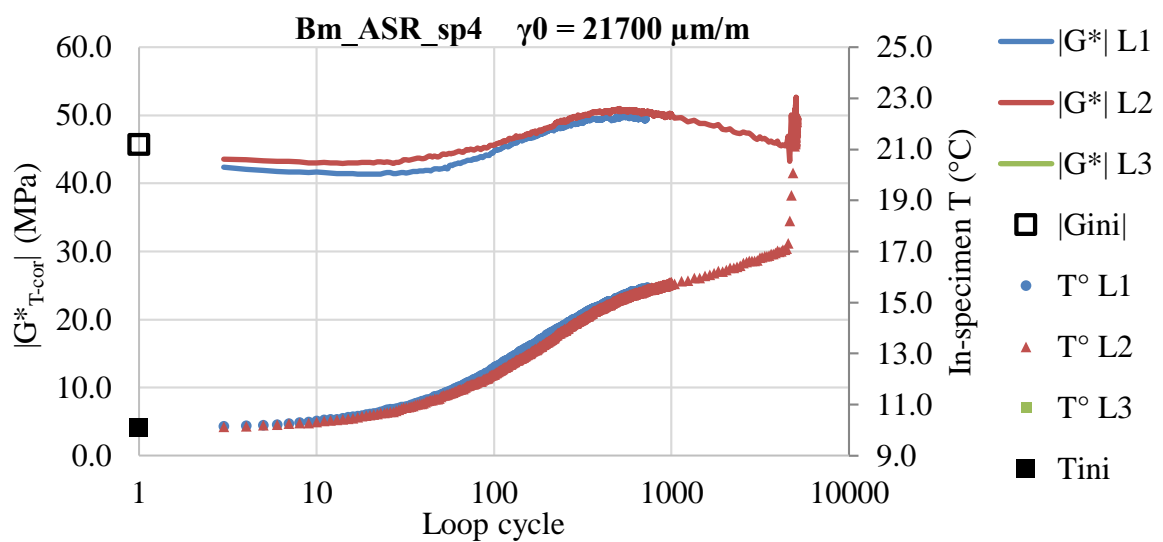
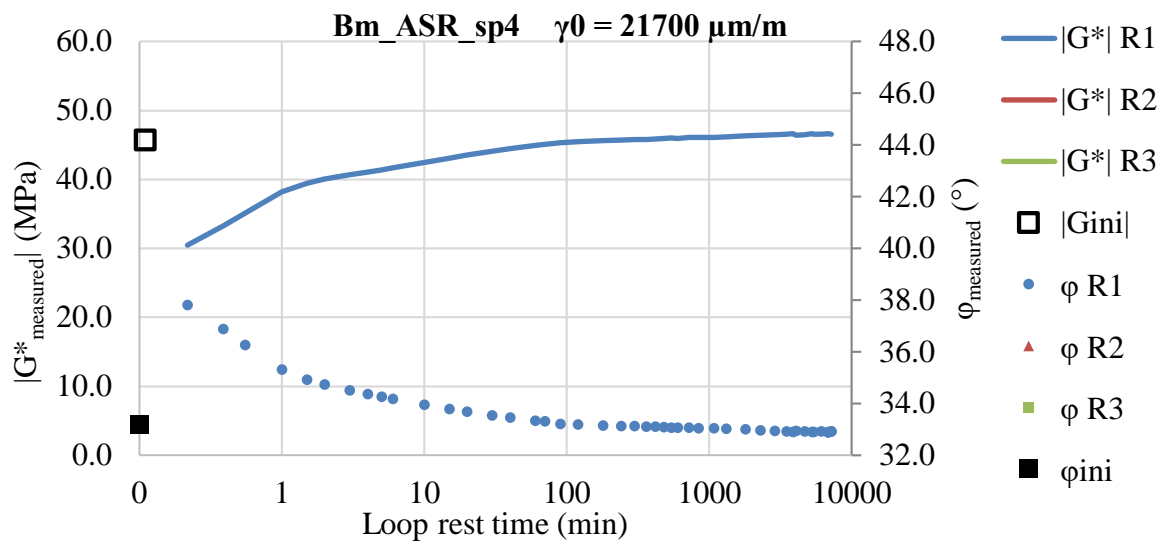
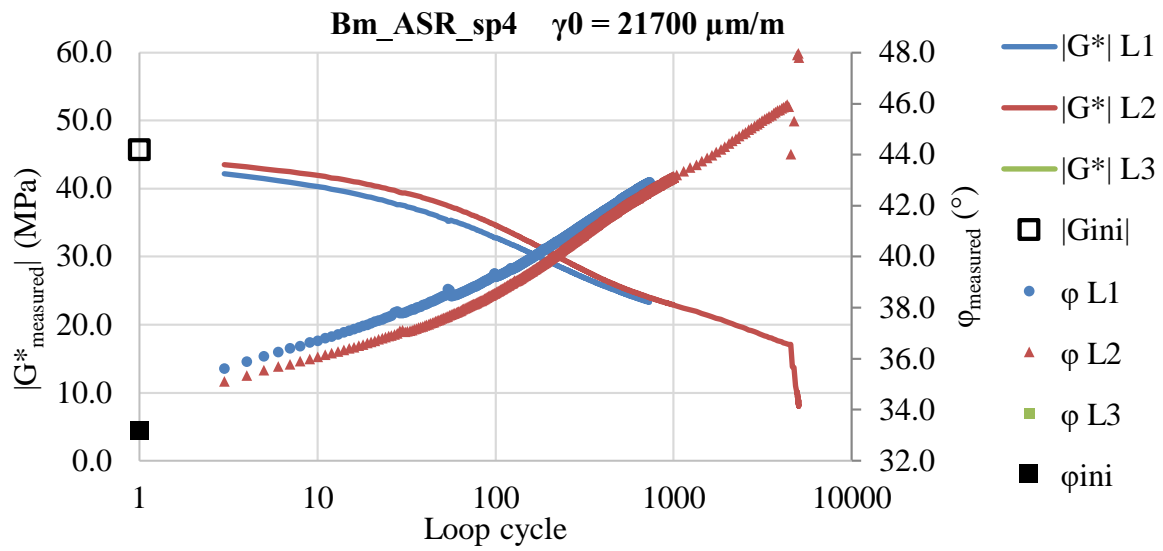




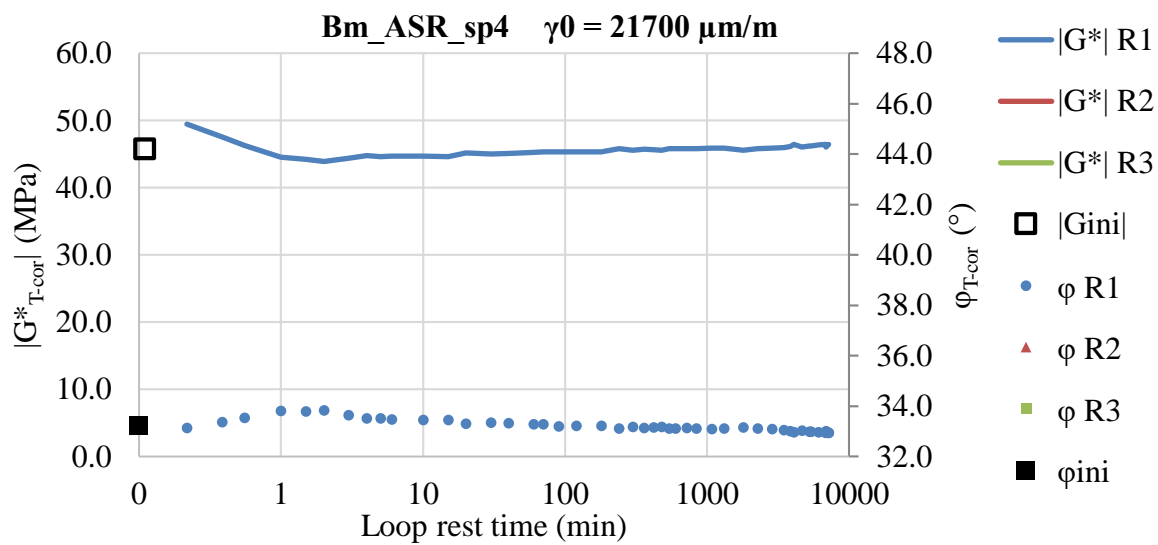
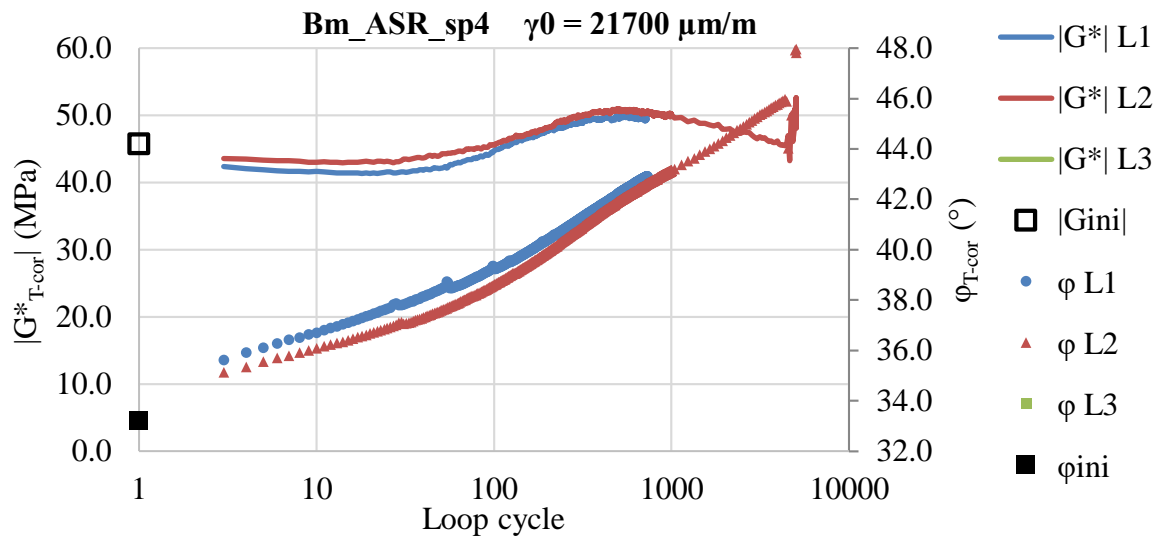
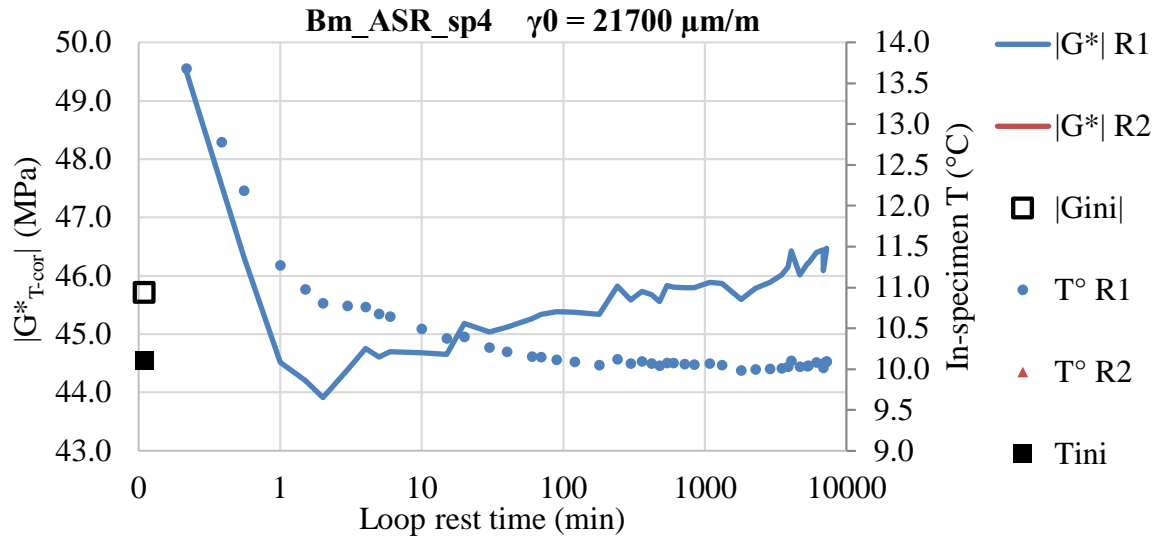
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



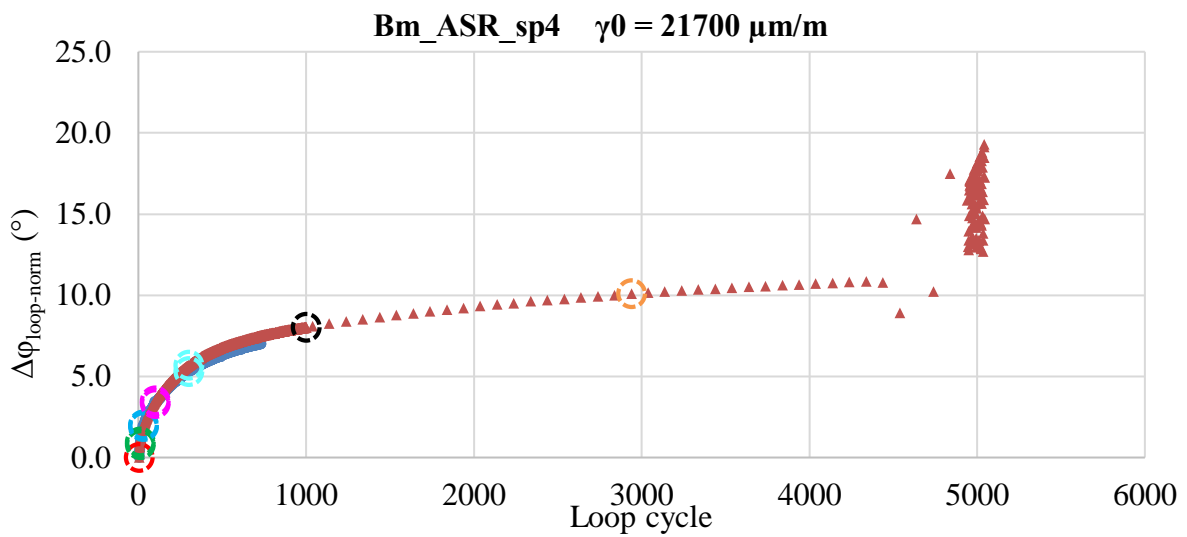
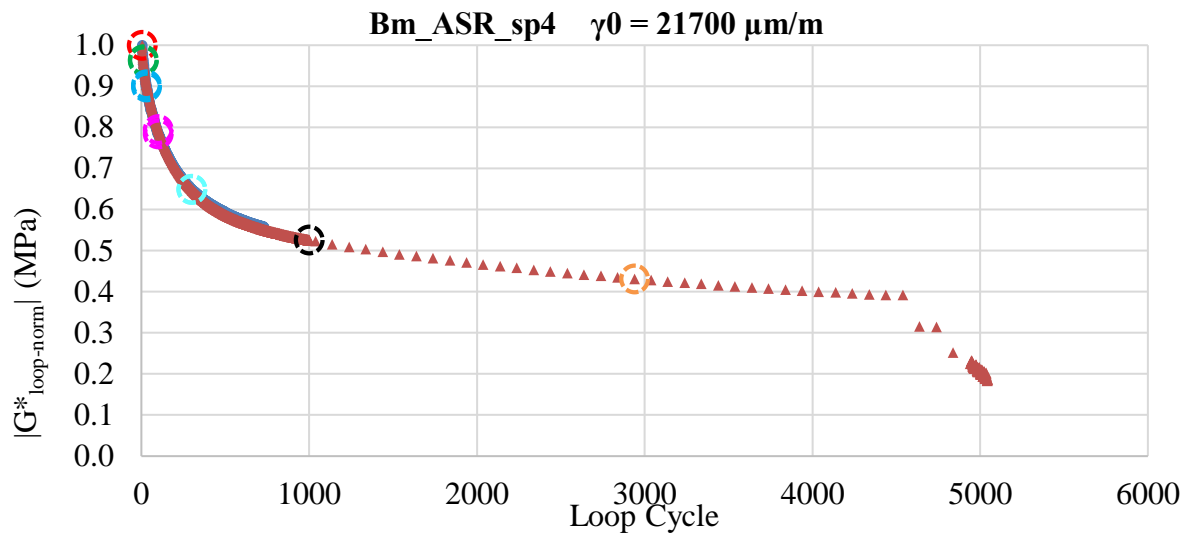
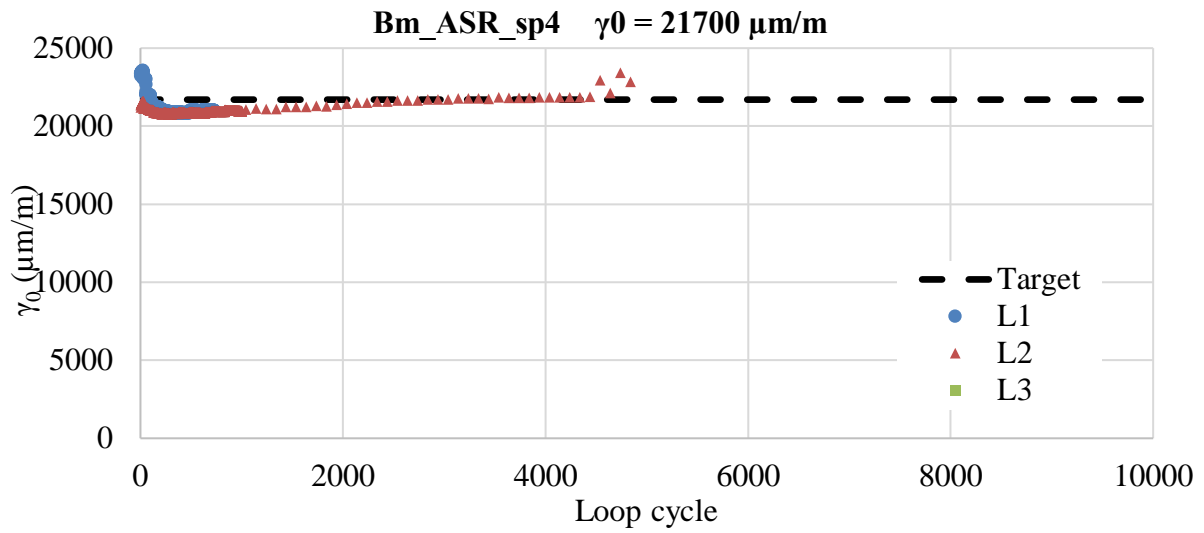
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



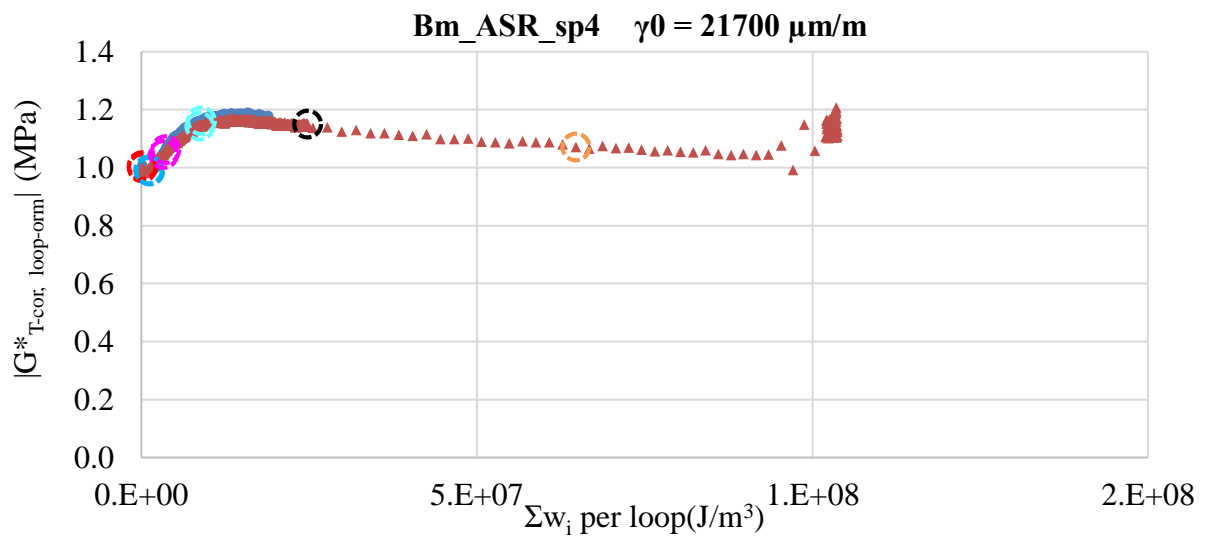
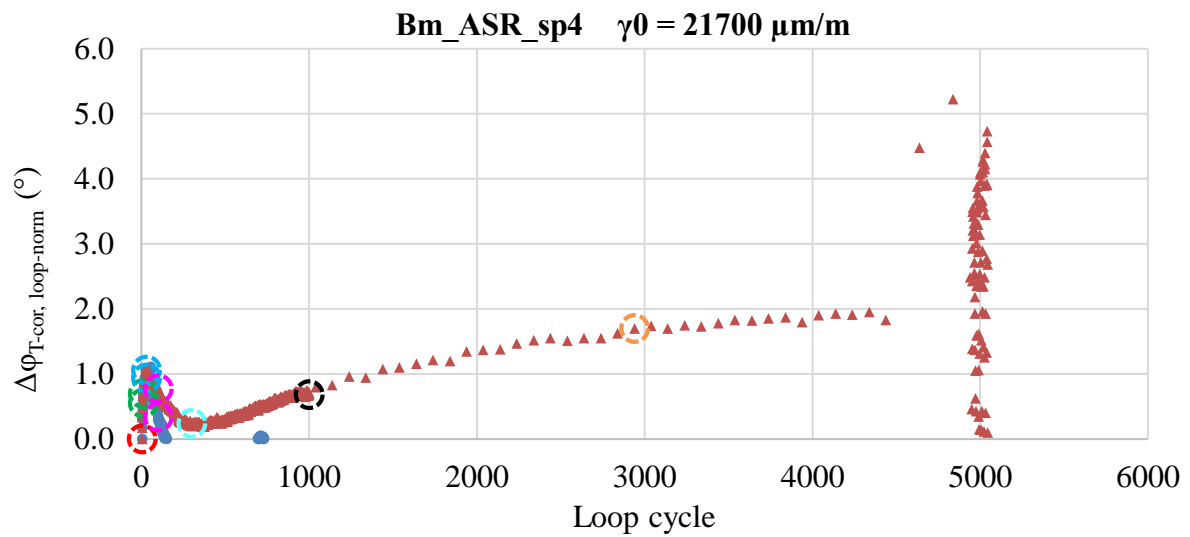
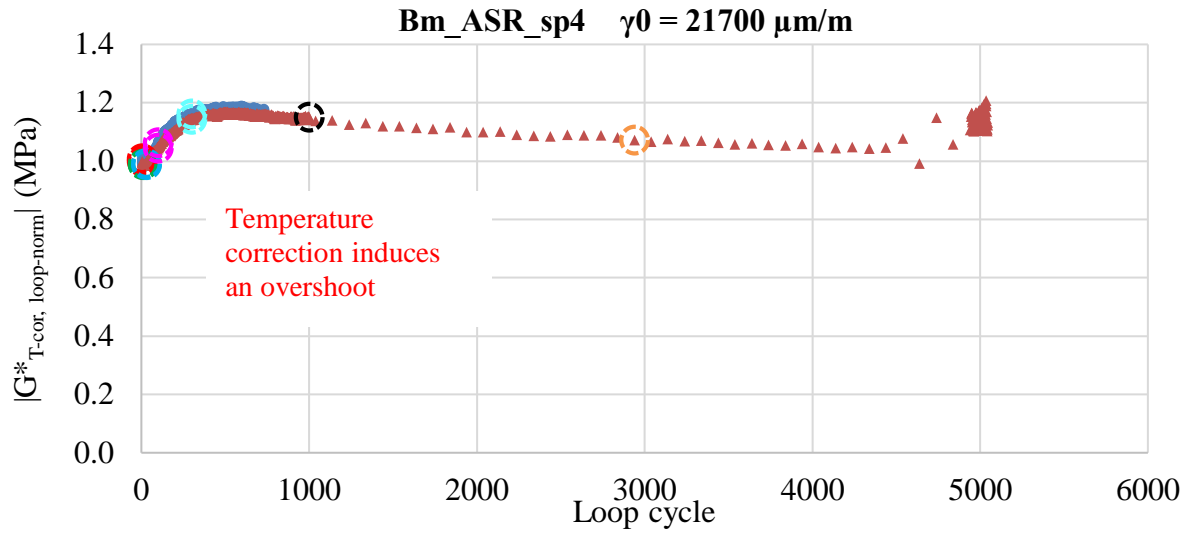
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



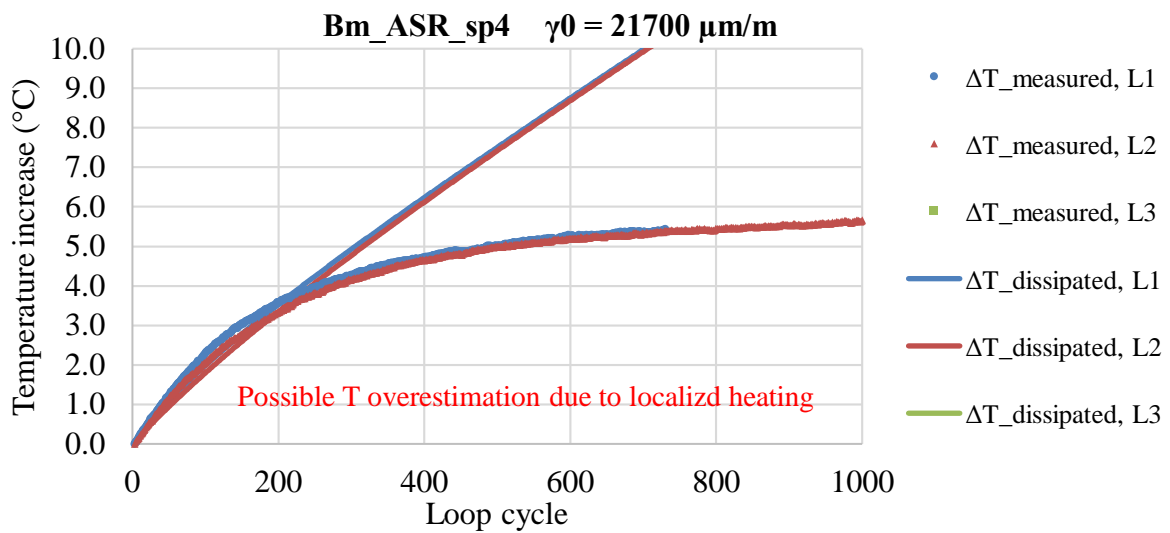
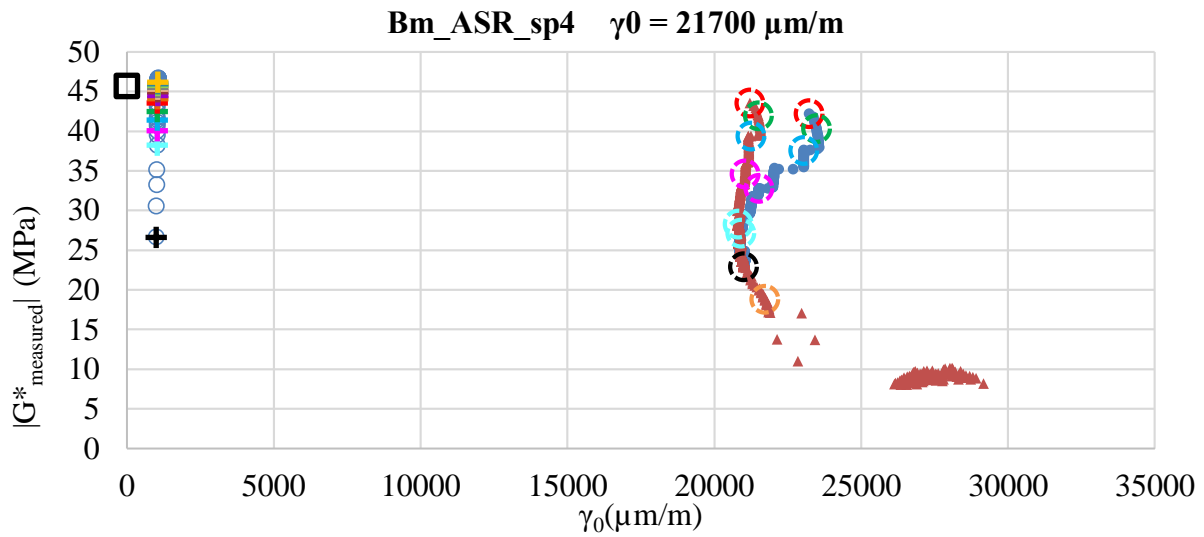
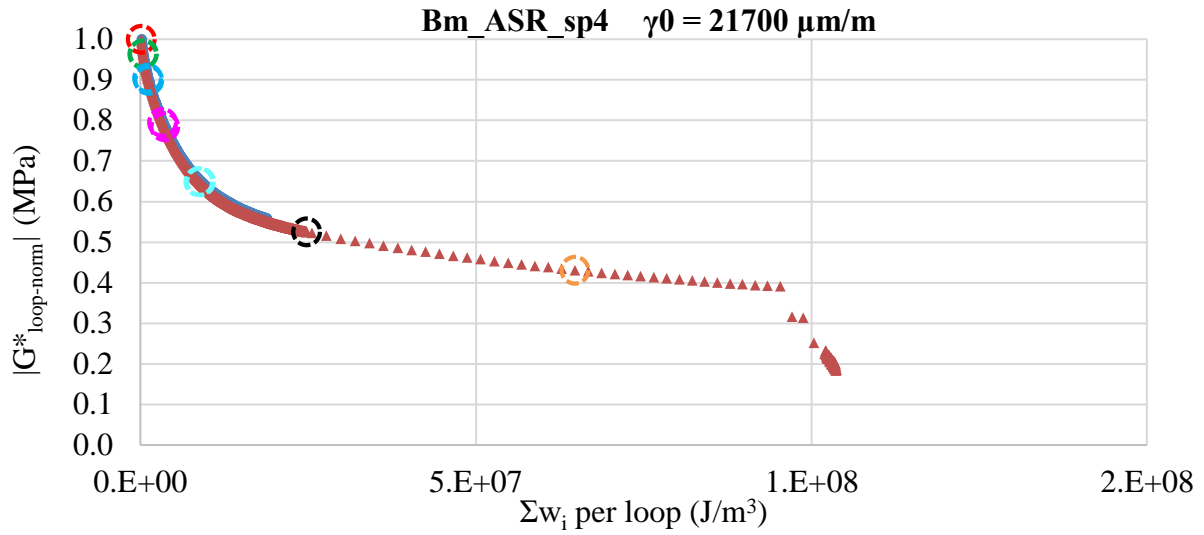
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



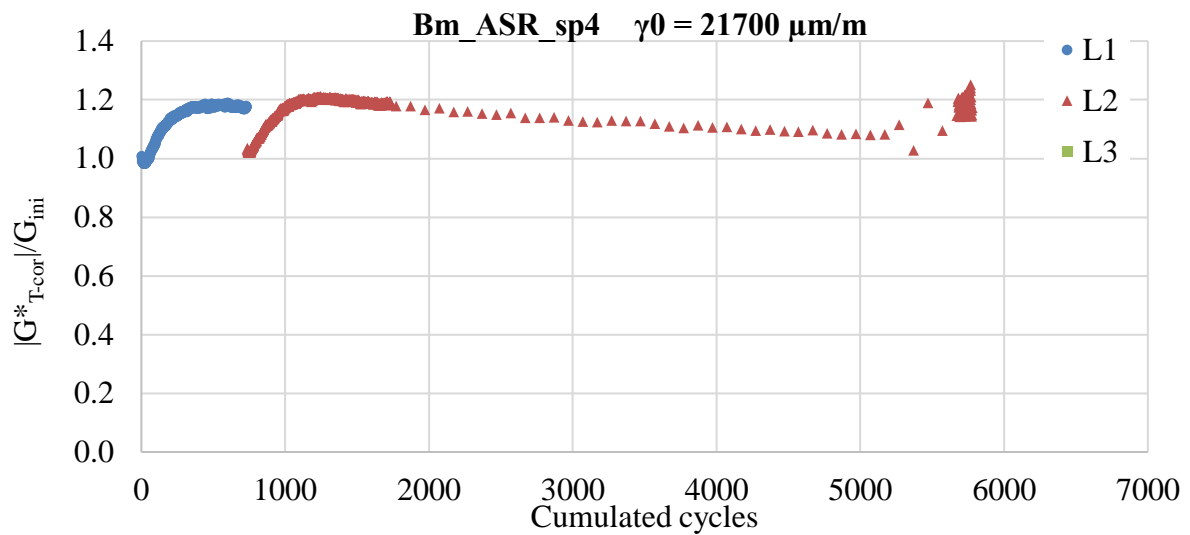
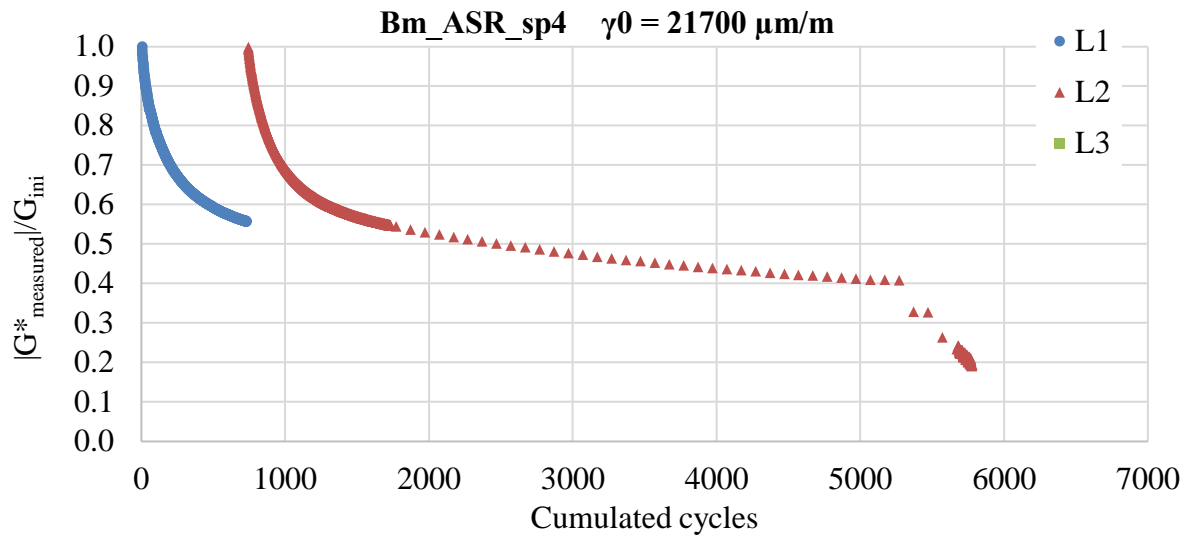
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

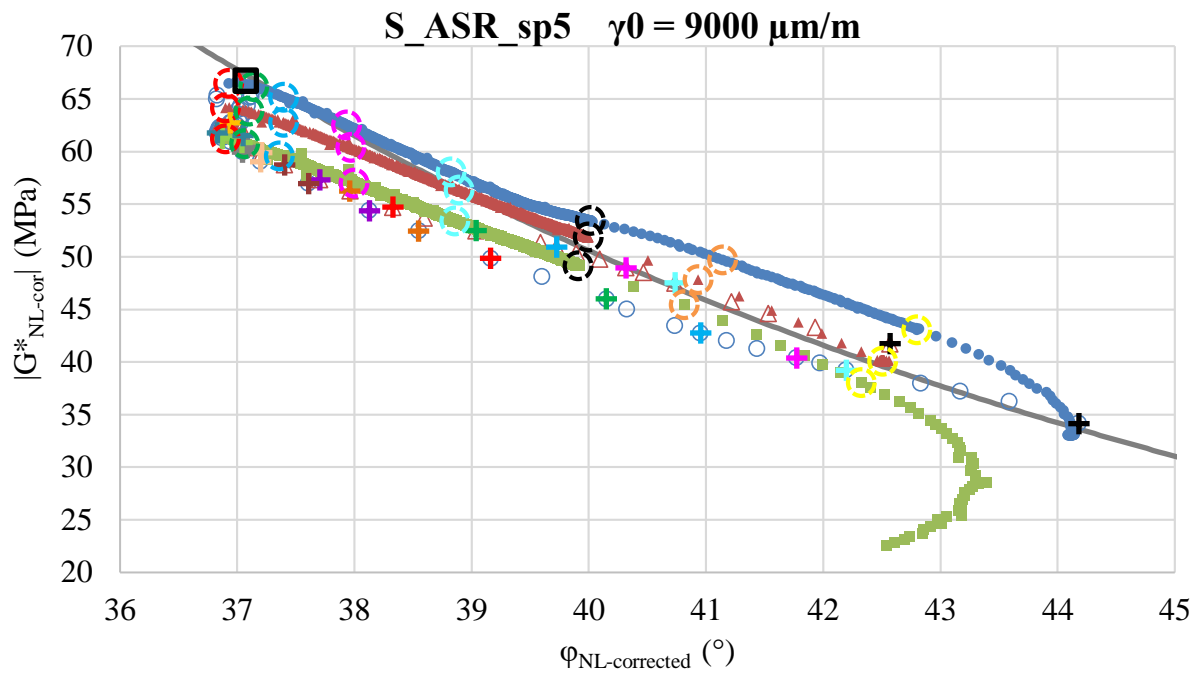
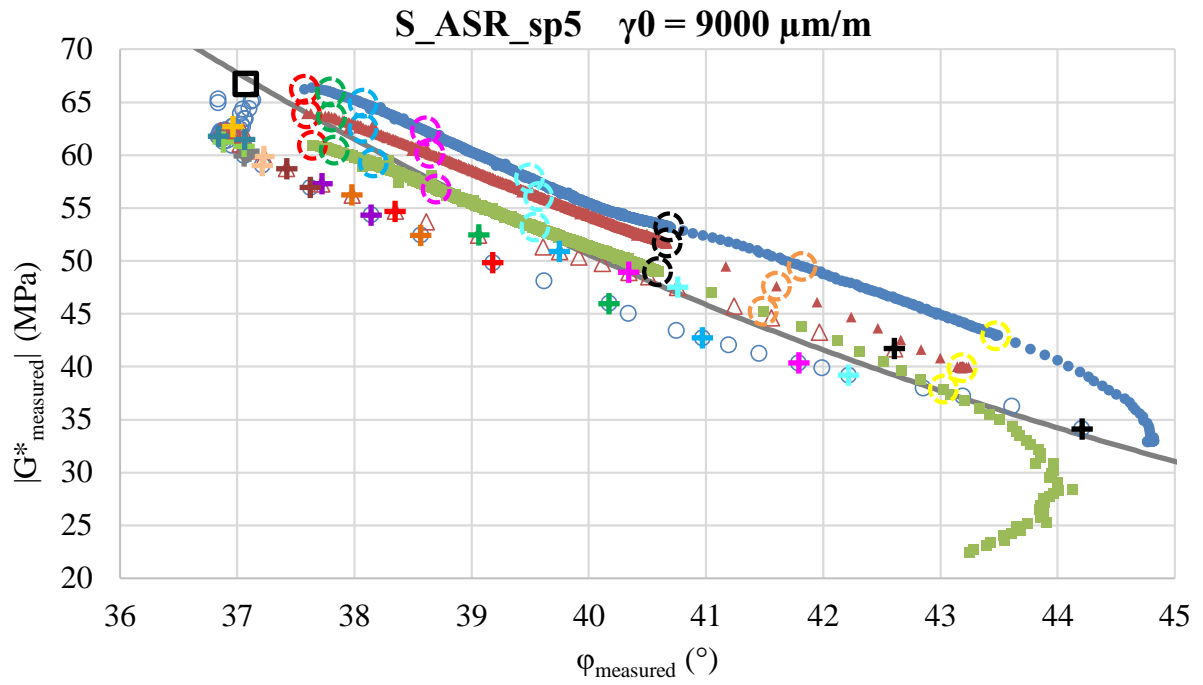


1.5.3.S\_ASR

1.5.3.1. S\_ASR\_sp5 (9000 $\mu\text{m/m}$ )

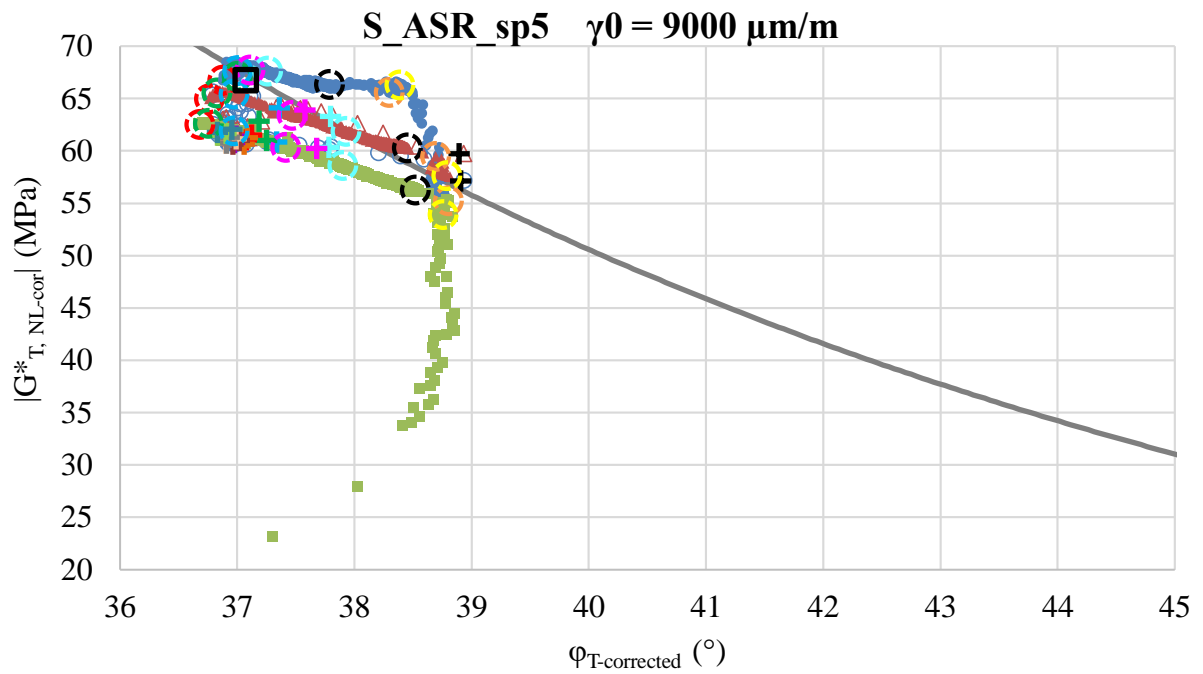
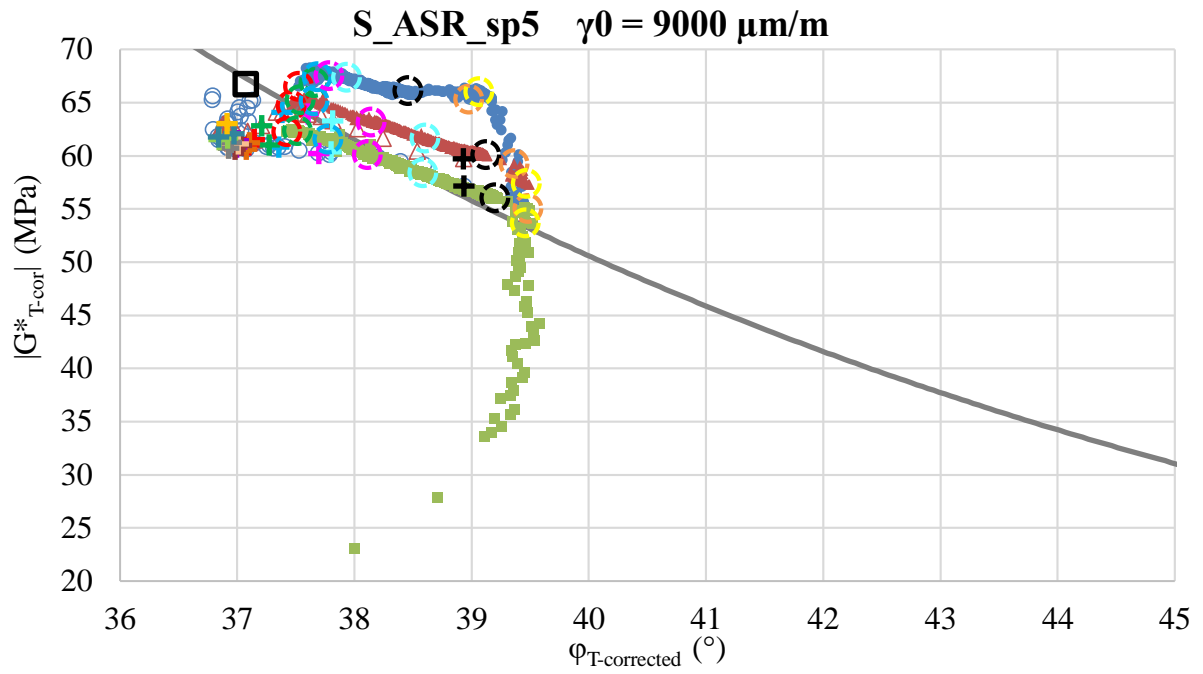
- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G*ini        | — 2S2P1D        |

1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

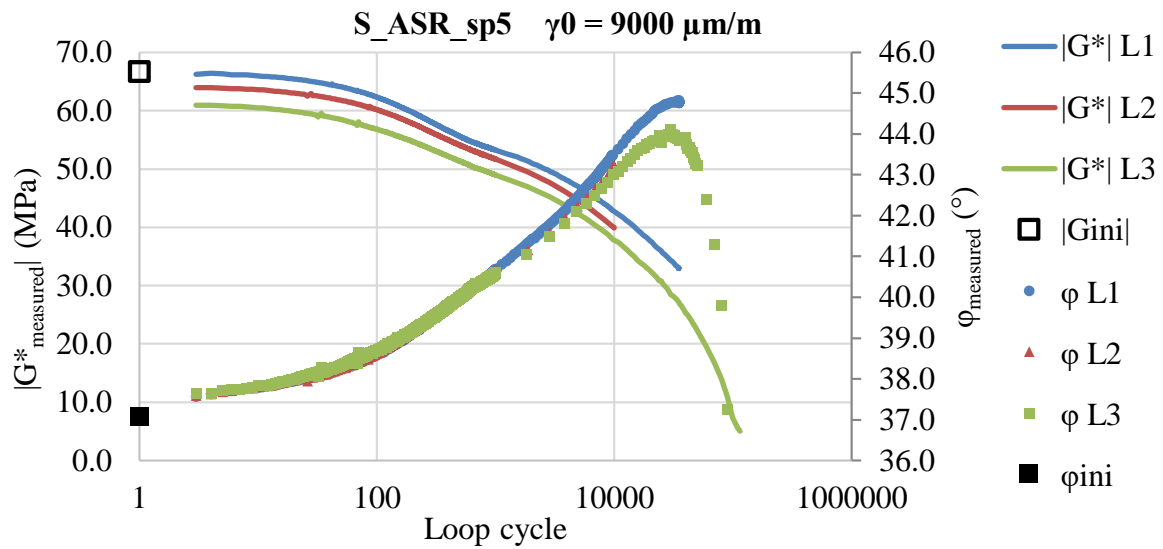
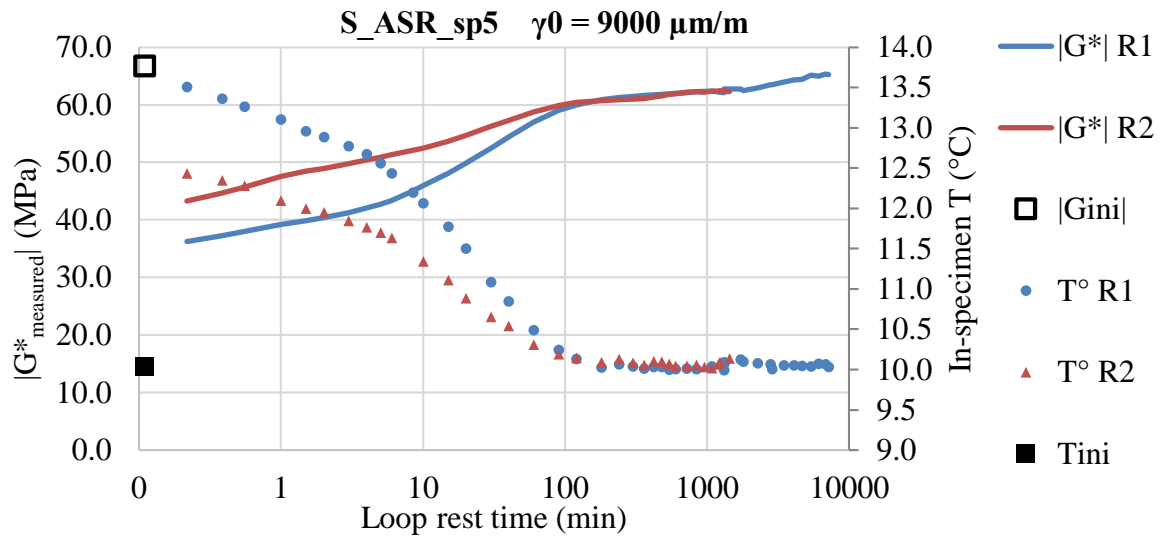
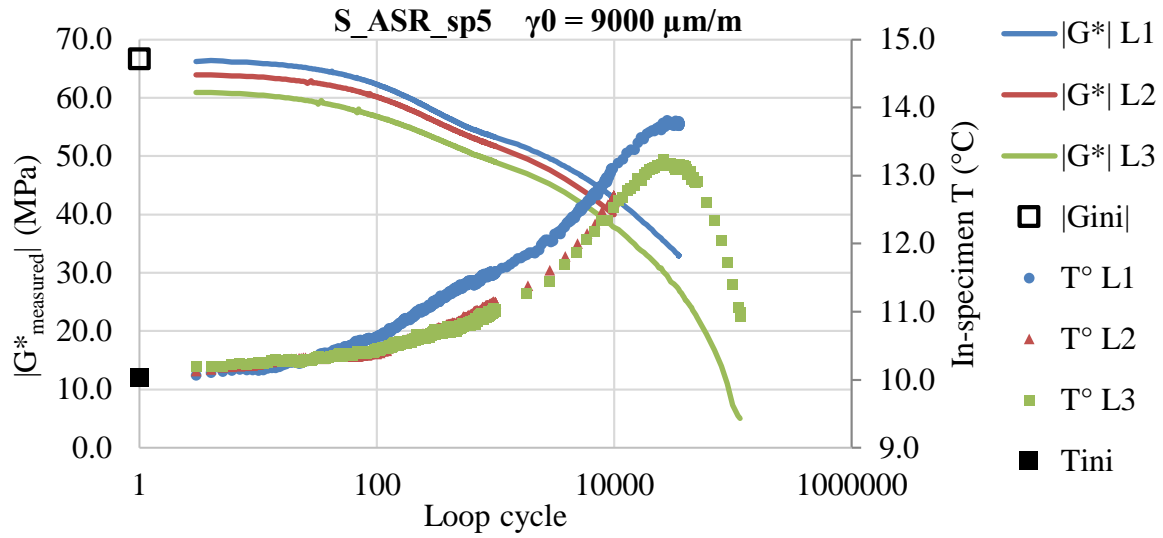




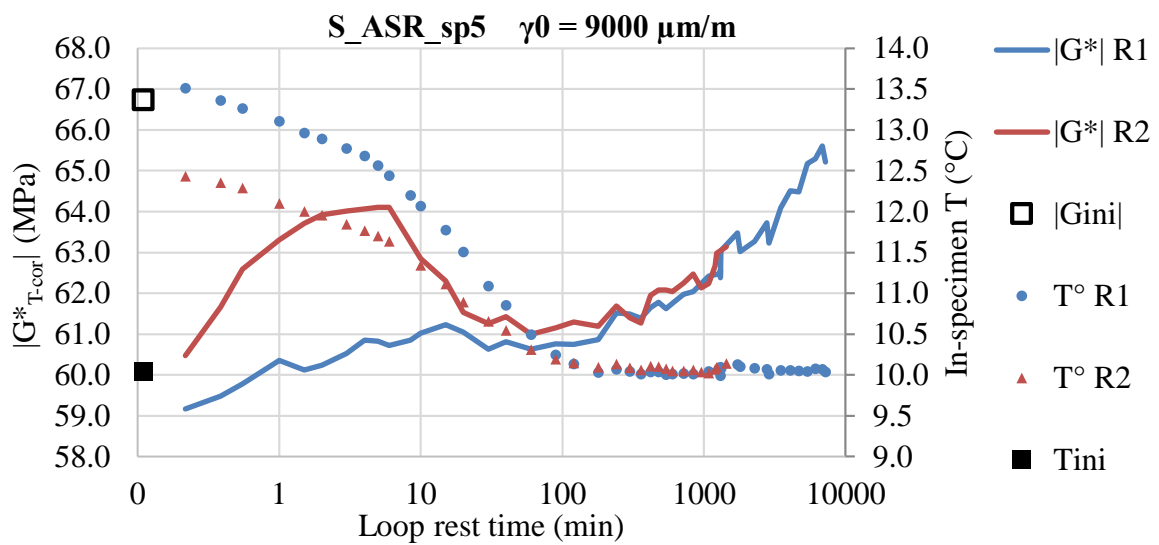
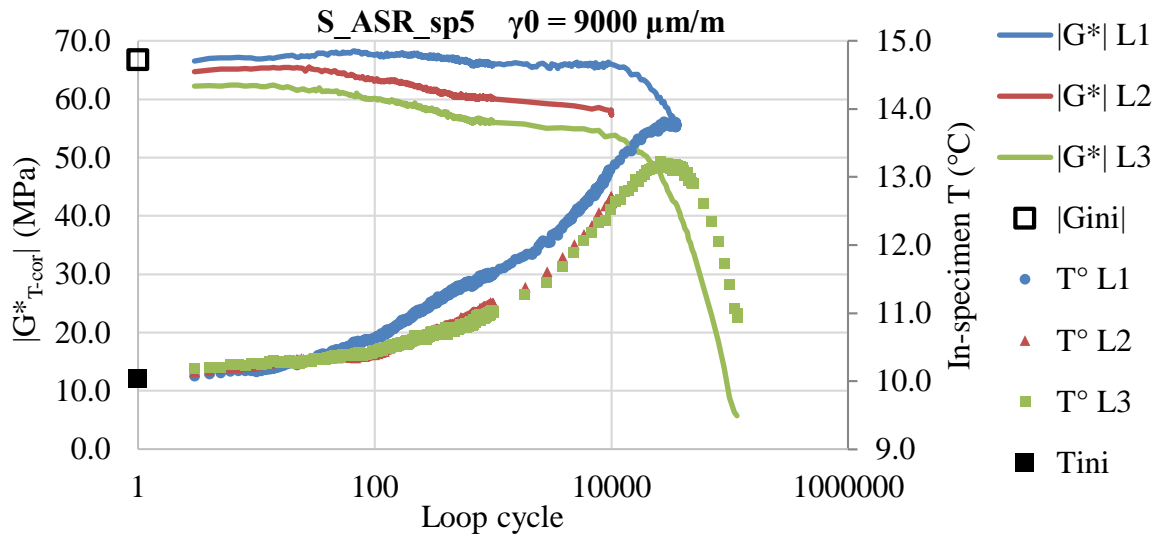
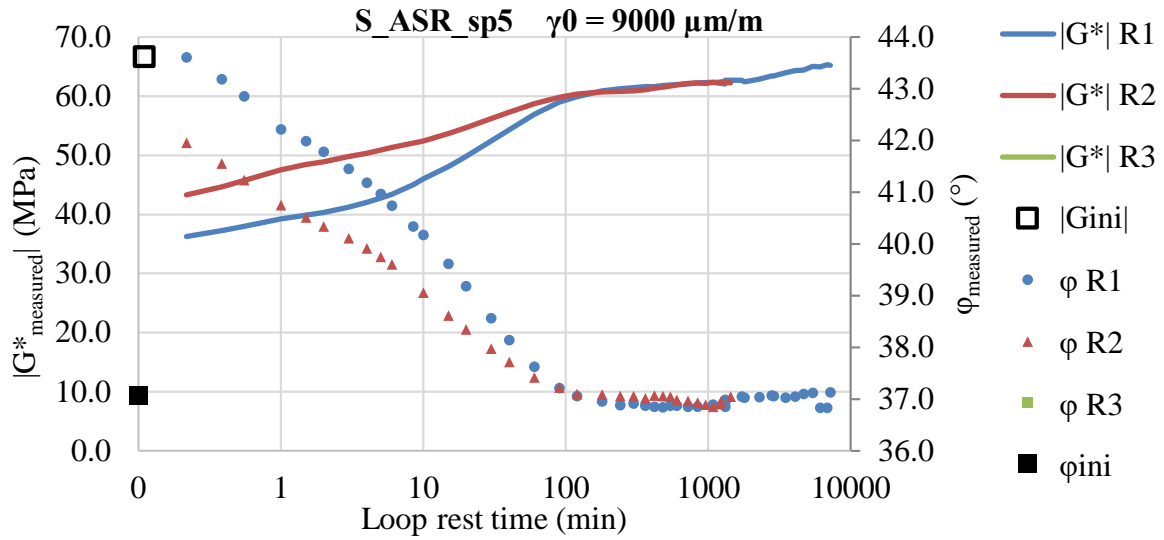
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



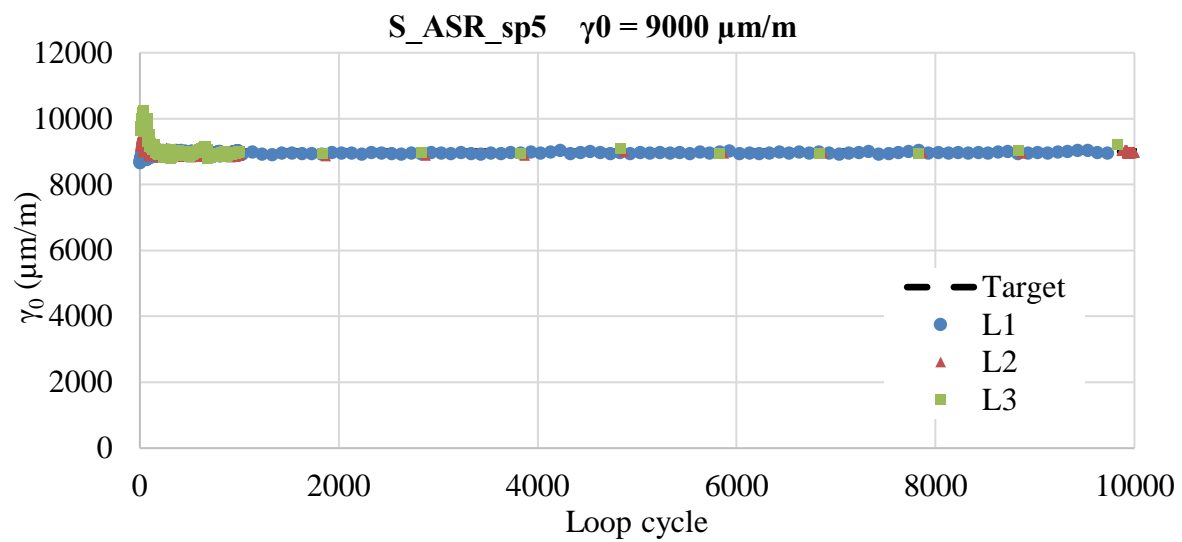
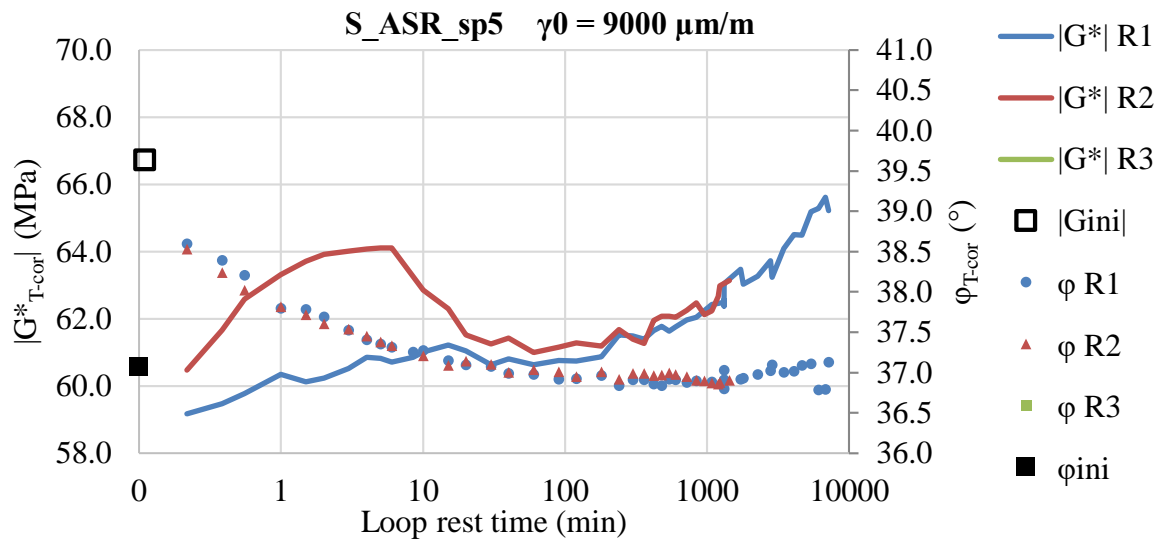
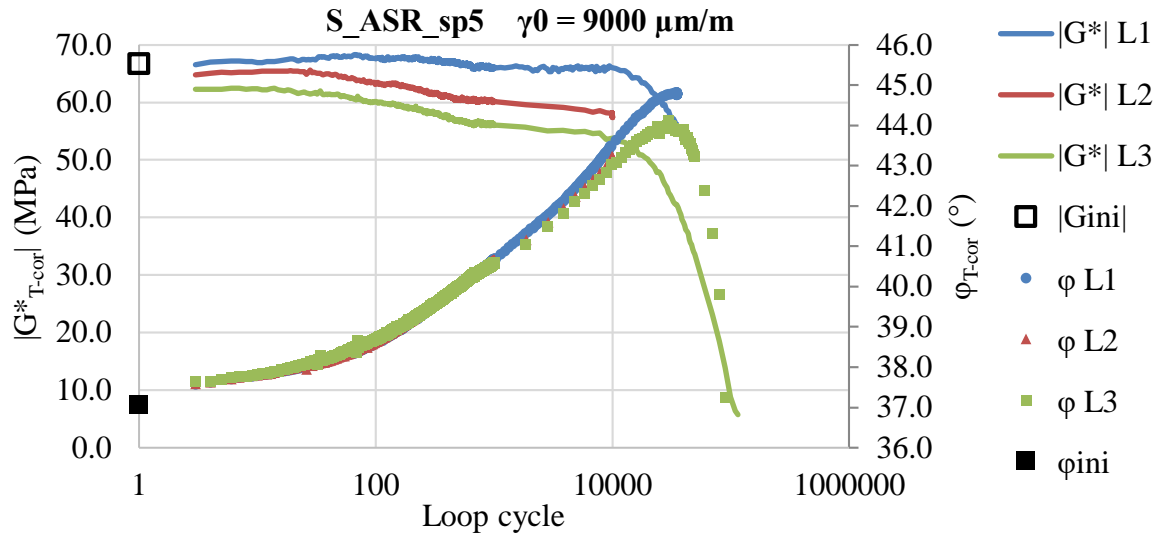
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



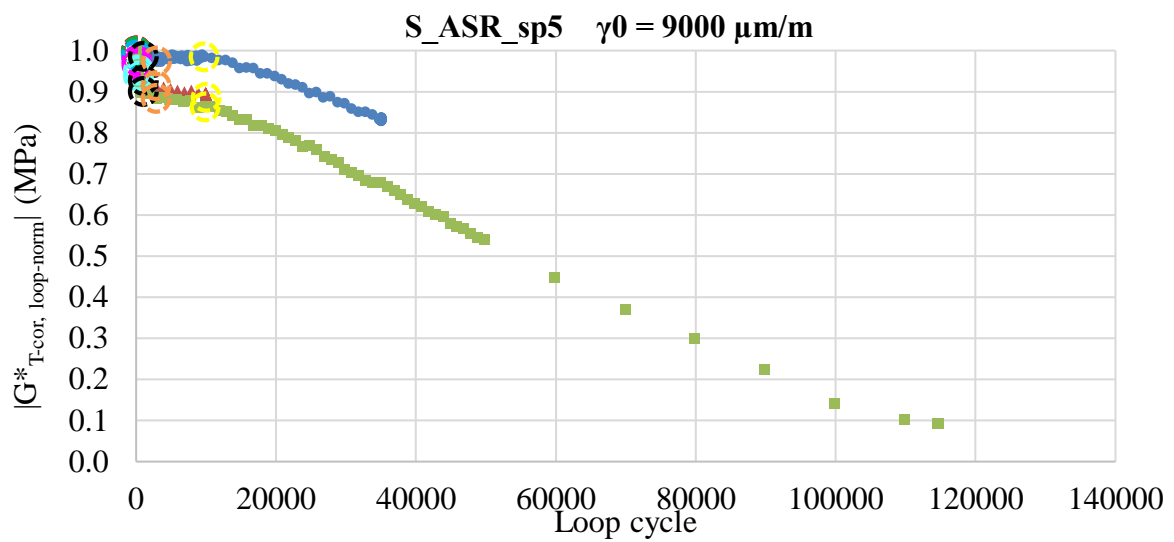
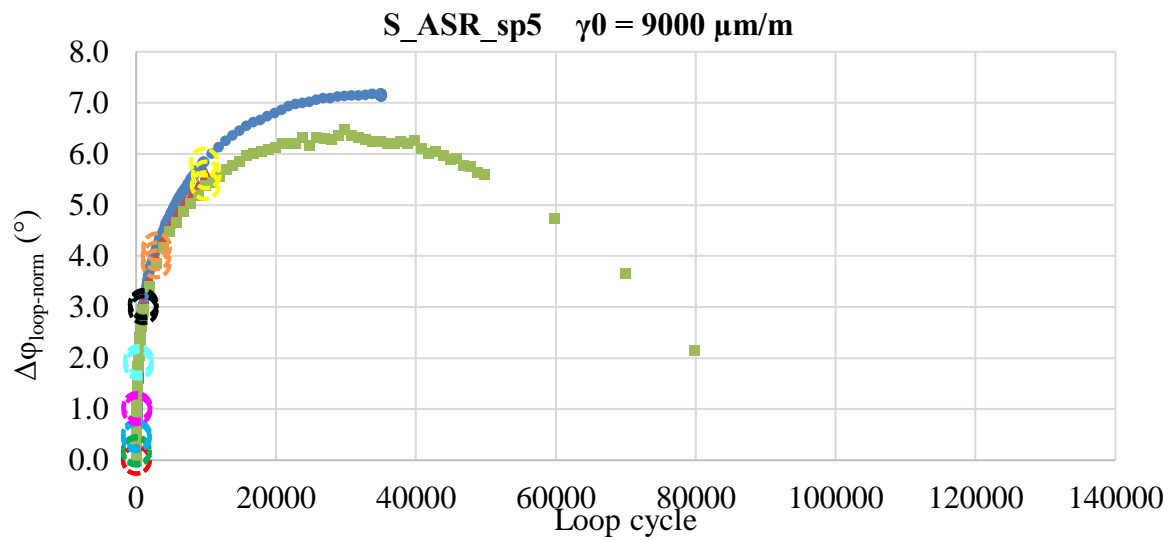
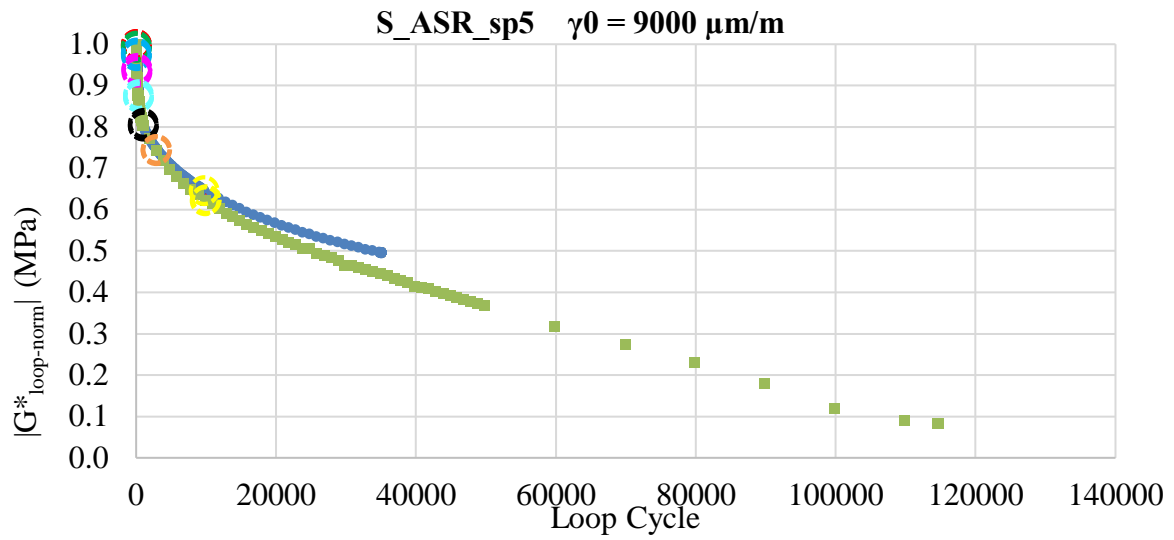
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



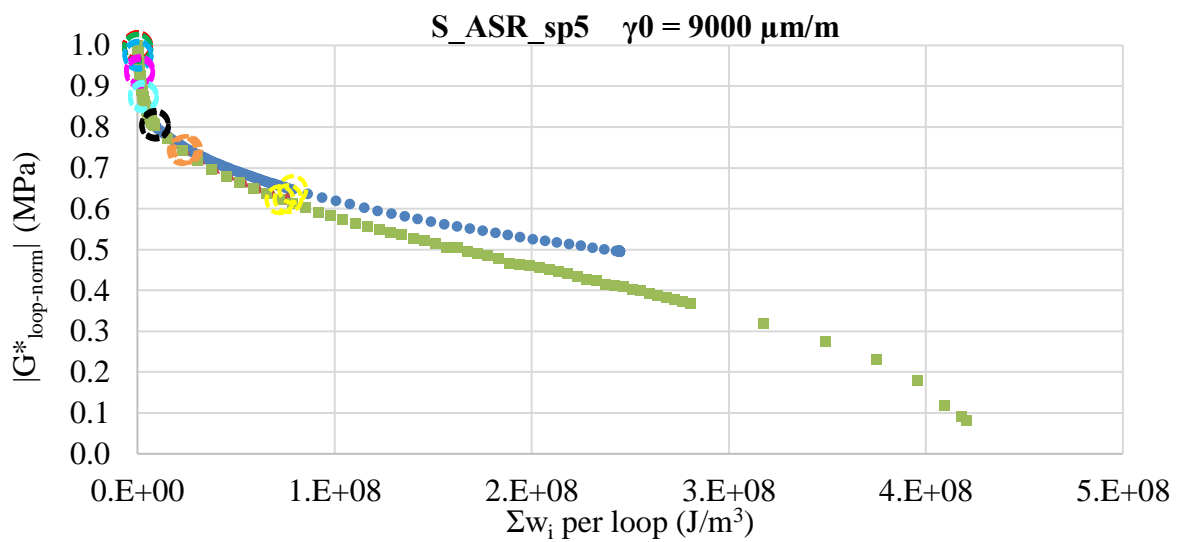
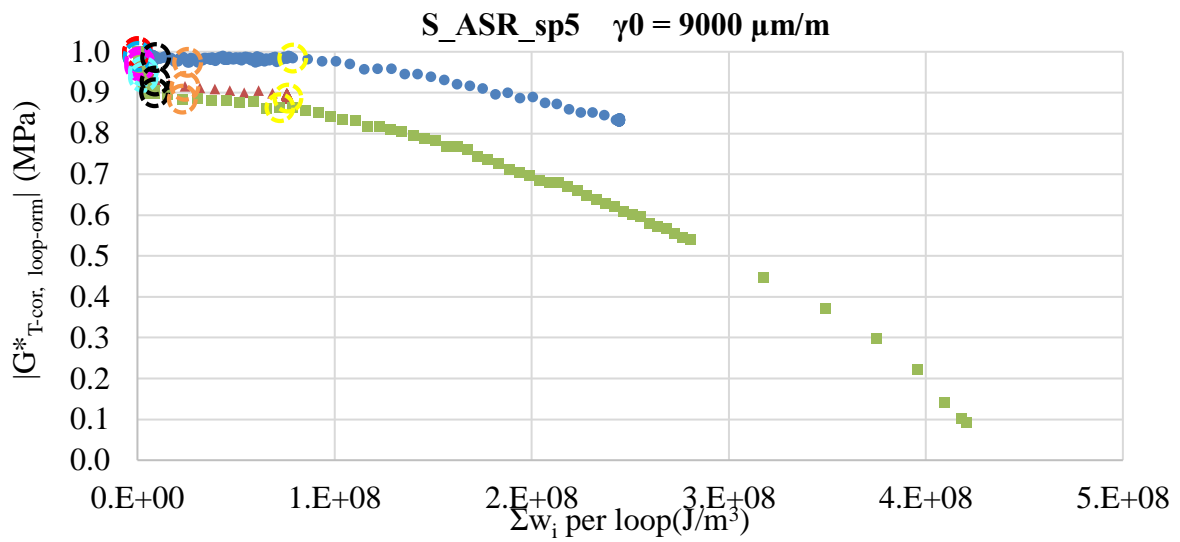
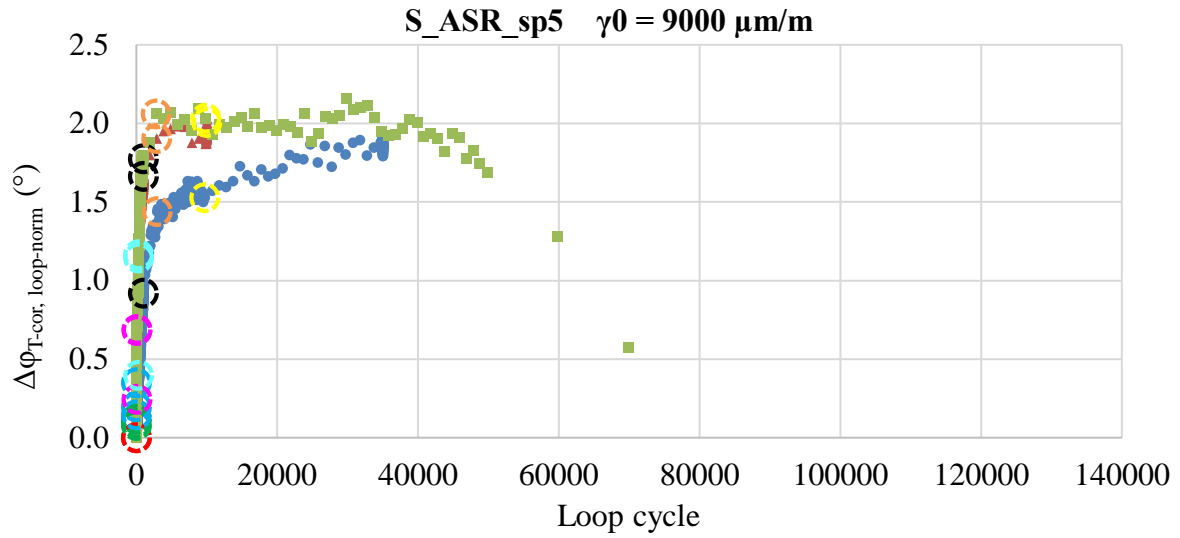
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



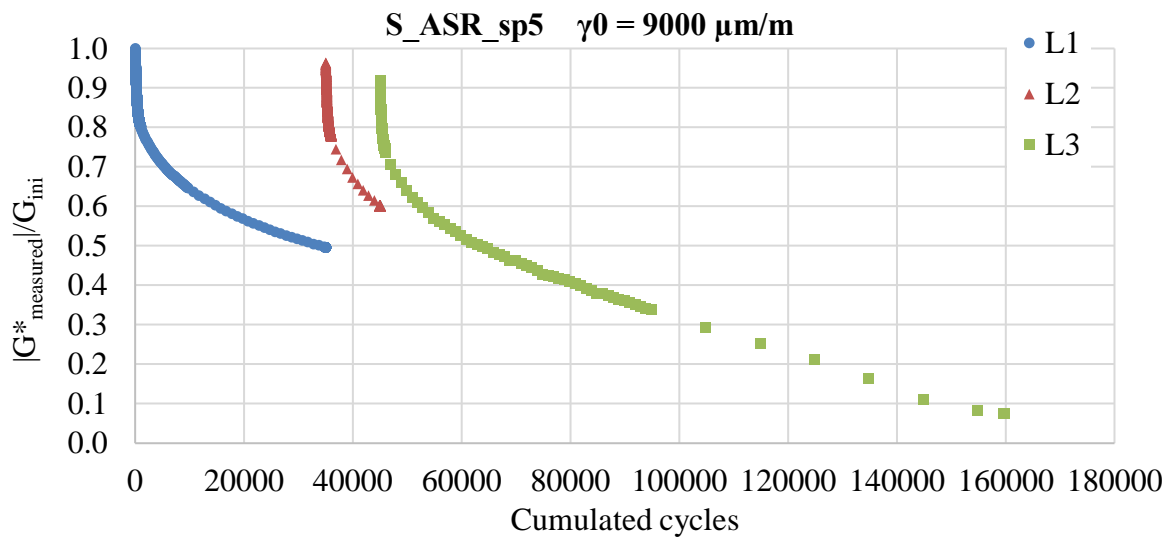
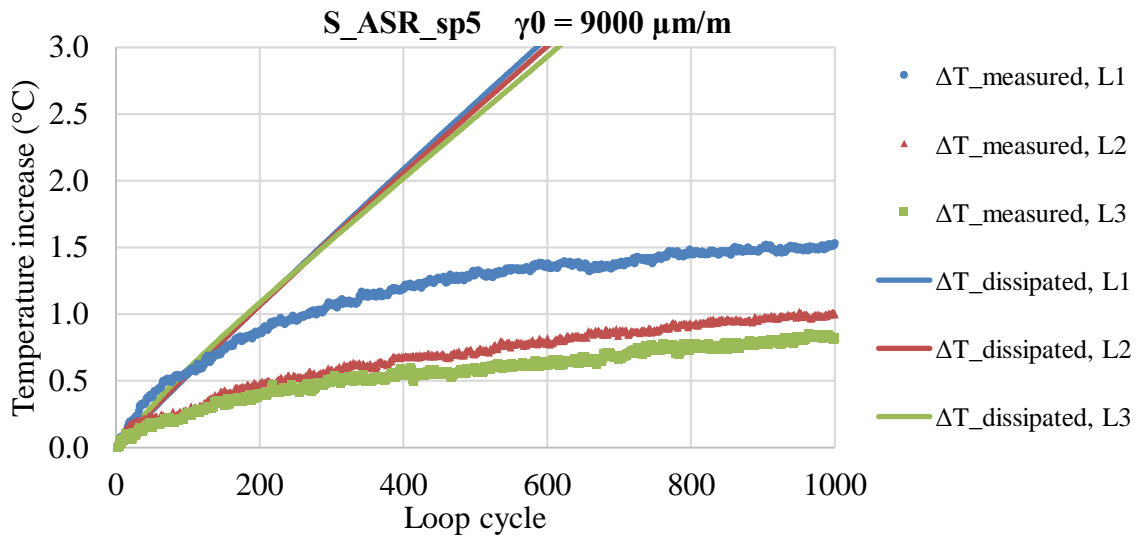
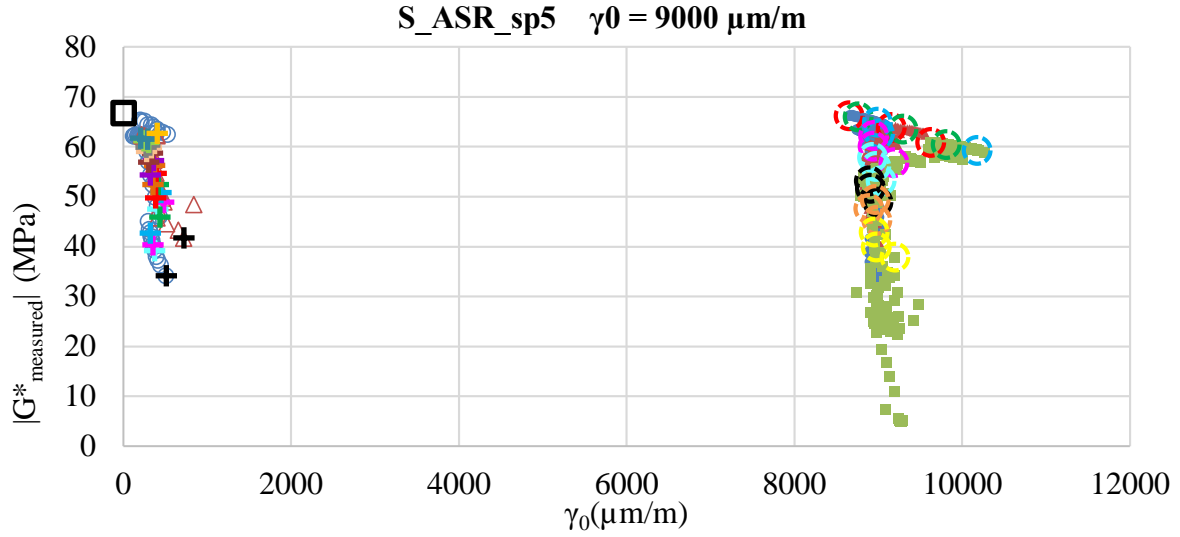
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



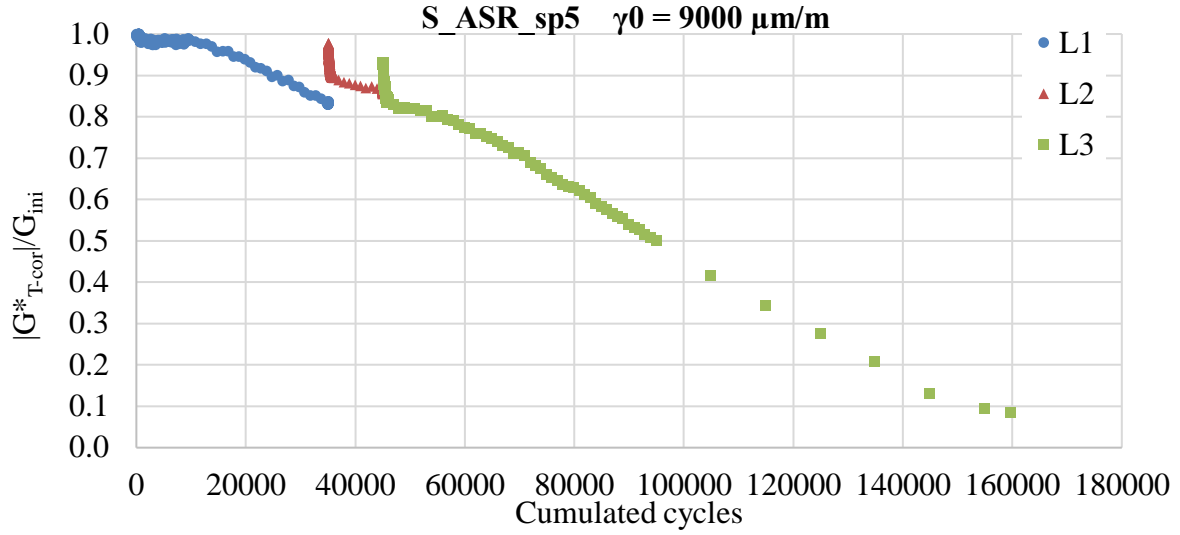
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

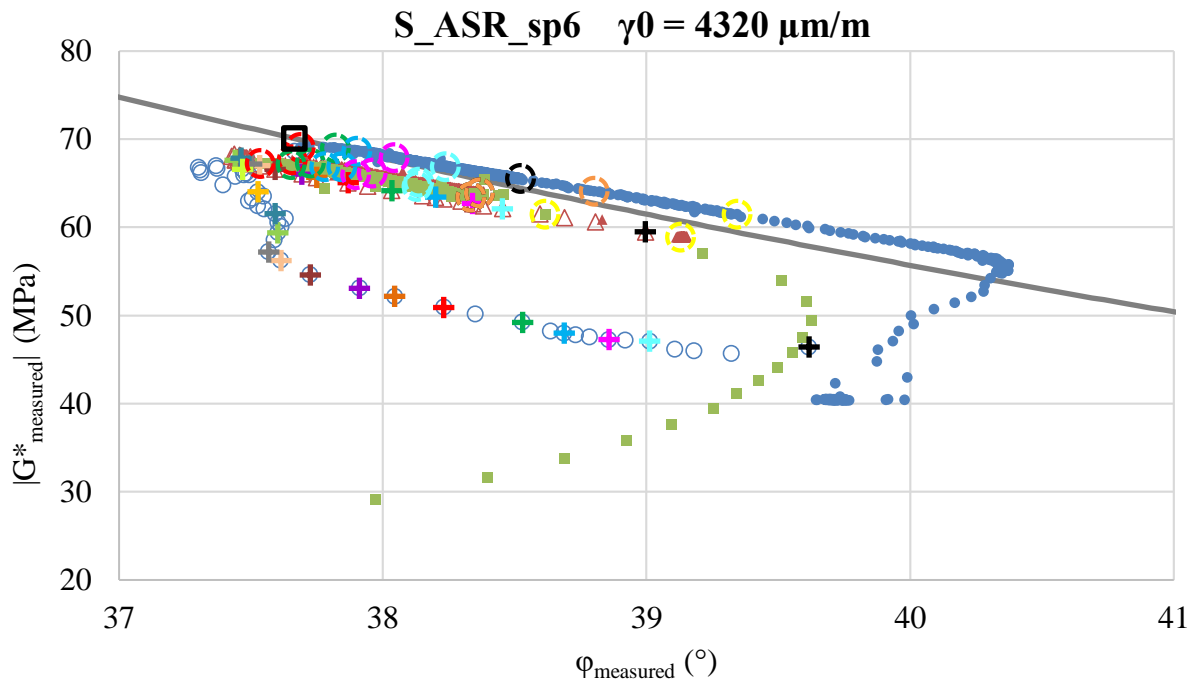


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



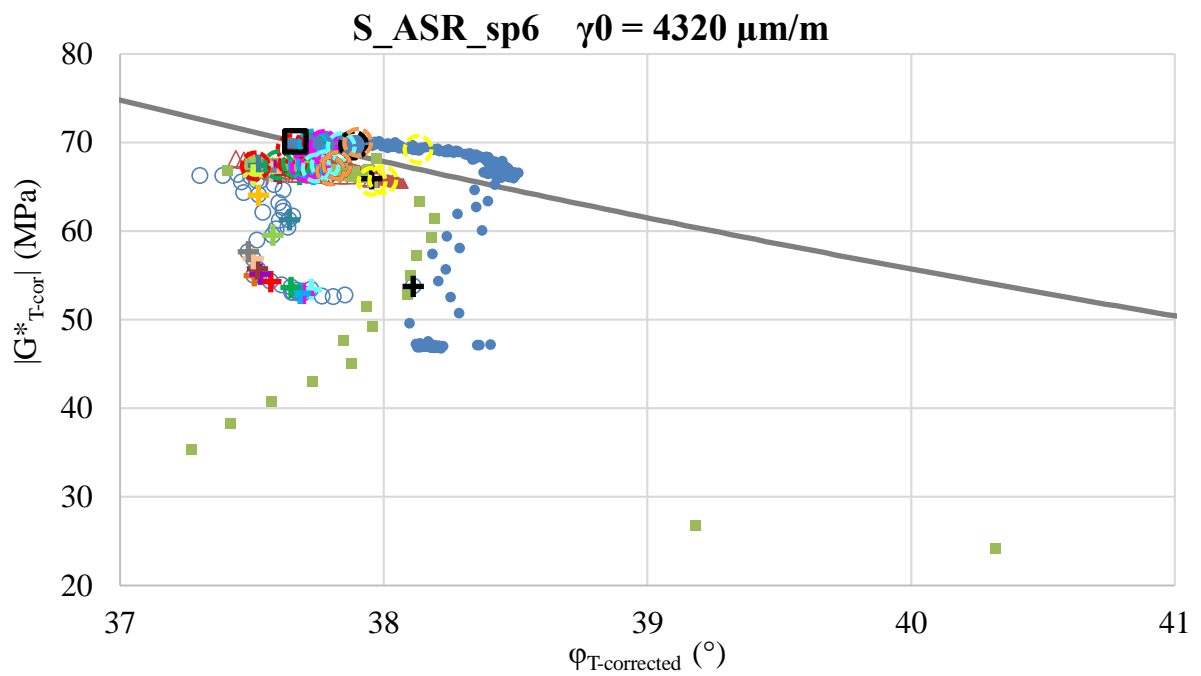
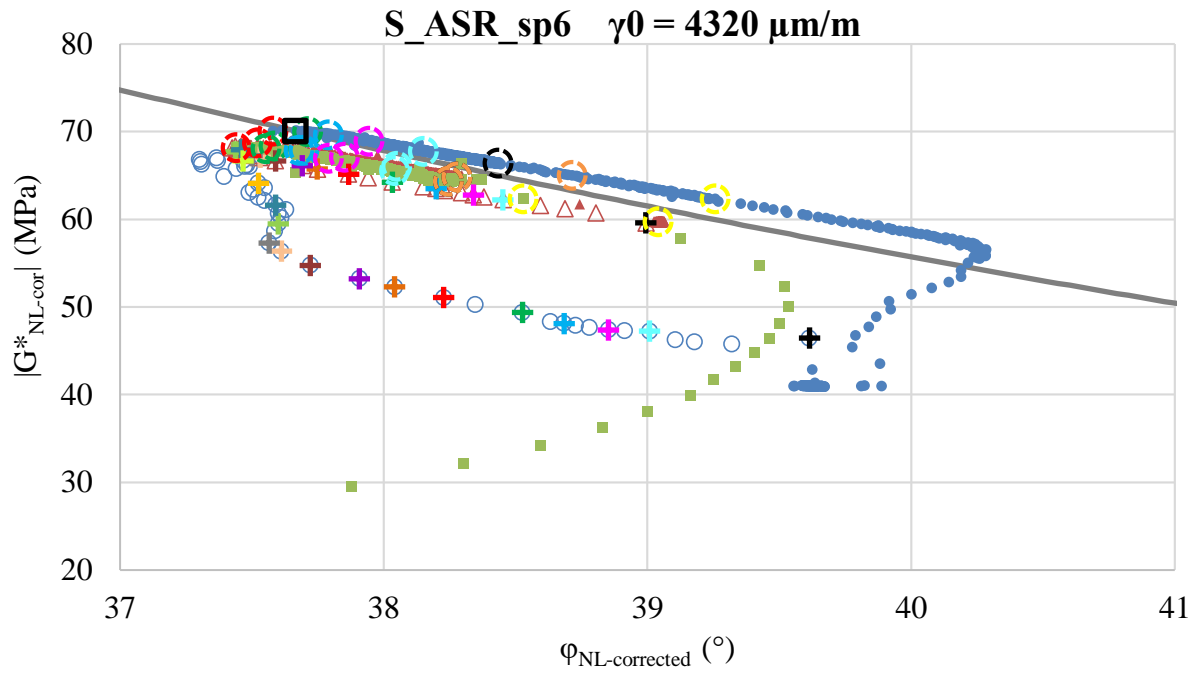
1.5.3.2. S\_ASR\_sp6 (4320 $\mu\text{m/m}$ )

- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G*ini        | — 2S2P1D        |

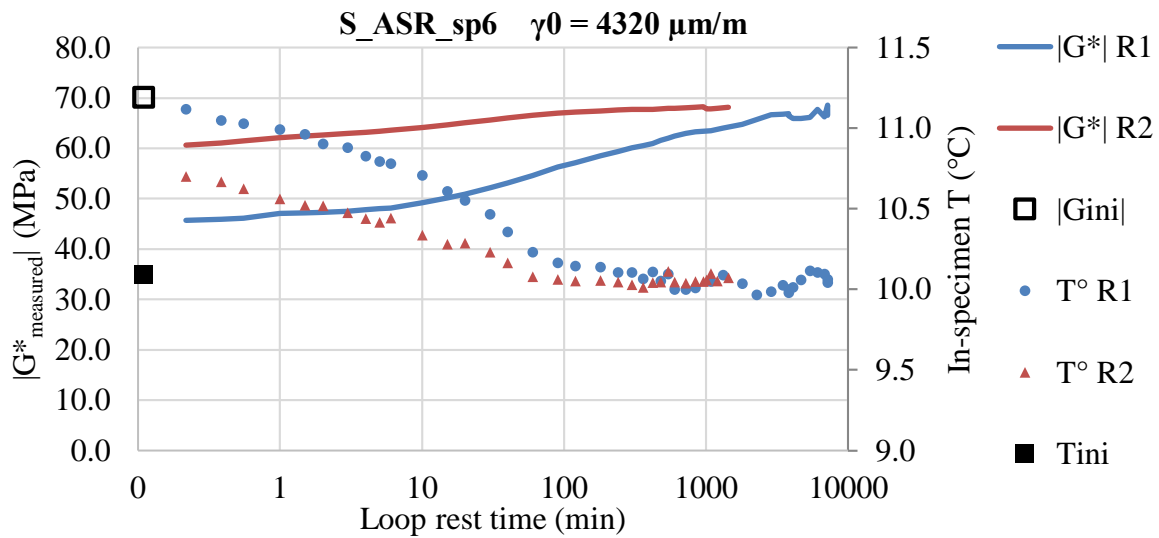
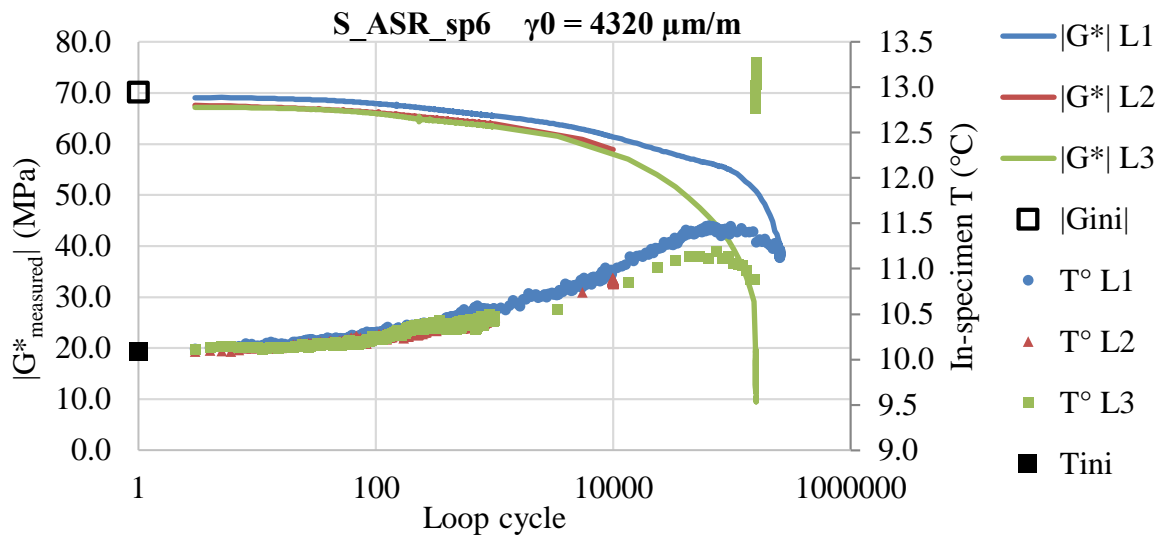
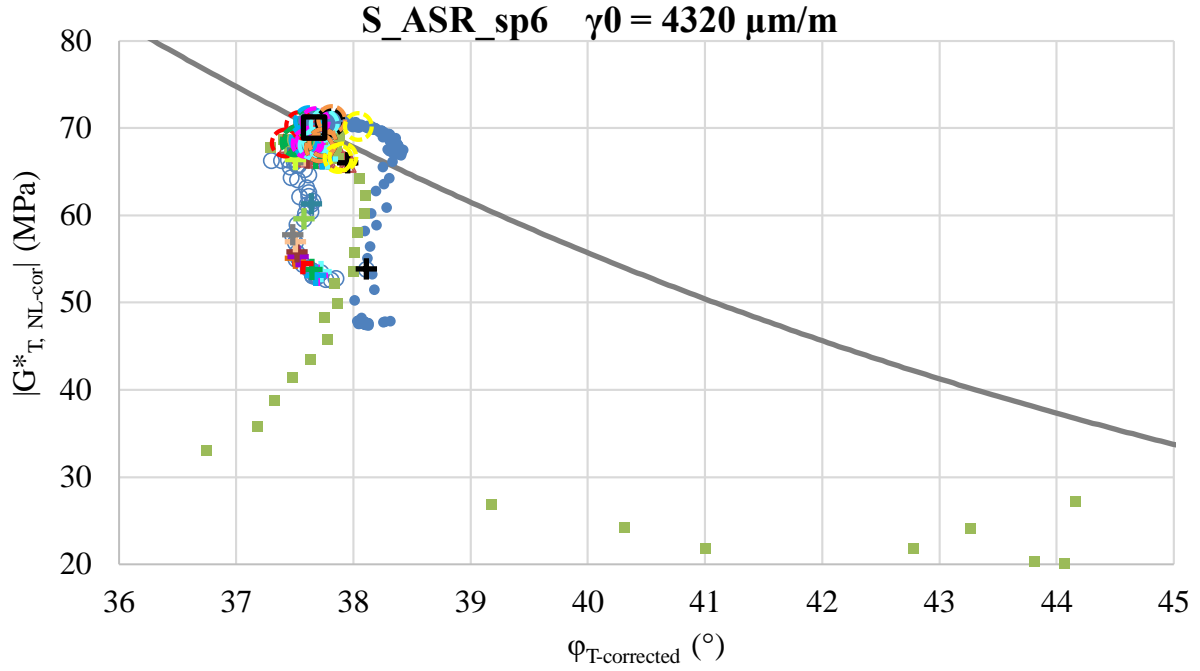




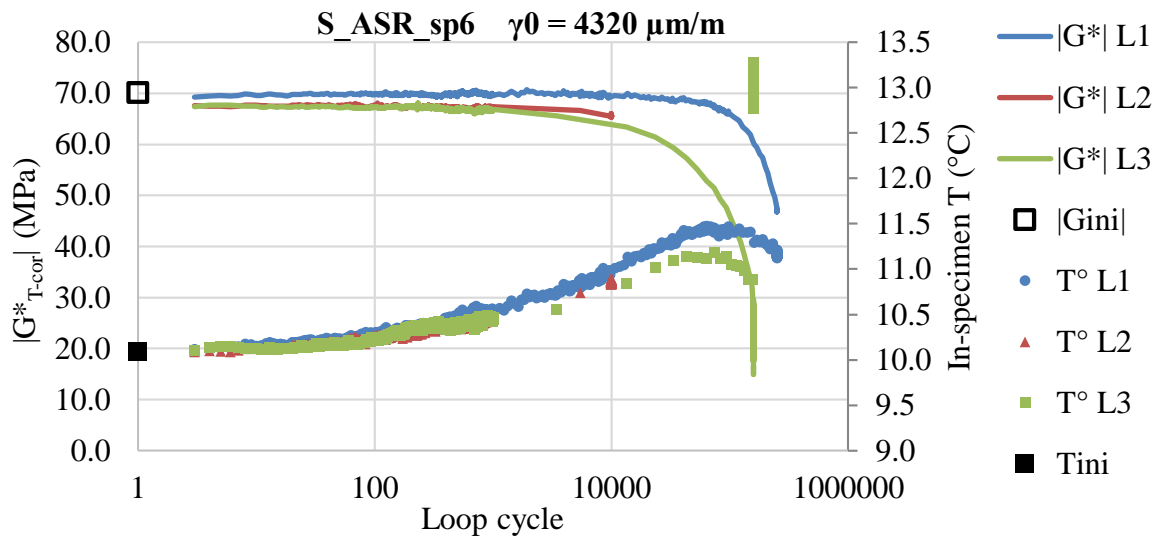
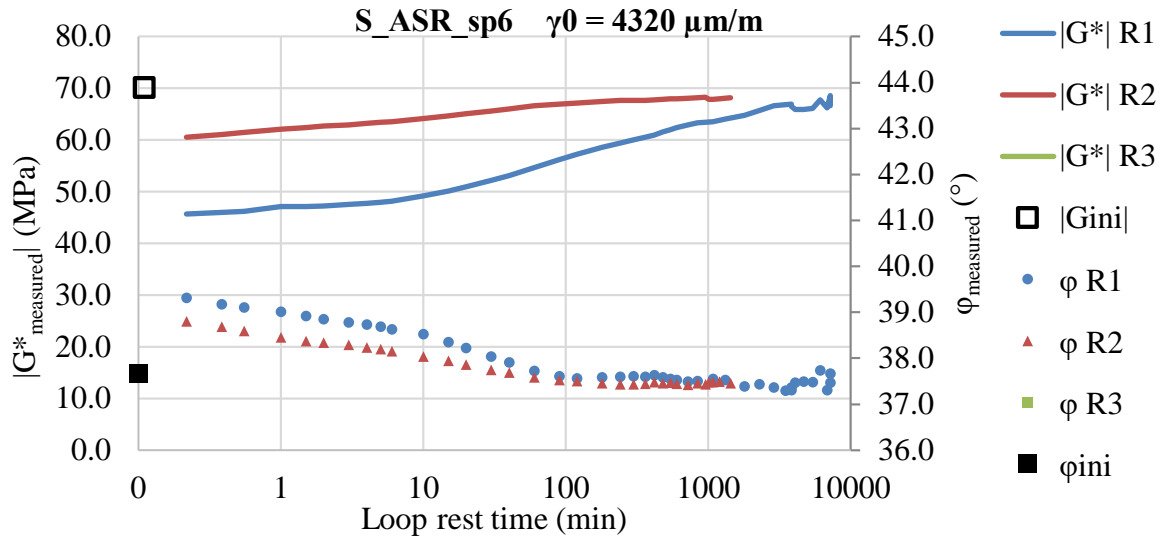
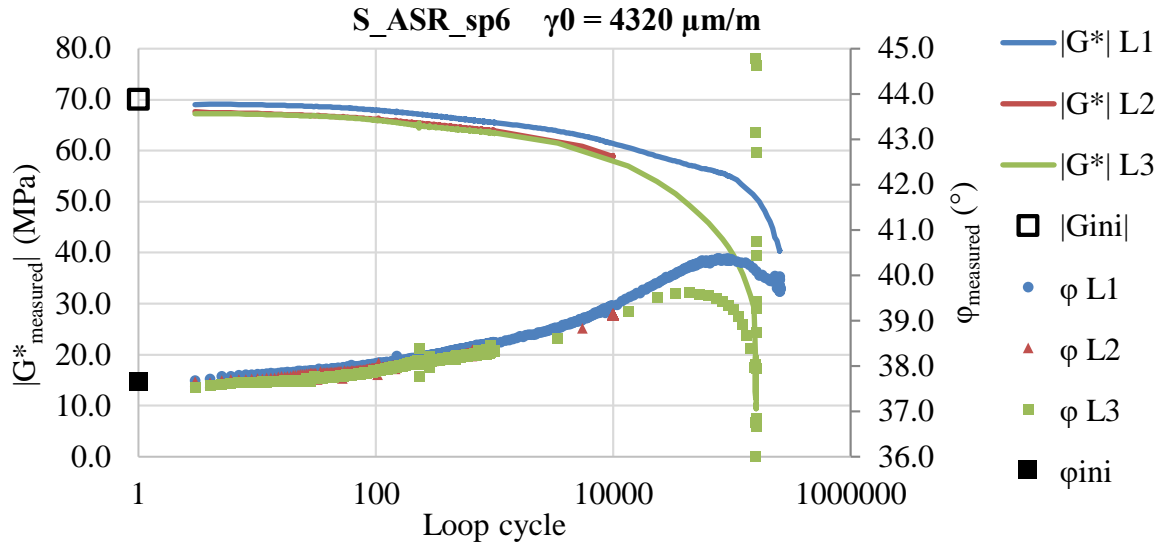
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



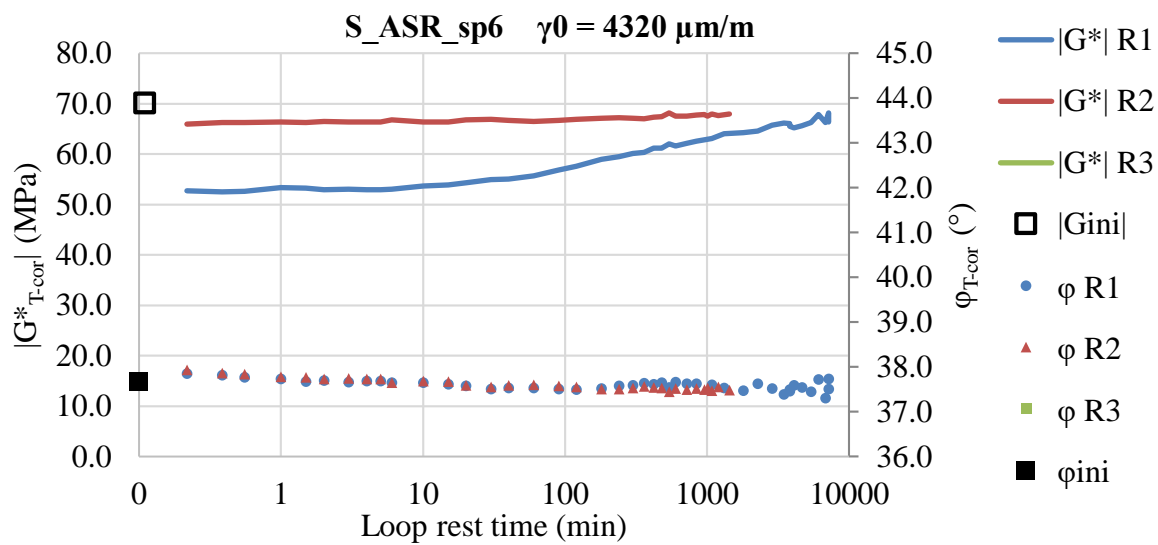
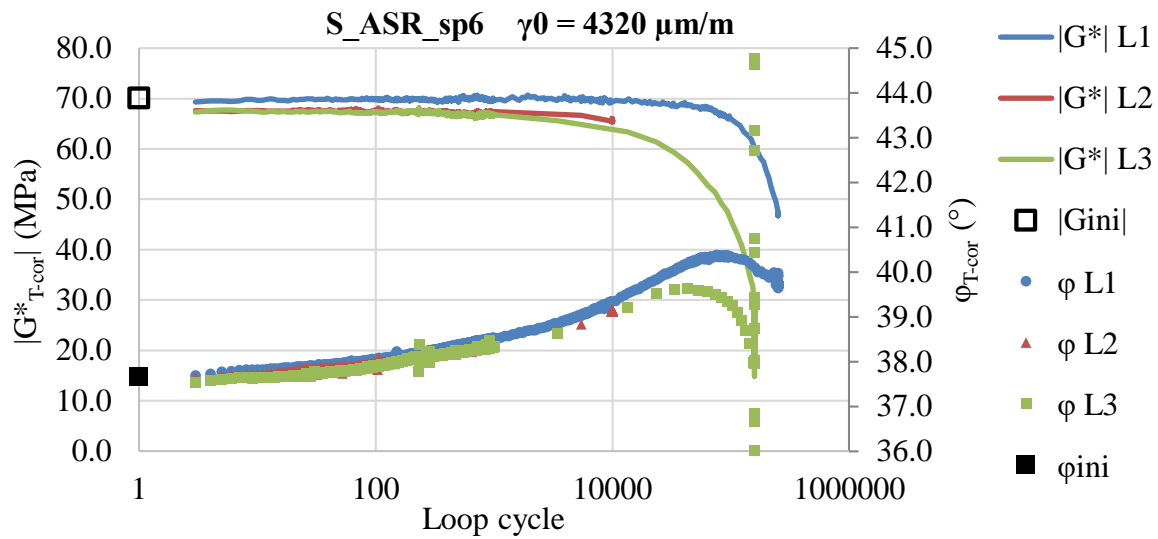
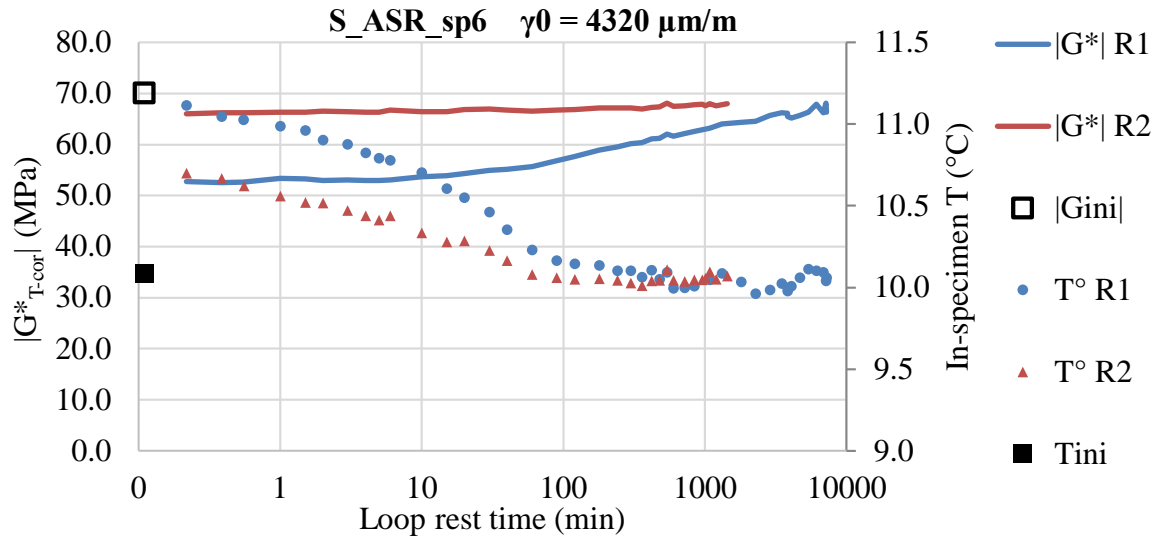
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



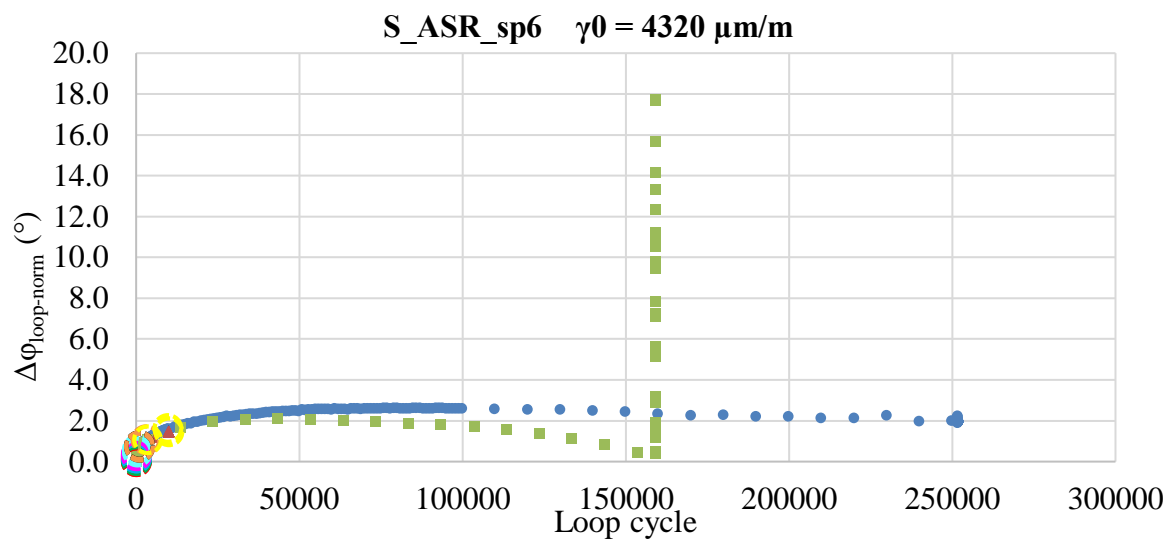
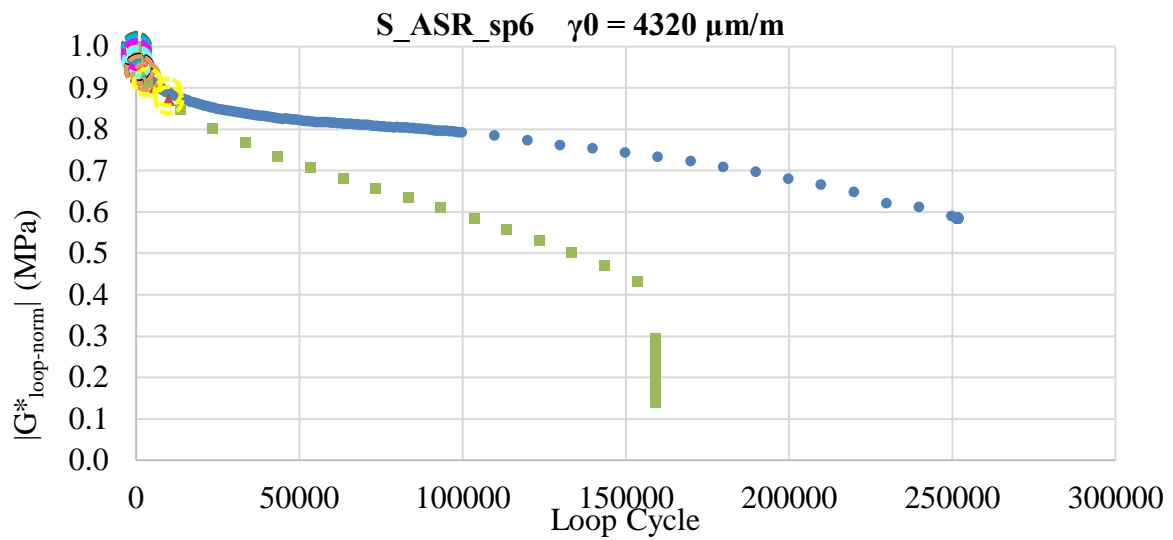
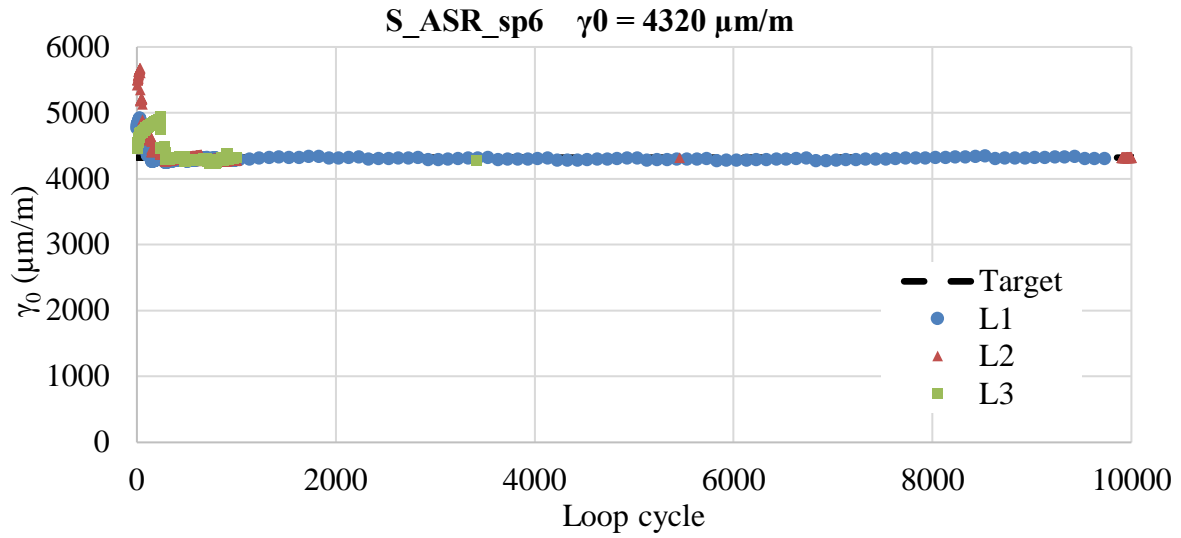
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



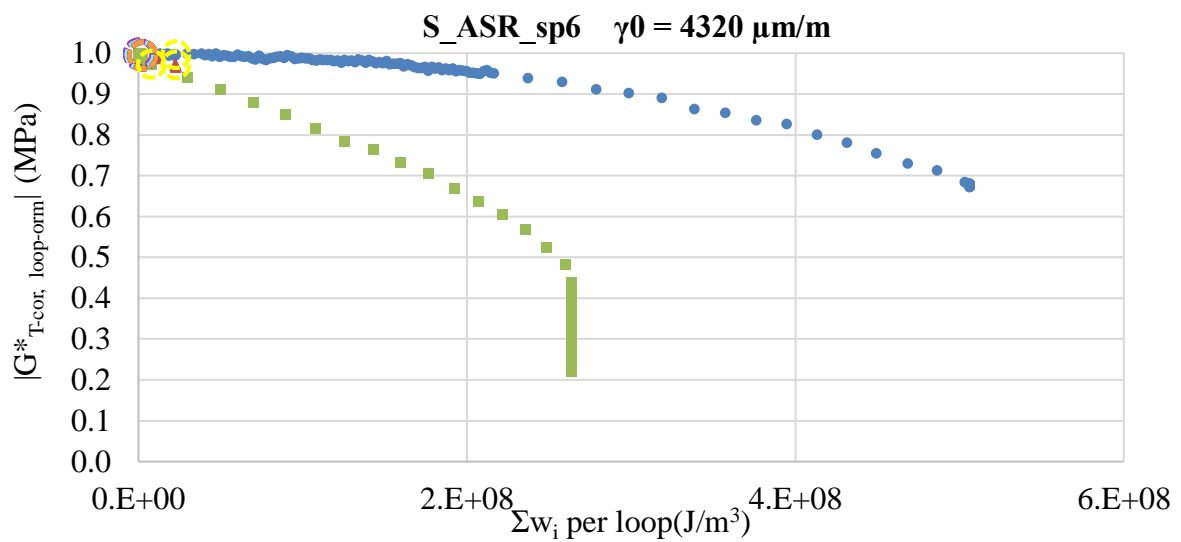
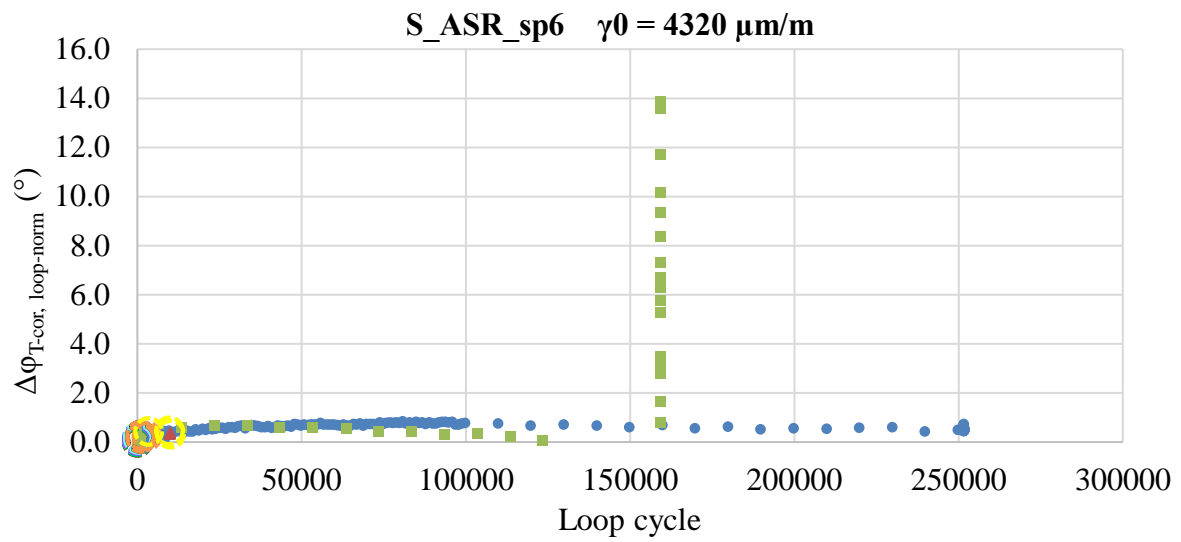
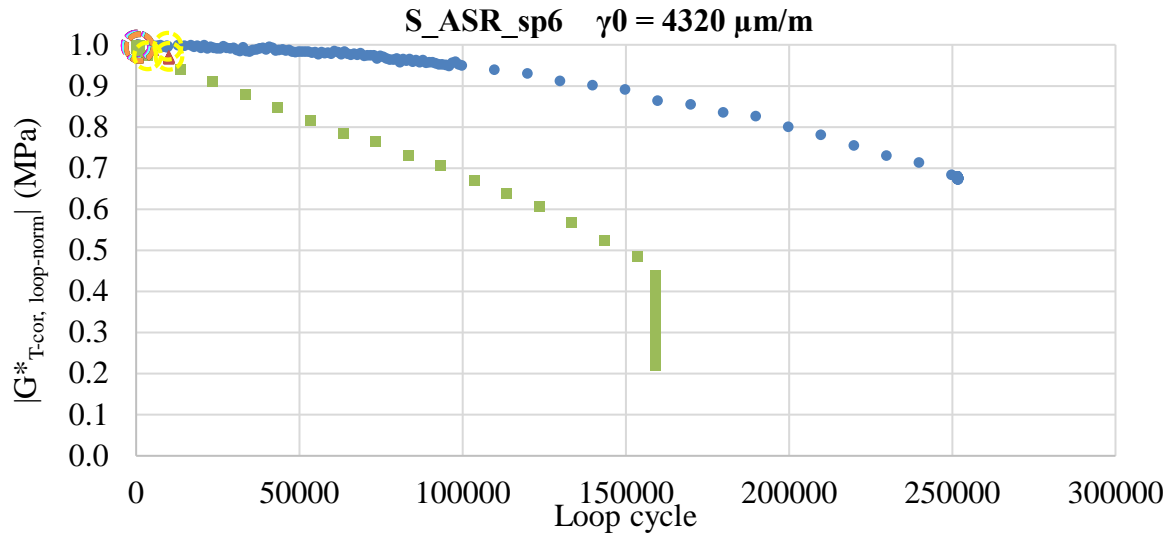
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



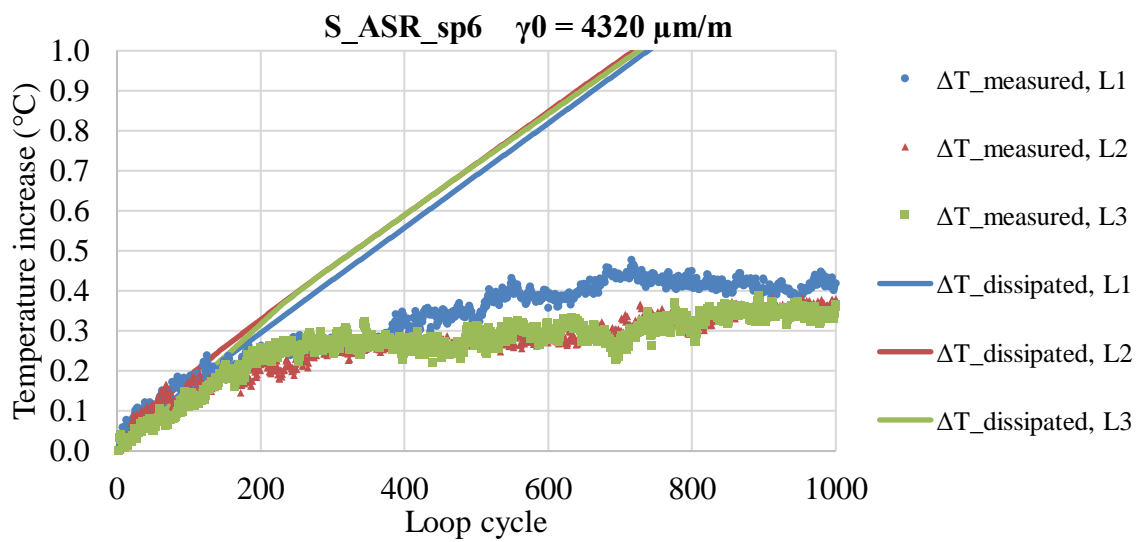
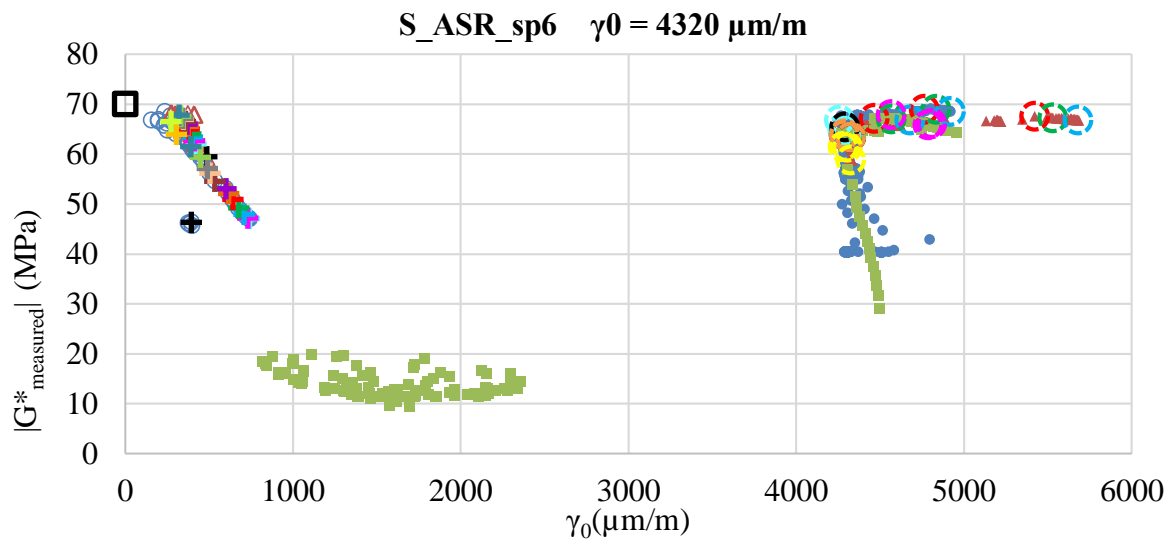
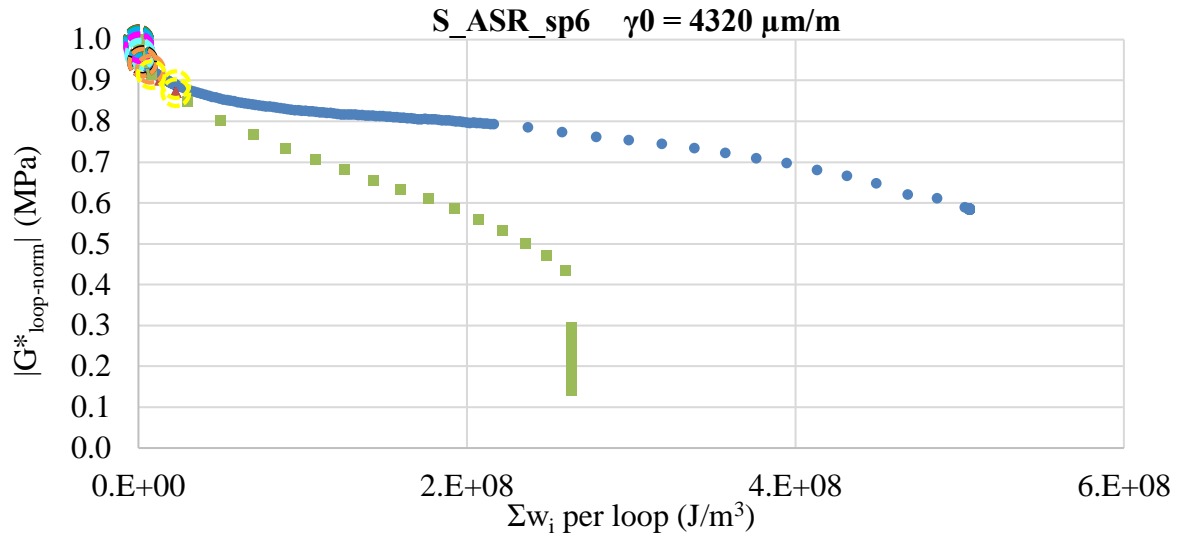
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



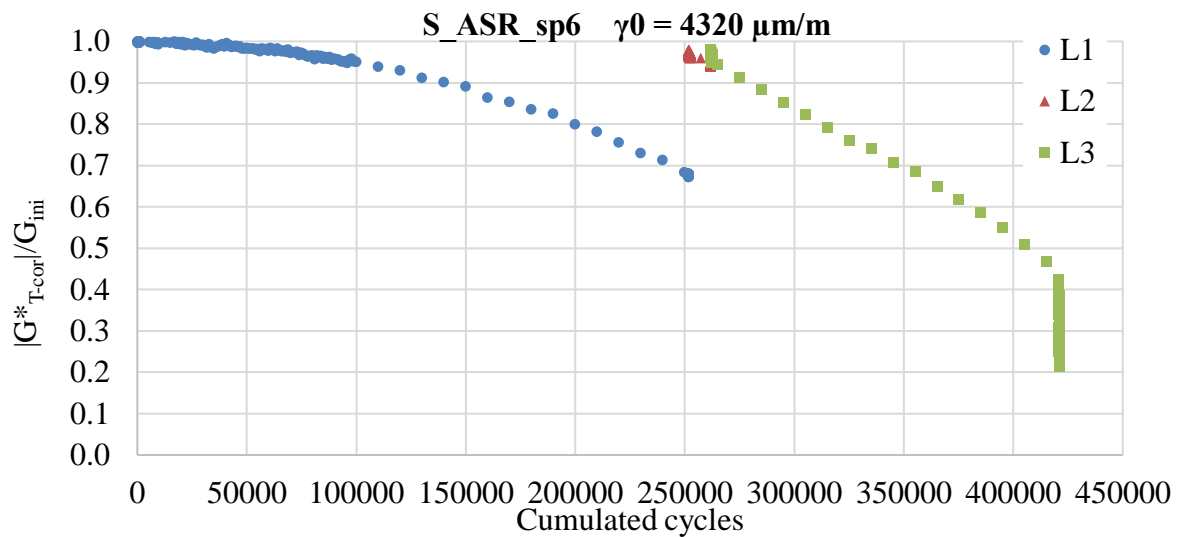
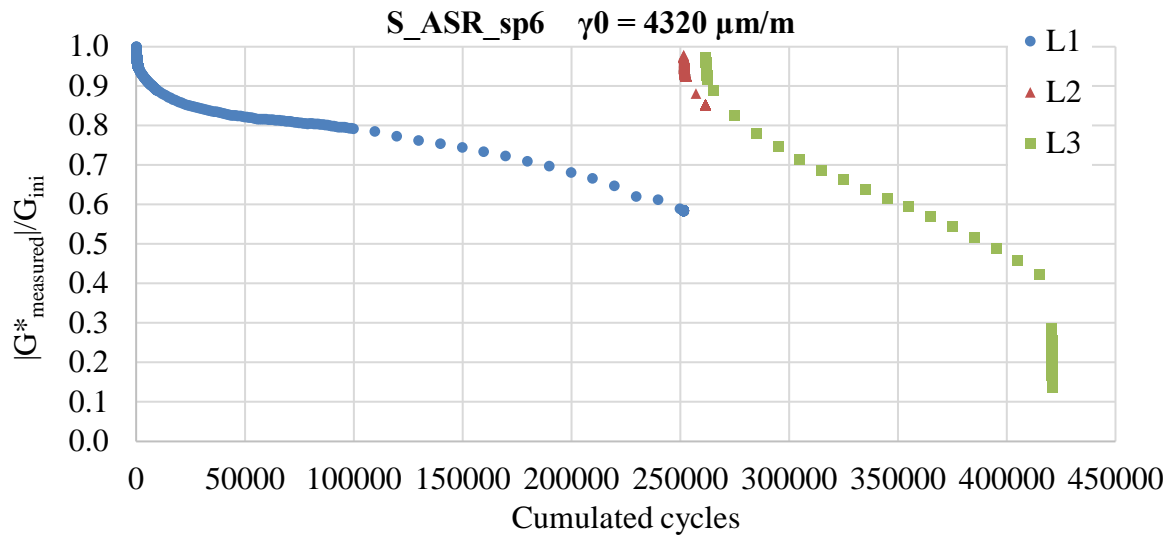
1 Thermomechanical tests on bituminous binders  
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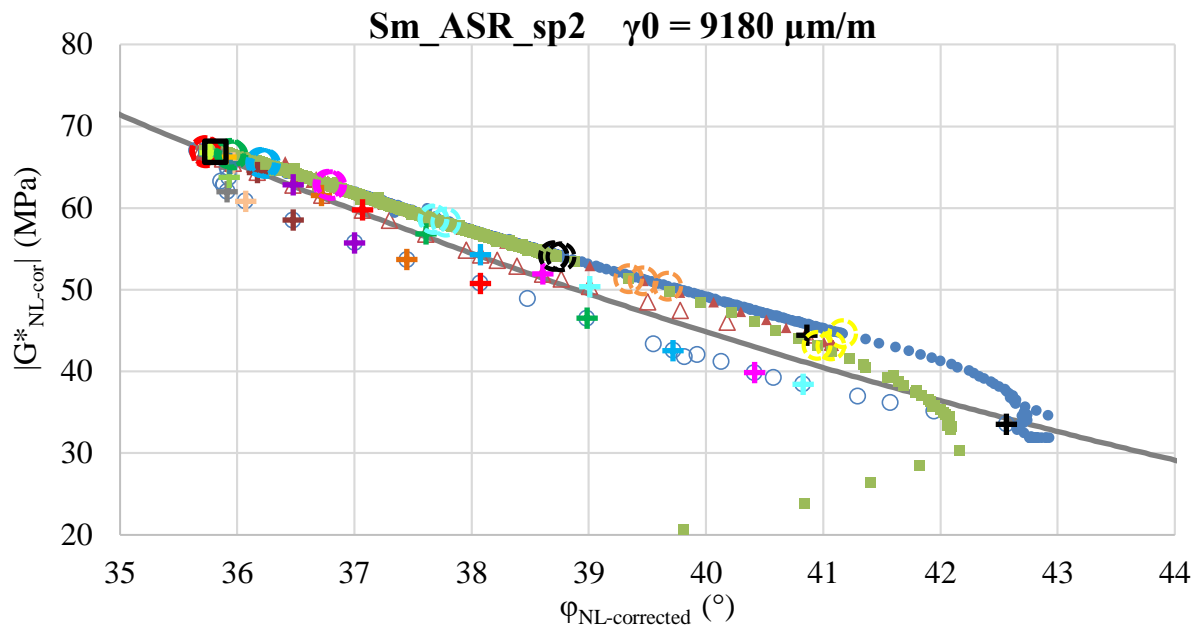
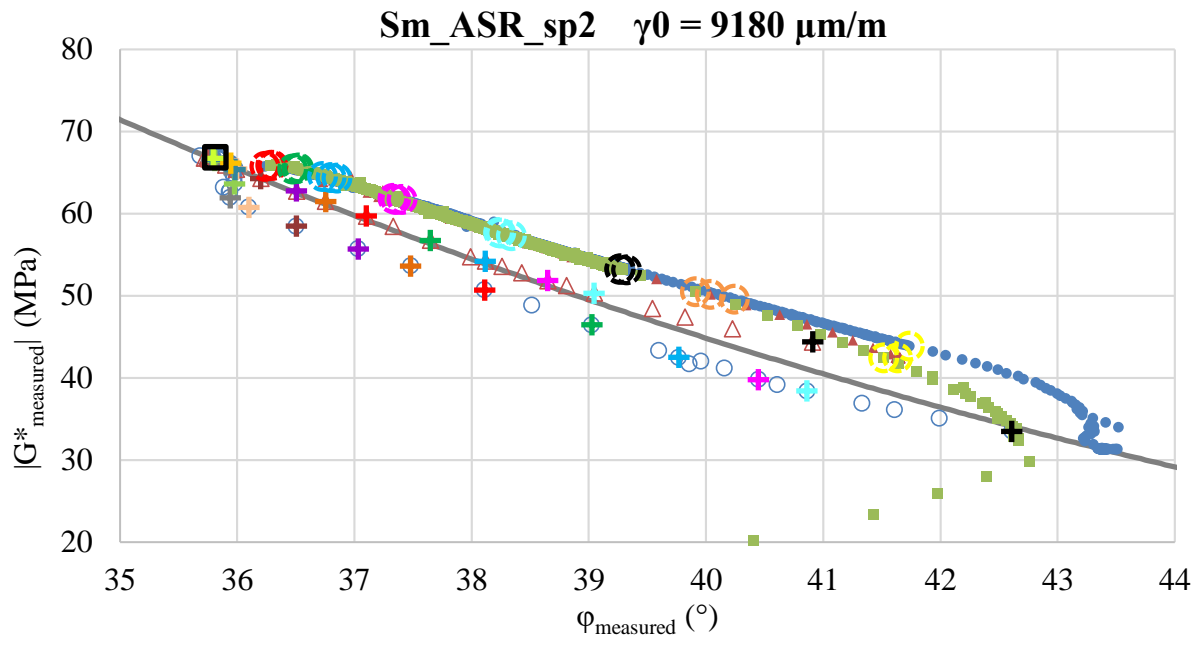
1.5.4.Sm\_ASR

1.5.4.1. Sm\_ASR\_sp6 (9180 $\mu\text{m/m}$ )

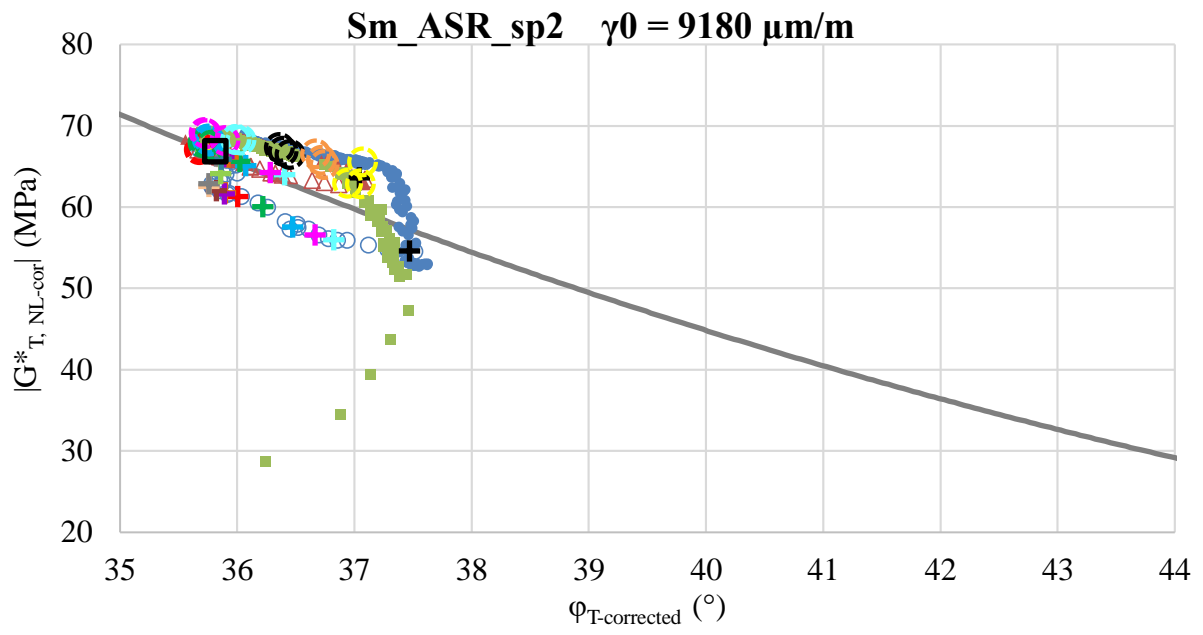
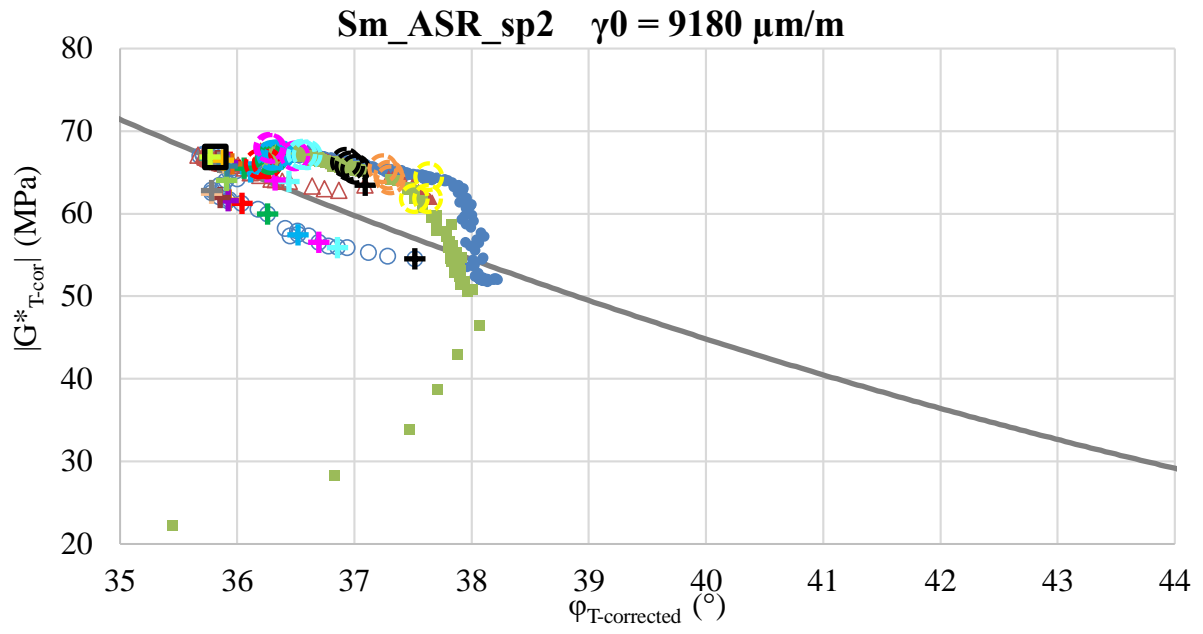
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|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G*ini        | — 2S2P1D        |



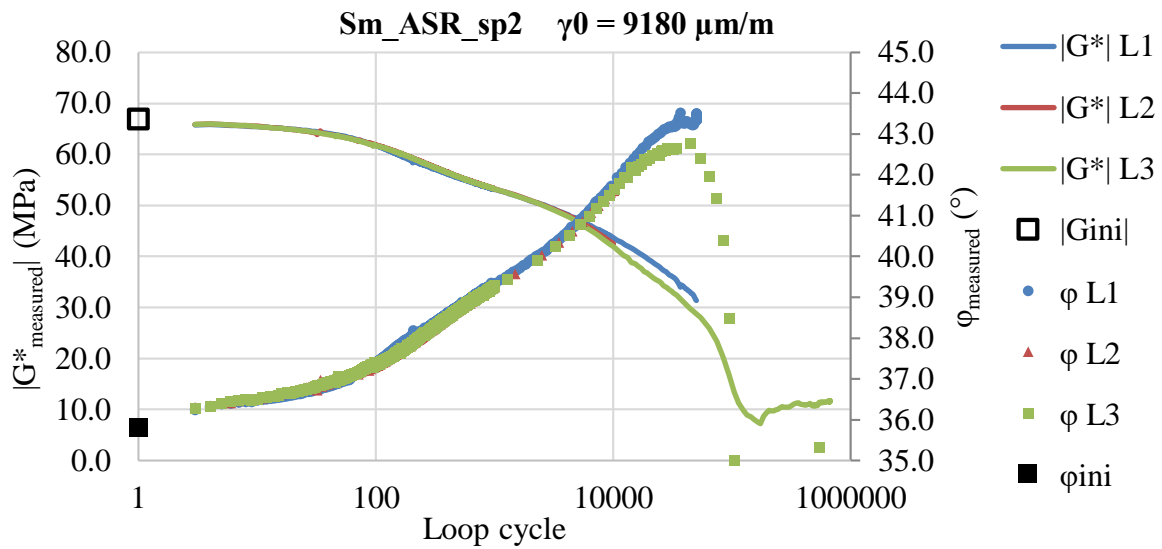
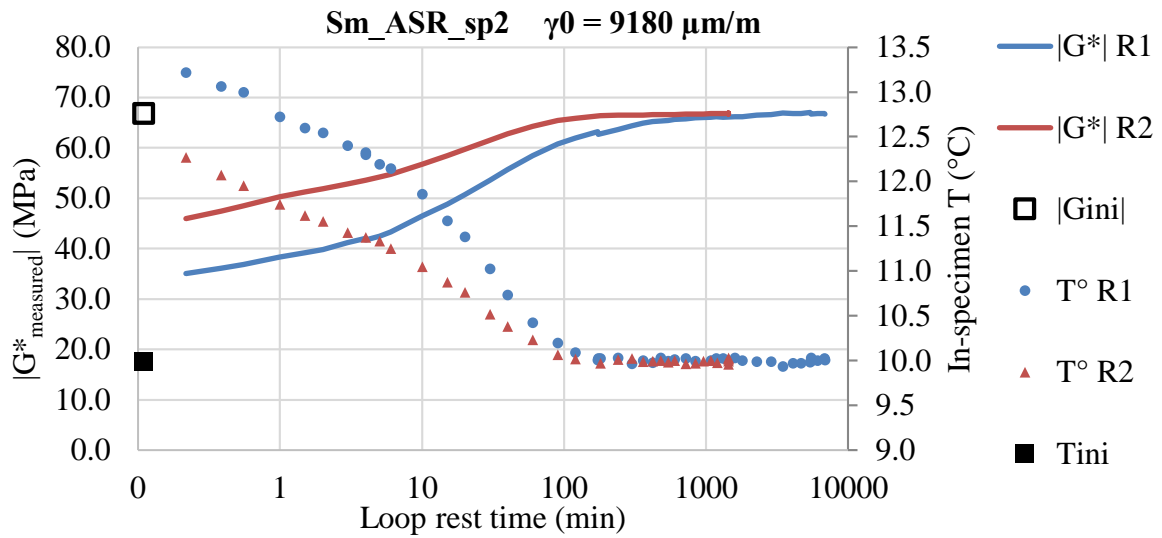
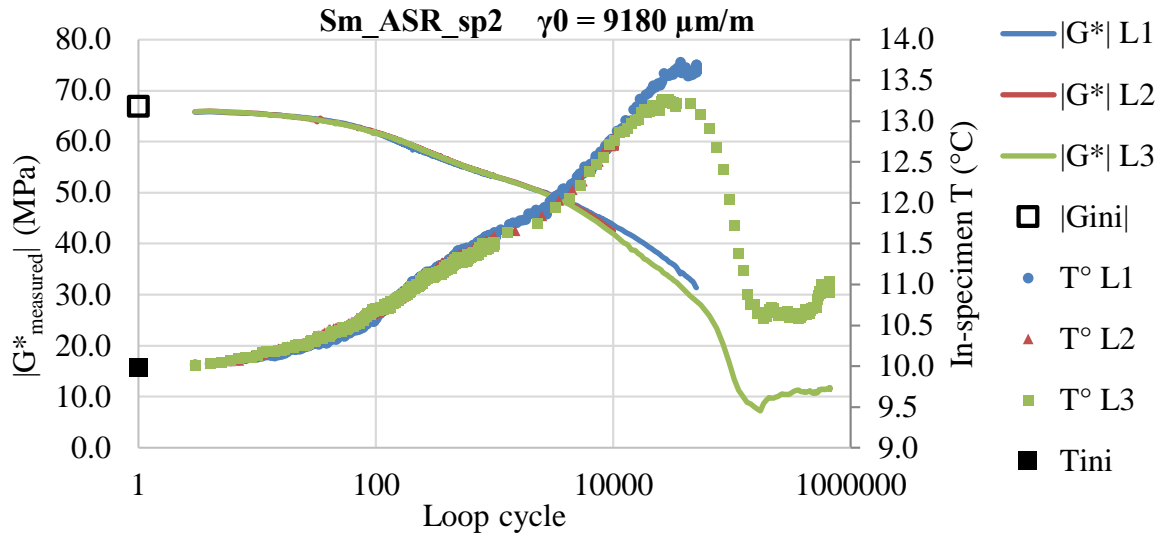
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



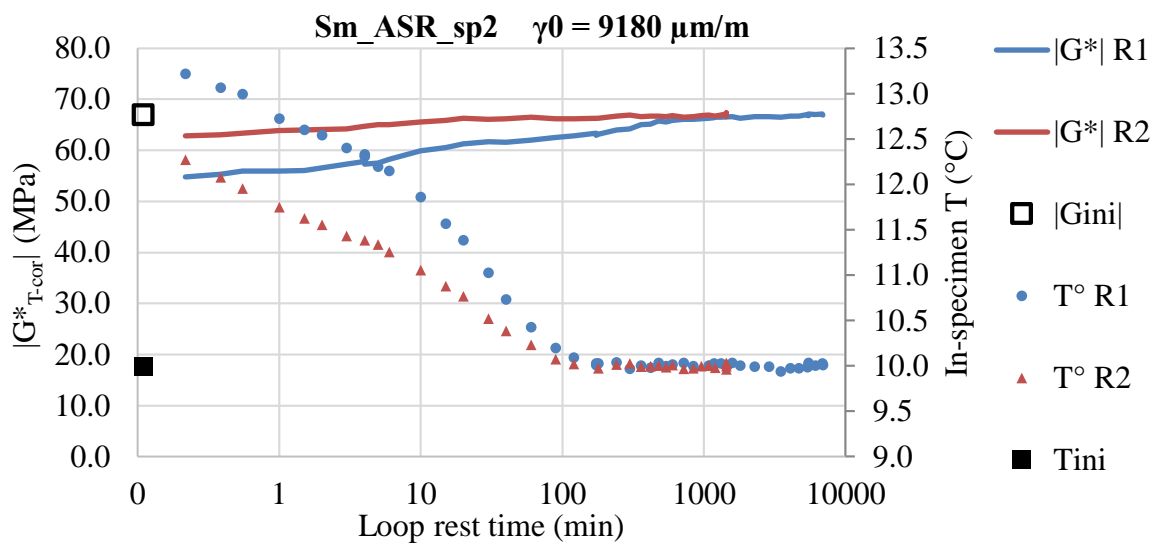
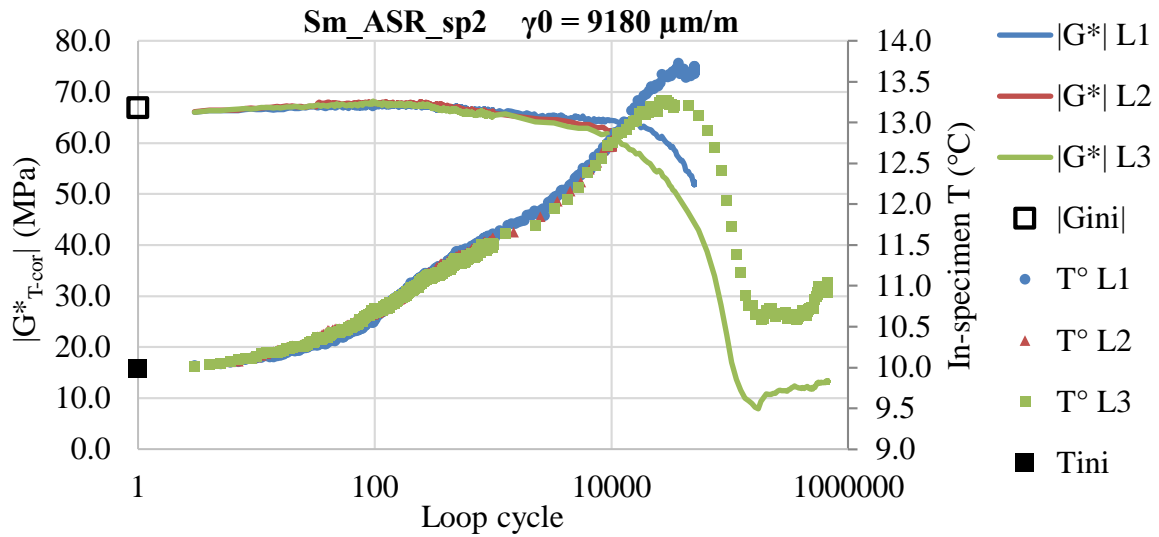
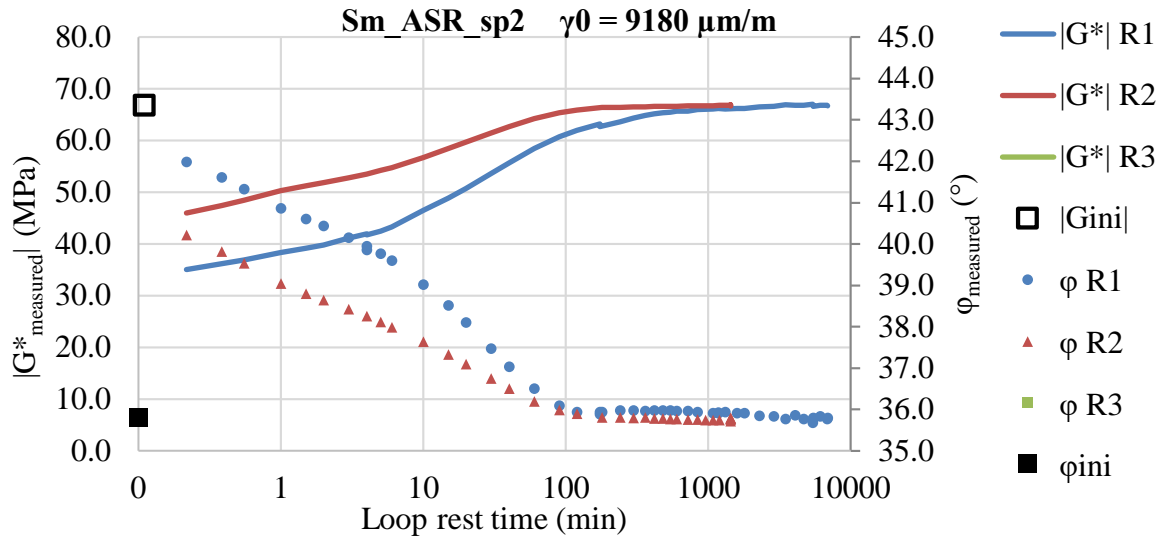
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



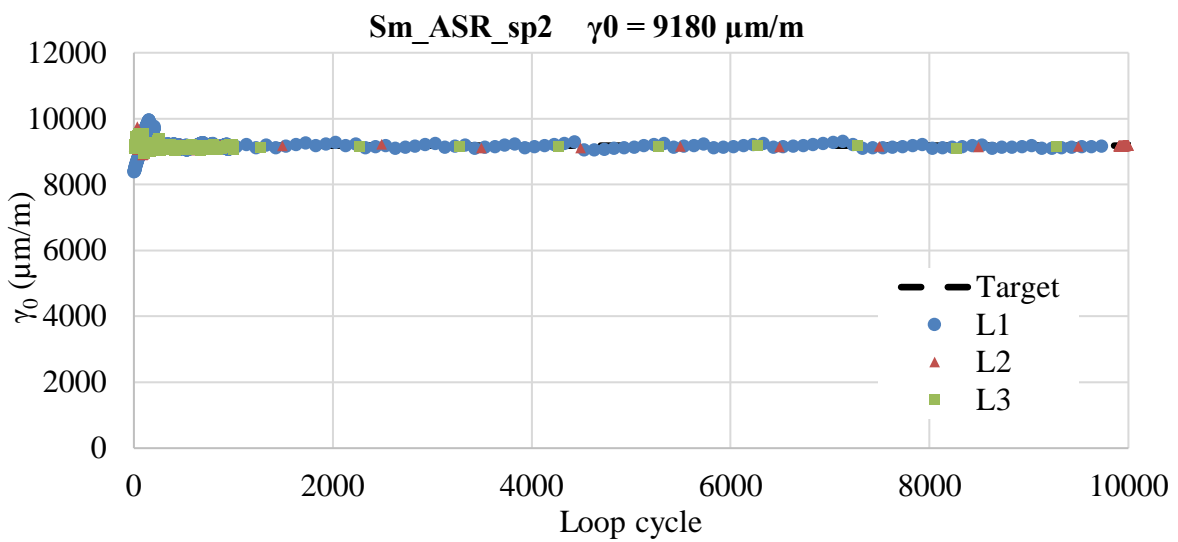
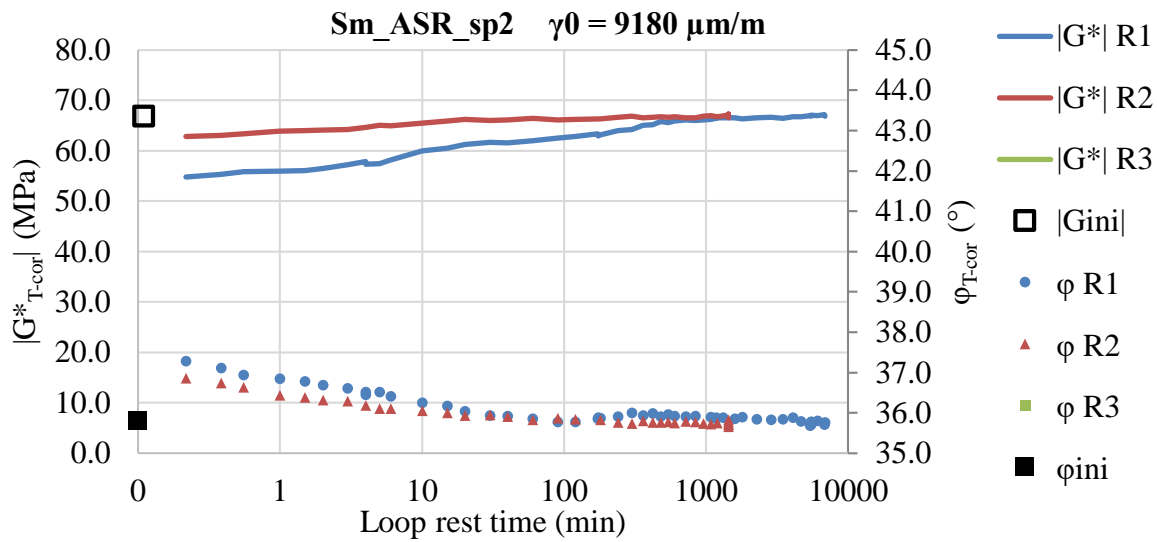
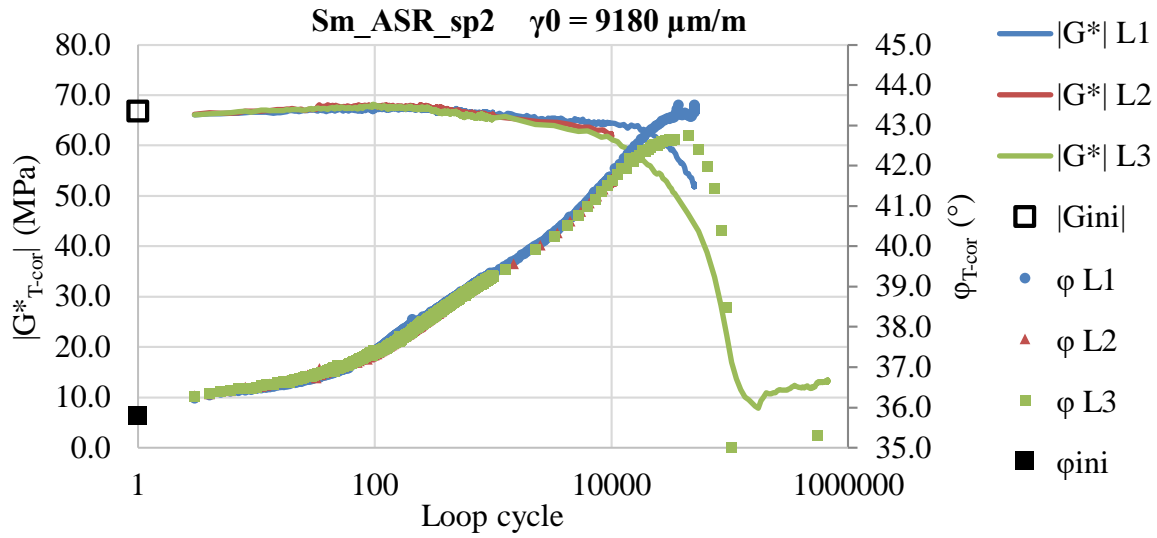
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



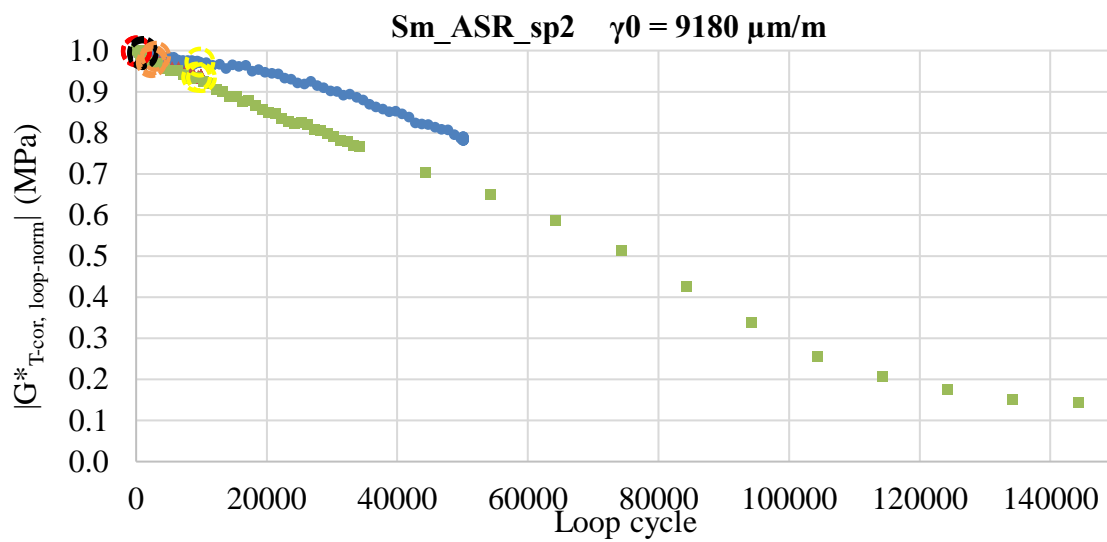
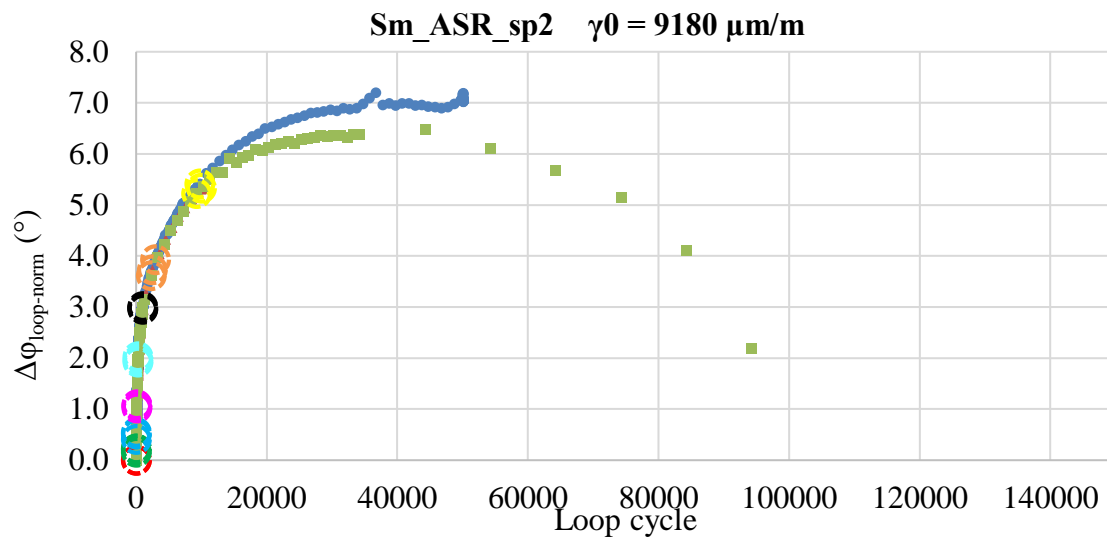
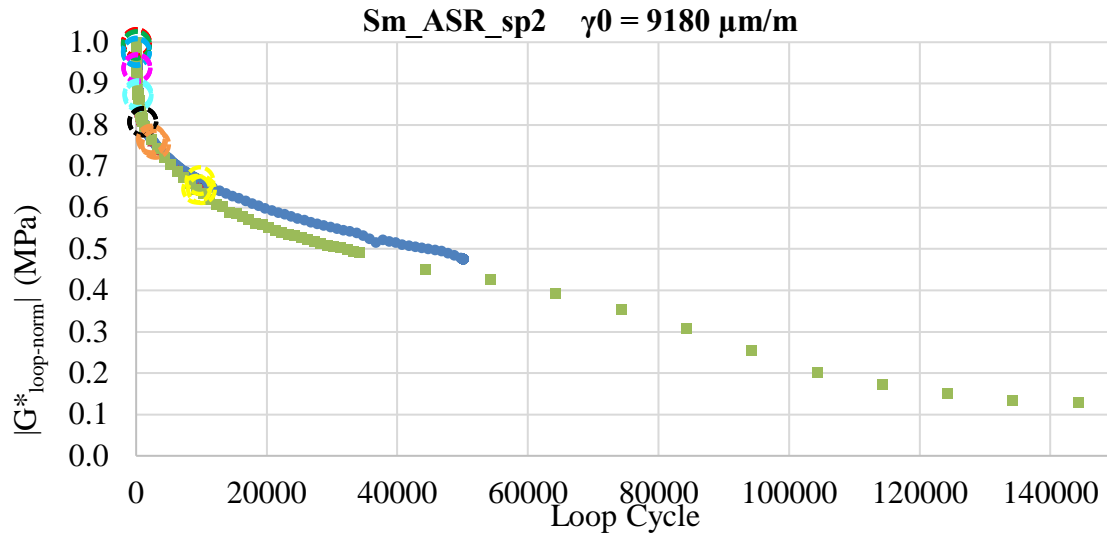
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



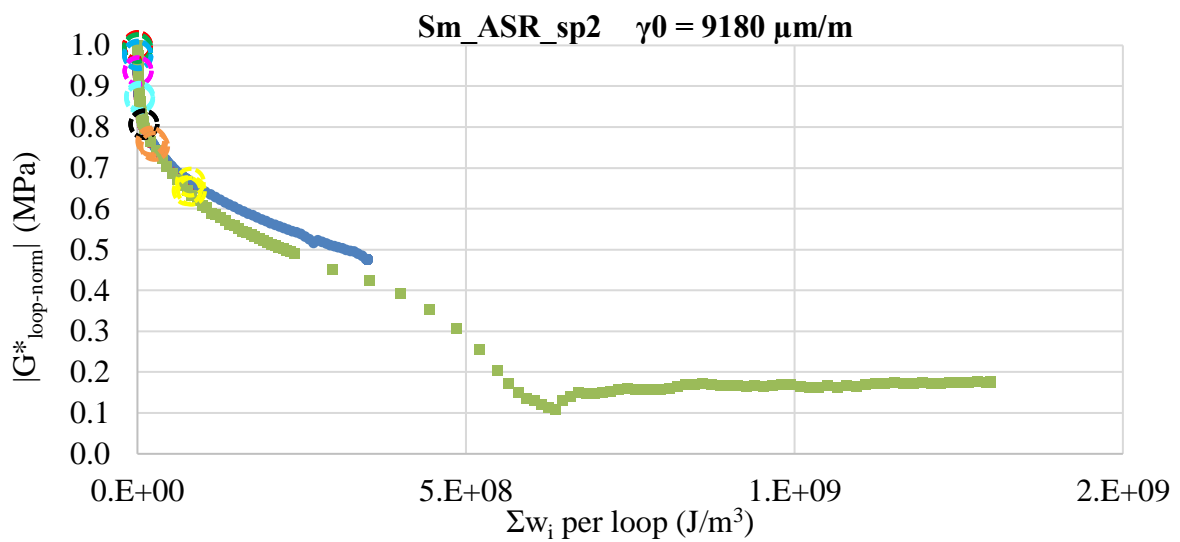
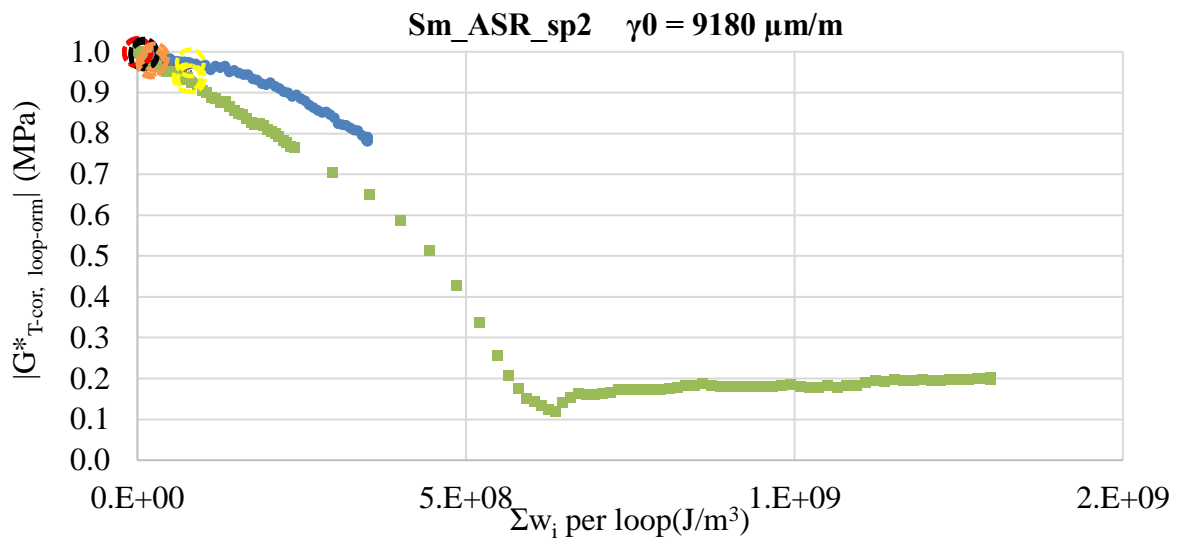
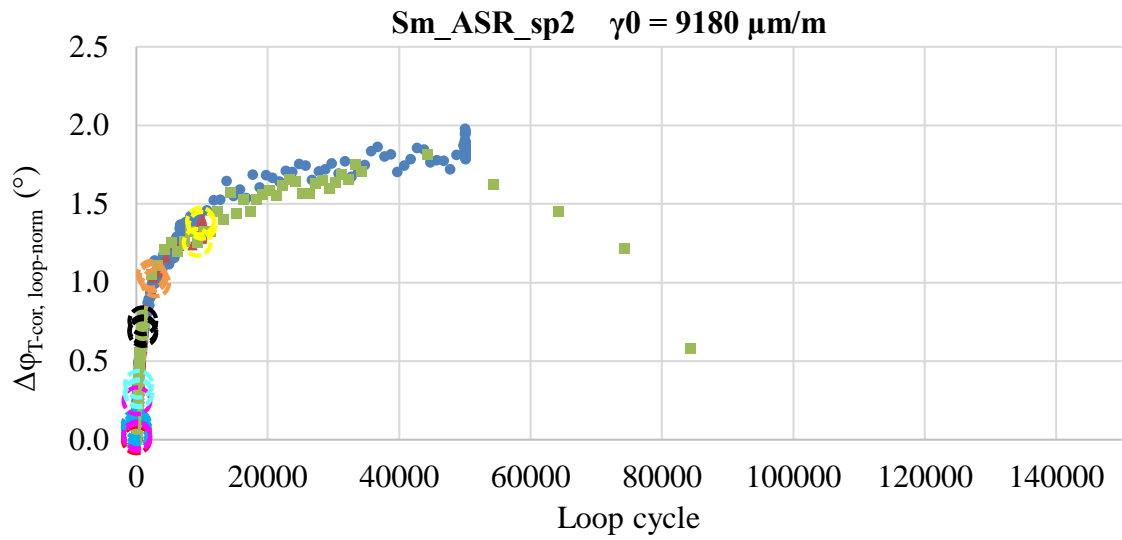
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



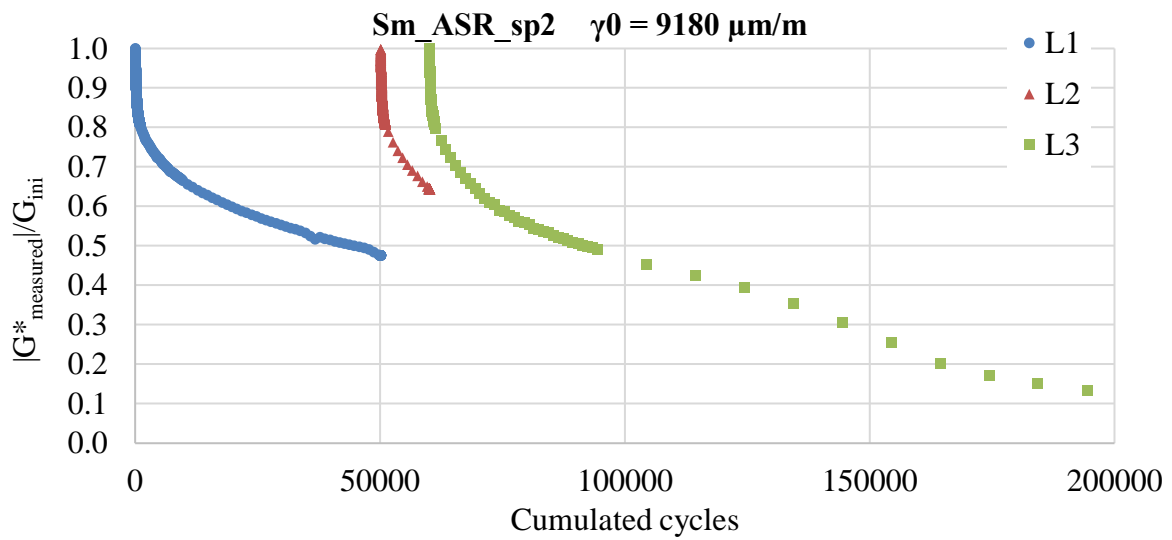
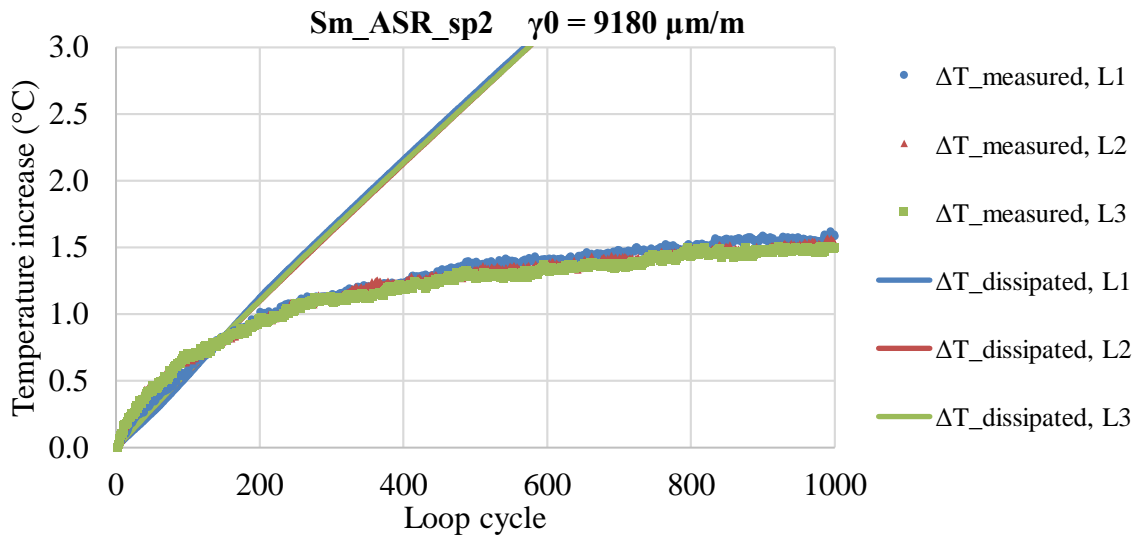
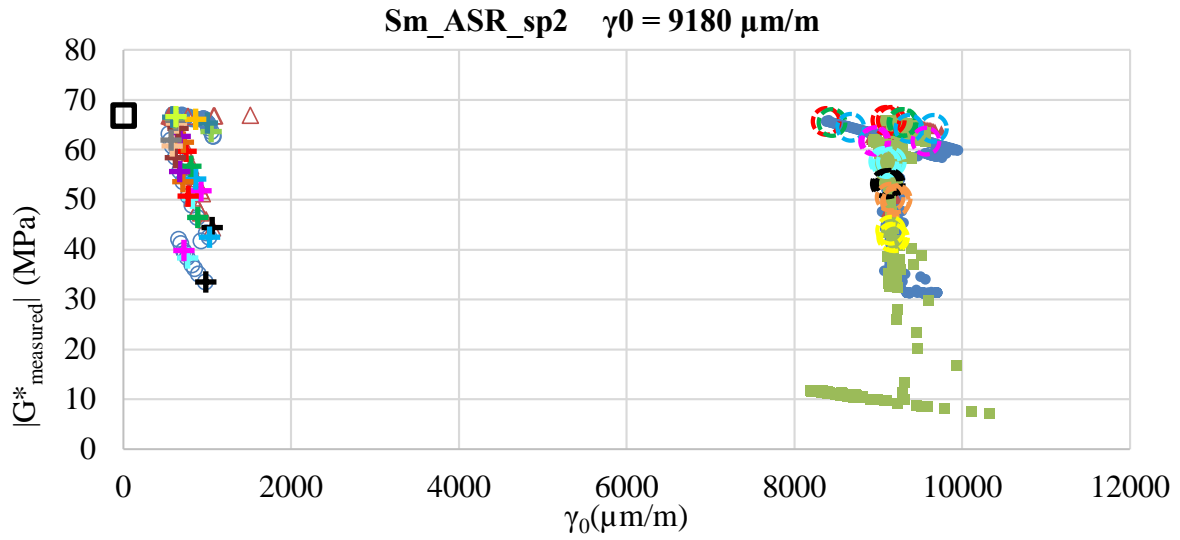
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

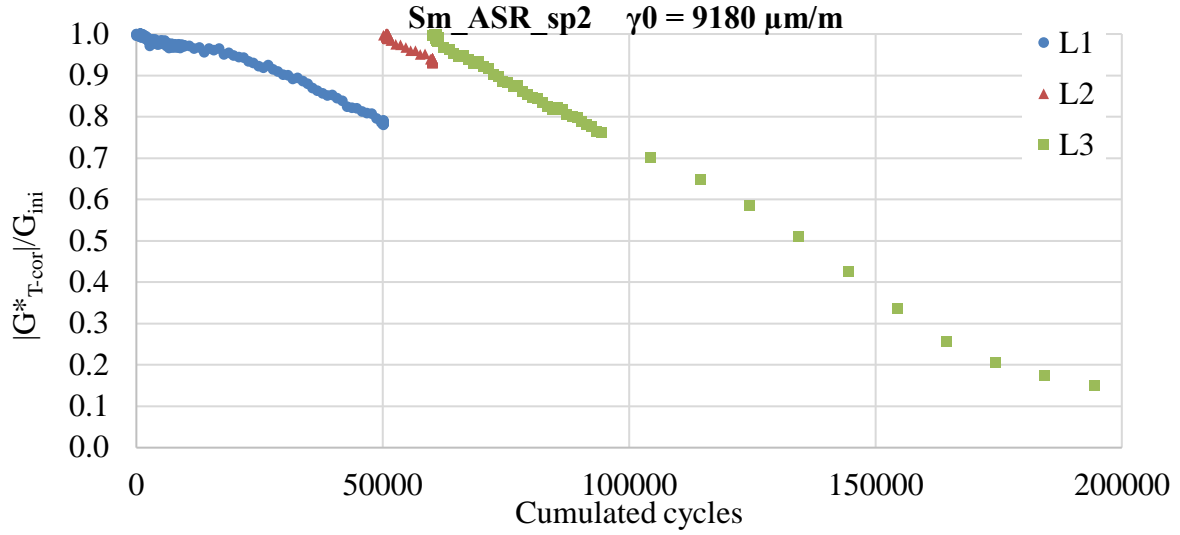


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



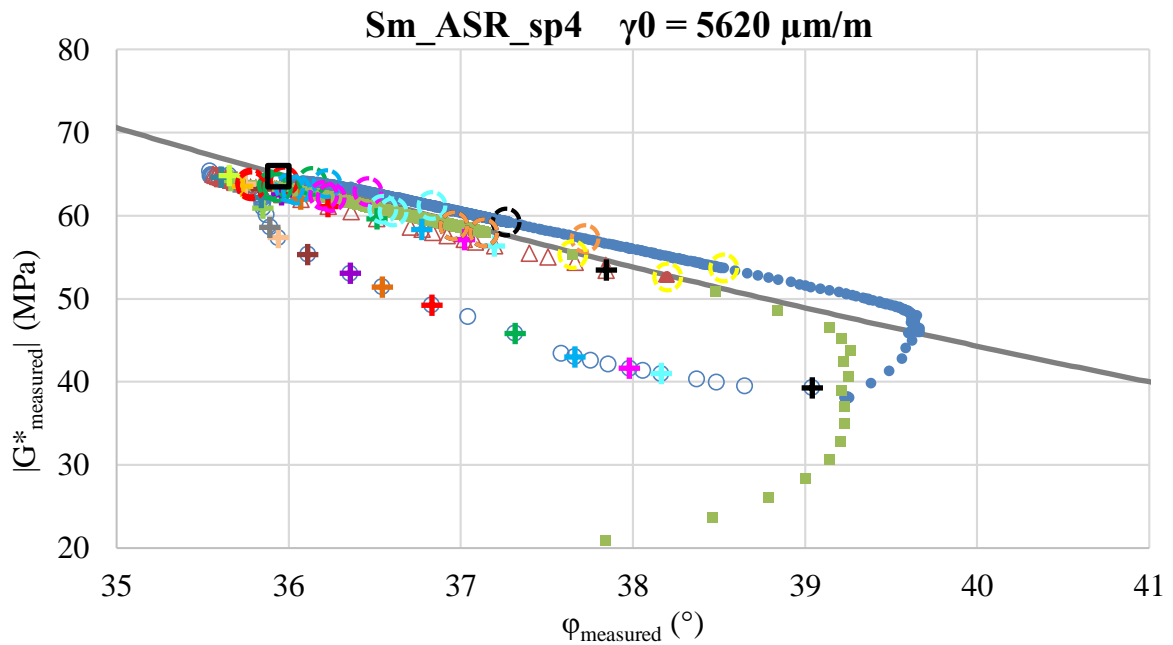


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

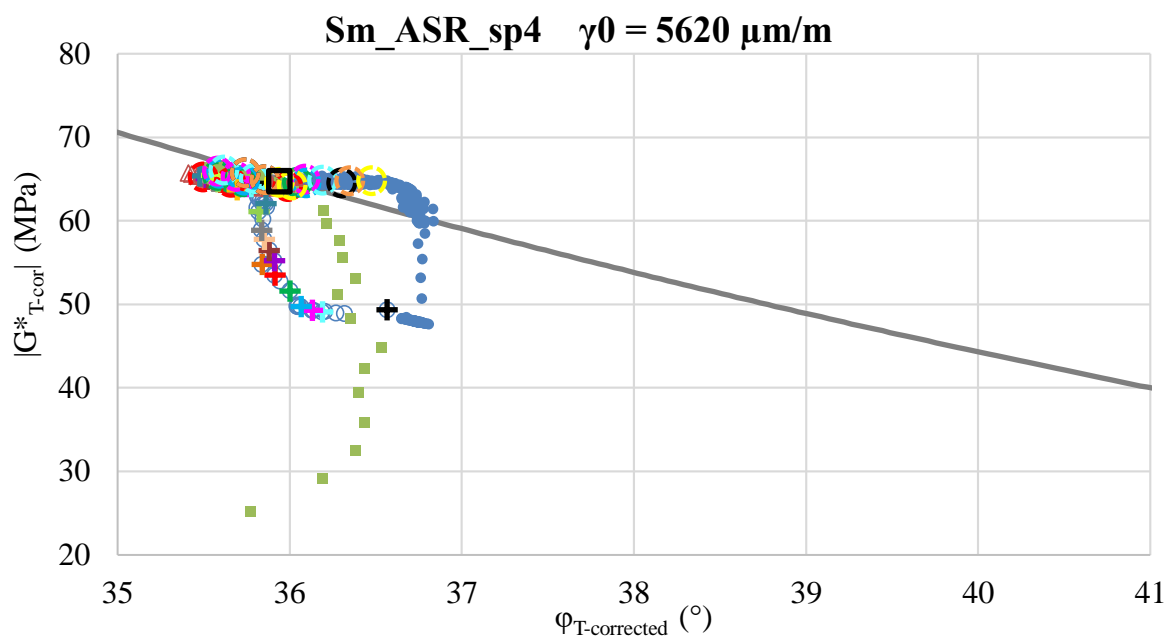
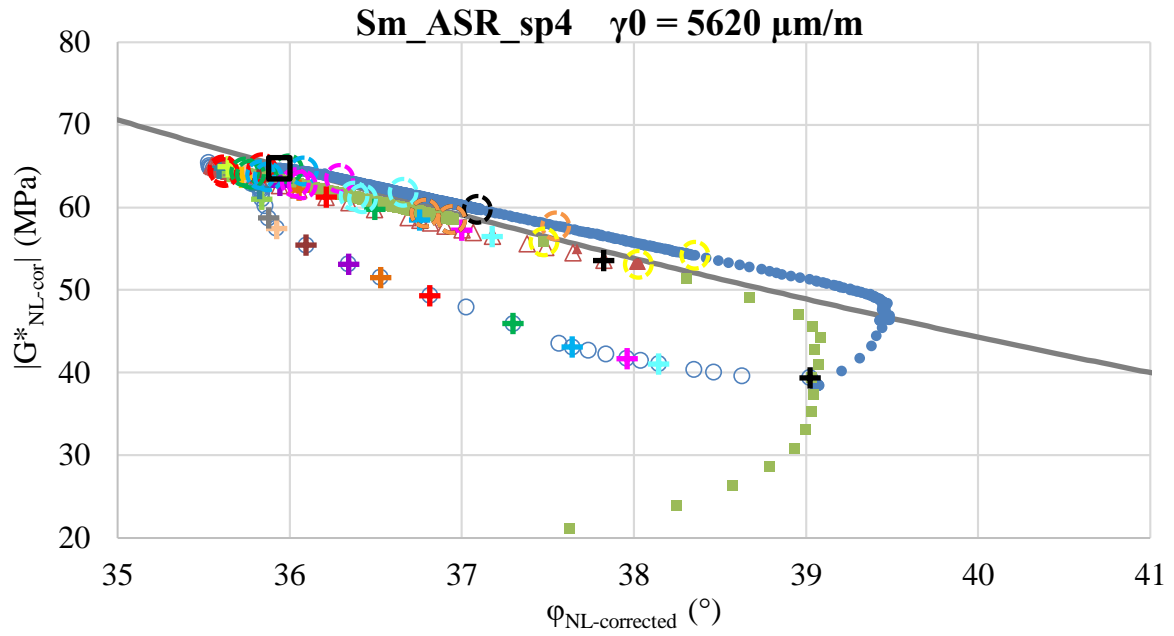


1.5.4.2. Sm\_ASR\_sp6 (5620μm/m)

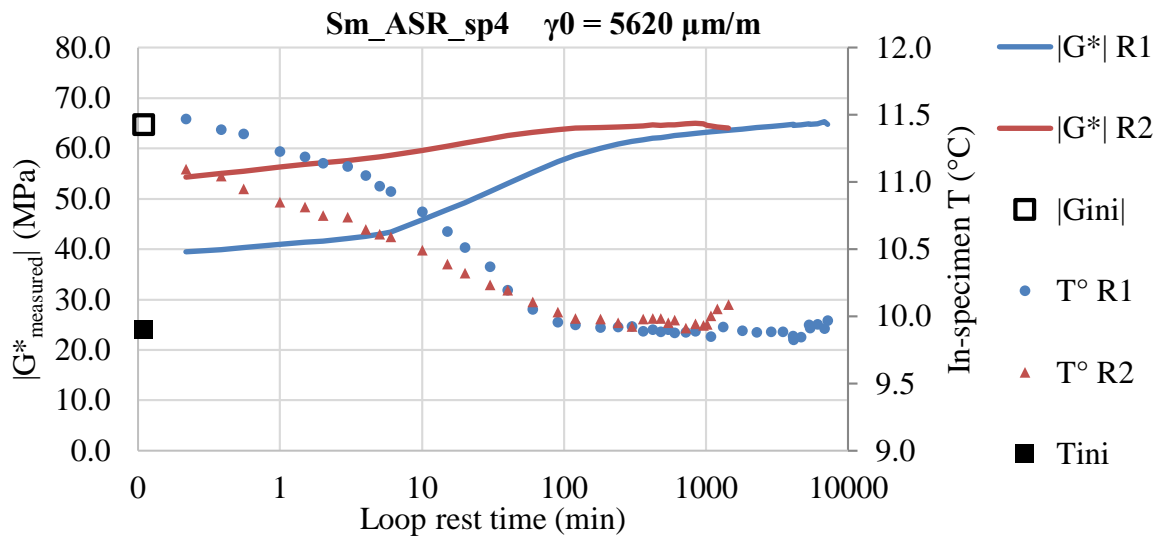
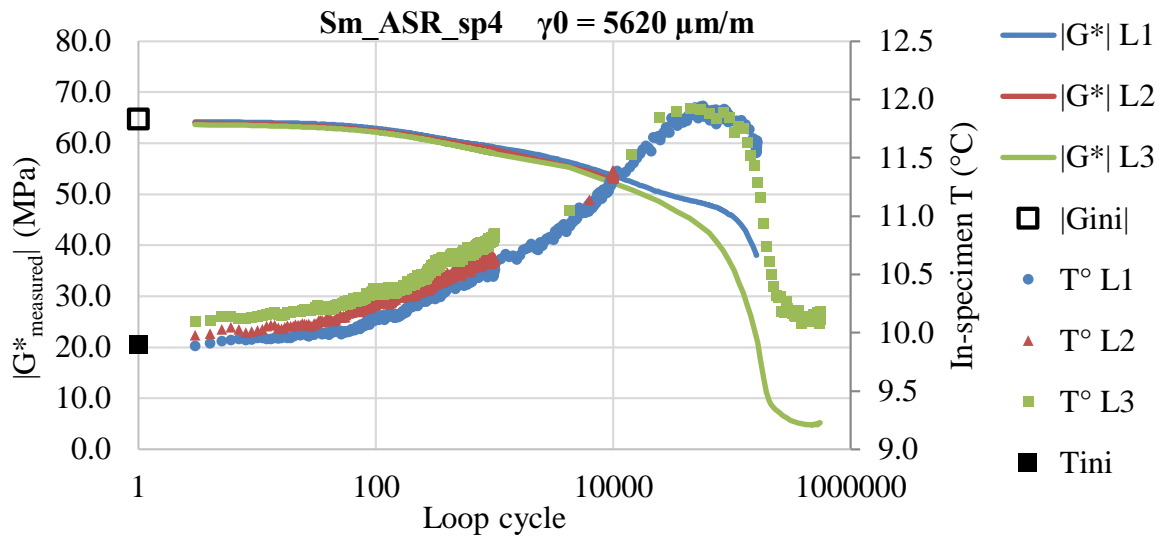
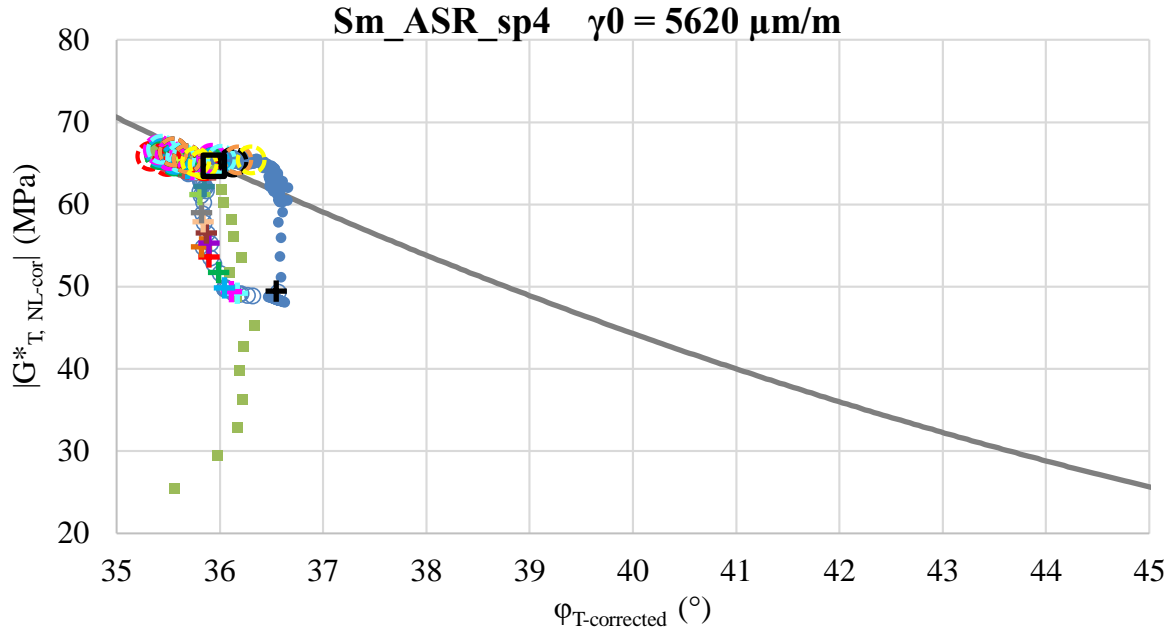
- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G*ini        | — 2S2P1D        |



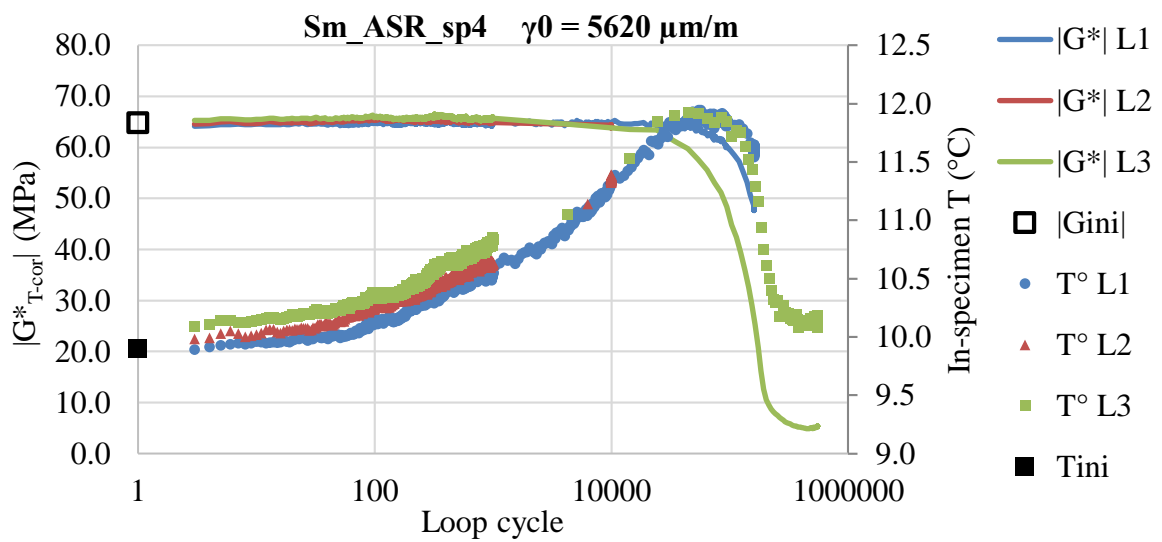
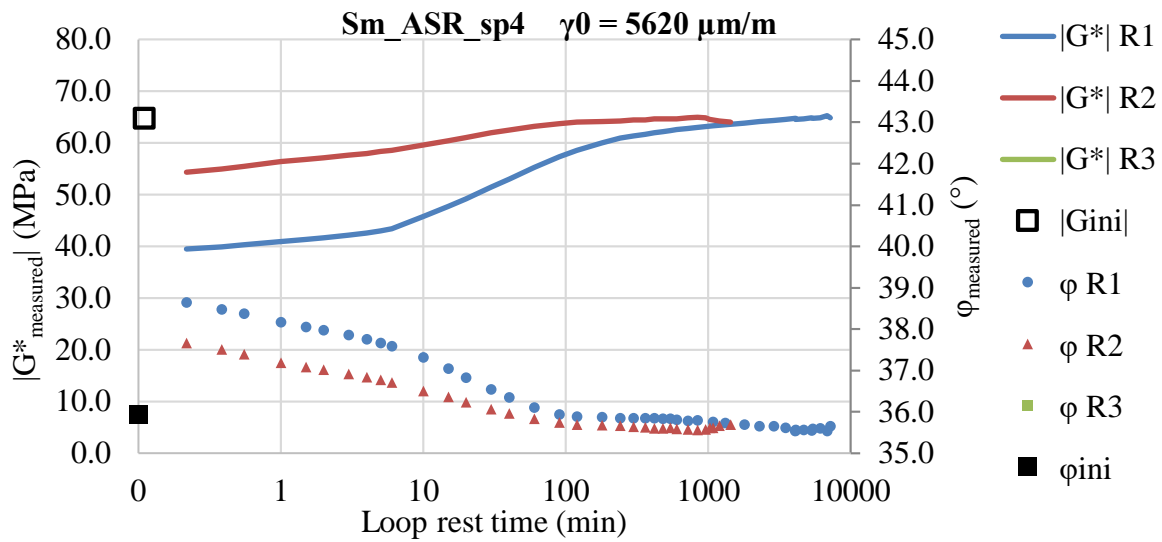
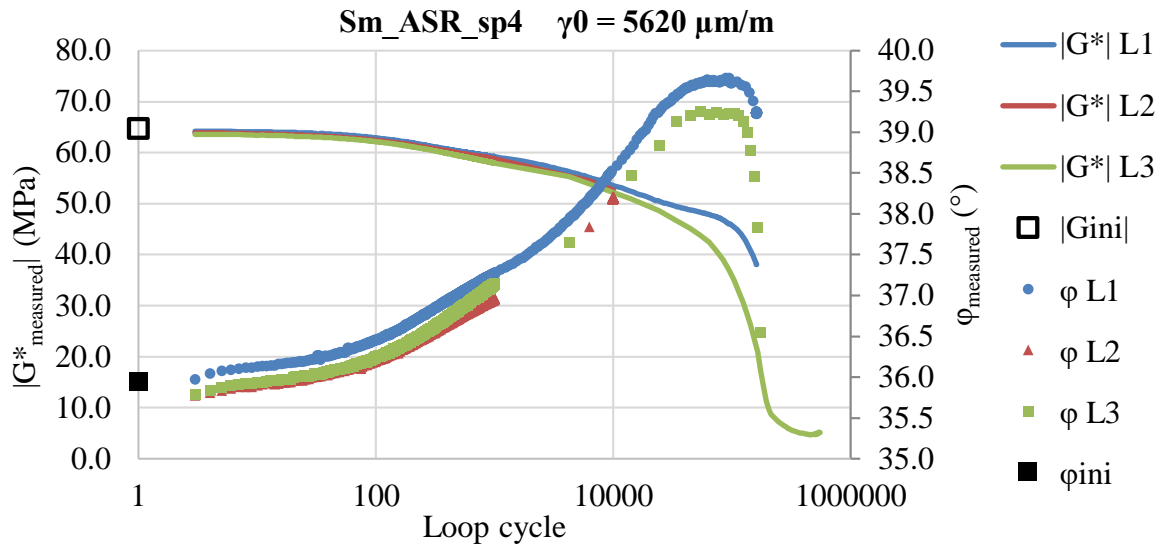
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



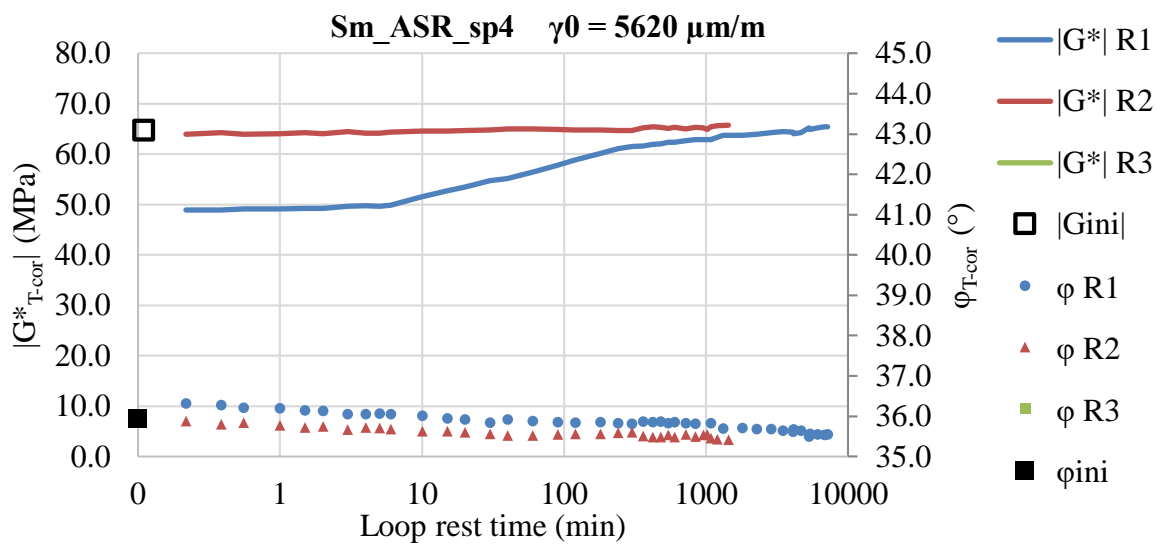
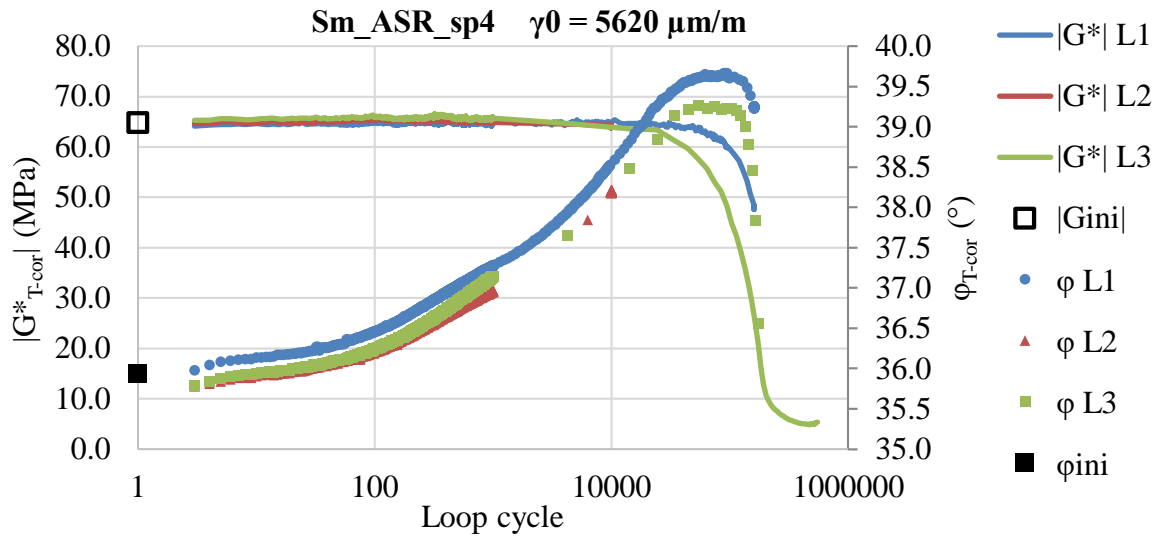
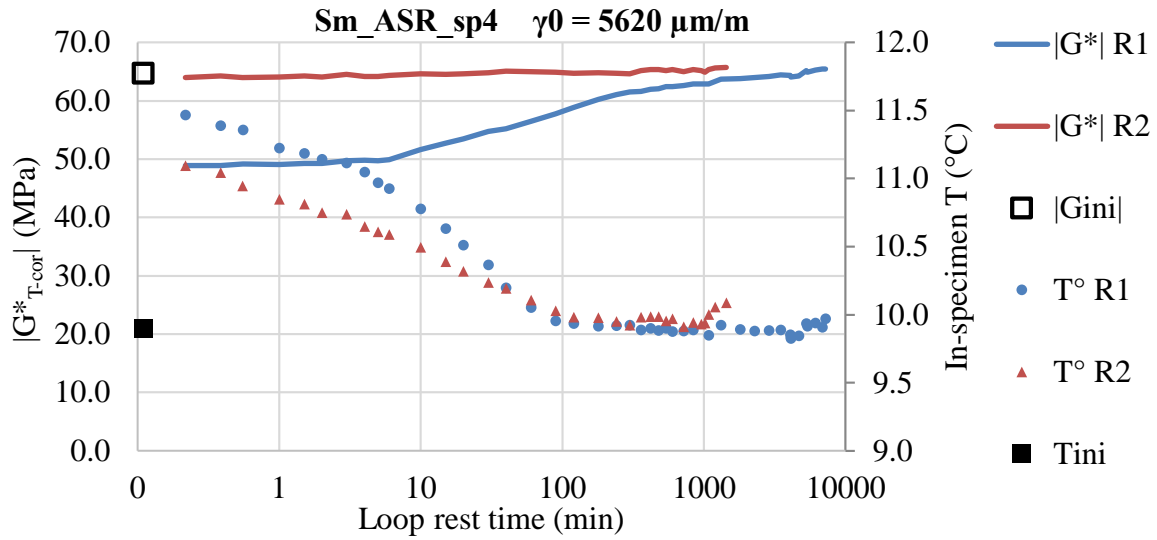
1 Thermomechanical tests on bituminous binders  
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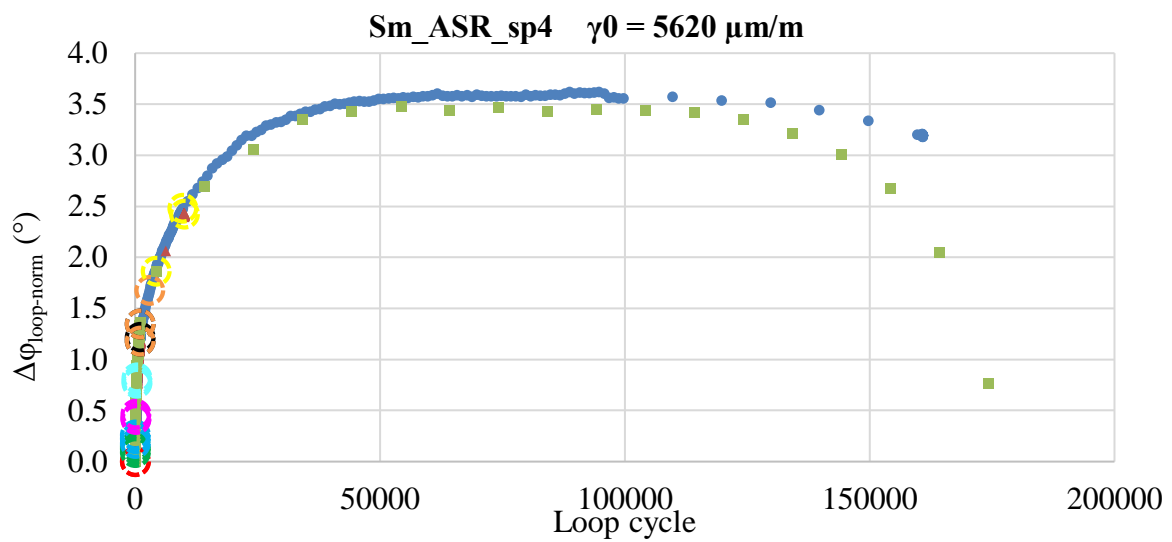
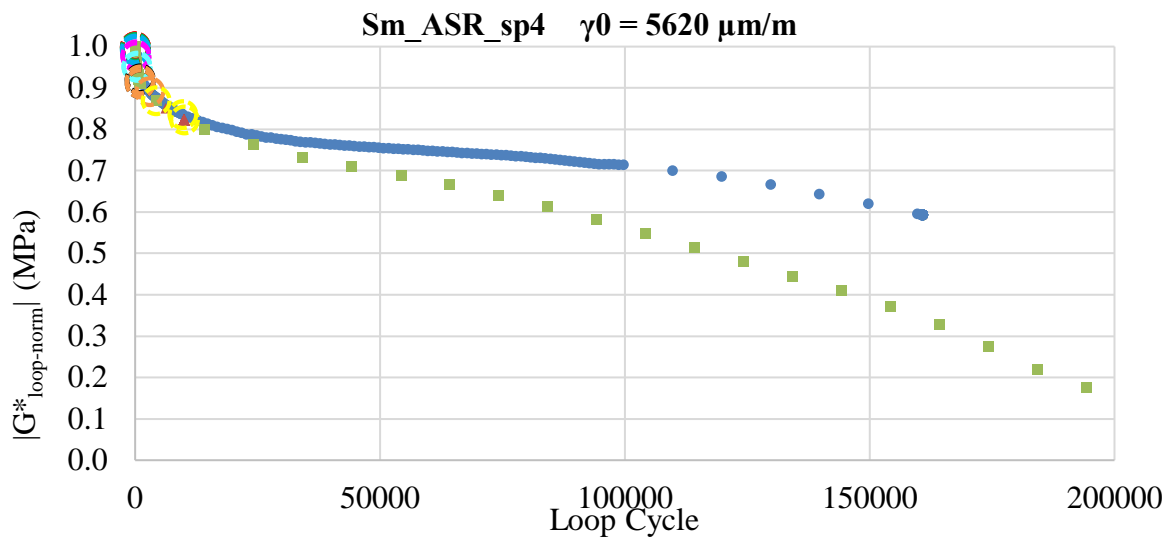
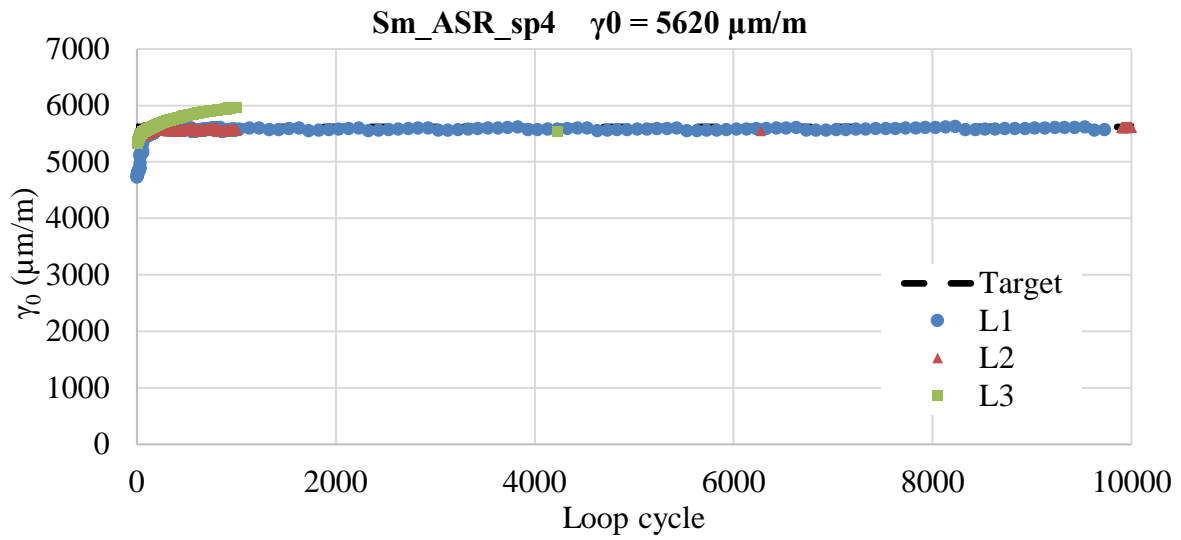
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



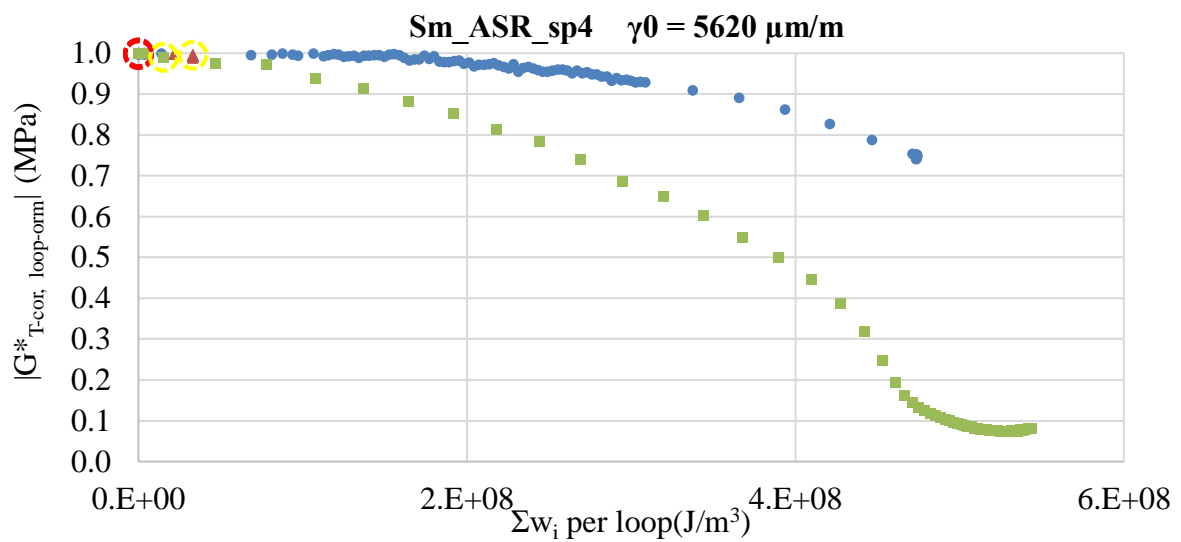
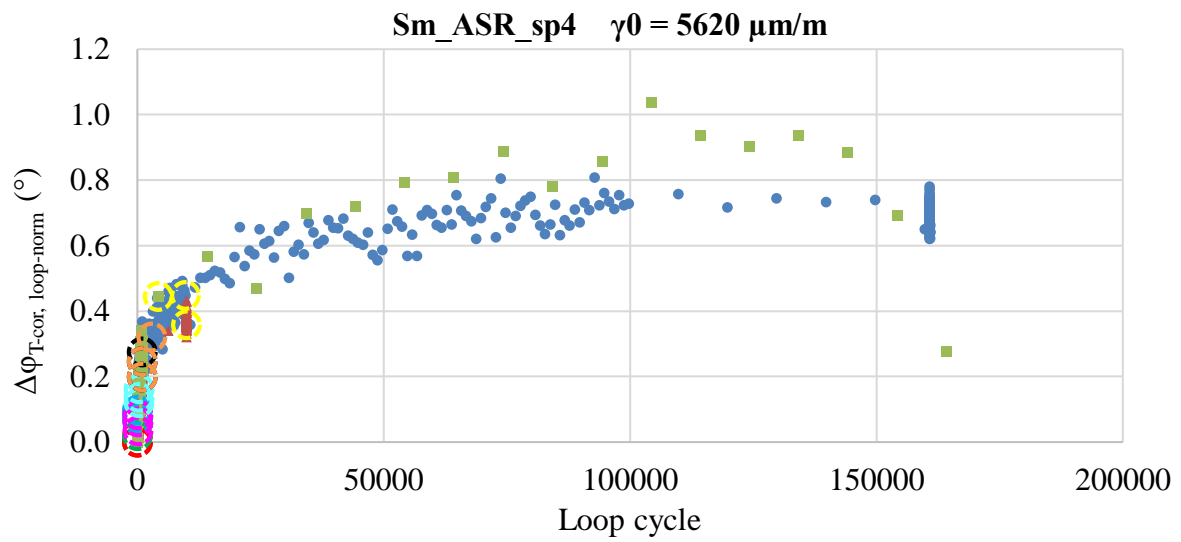
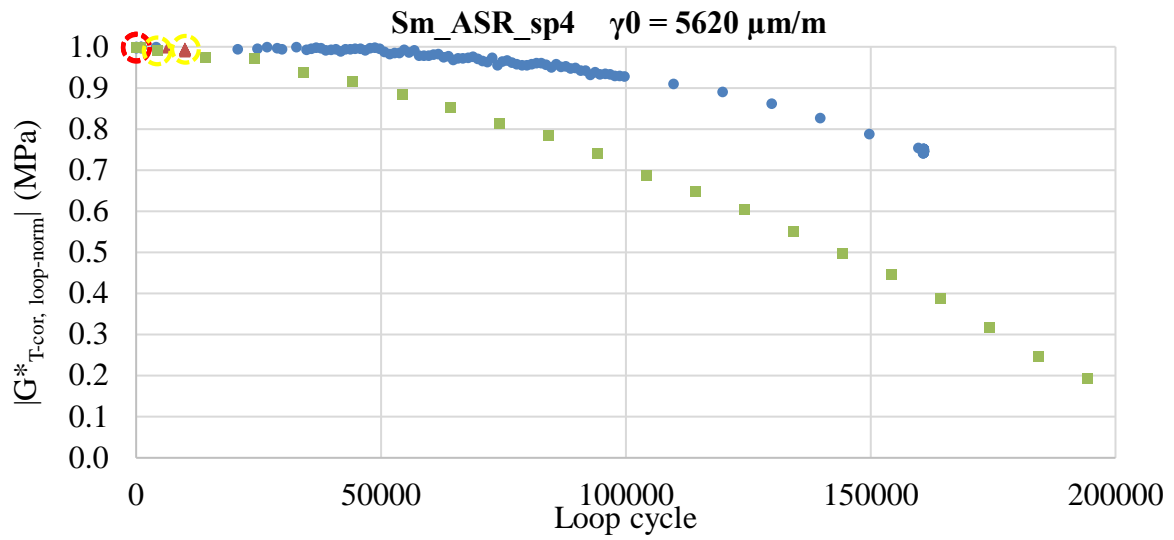
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



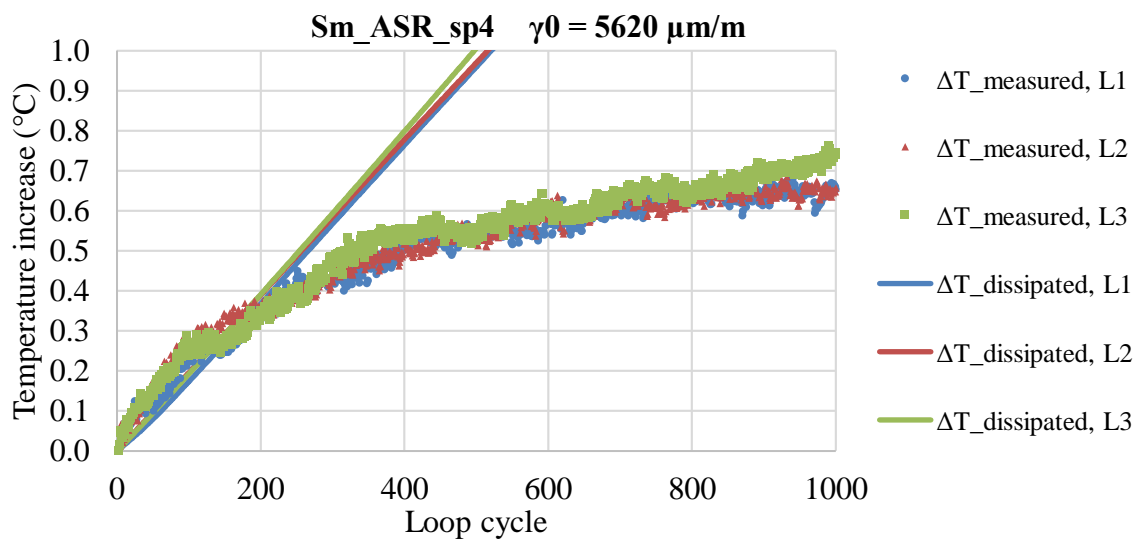
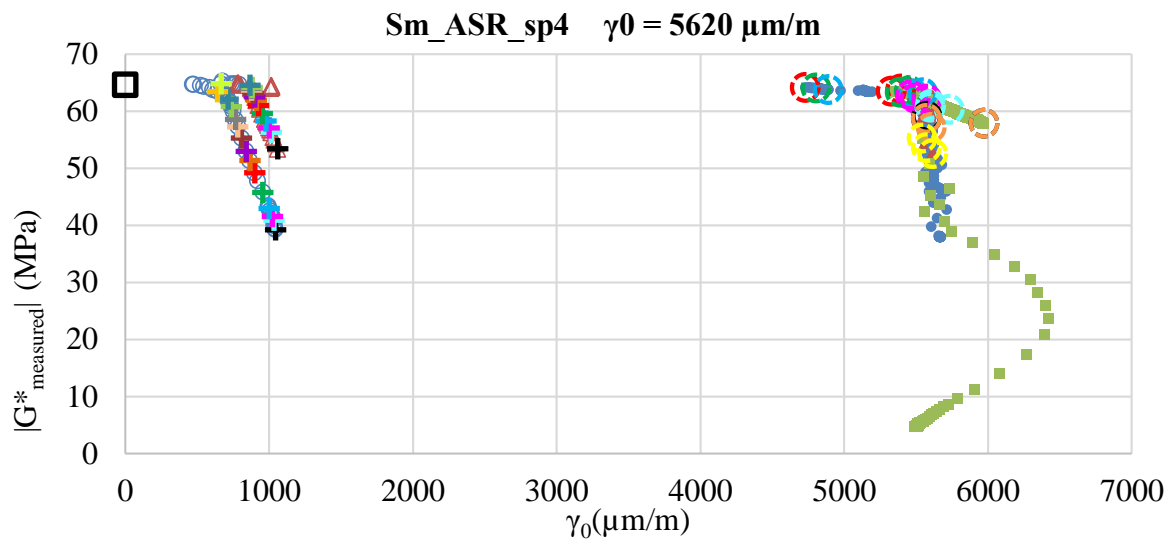
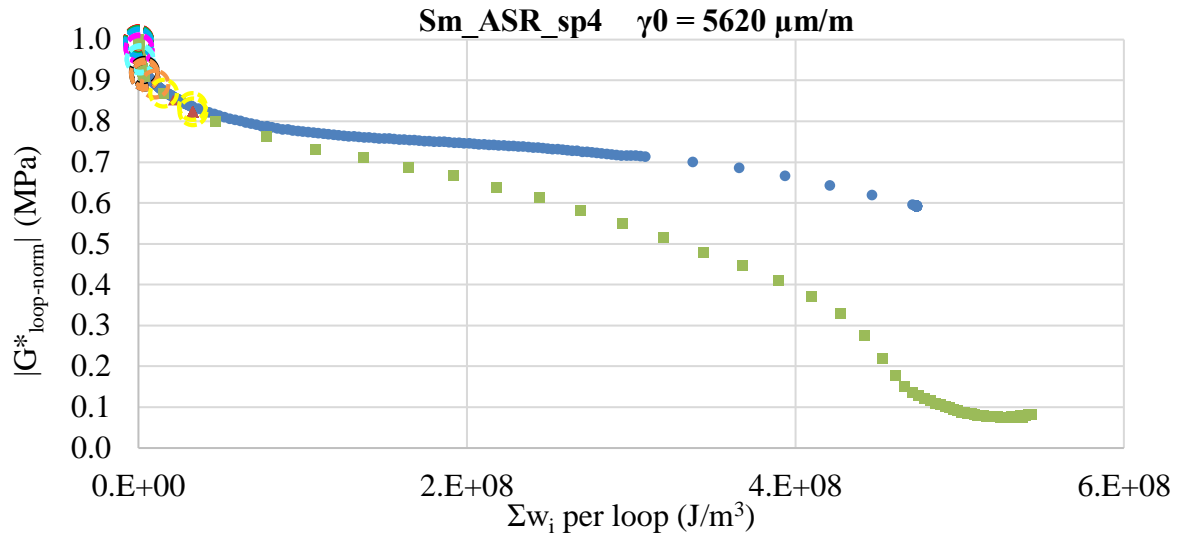
1 Thermomechanical tests on bituminous binders  
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1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

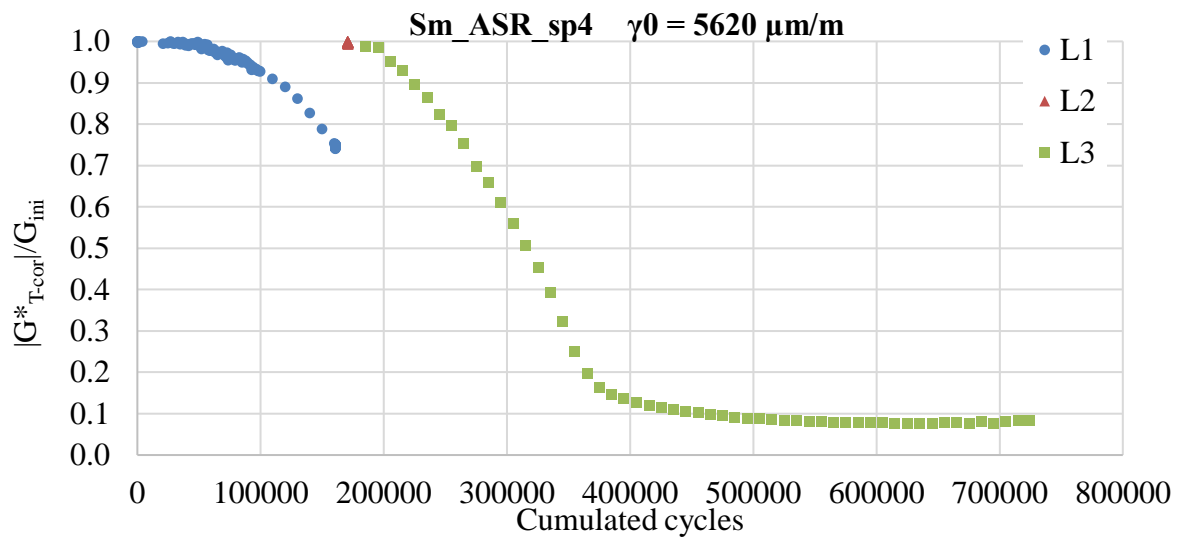
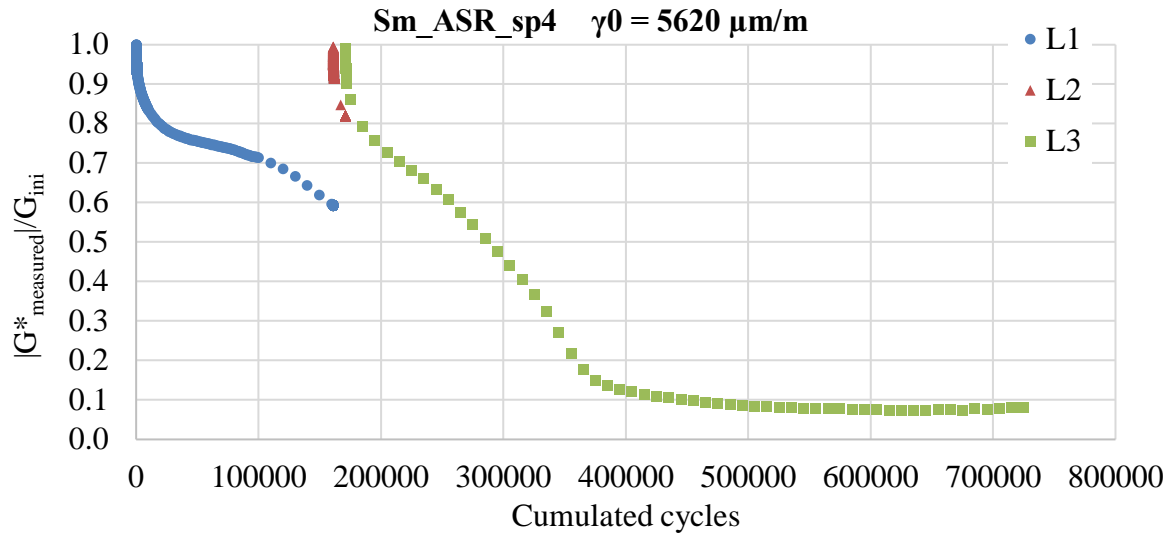


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz





1 Thermomechanical tests on bituminous binders  
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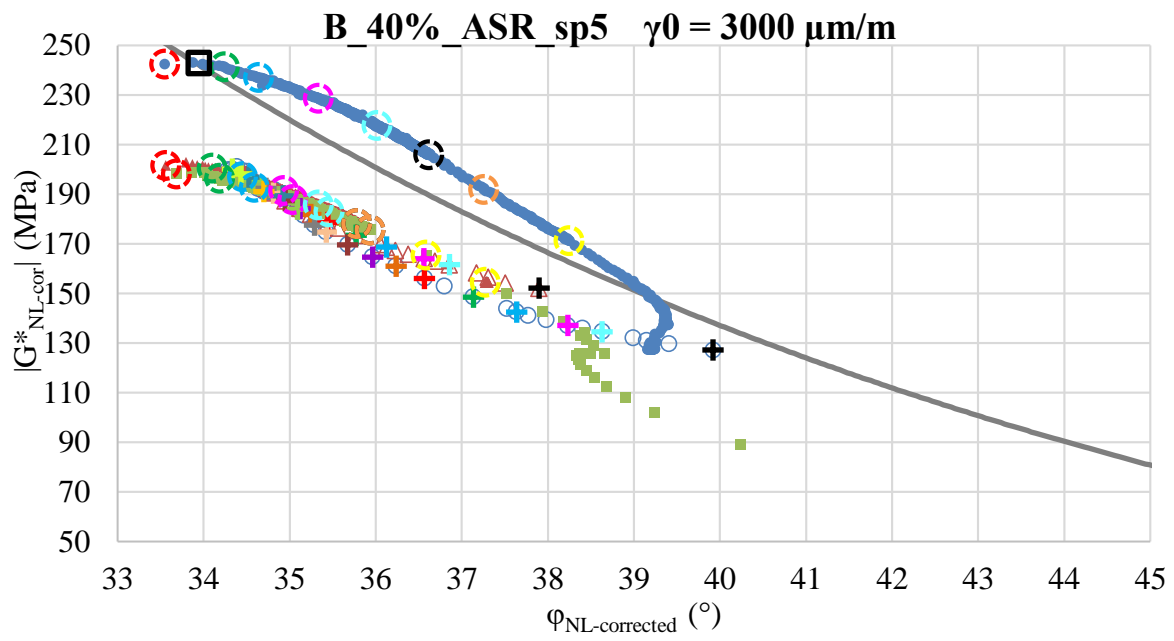
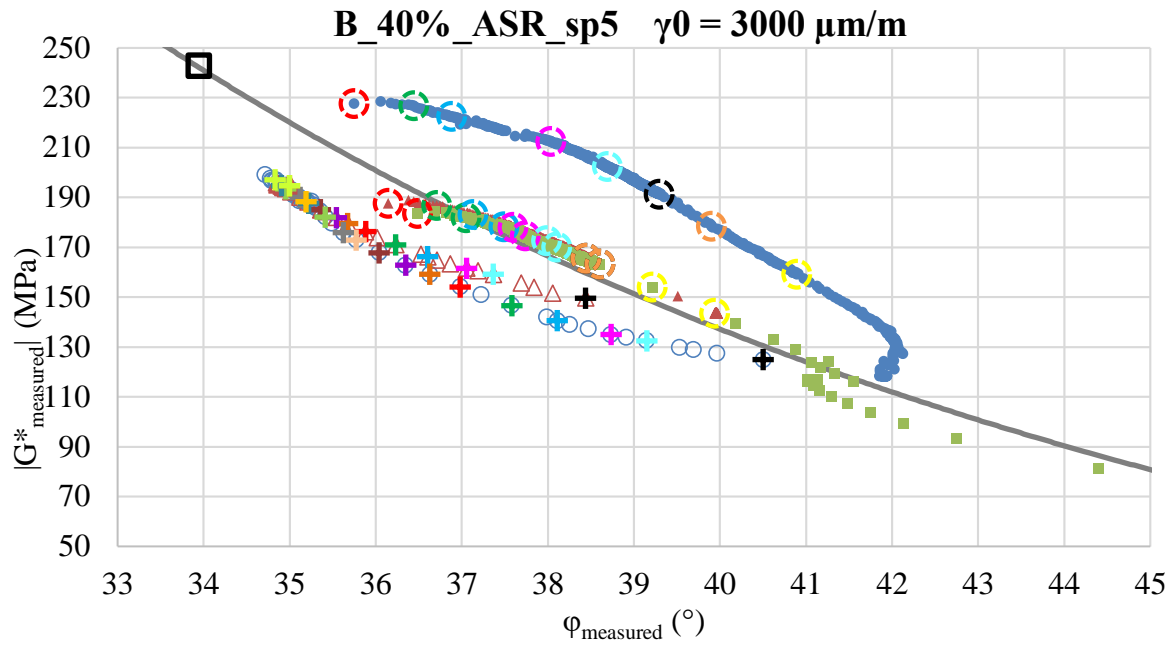


1.5.5.B\_40%\_ASR

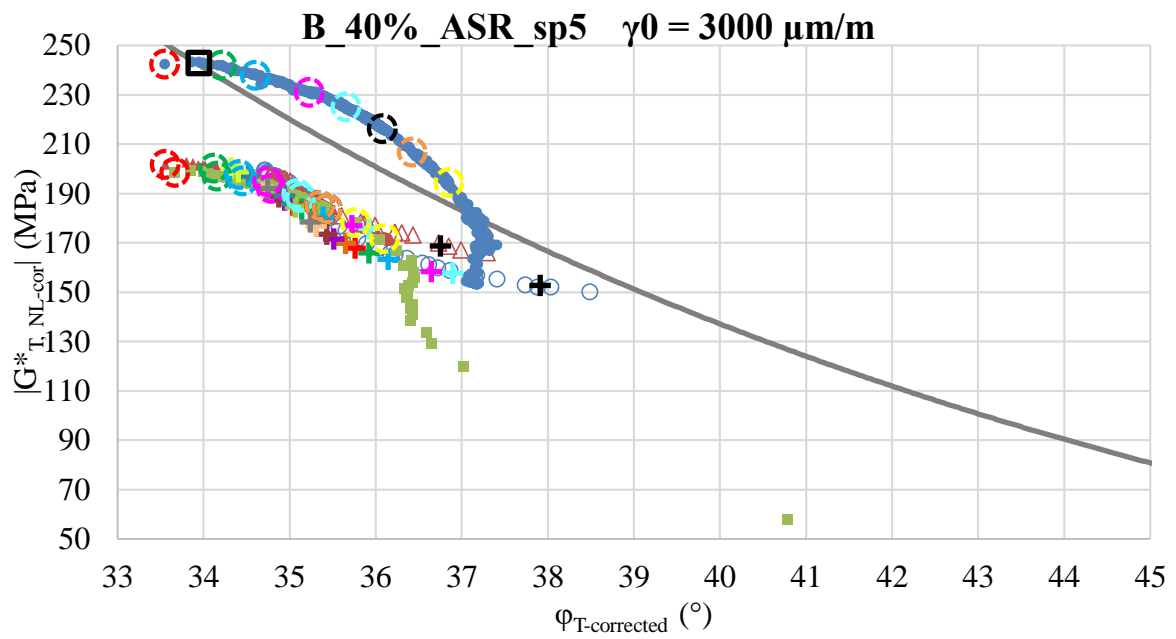
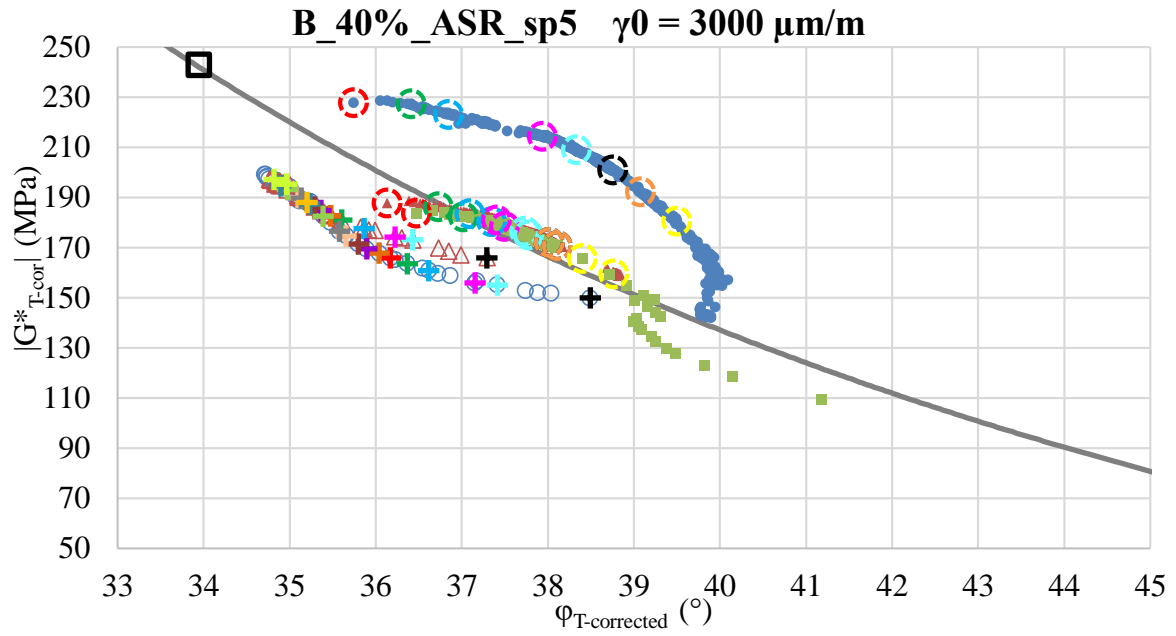
1.5.5.1. B\_40%\_ASR\_sp5 (3000 $\mu\text{m/m}$ )

- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G*ini        | — 2S2P1D        |

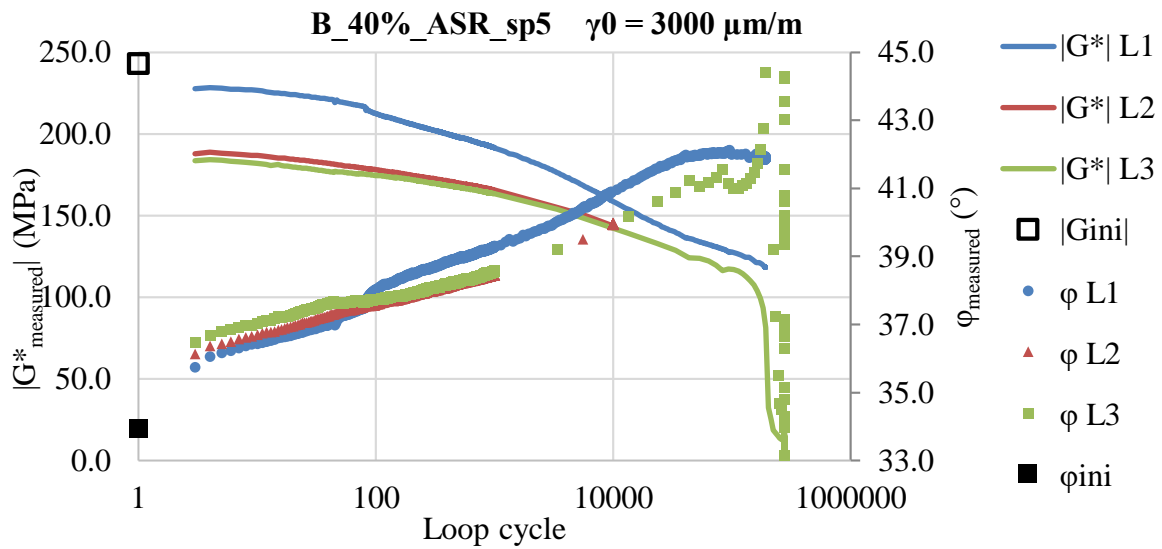
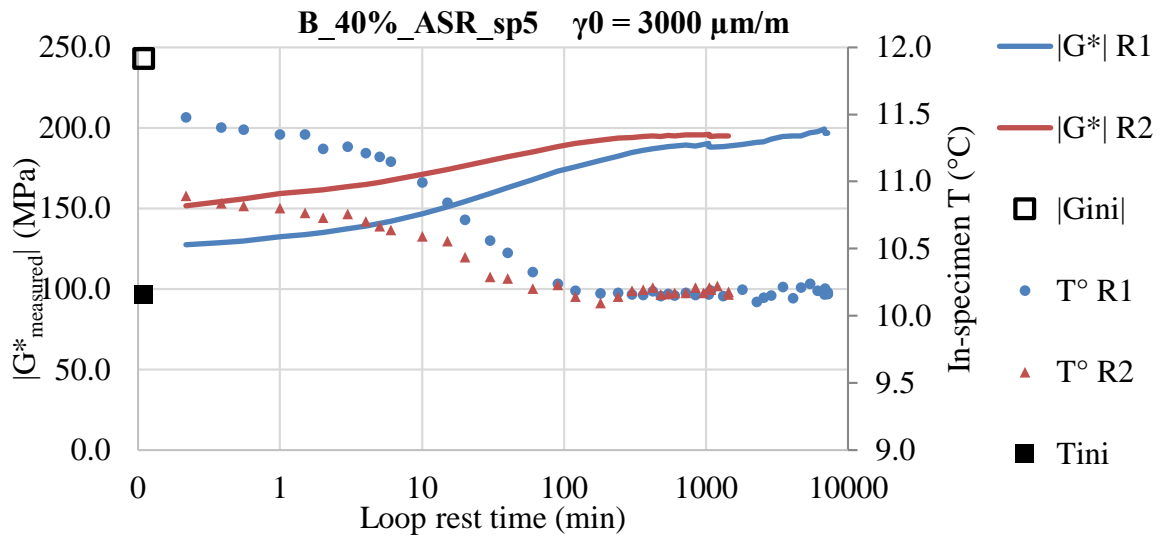
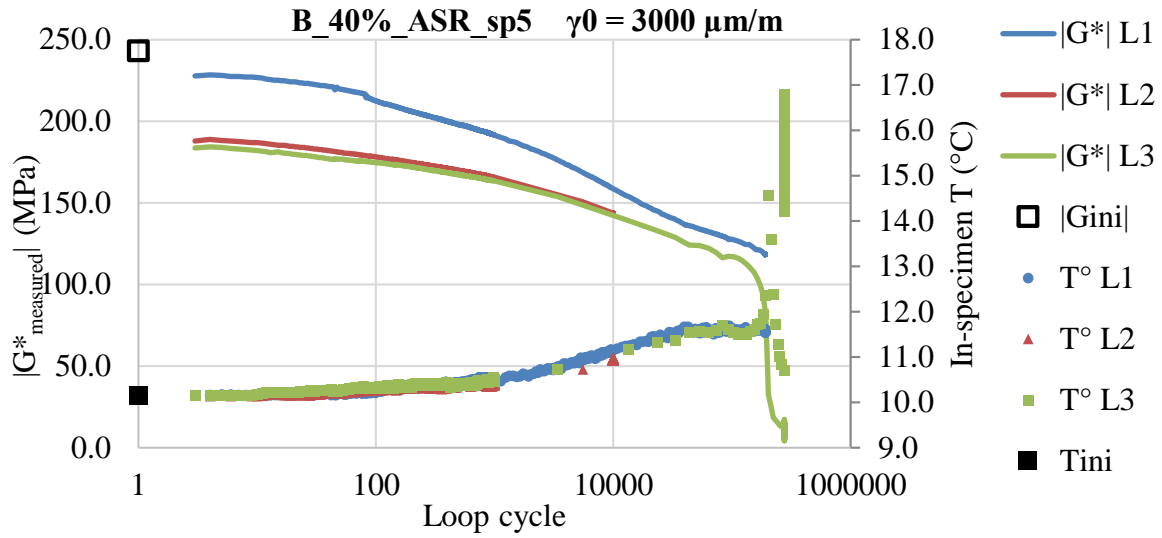
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



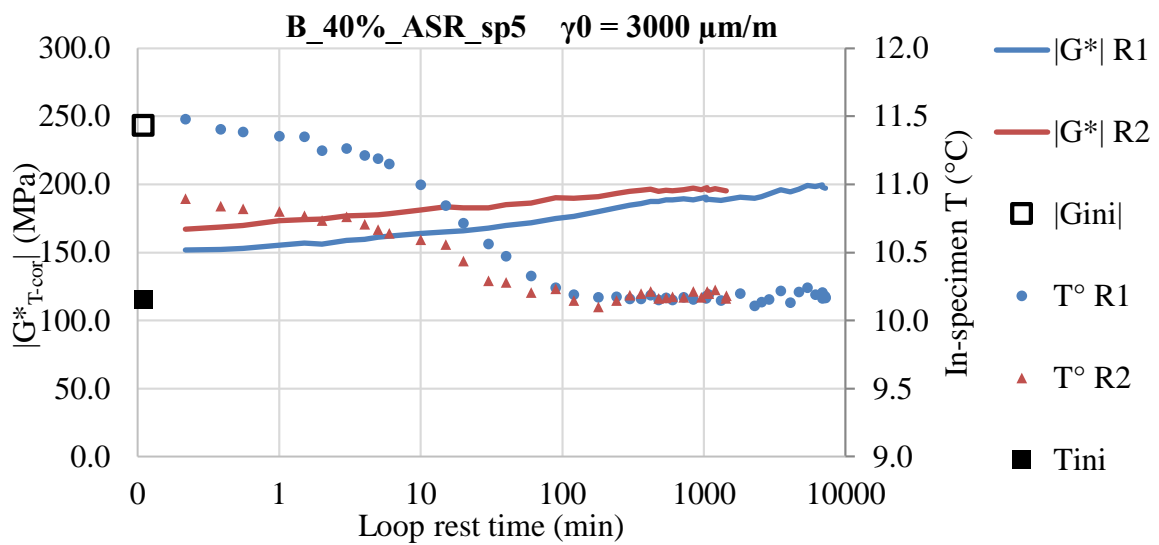
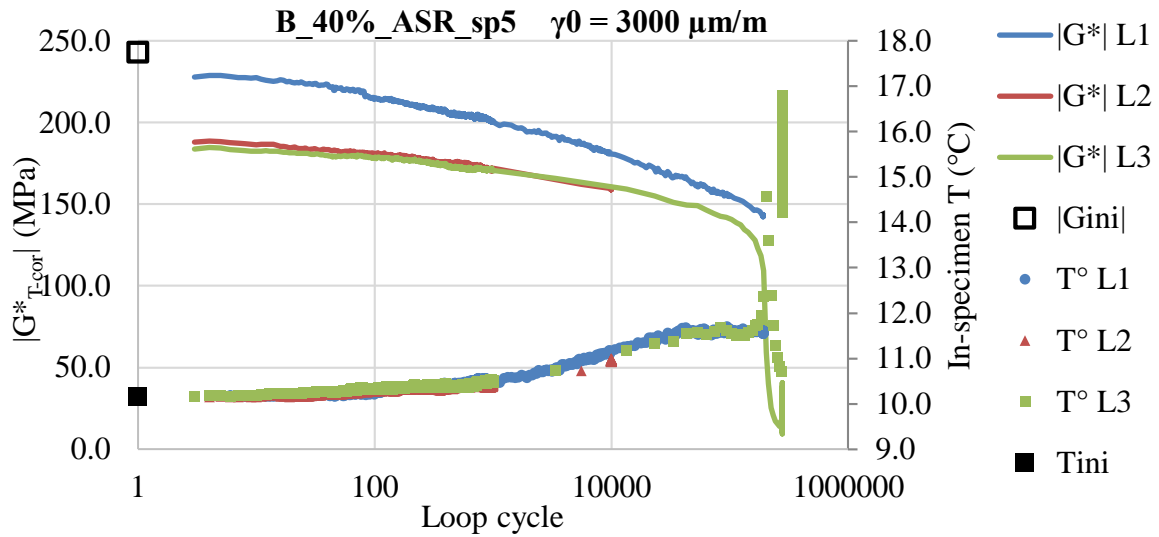
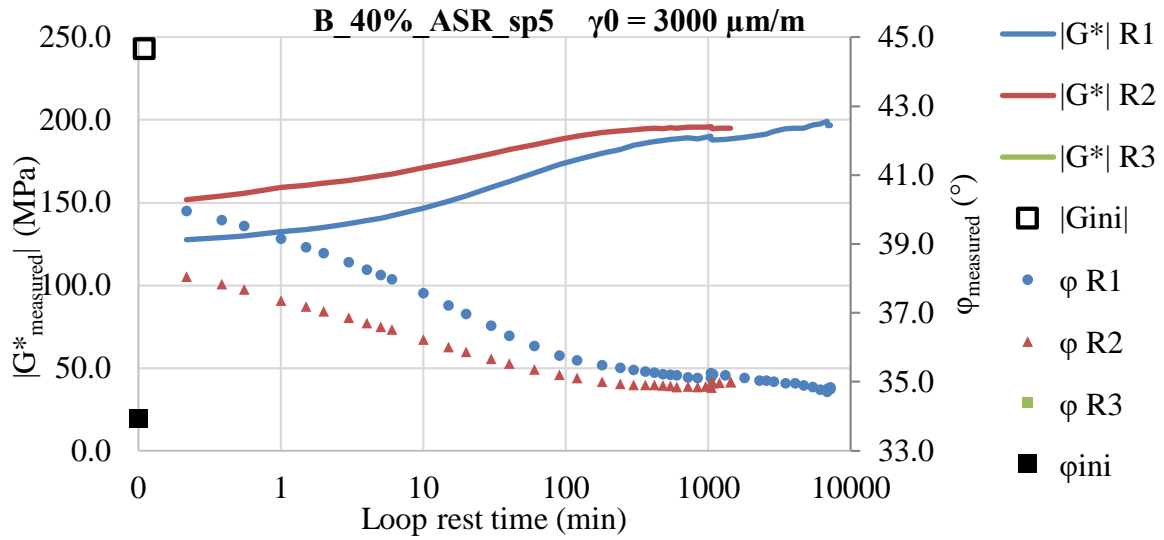
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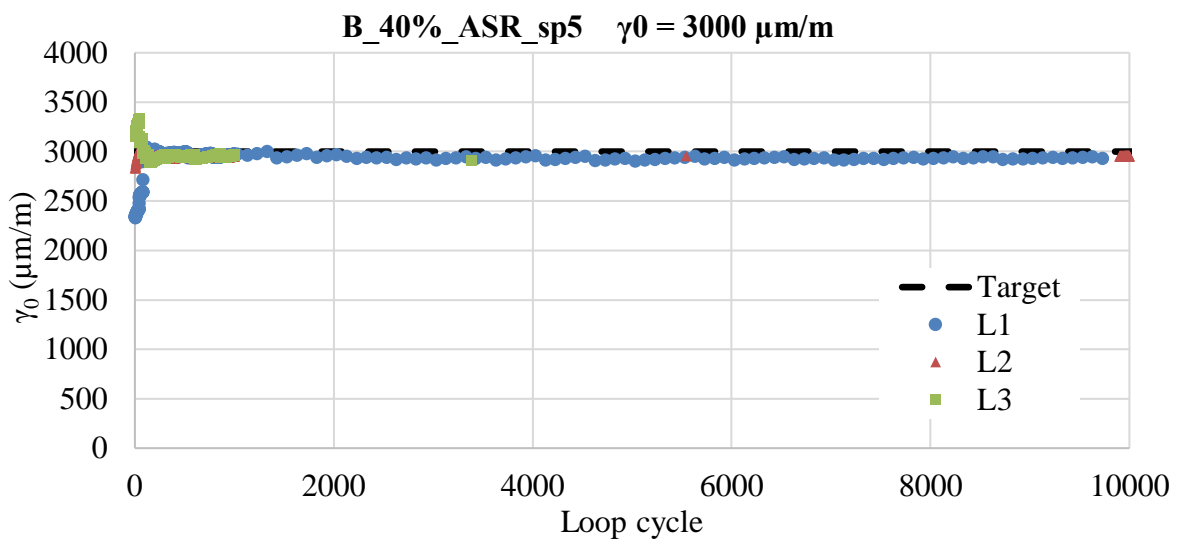
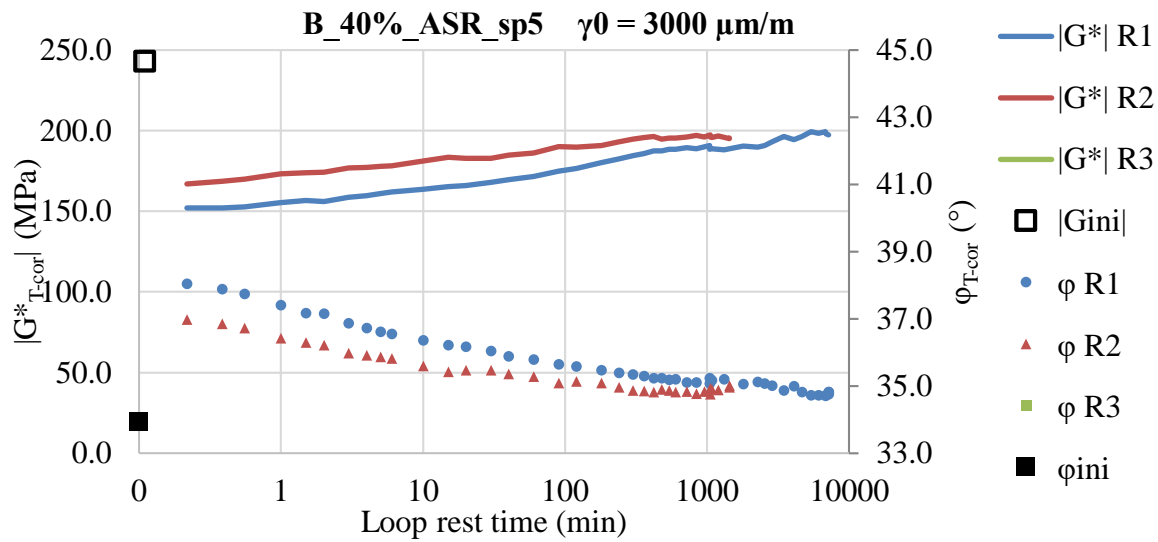
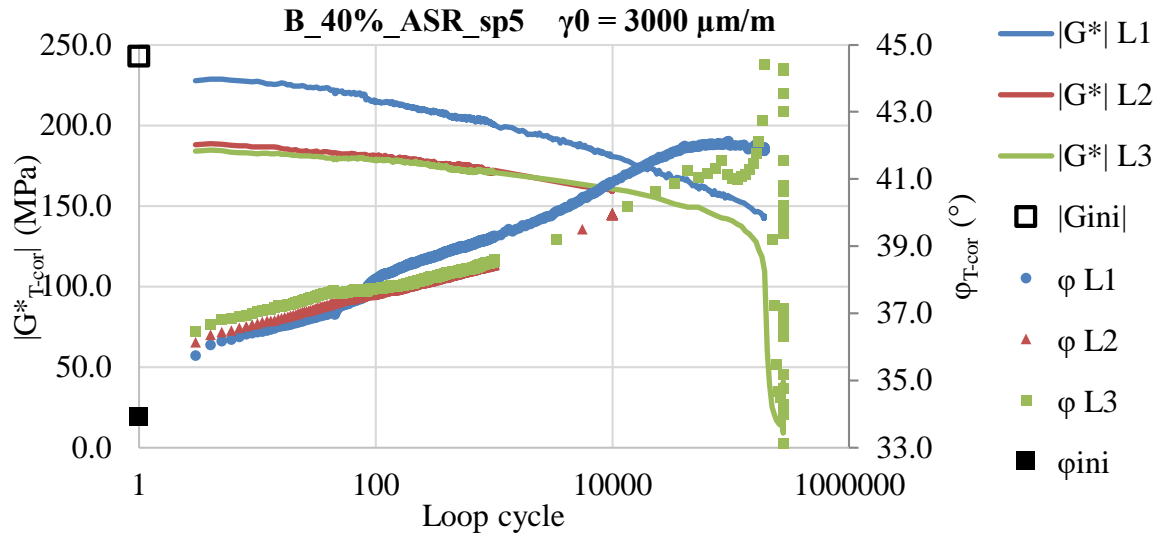
1 Thermomechanical tests on bituminous binders  
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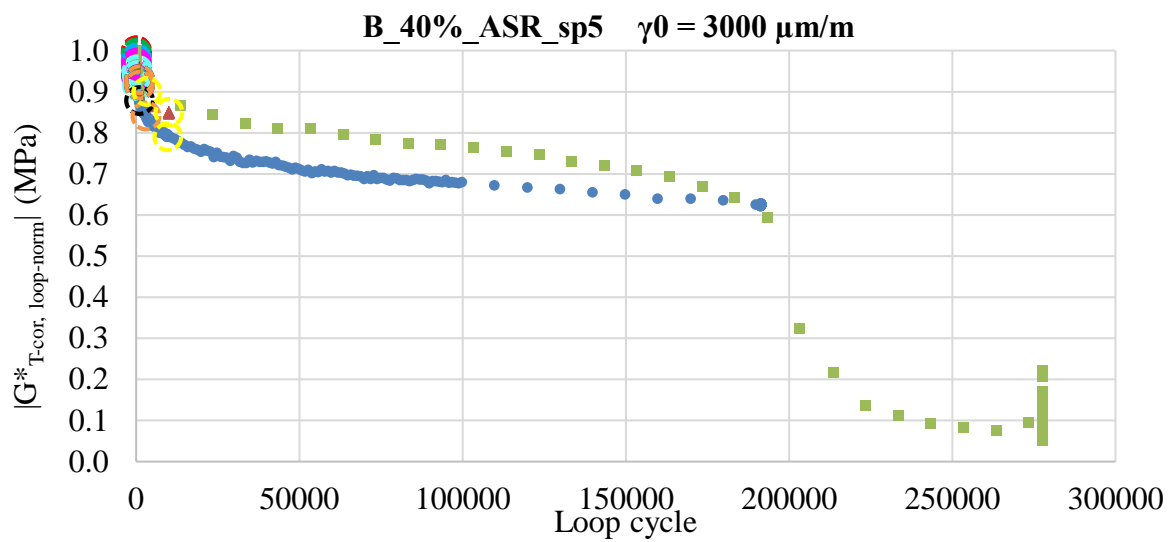
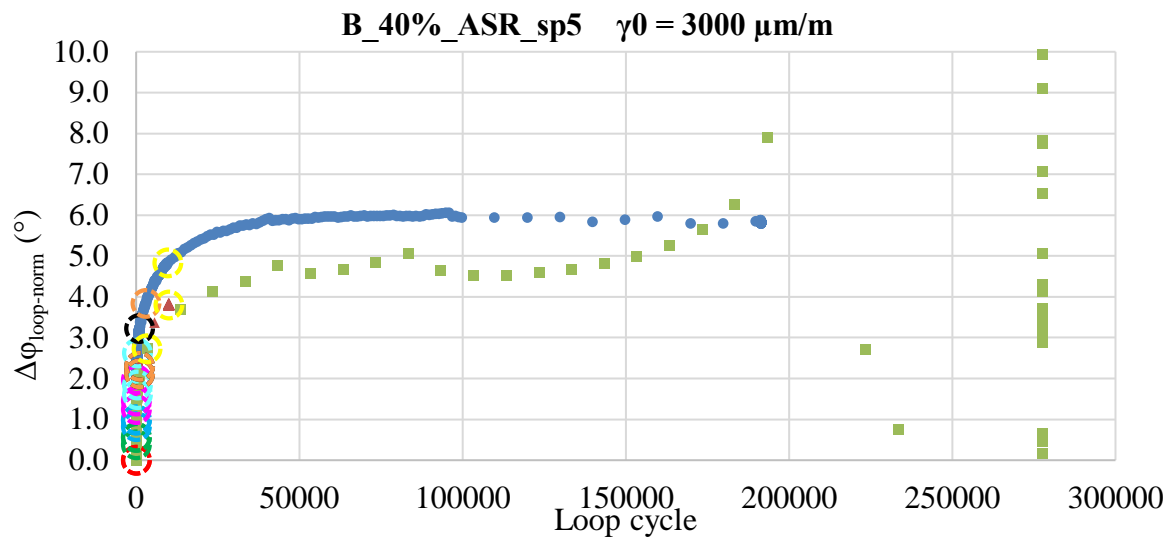
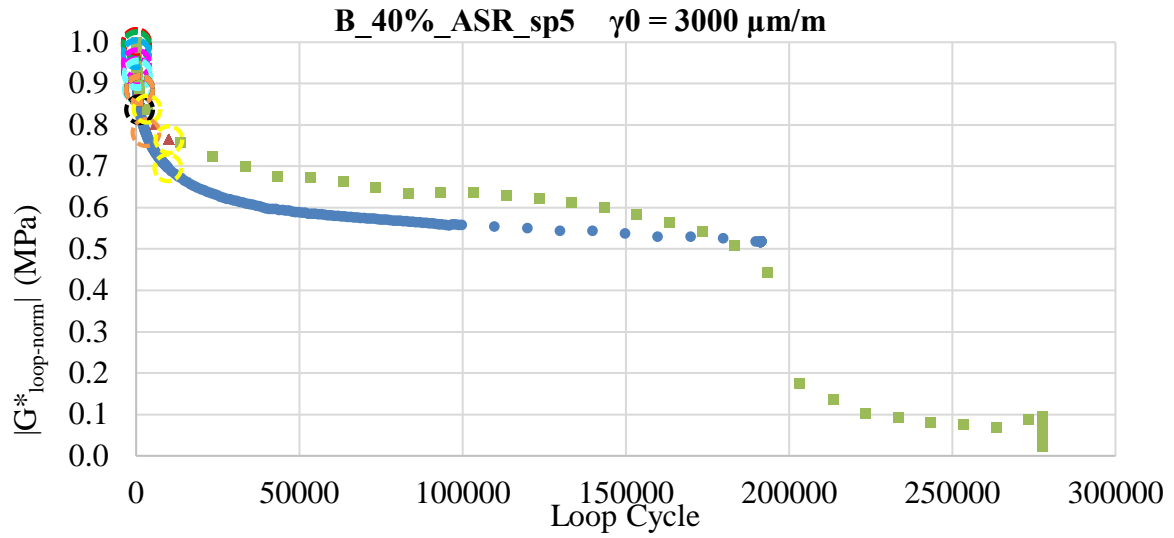
1 Thermomechanical tests on bituminous binders  
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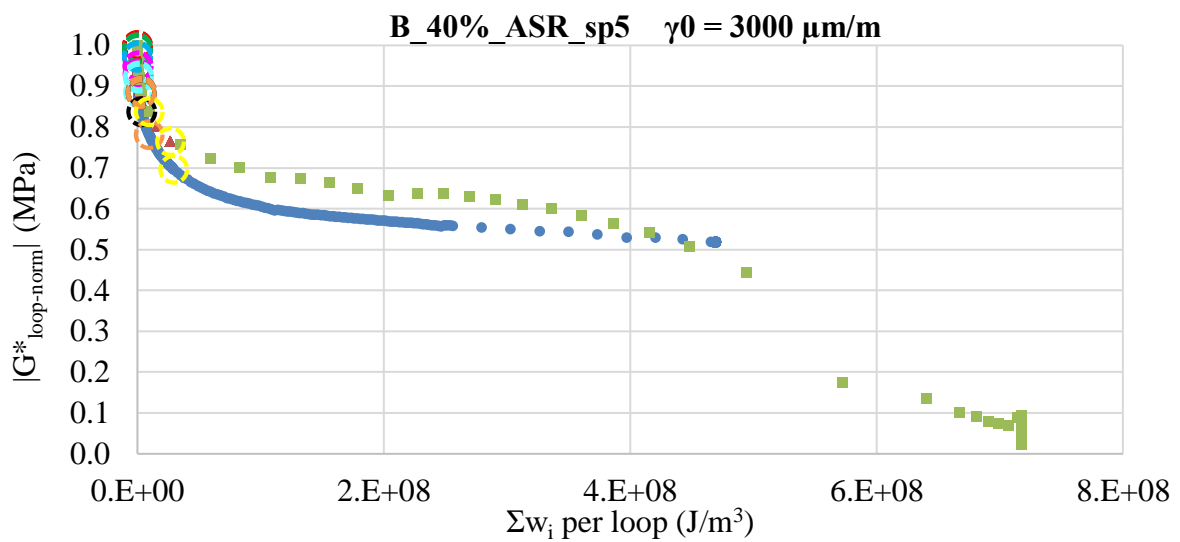
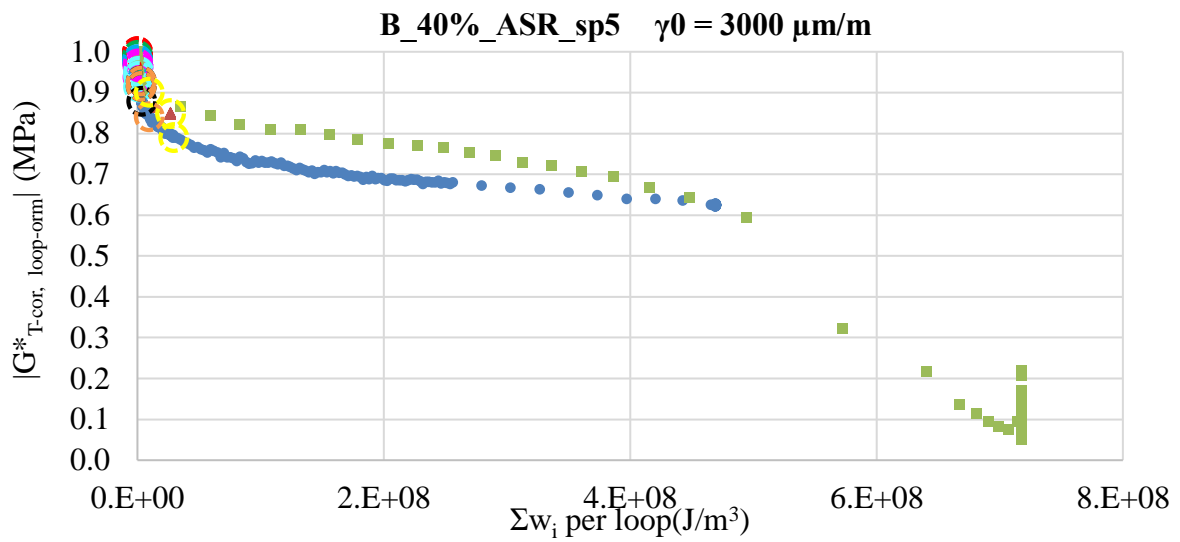
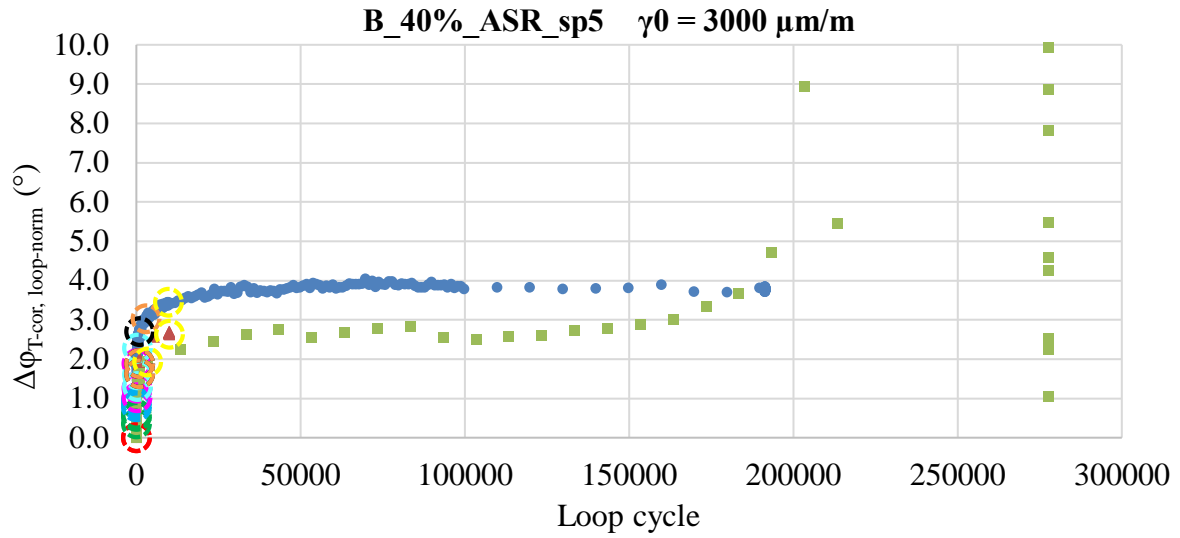
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1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

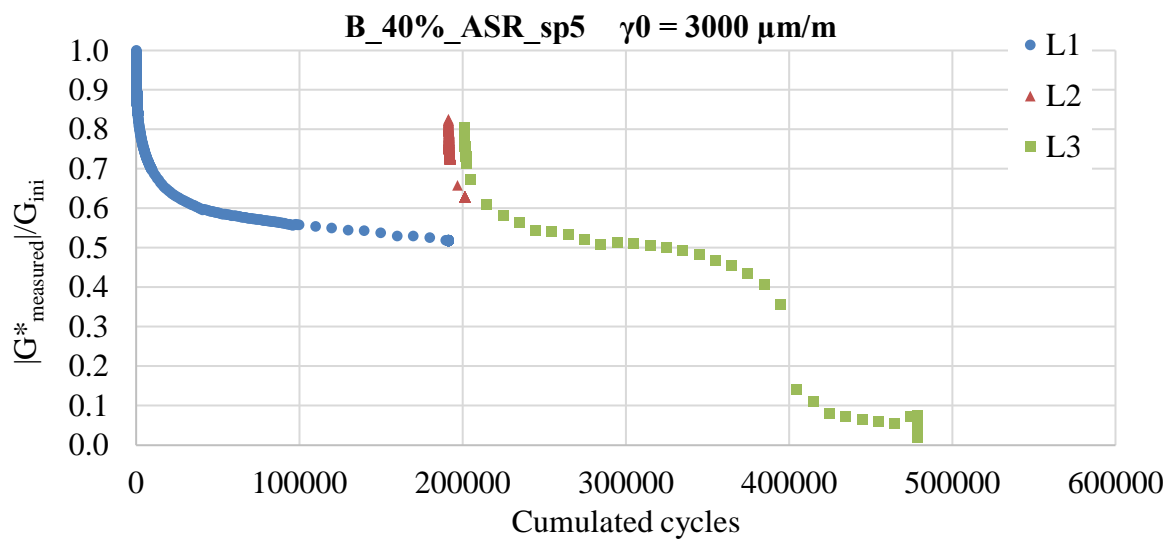
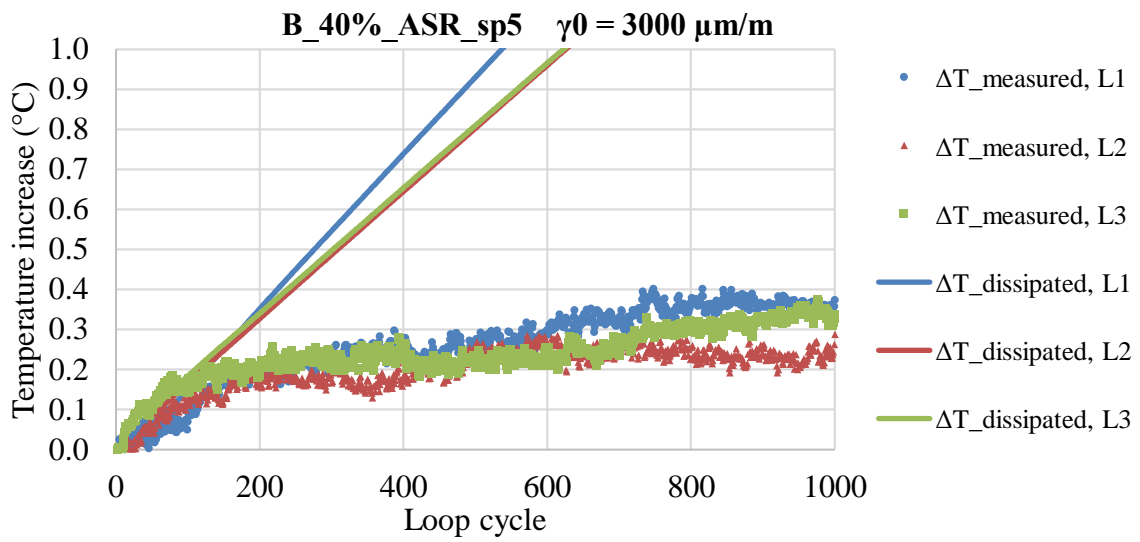
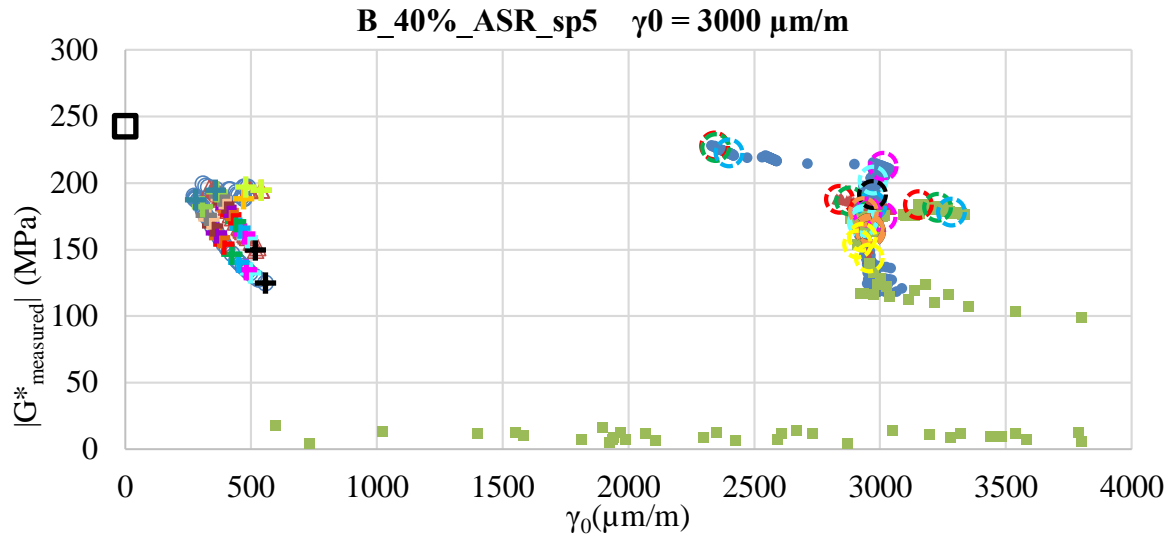


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

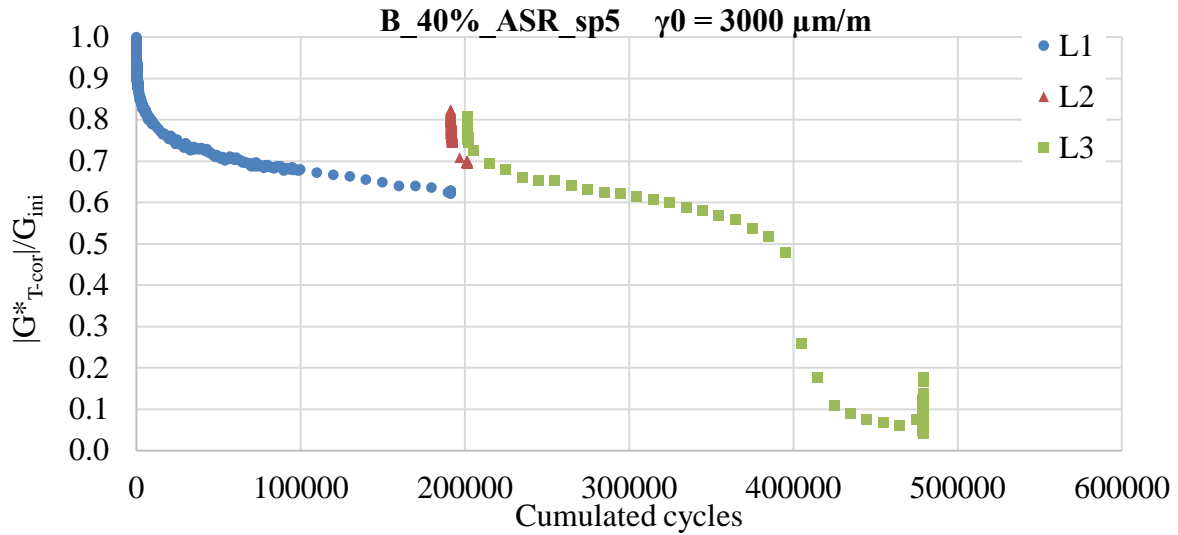




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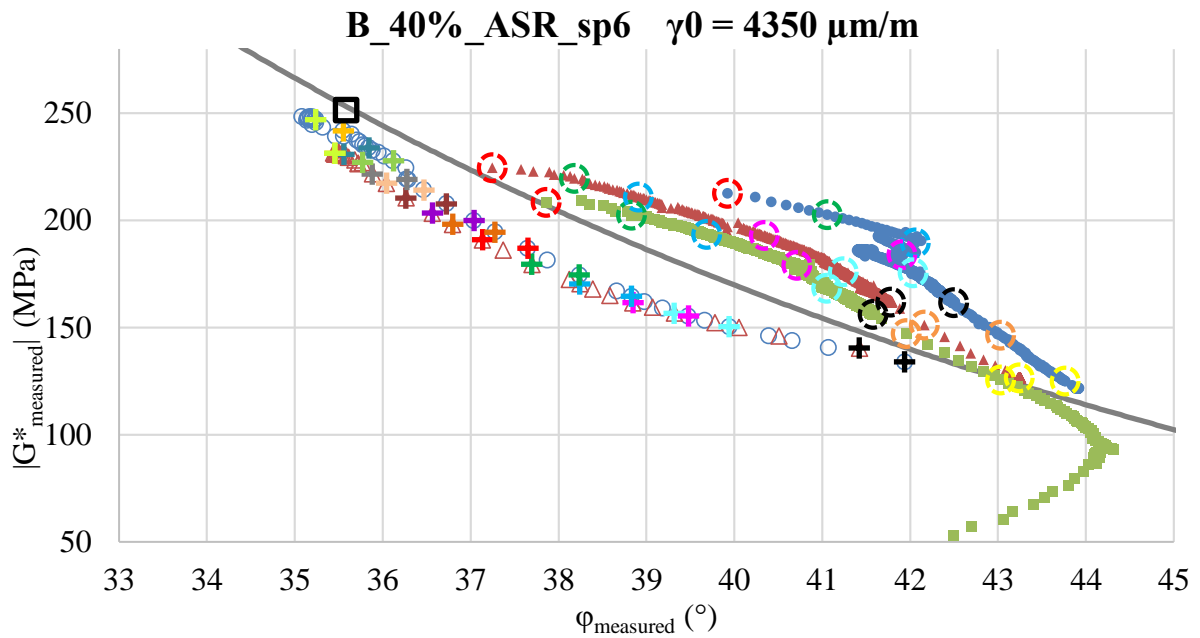


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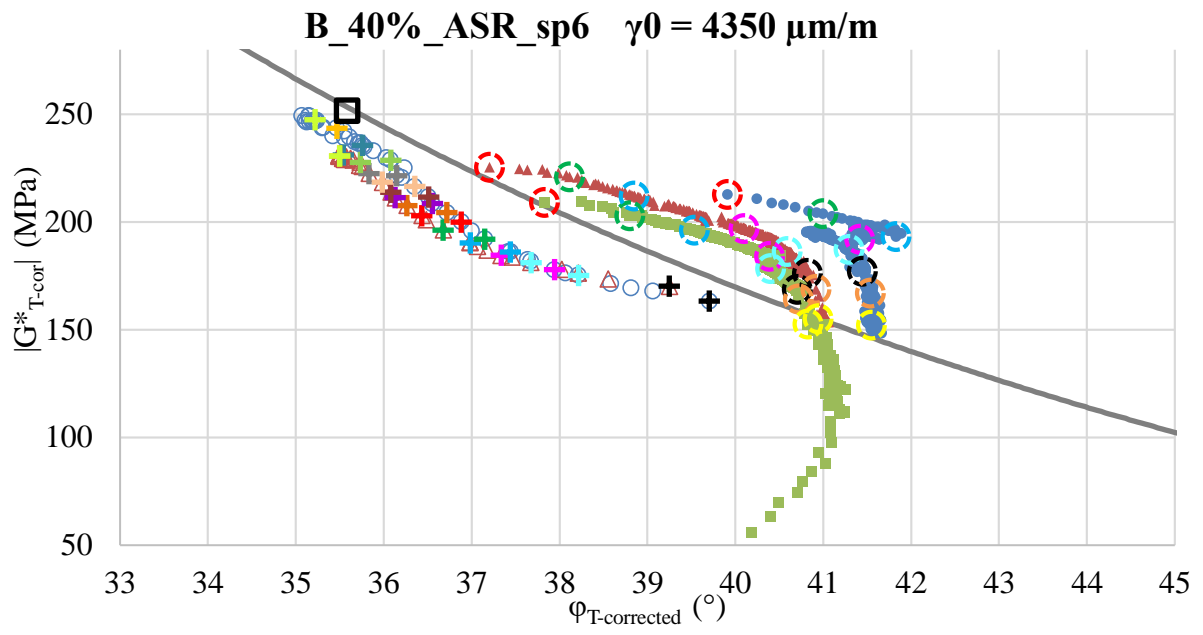
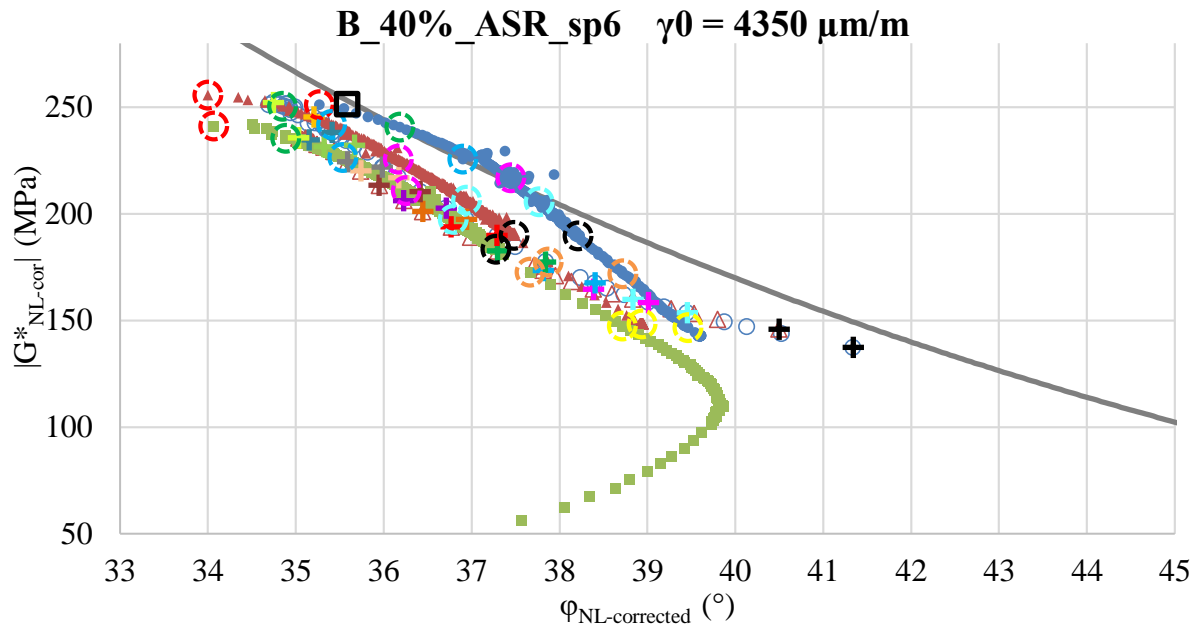


1.5.5.2. B\_40%\_ASR\_sp6 (4350 $\mu\text{m/m}$ )

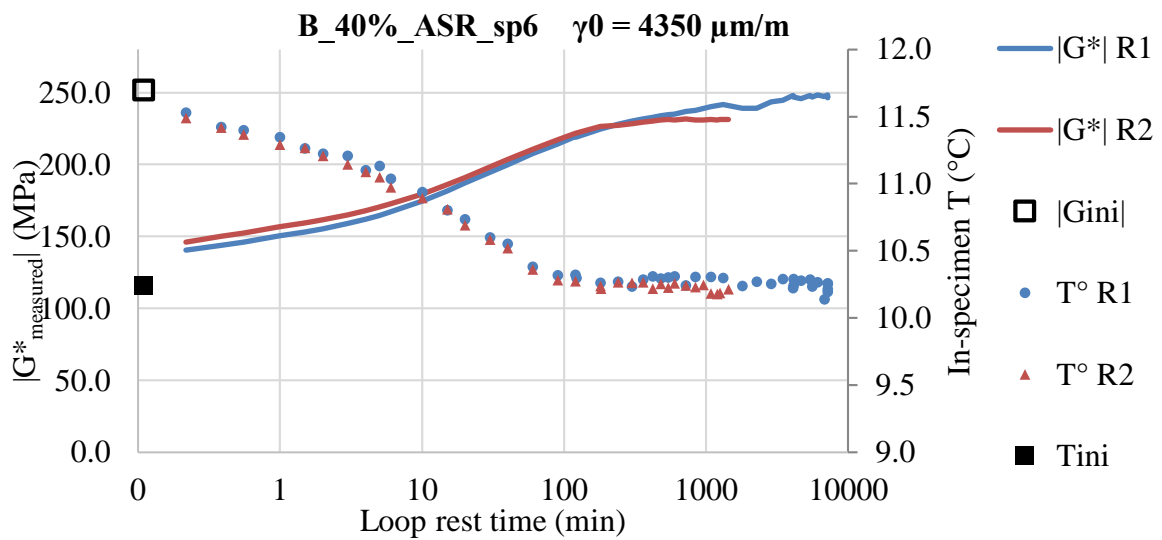
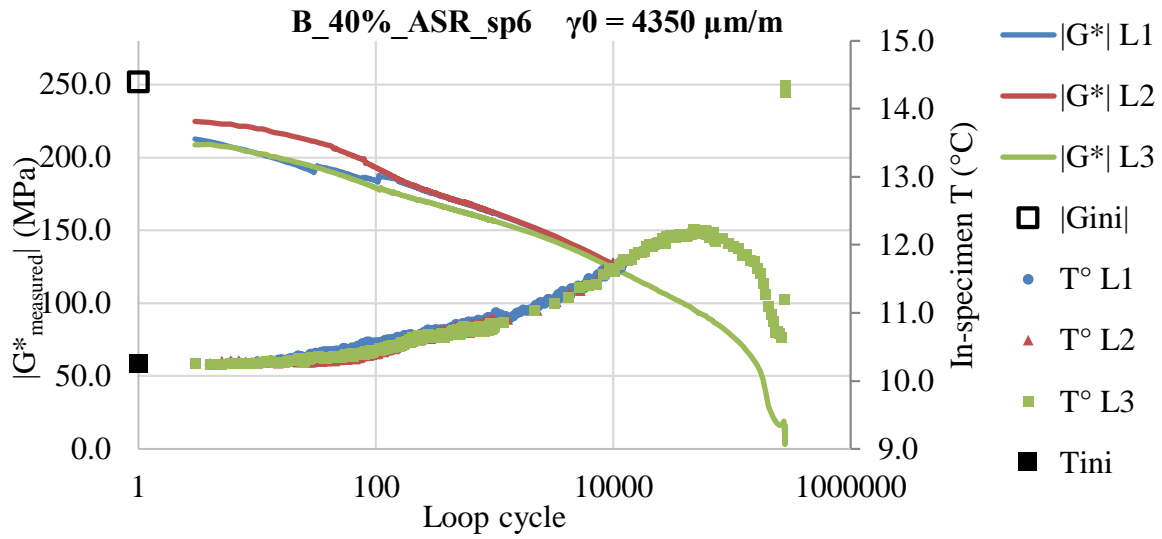
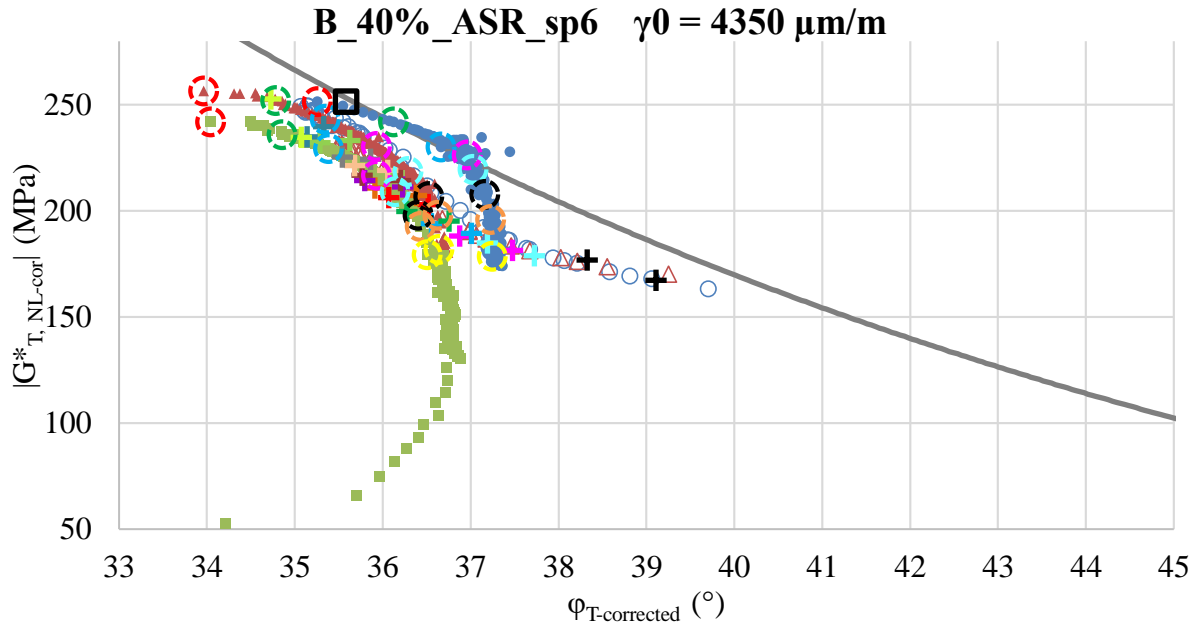
- |                 |                 |                 |                     |                 |
|-----------------|-----------------|-----------------|---------------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2                | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min       | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min      | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day      | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100         | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G* <sub>ini</sub> | — 2S2P1D        |



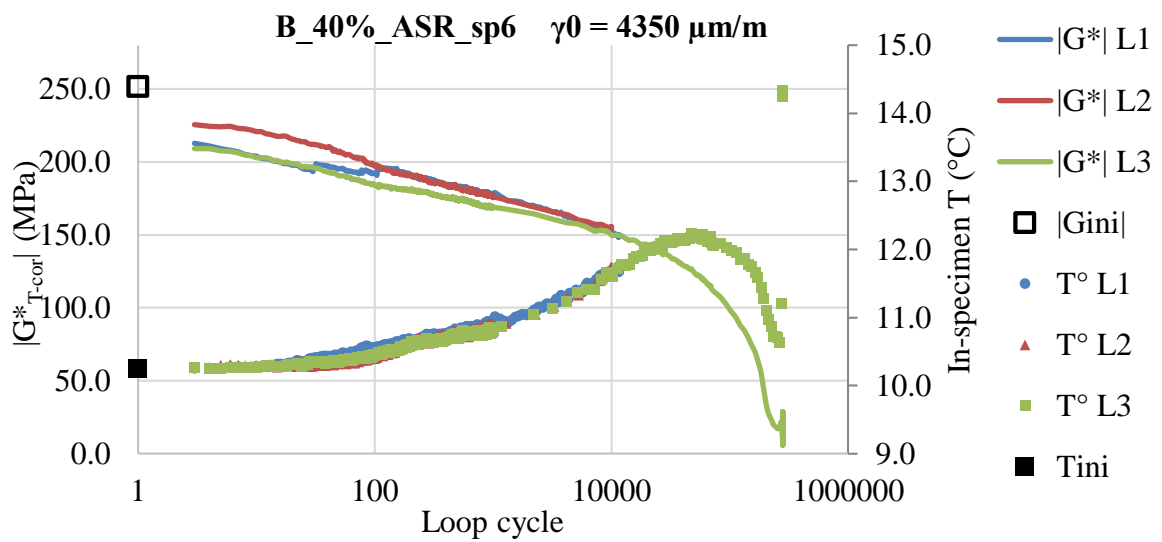
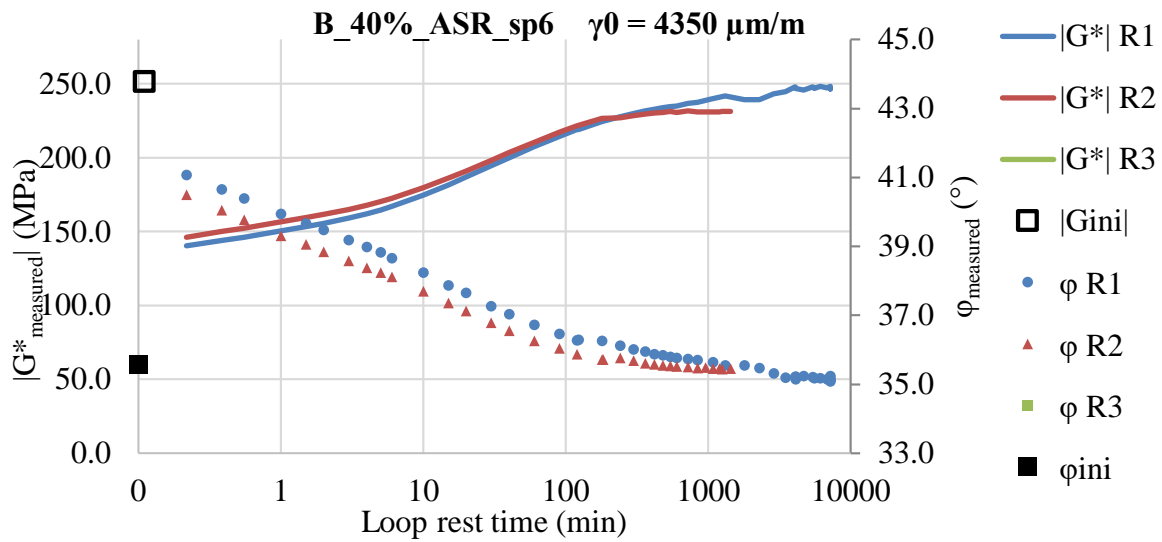
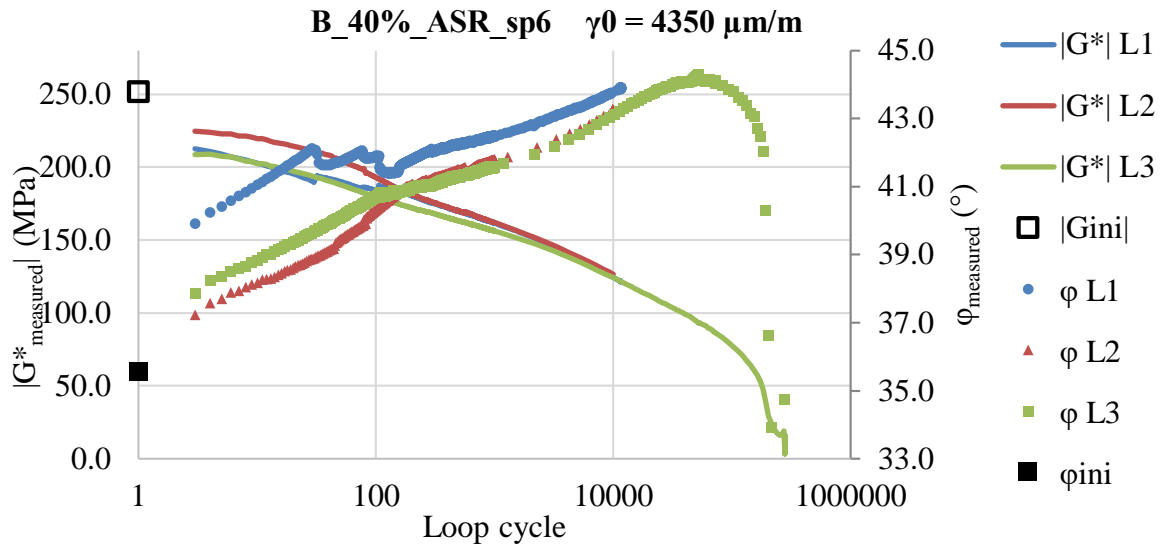
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



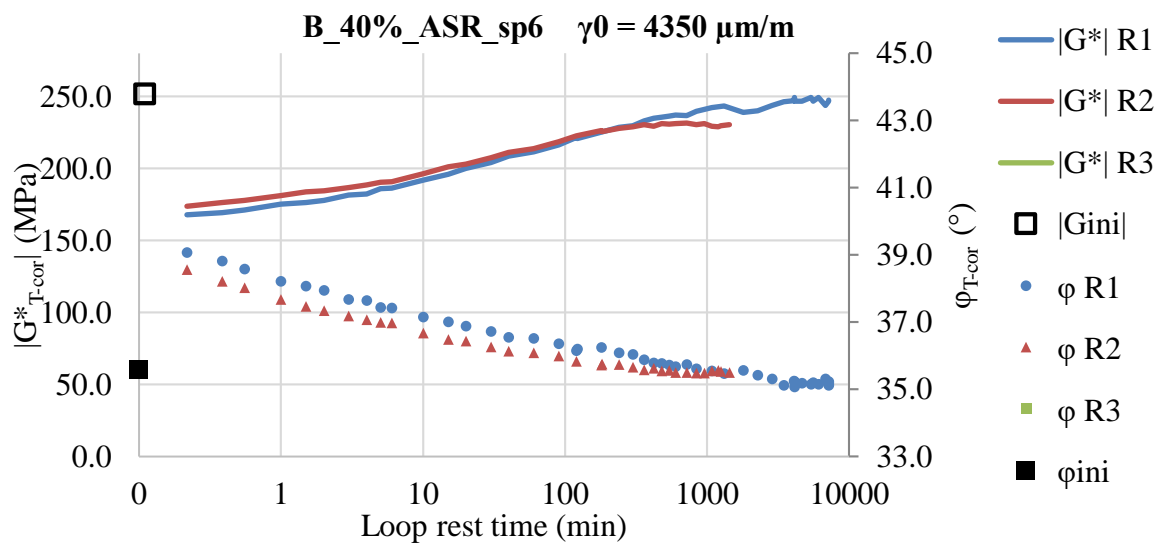
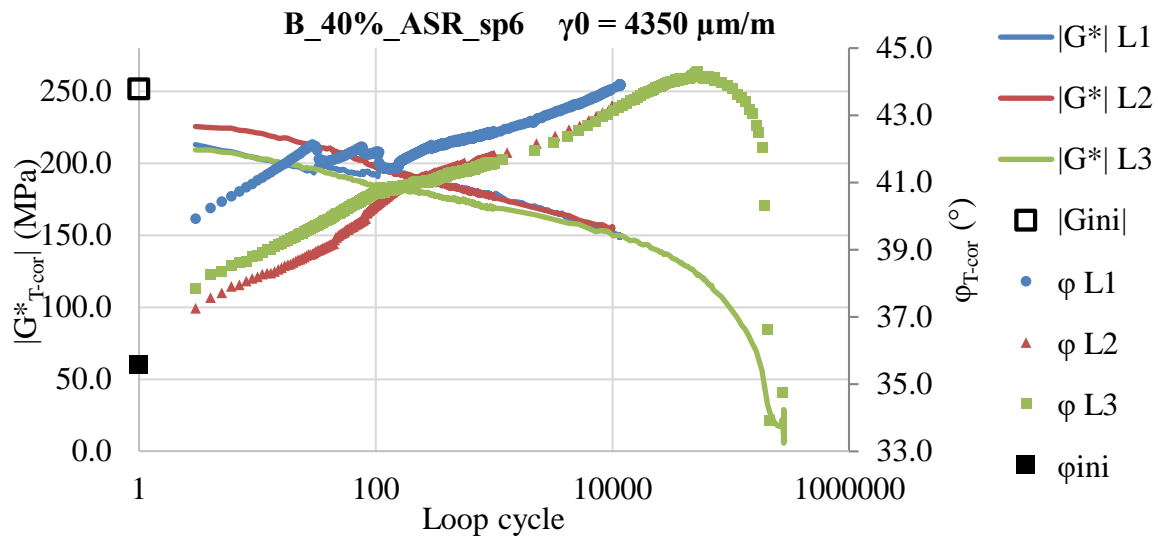
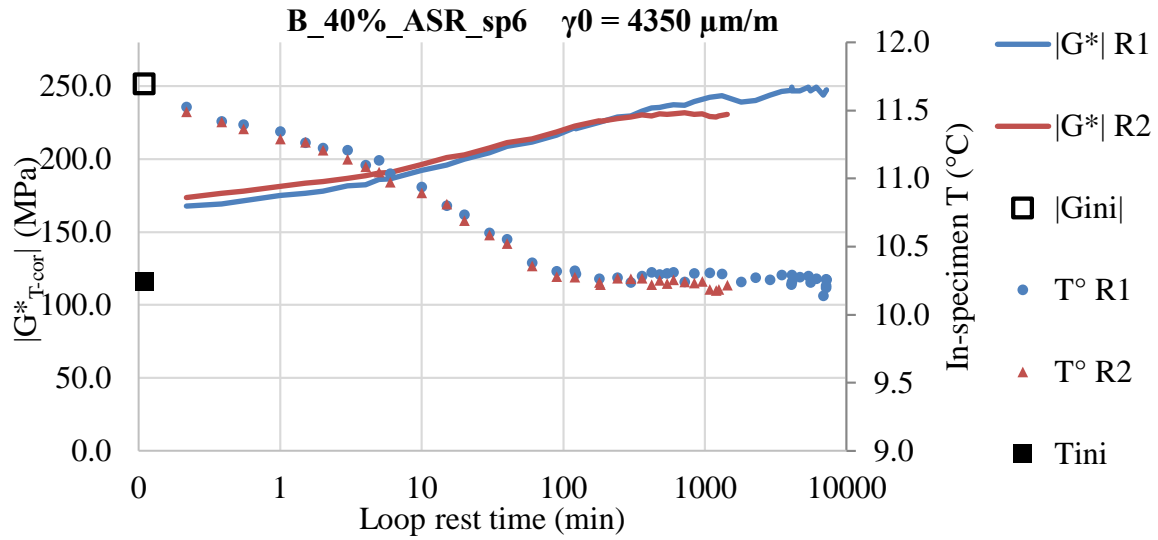
1 Thermomechanical tests on bituminous binders  
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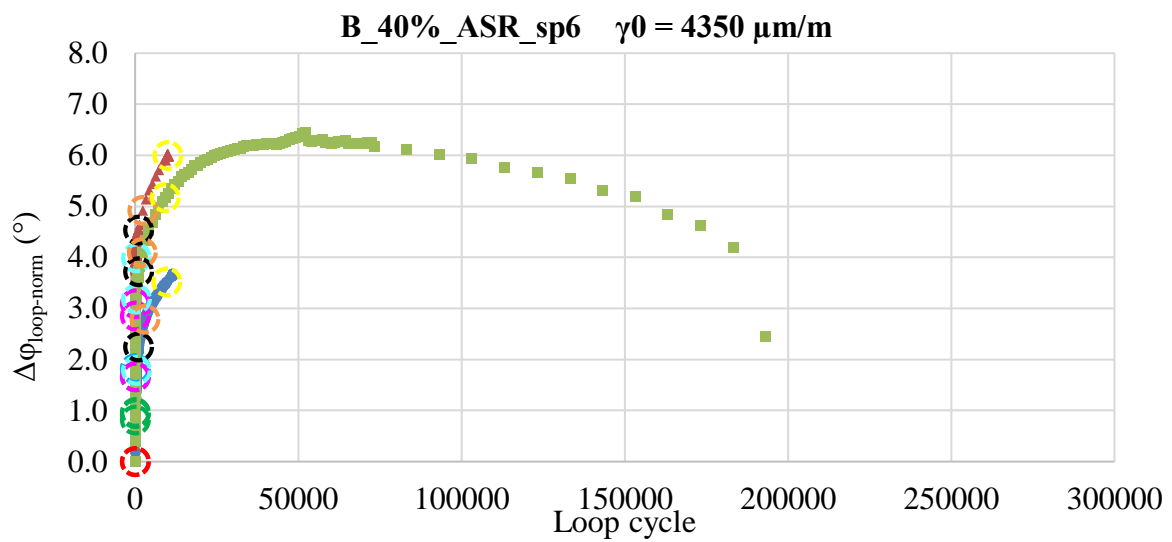
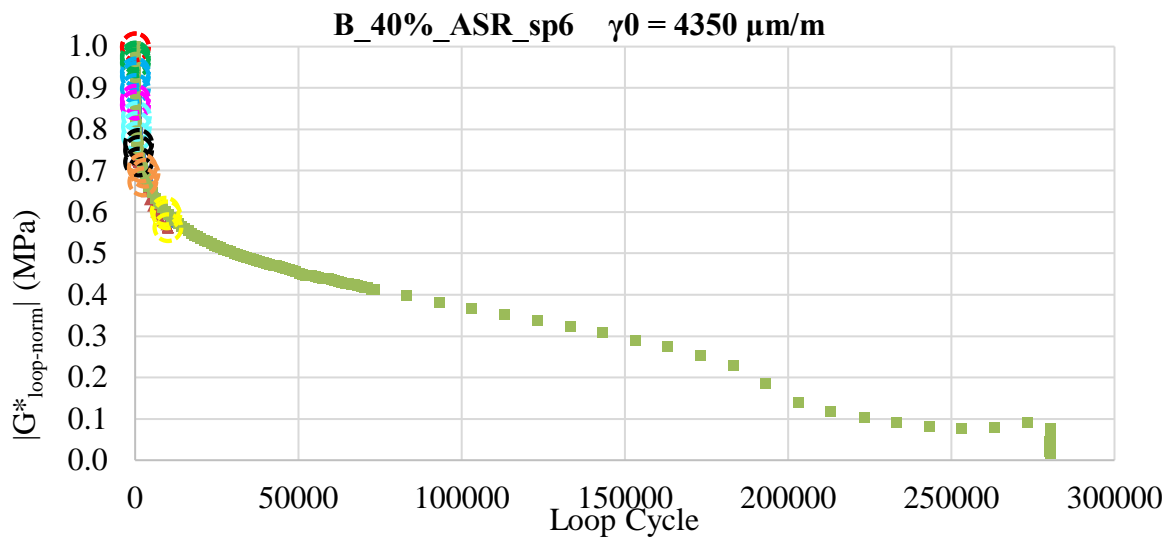
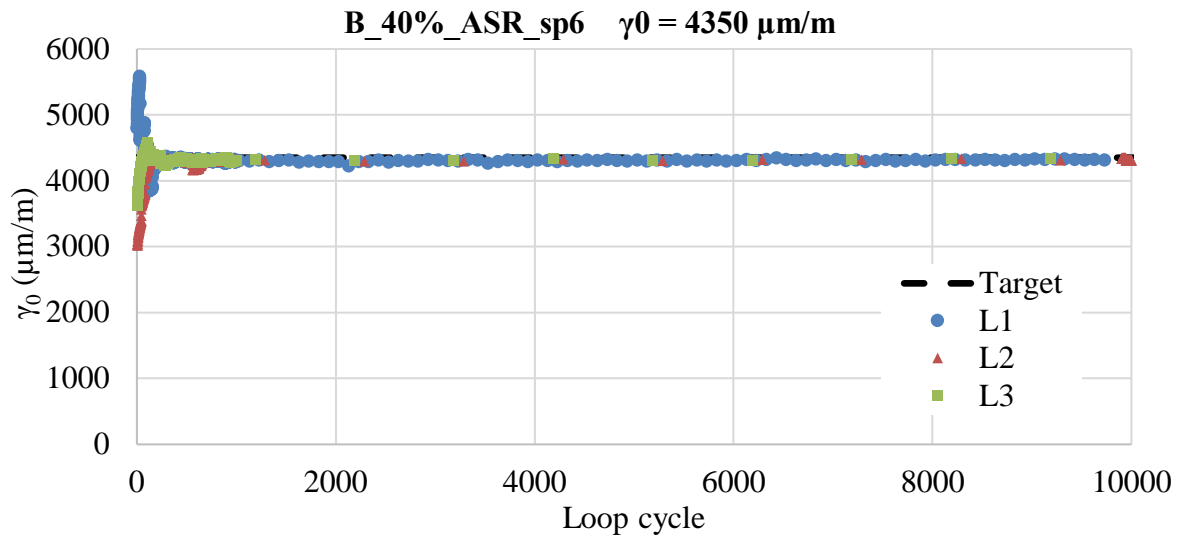
1 Thermomechanical tests on bituminous binders  
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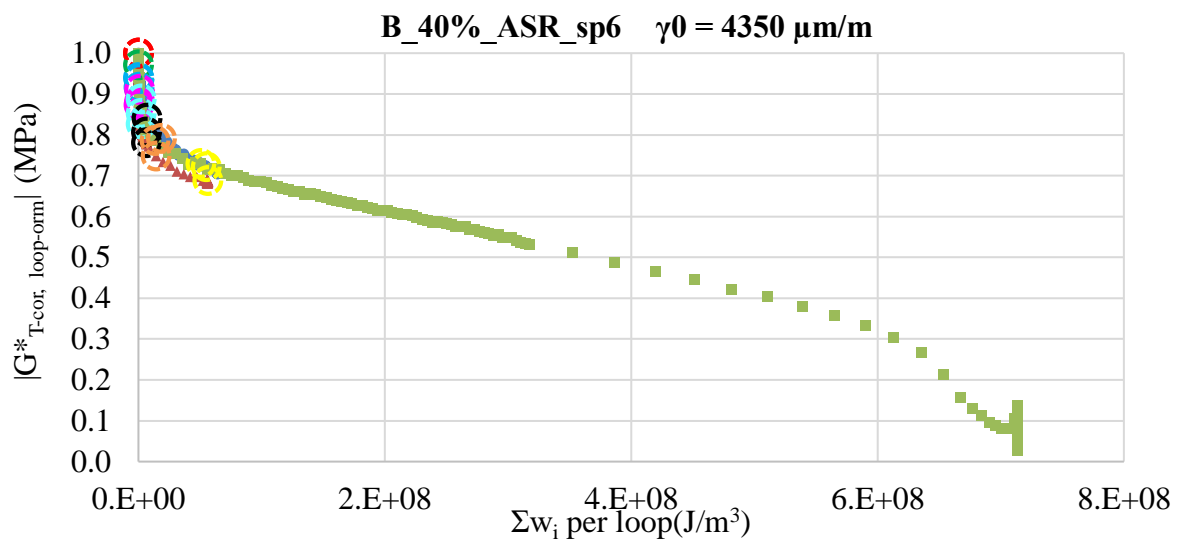
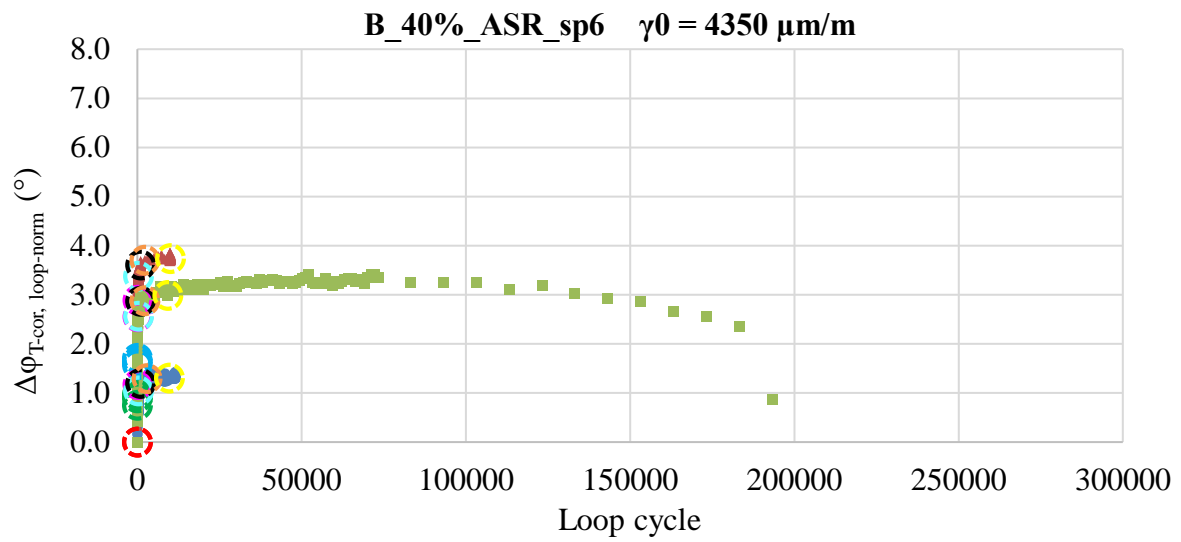
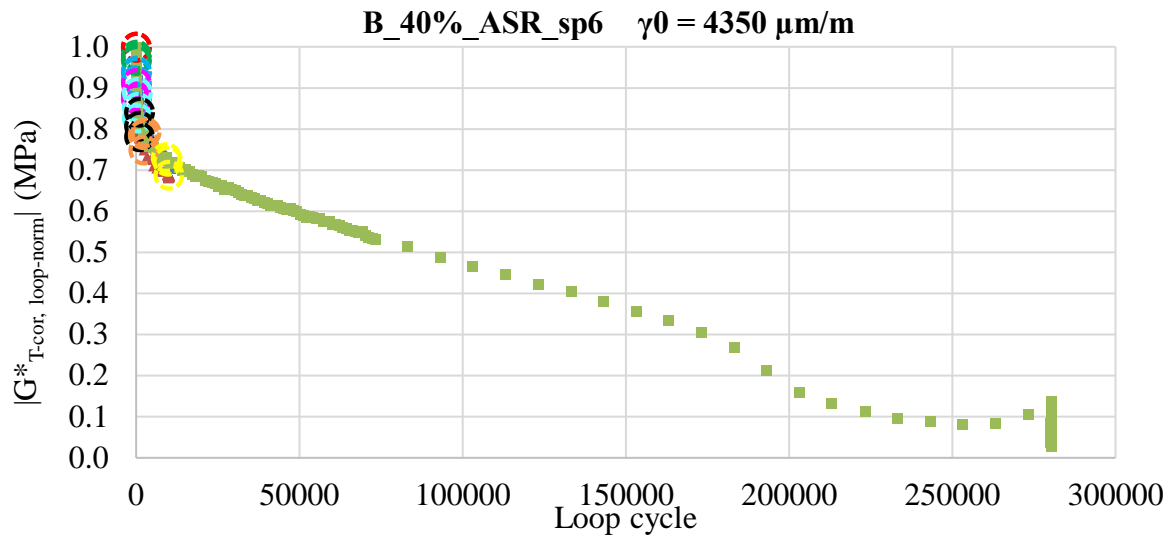
1 Thermomechanical tests on bituminous binders  
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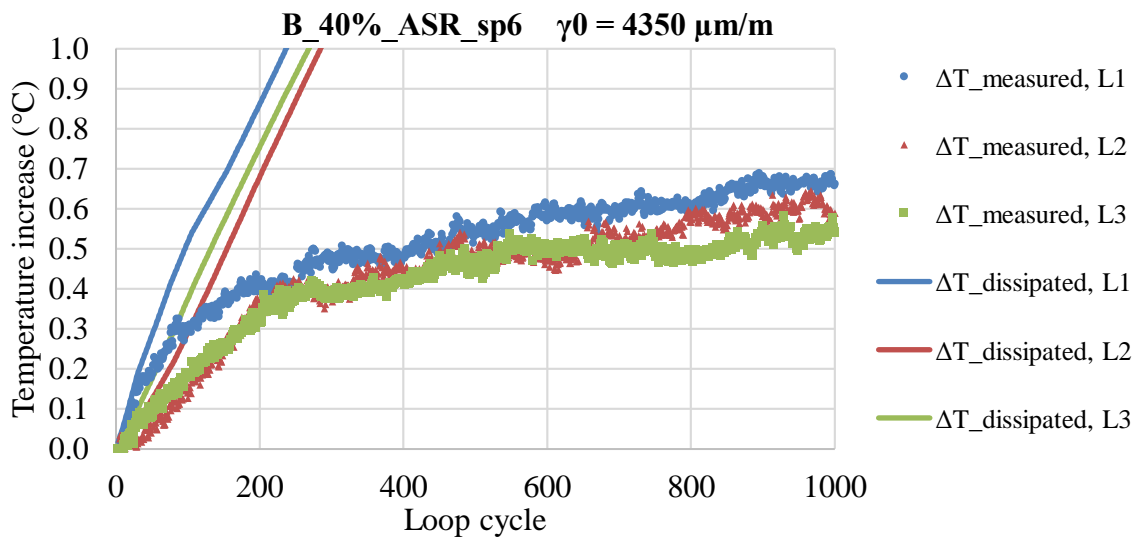
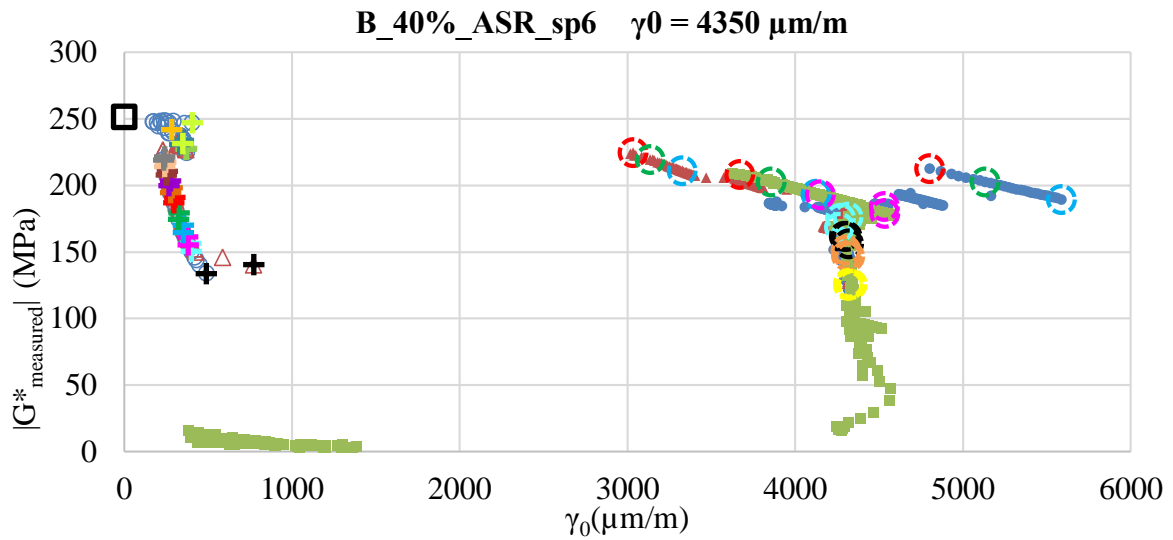
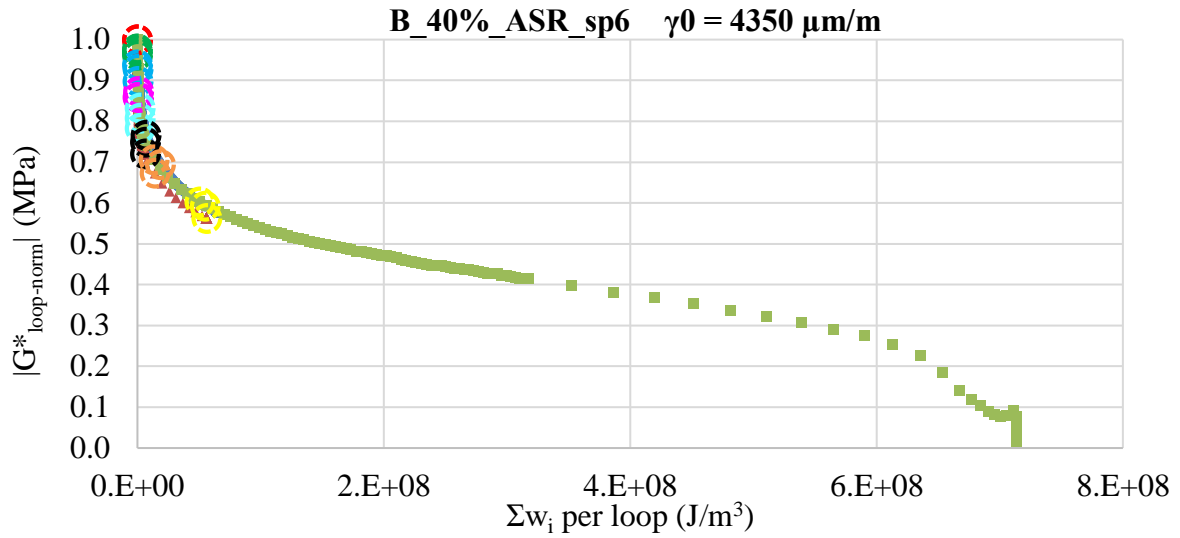


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

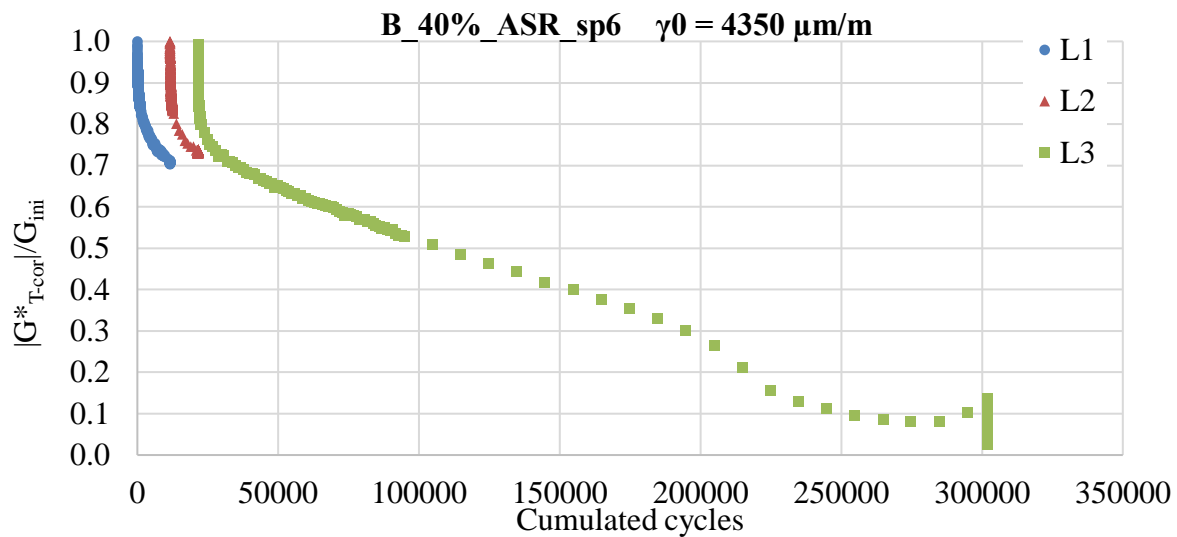
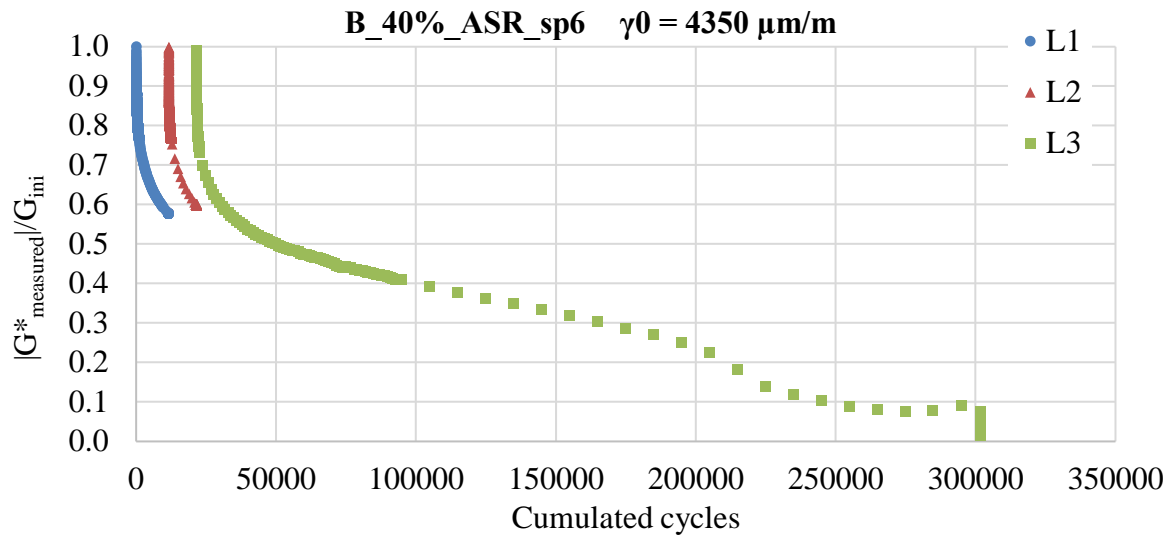




1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



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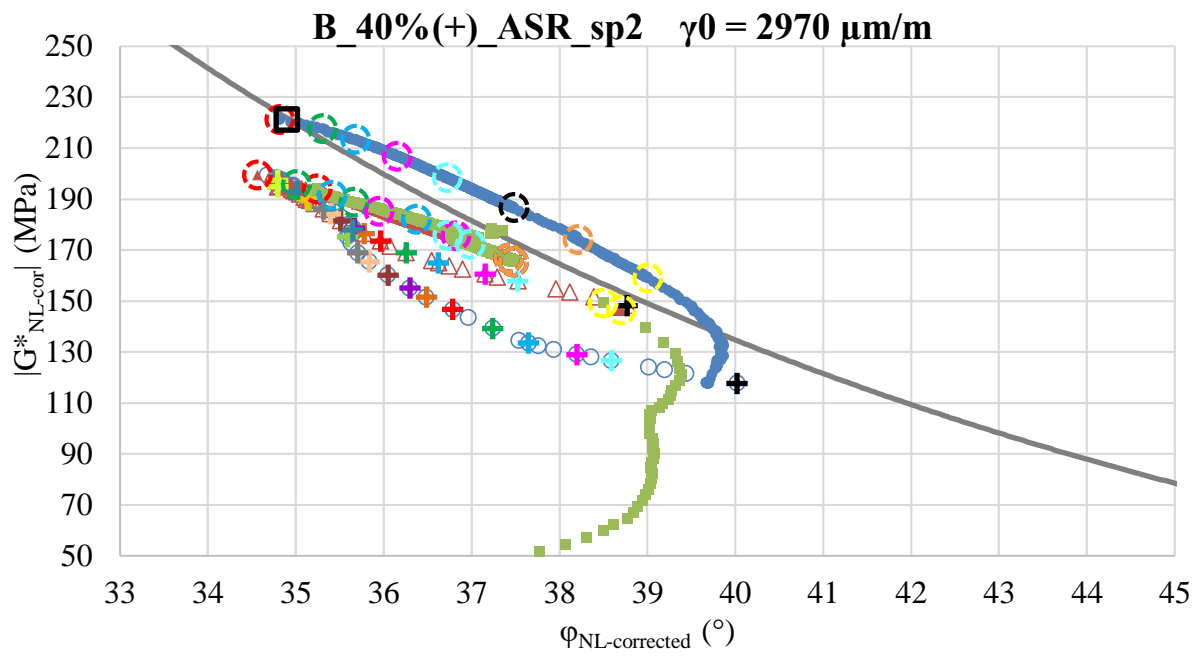
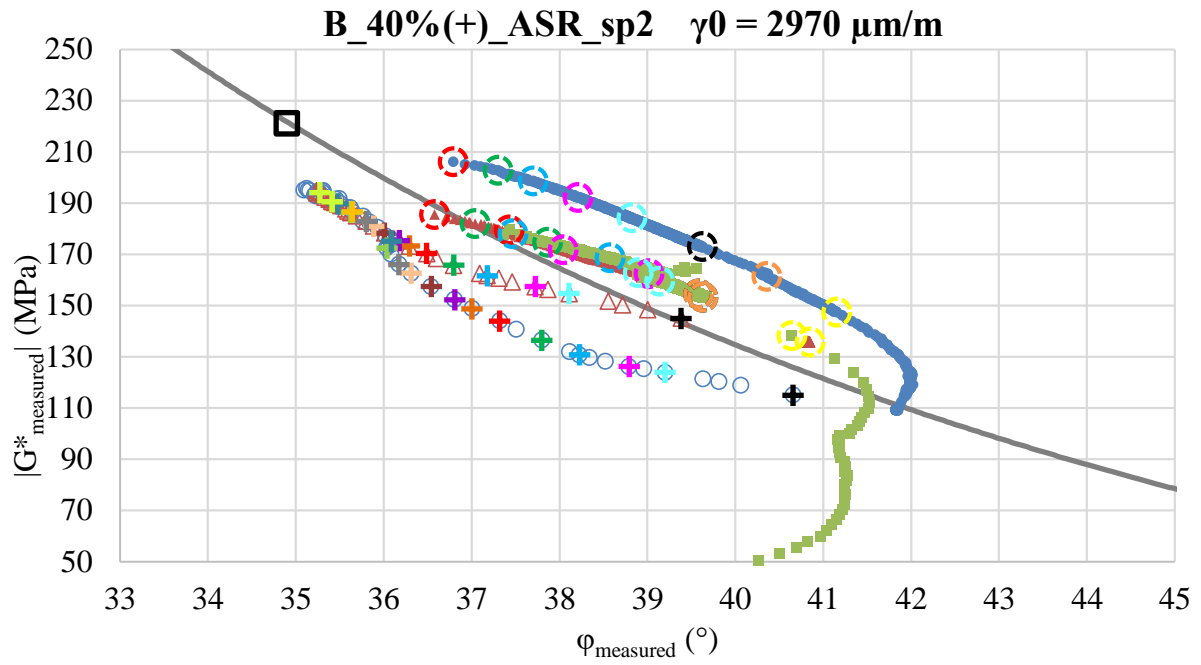


1.5.6.B\_40%(+)\_ASR

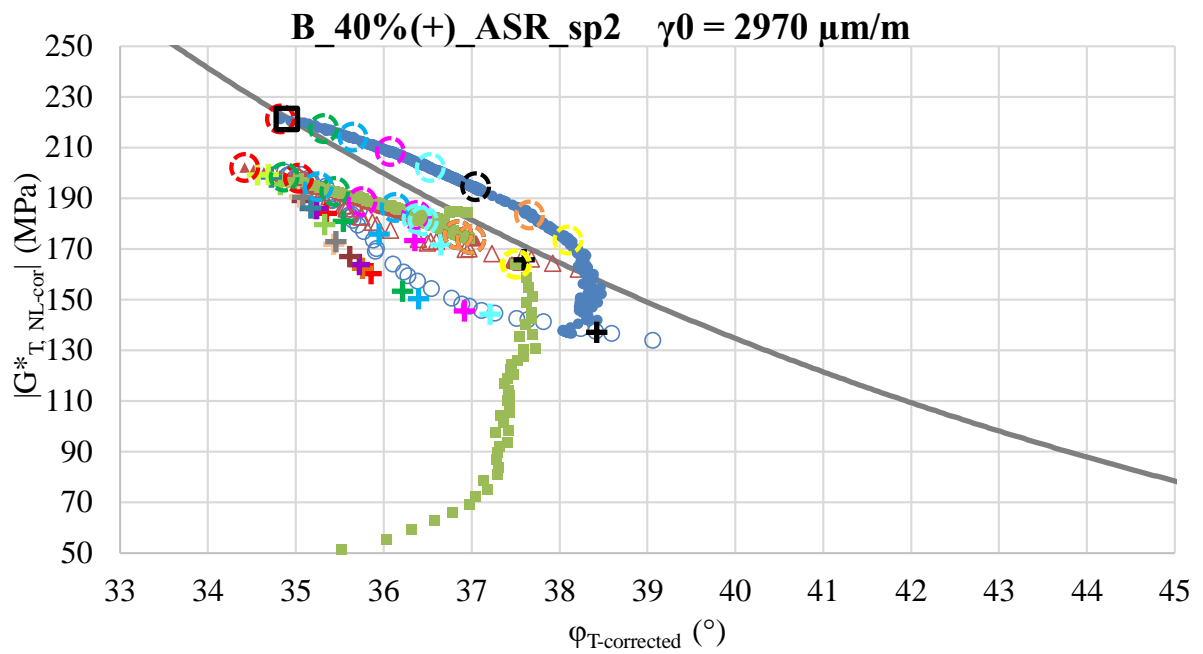
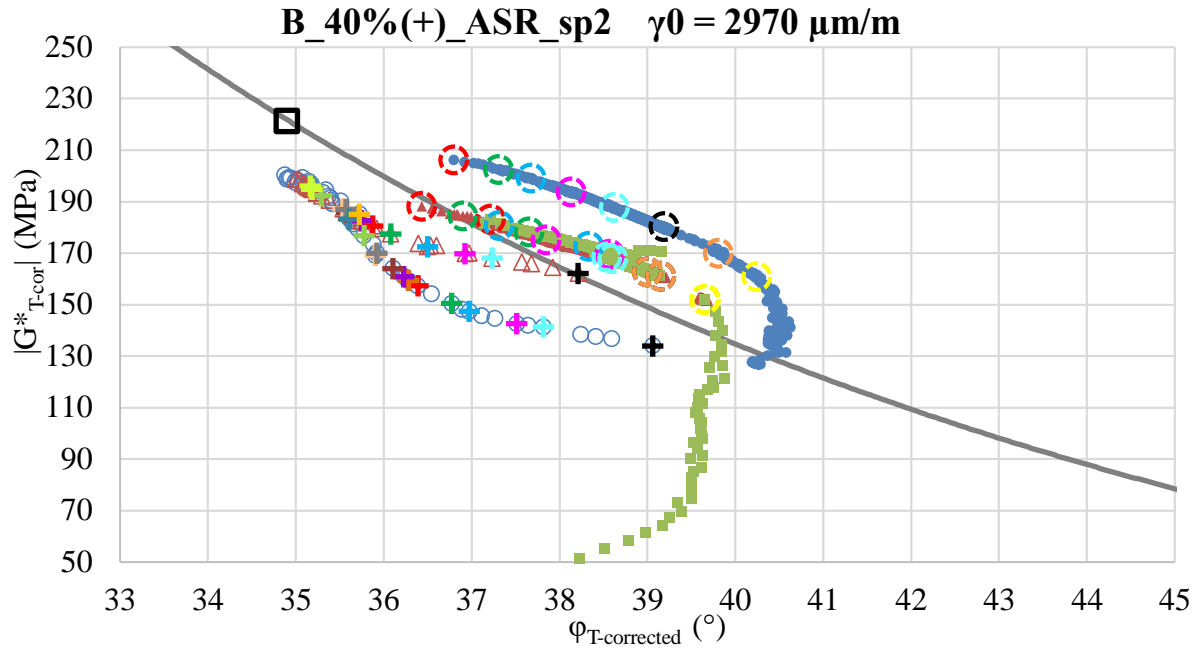
1.5.6.1. B\_40%(+)\_ASR\_sp3 (2970 $\mu\text{m/m}$ )

- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G*ini        | — 2S2P1D        |

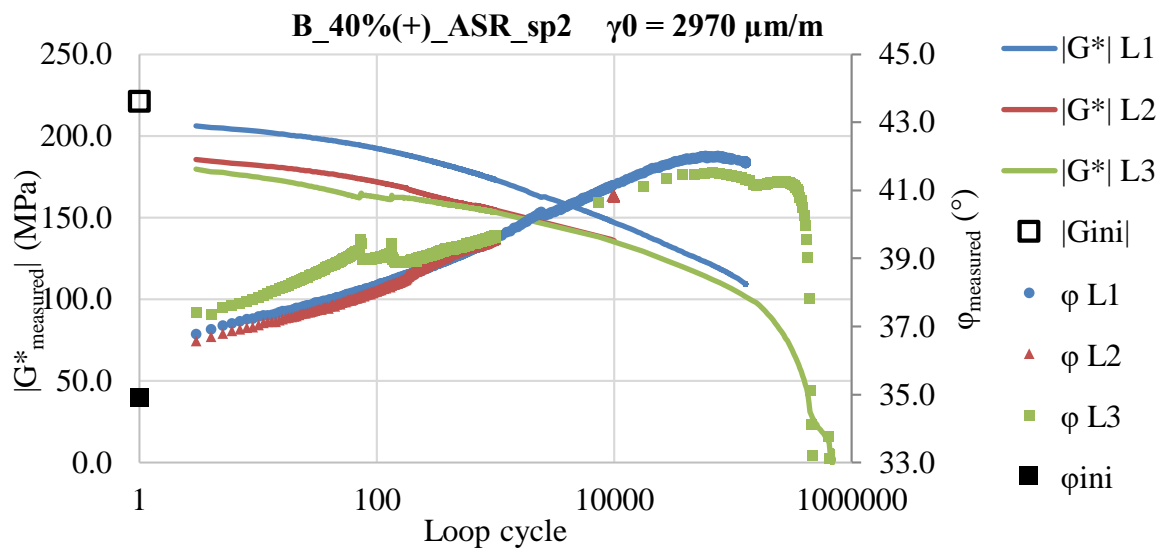
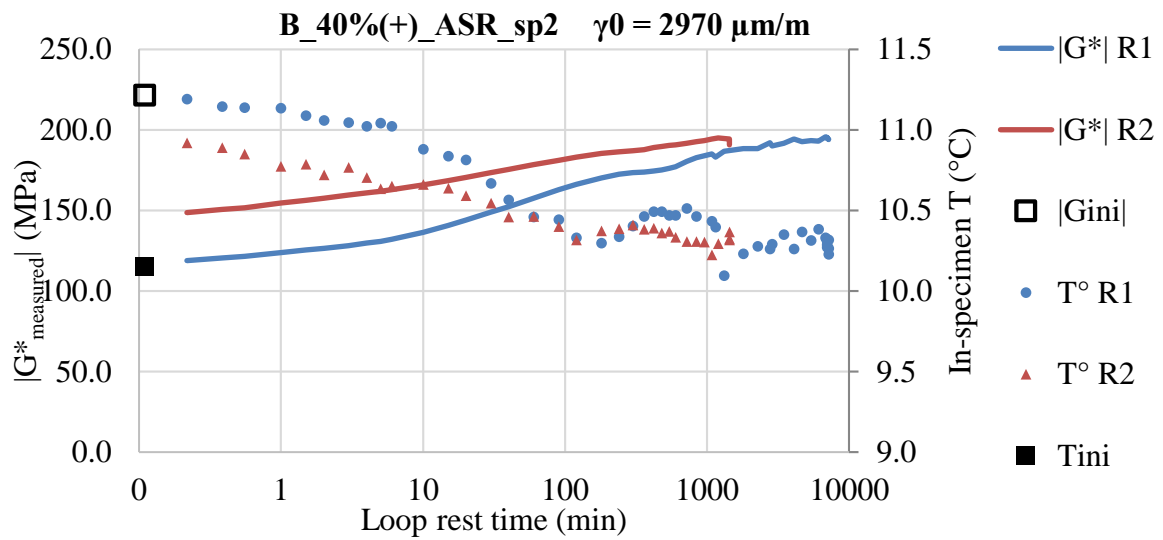
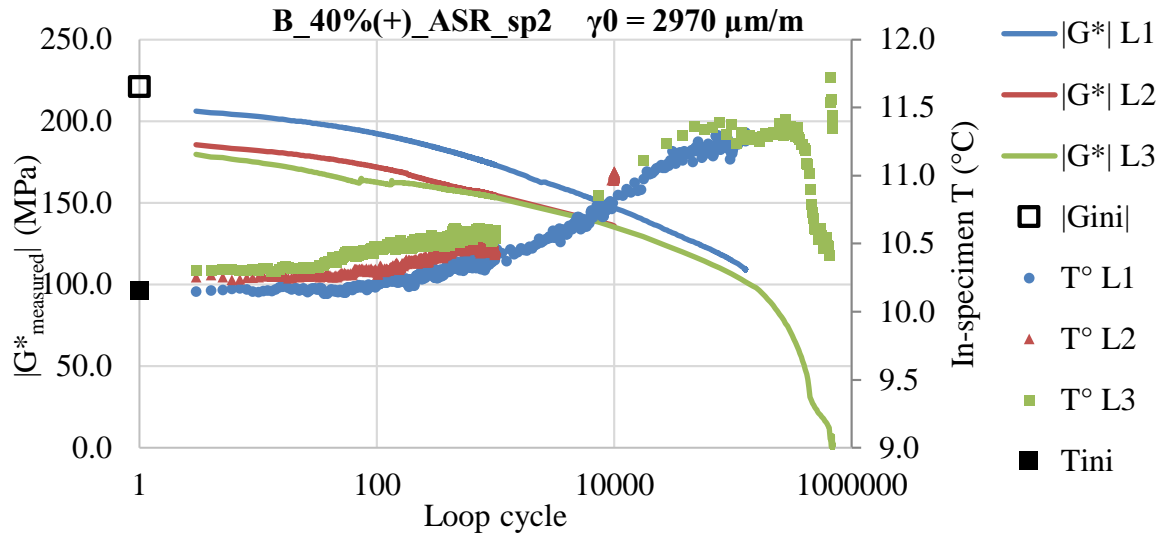
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



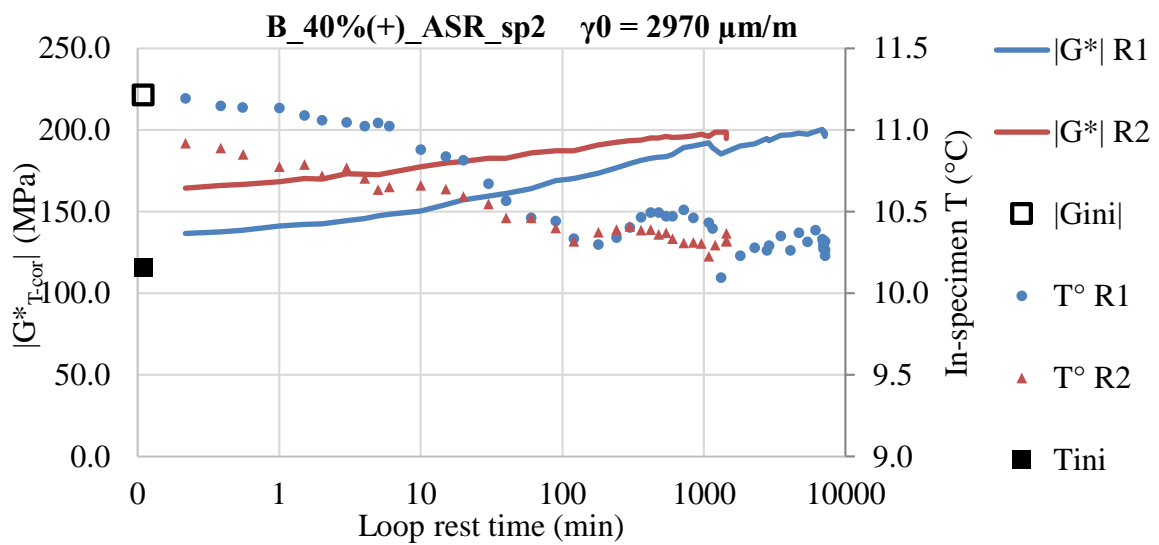
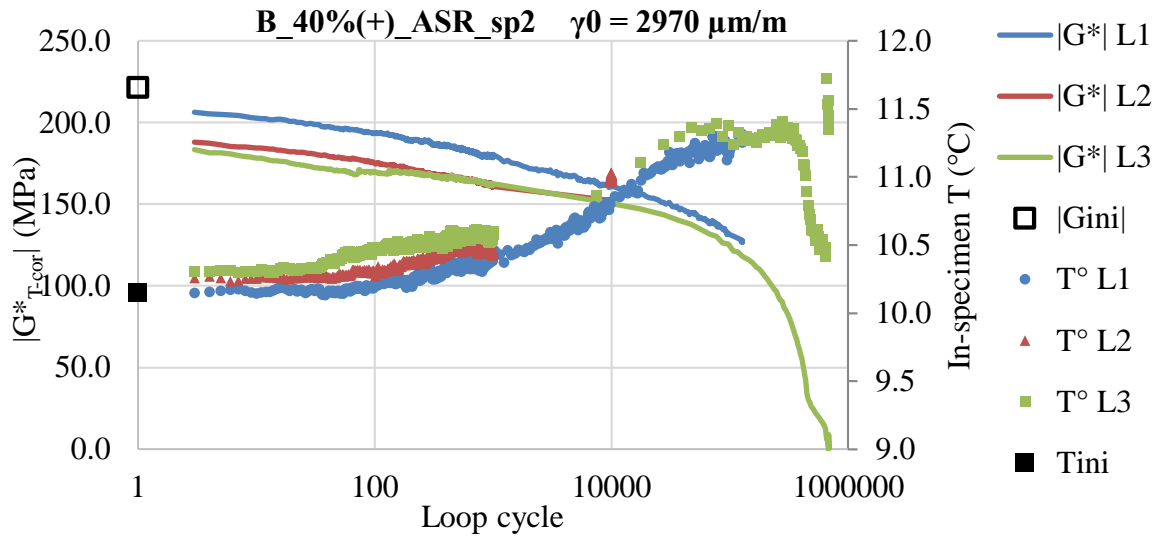
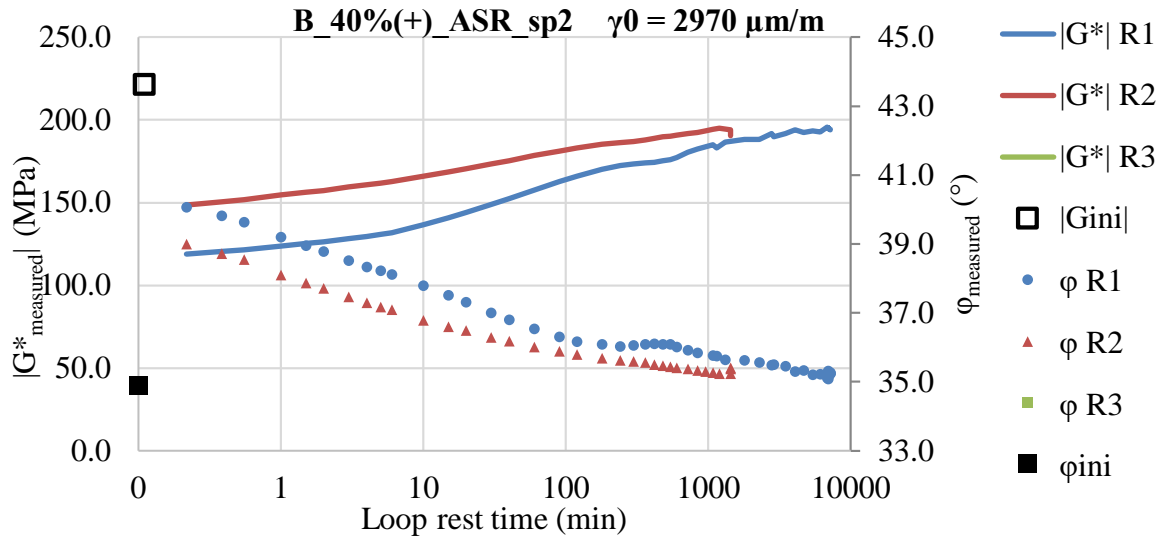
1 Thermomechanical tests on bituminous binders  
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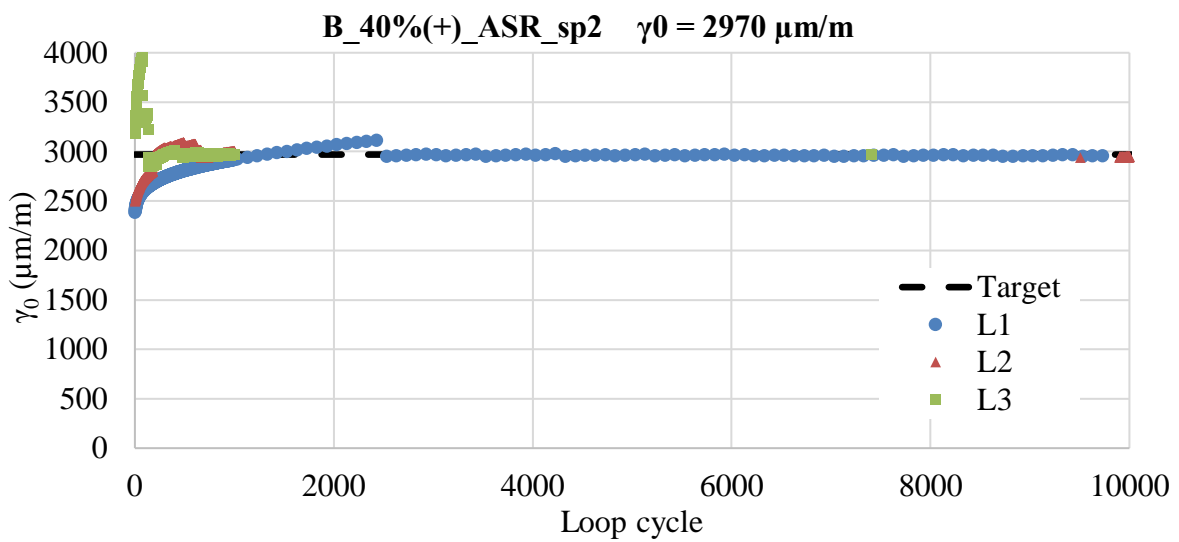
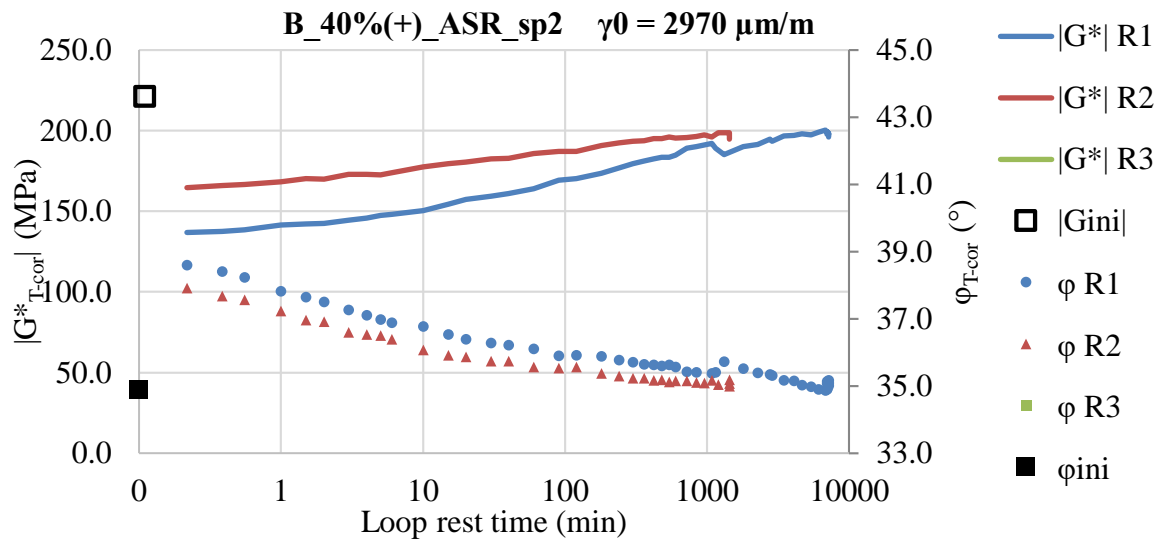
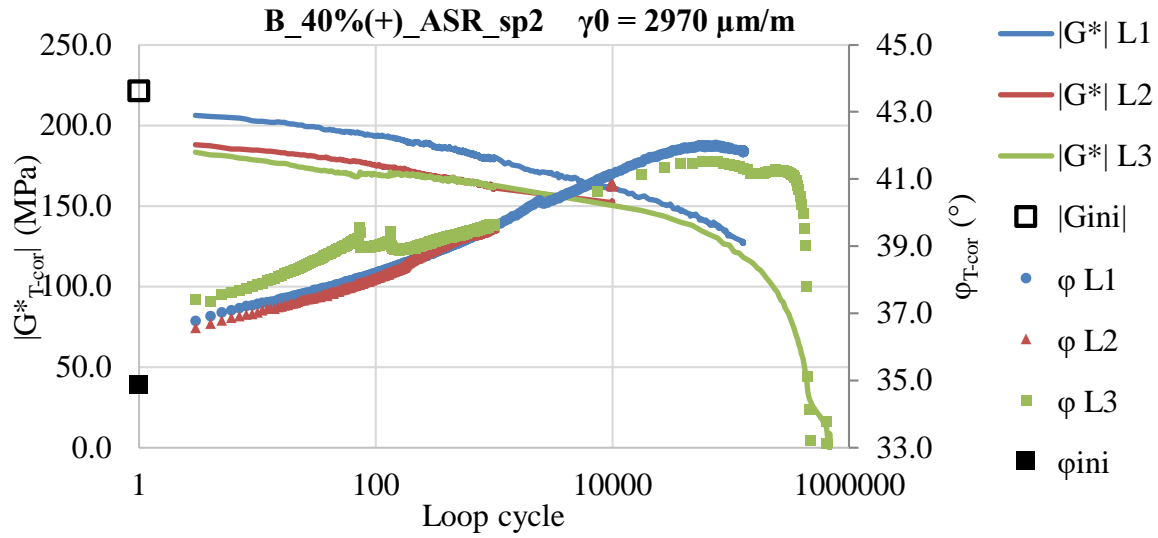
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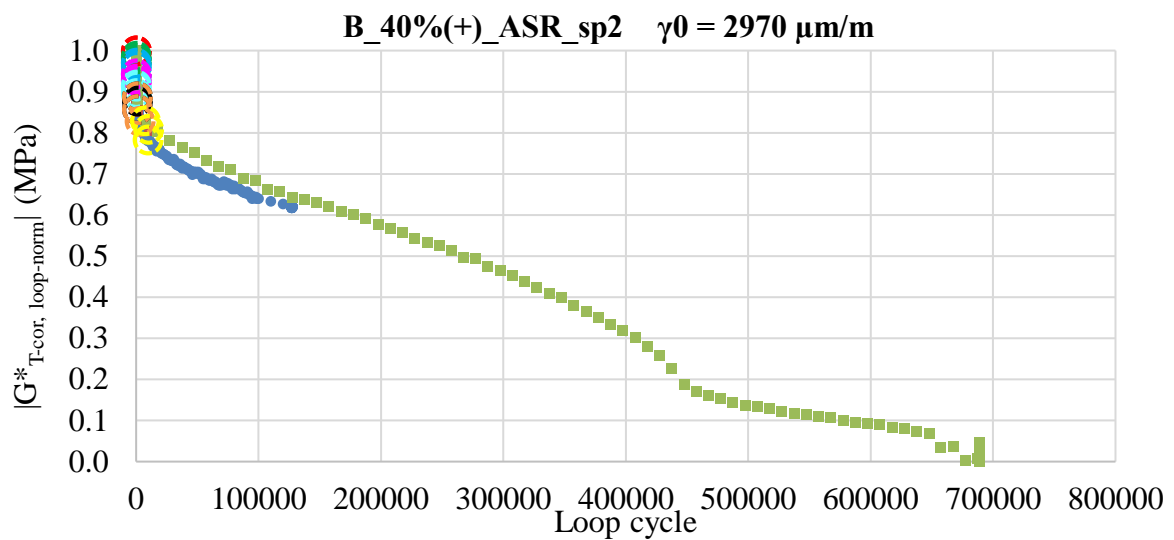
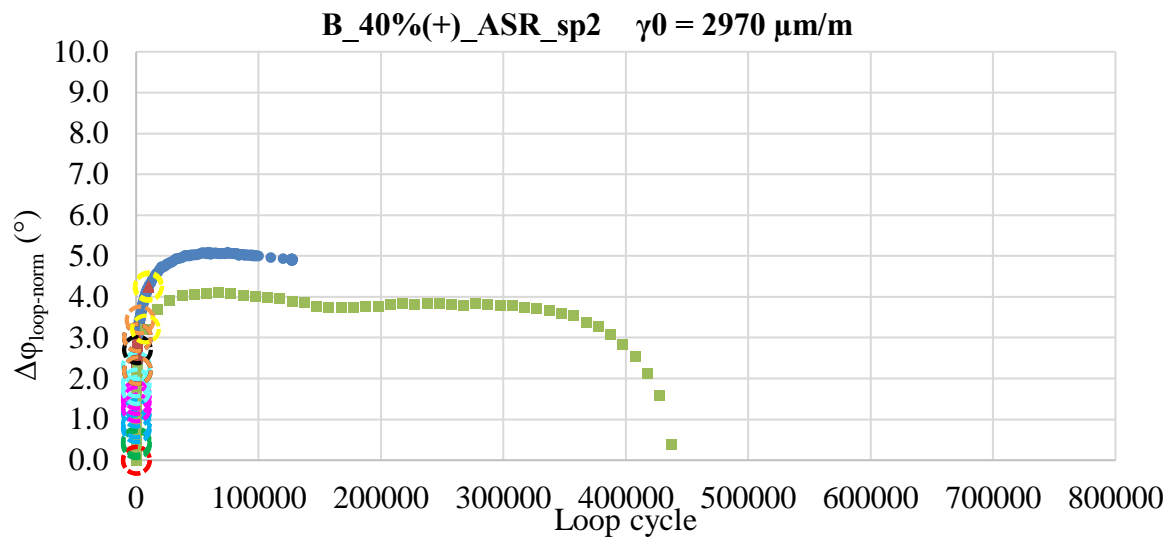
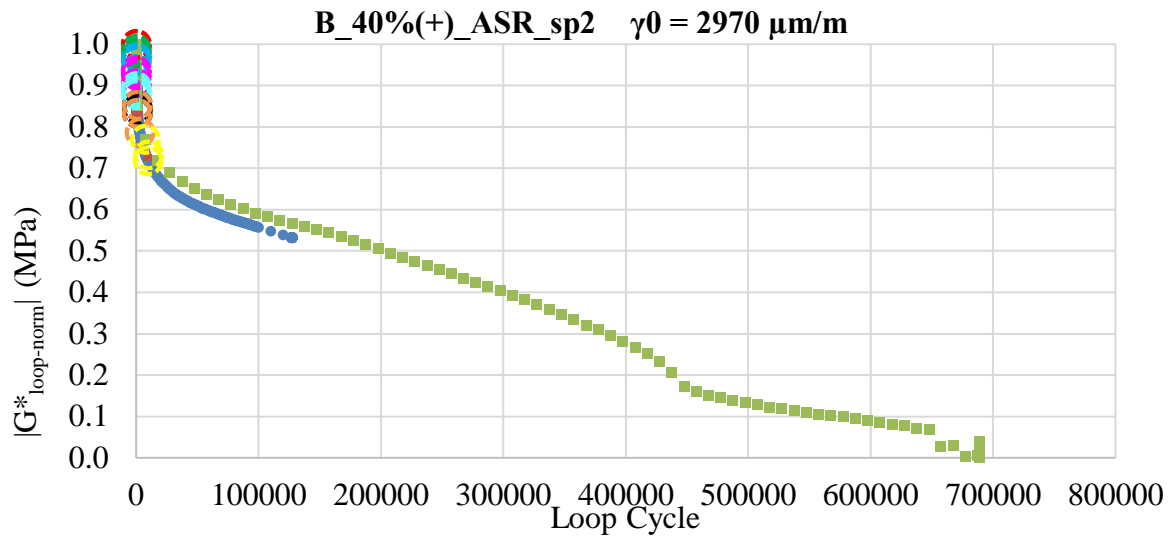
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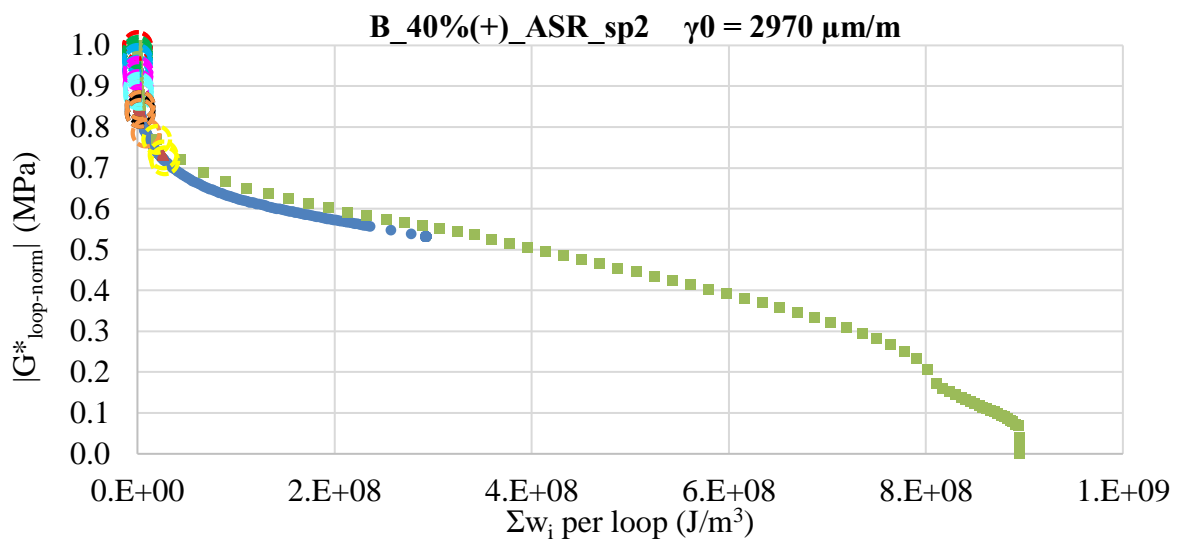
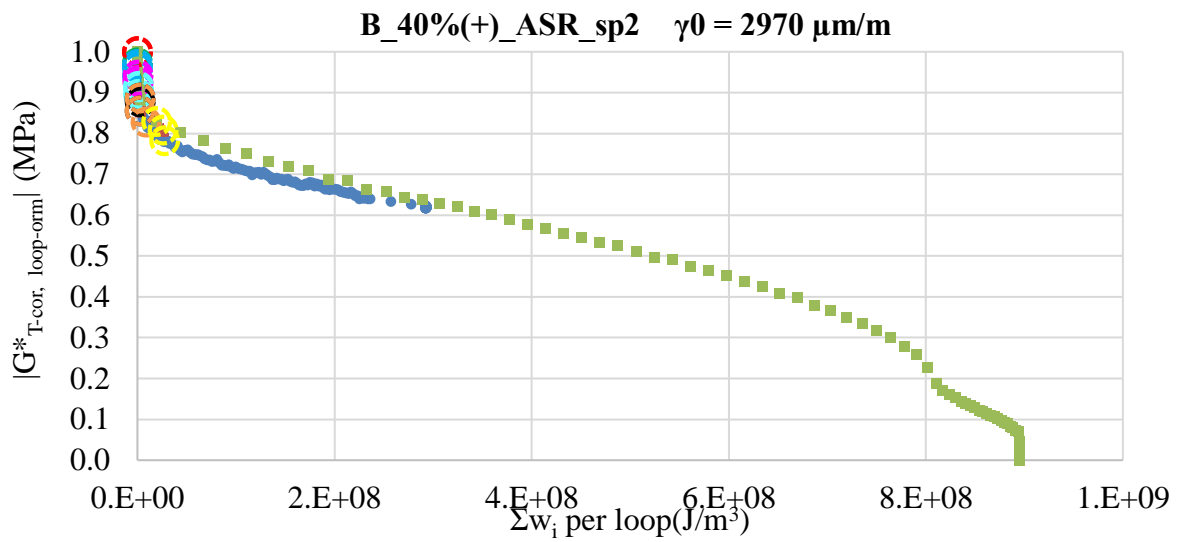
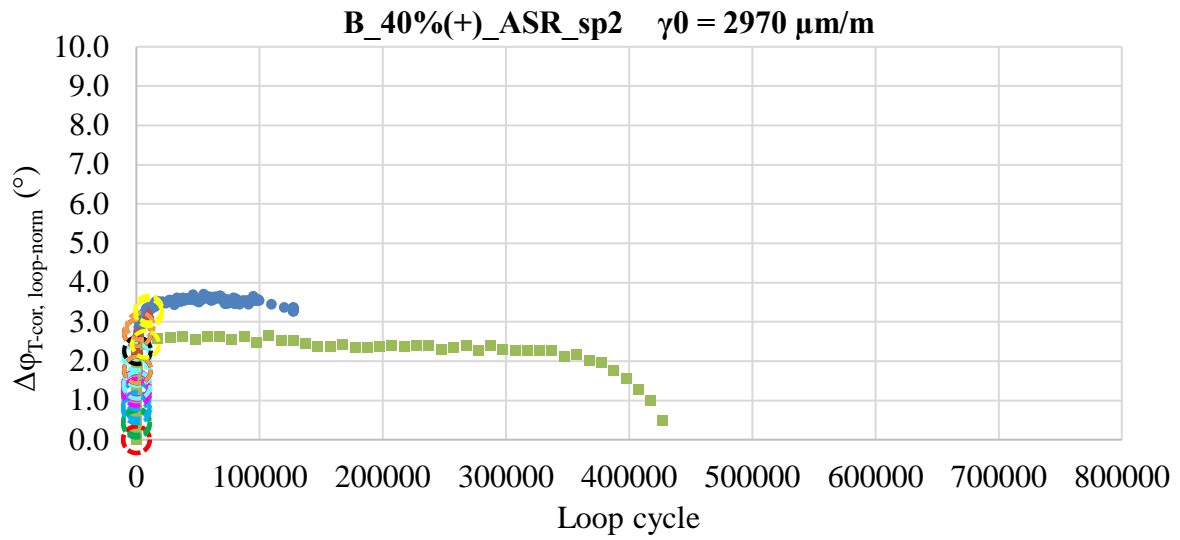


1 Thermomechanical tests on bituminous binders  
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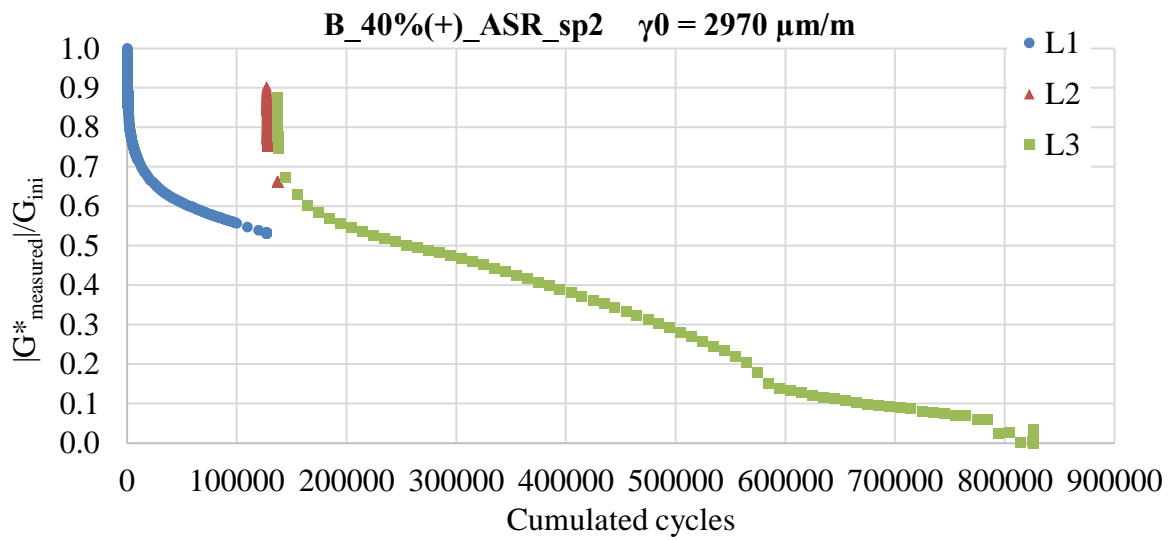
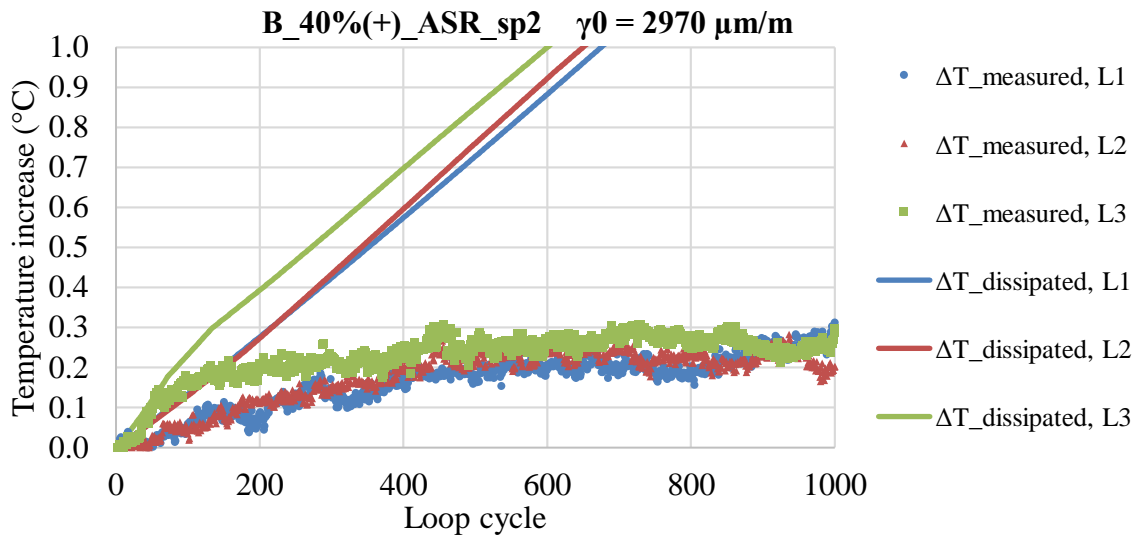
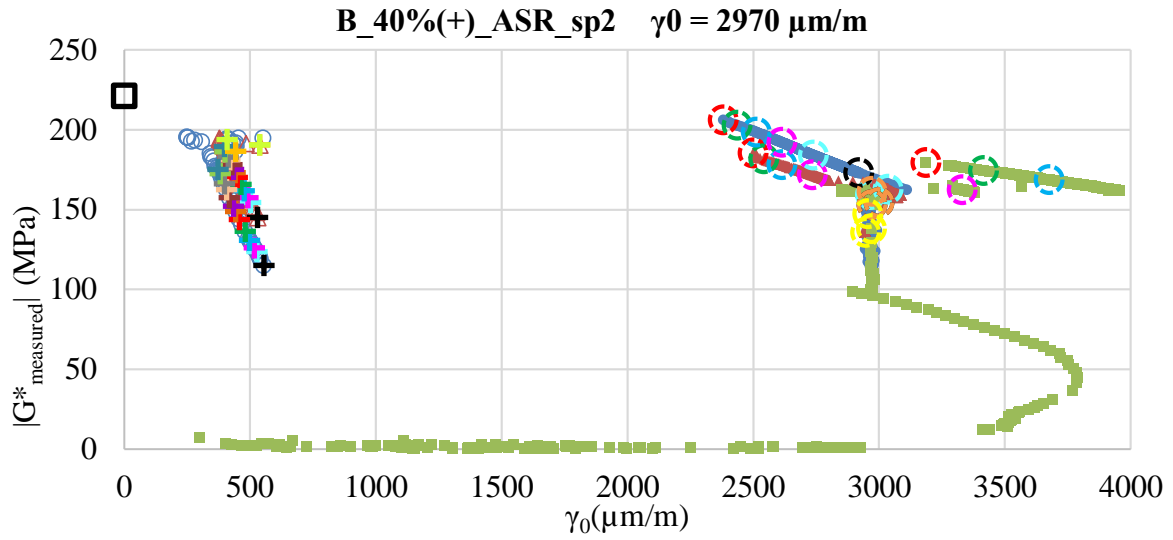




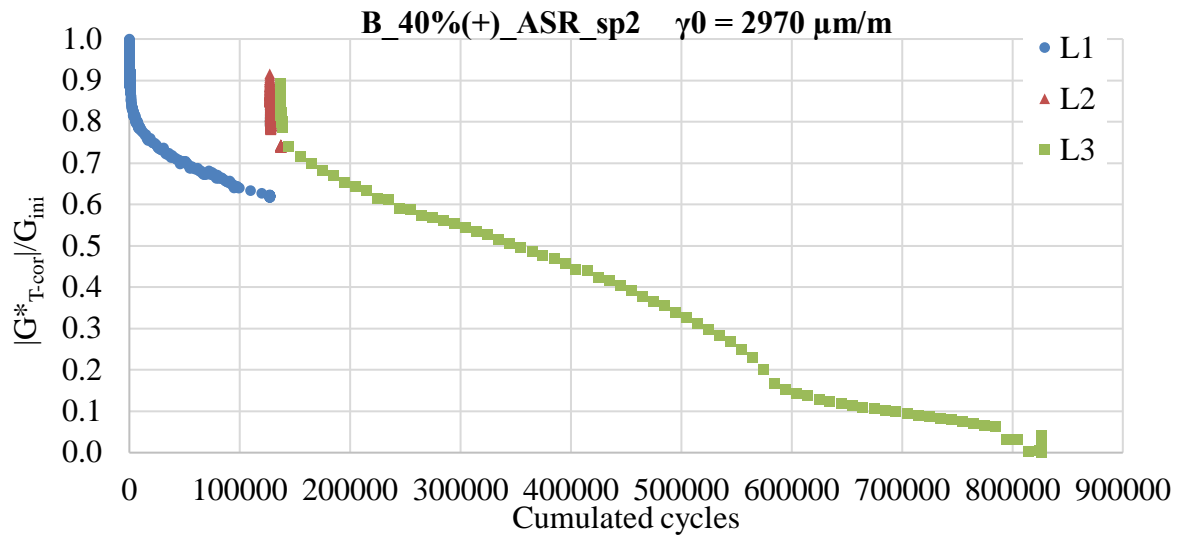
1 Thermomechanical tests on bituminous binders  
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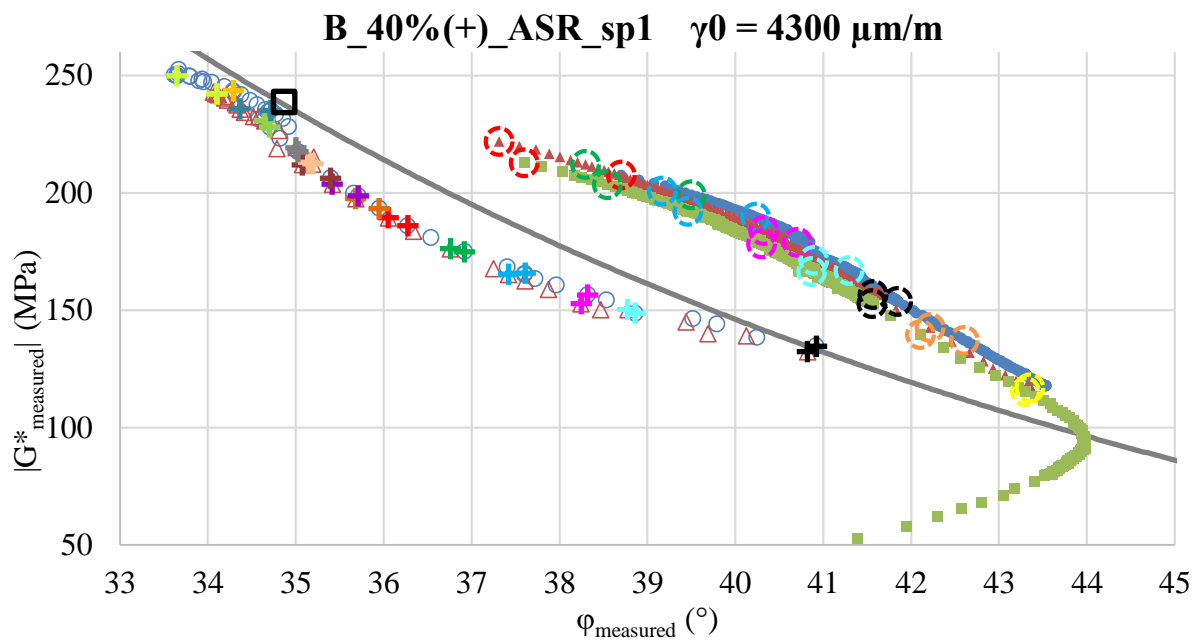


1 Thermomechanical tests on bituminous binders  
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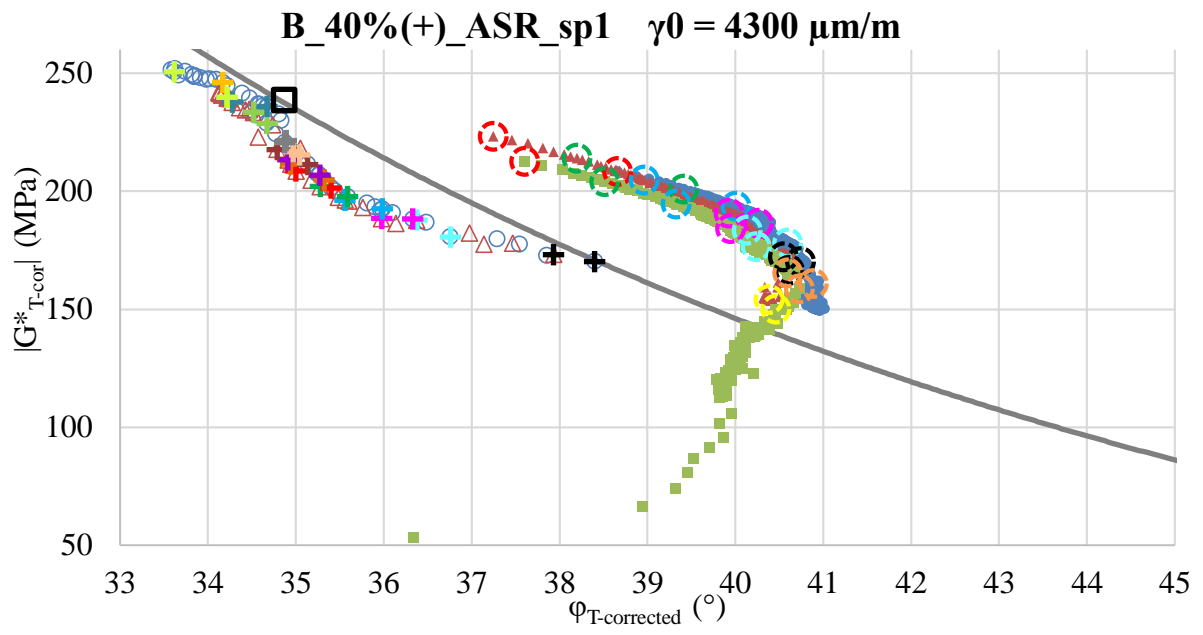
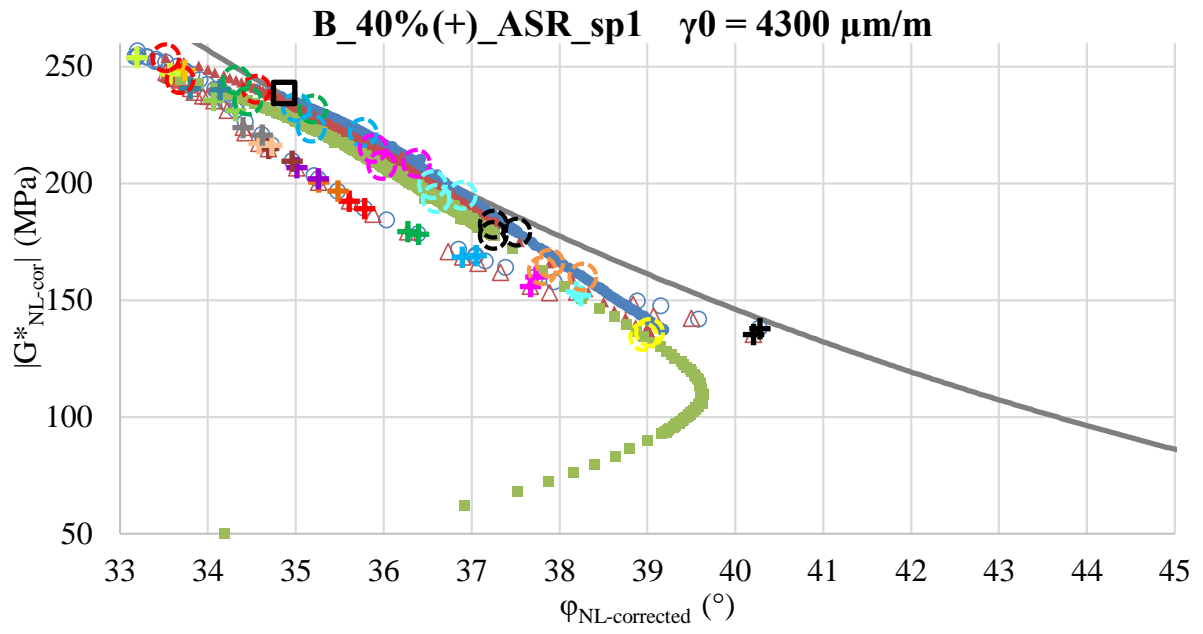


1.5.6.2. B\_40%(+)\_ASR\_sp1 (4300 $\mu\text{m/m}$ )

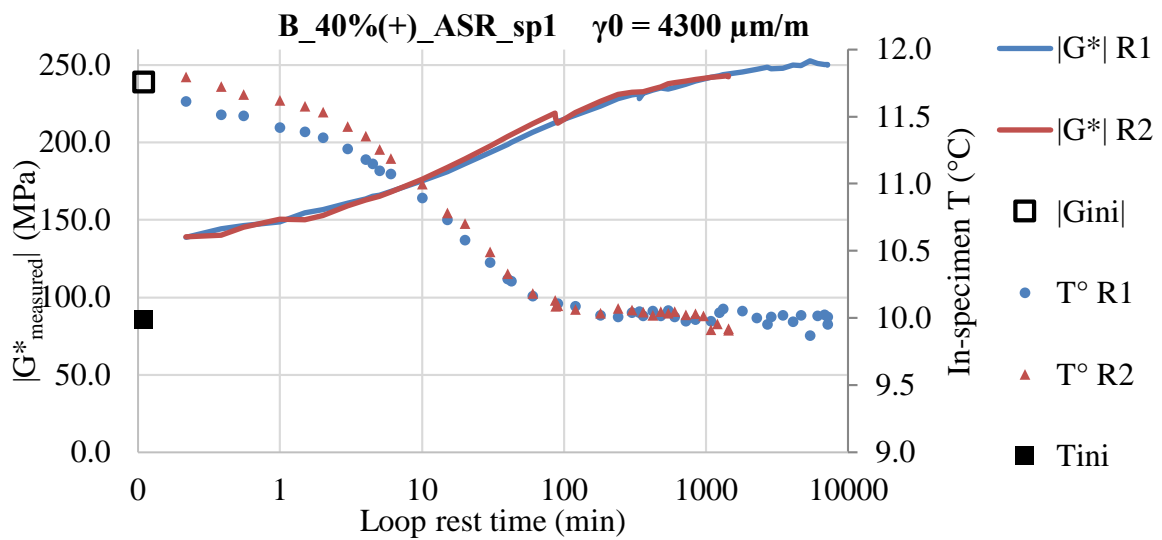
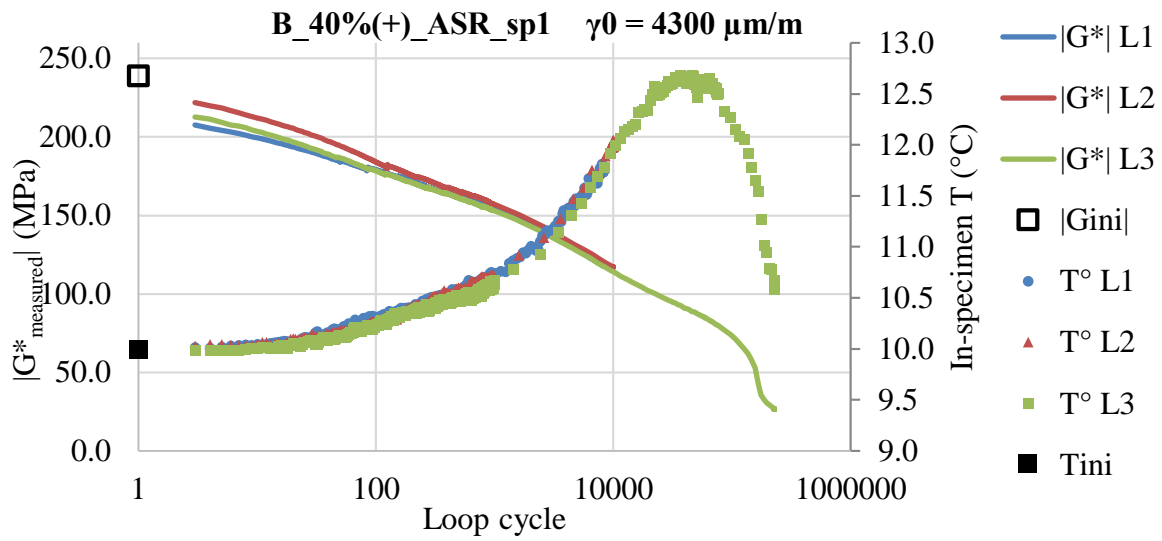
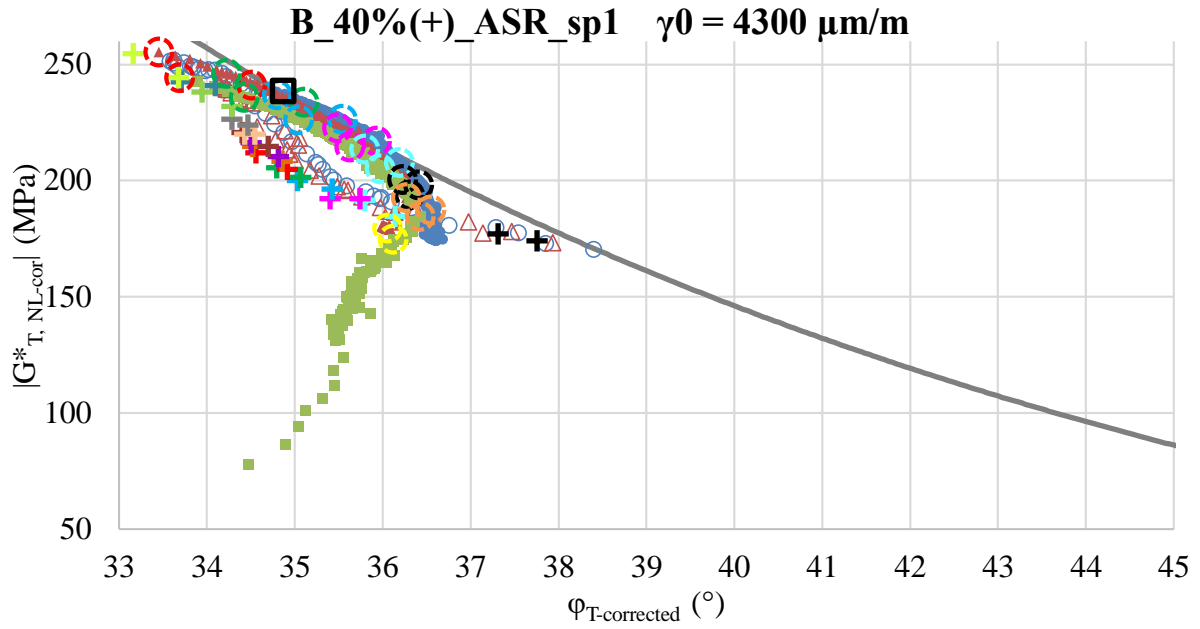
- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ✦ Rest = 0min   | ✦ Rest = 1min   | ✦ Rest = 2min   | ✦ Rest = 5min  | ✦ Rest = 10min  |
| ✦ Rest = 20min  | ✦ Rest = 30min  | ✦ Rest = 40min  | ✦ Rest = 60min | ✦ Rest = 90min  |
| ✦ Rest = 120min | ✦ Rest = 240min | ✦ Rest = 480min | ✦ Rest = 1 day | ✦ Rest = 5 days |
| ⊙ Cycle 3       | ⊙ Cycle 10      | ⊙ Cycle 30      | ⊙ Cycle 100    | ⊙ Cycle 300     |
| ⊙ Cycle 1000    | ⊙ Cycle 3000    | ⊙ Cycle 10000   | ■ G*ini        | — 2S2P1D        |



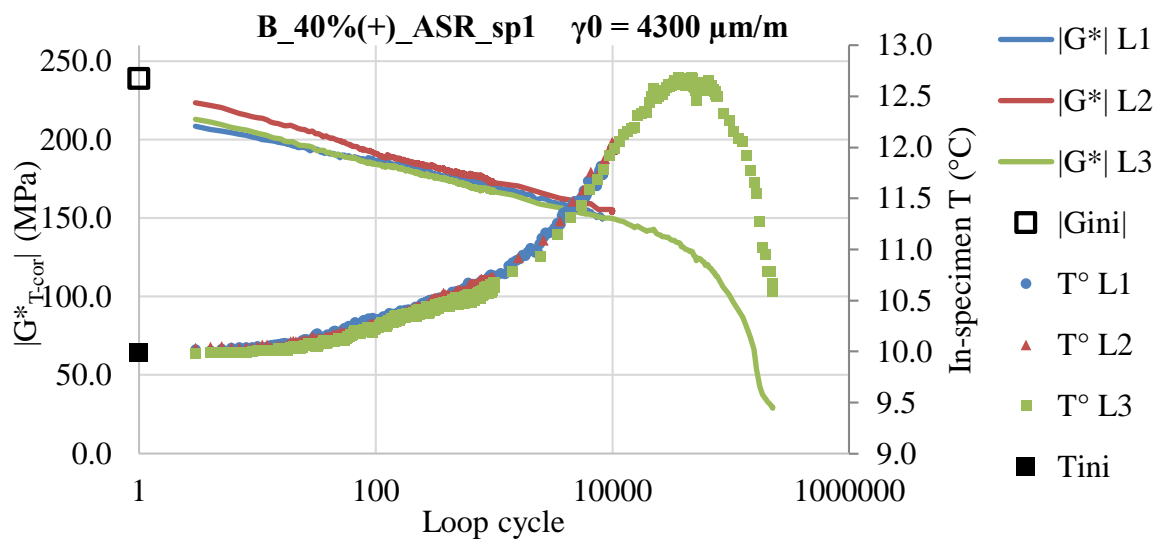
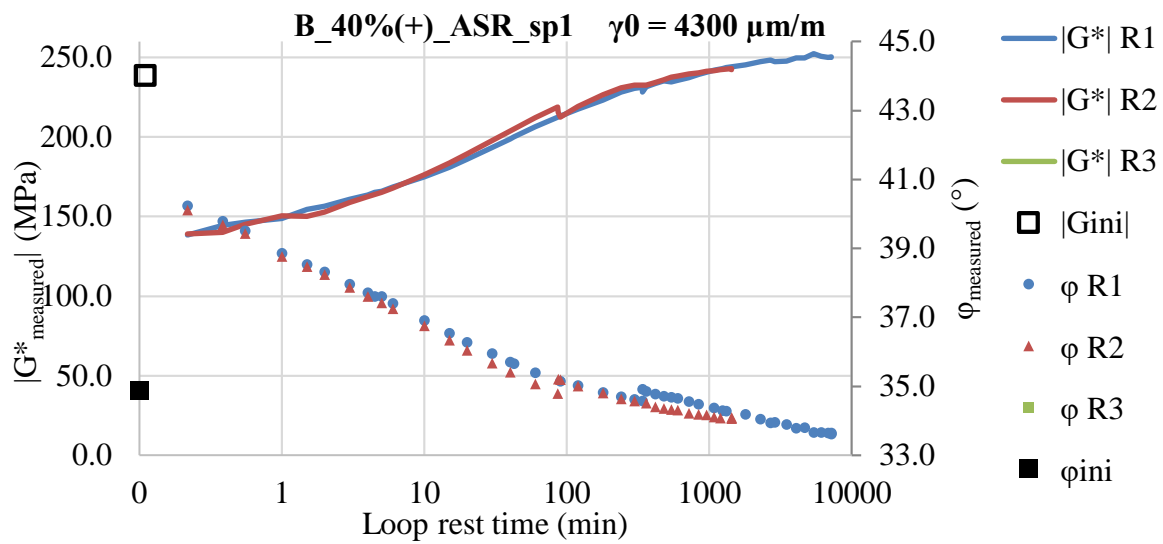
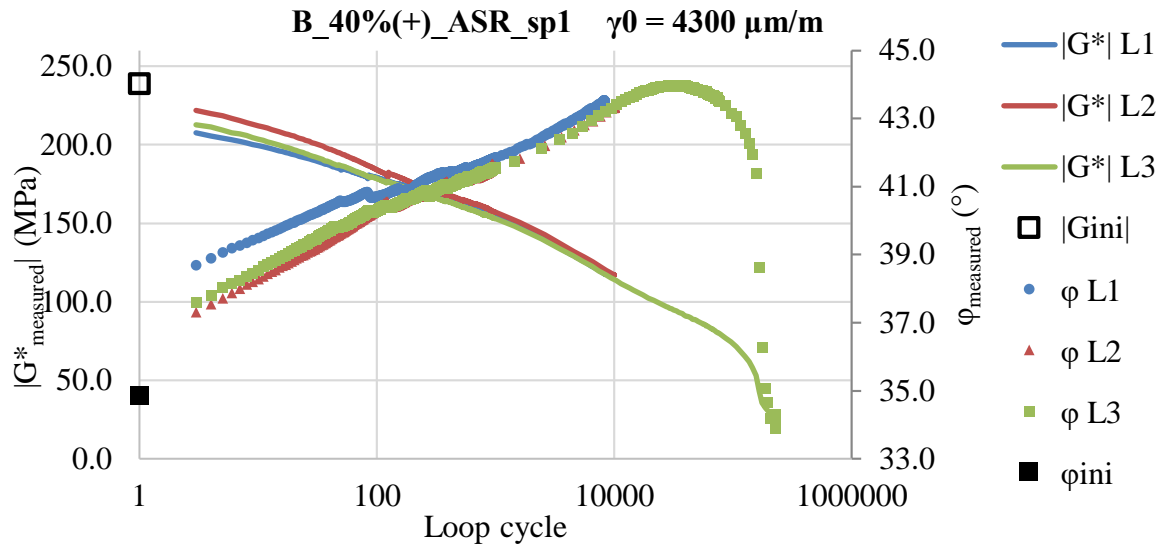
1 Thermomechanical tests on bituminous binders  
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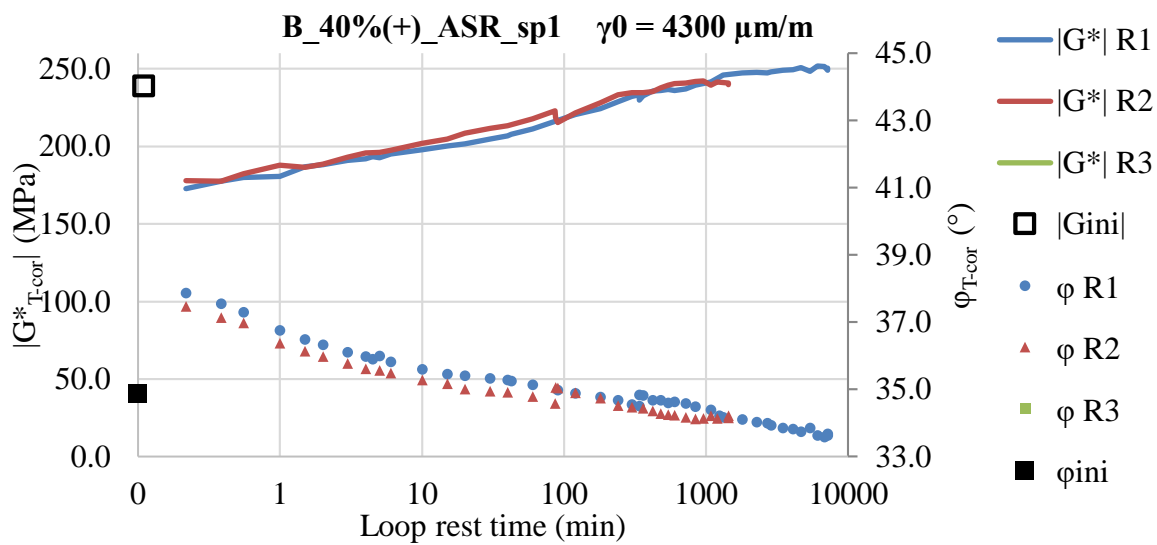
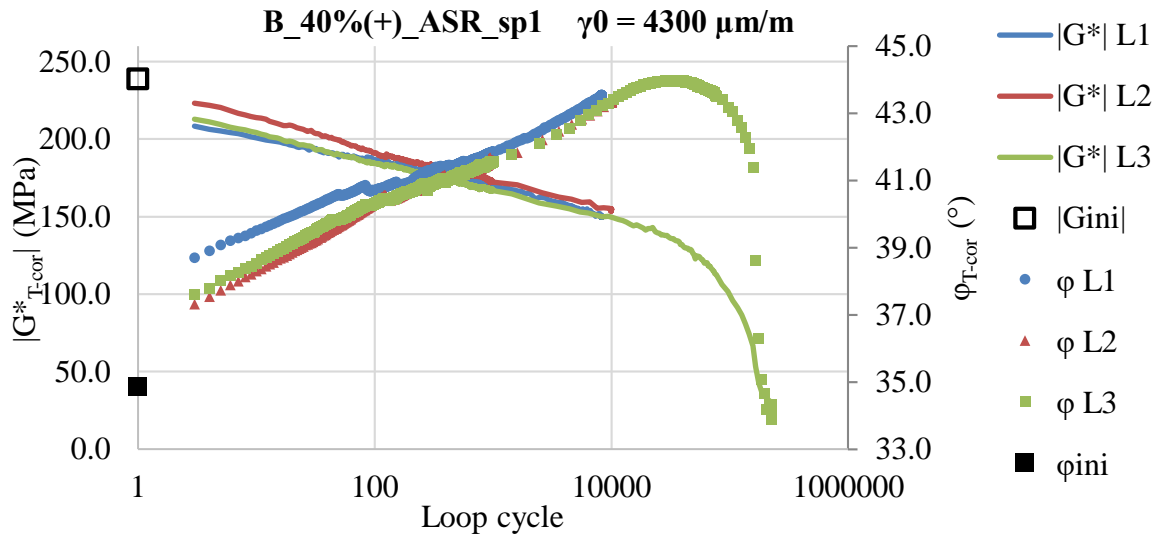
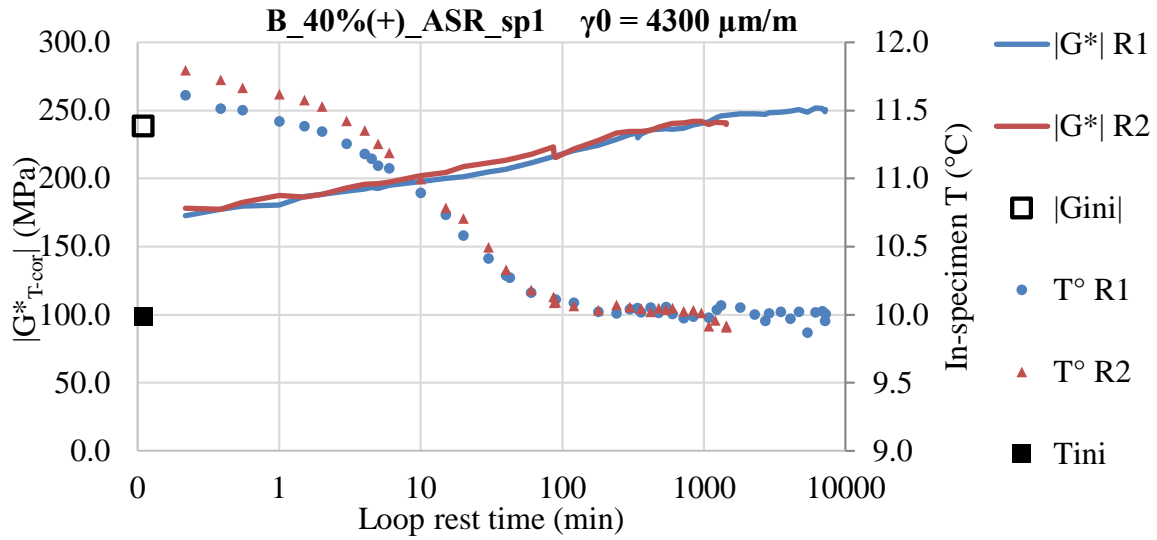
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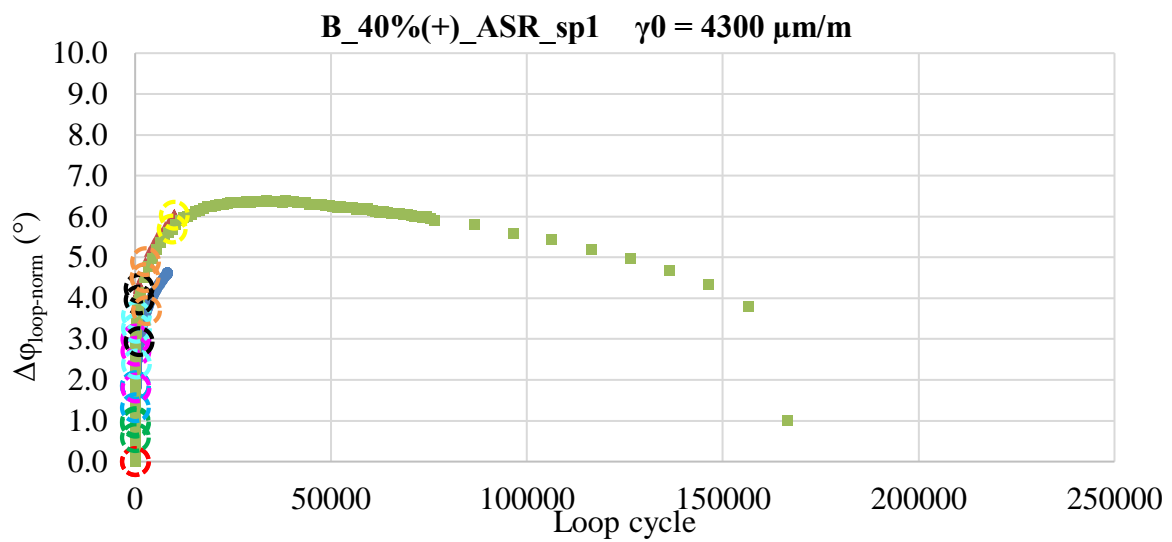
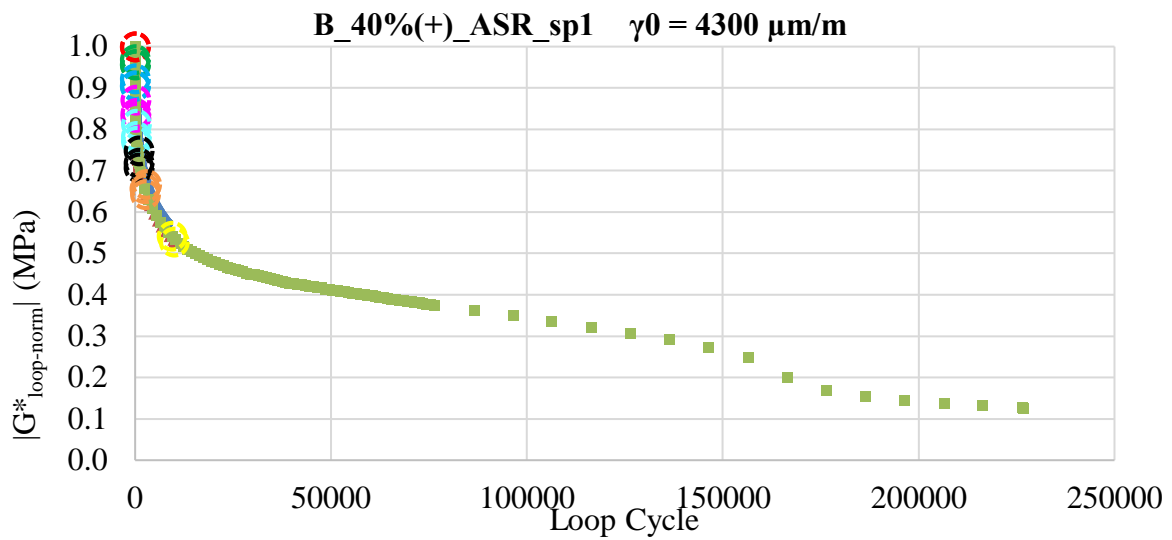
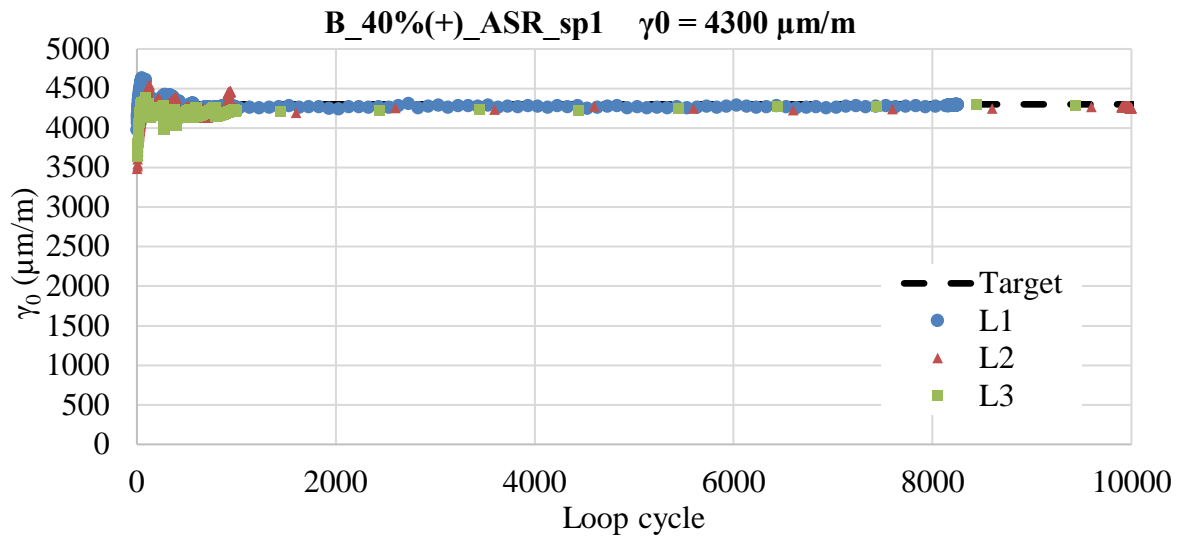
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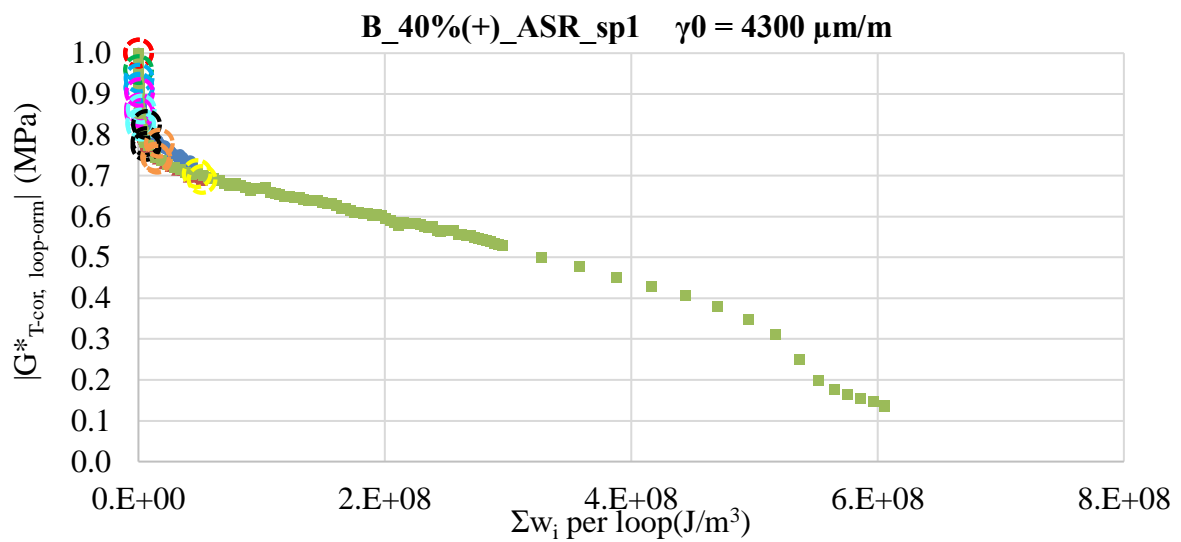
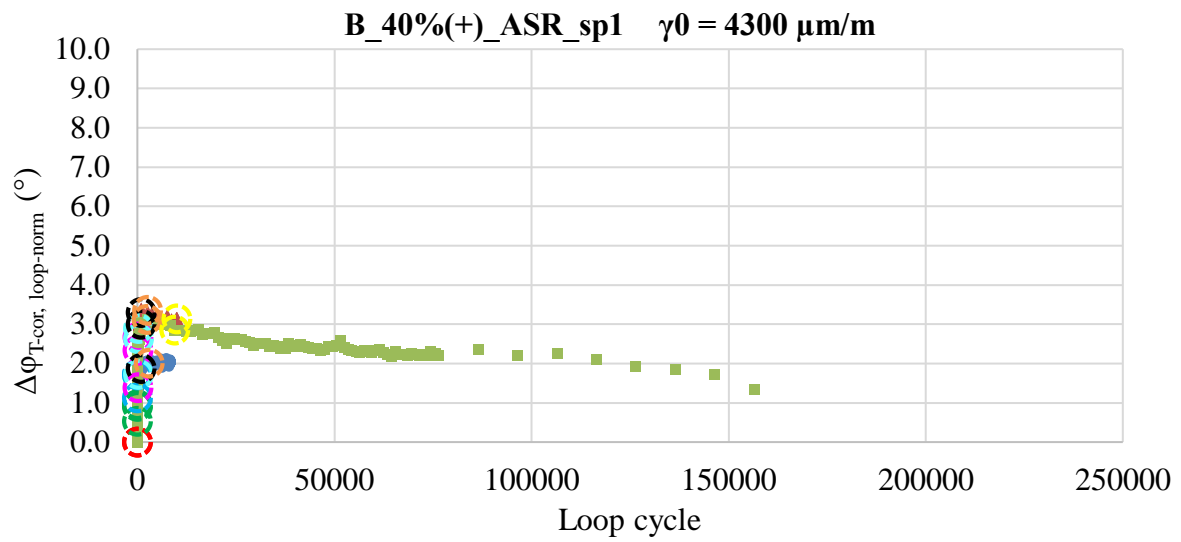
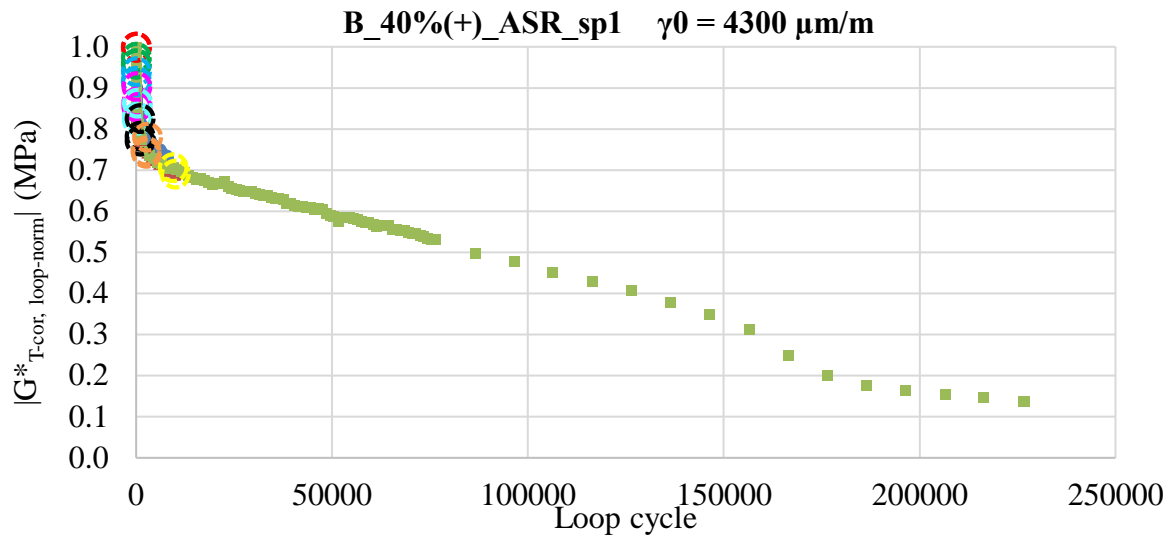


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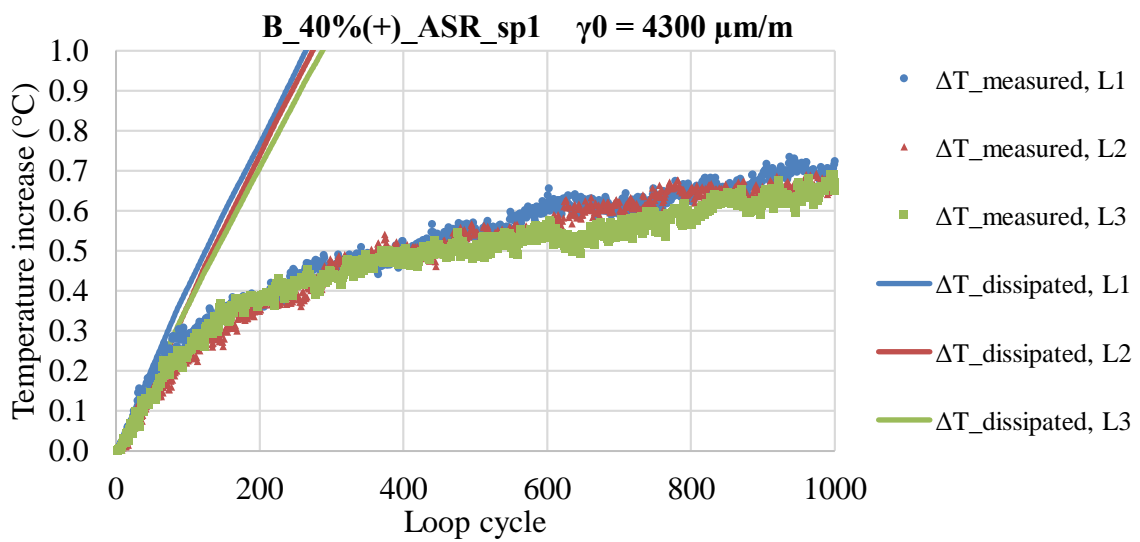
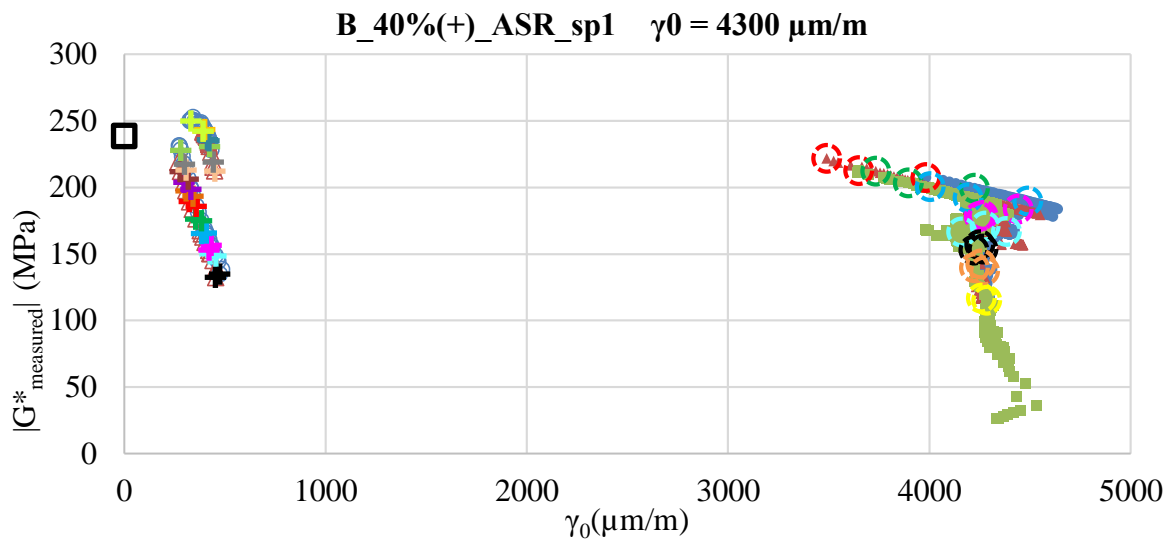
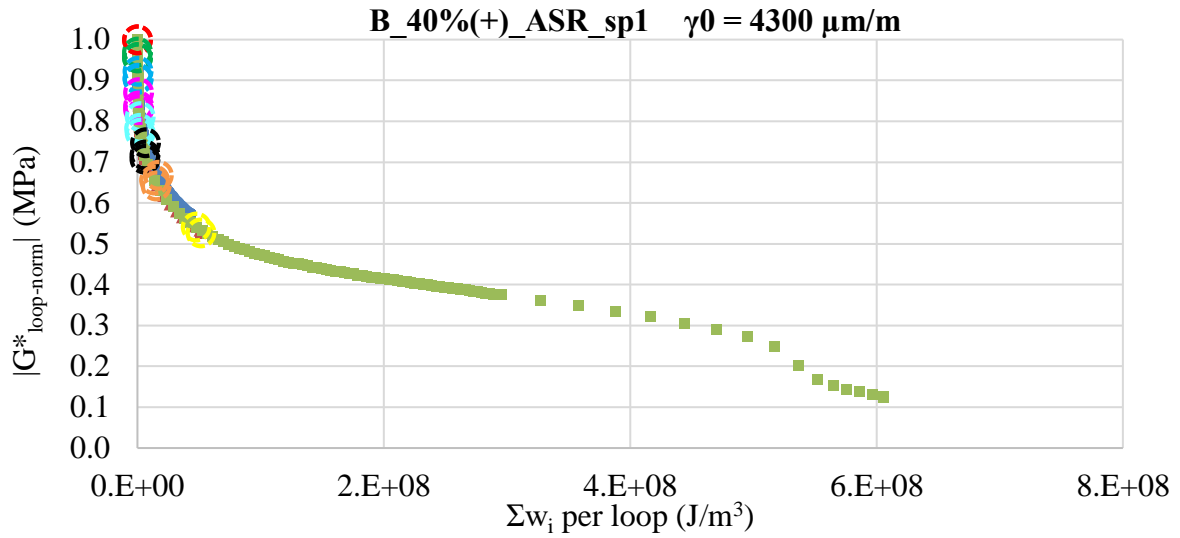




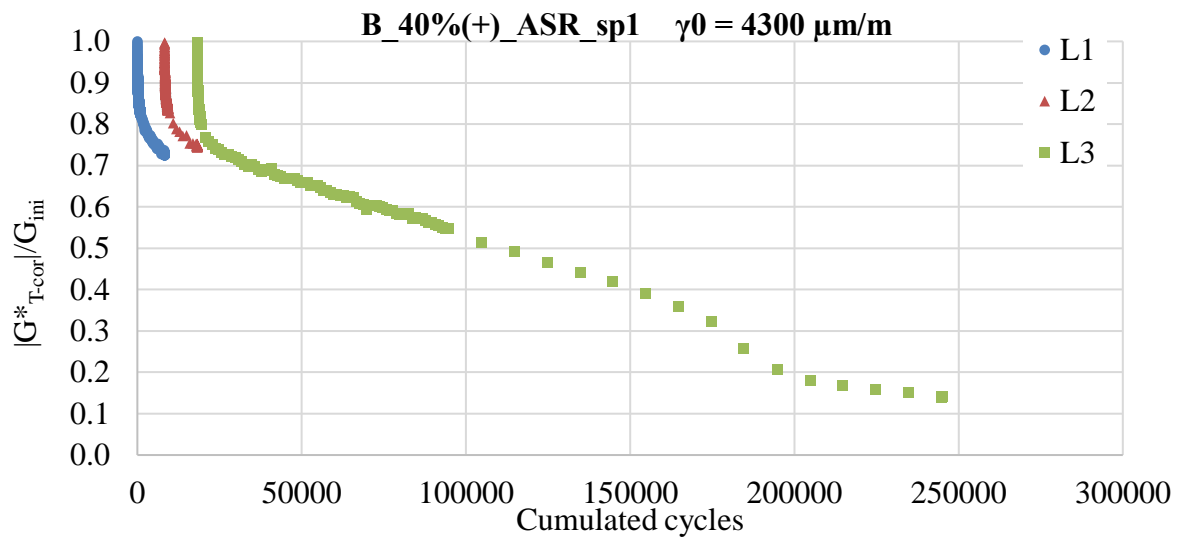
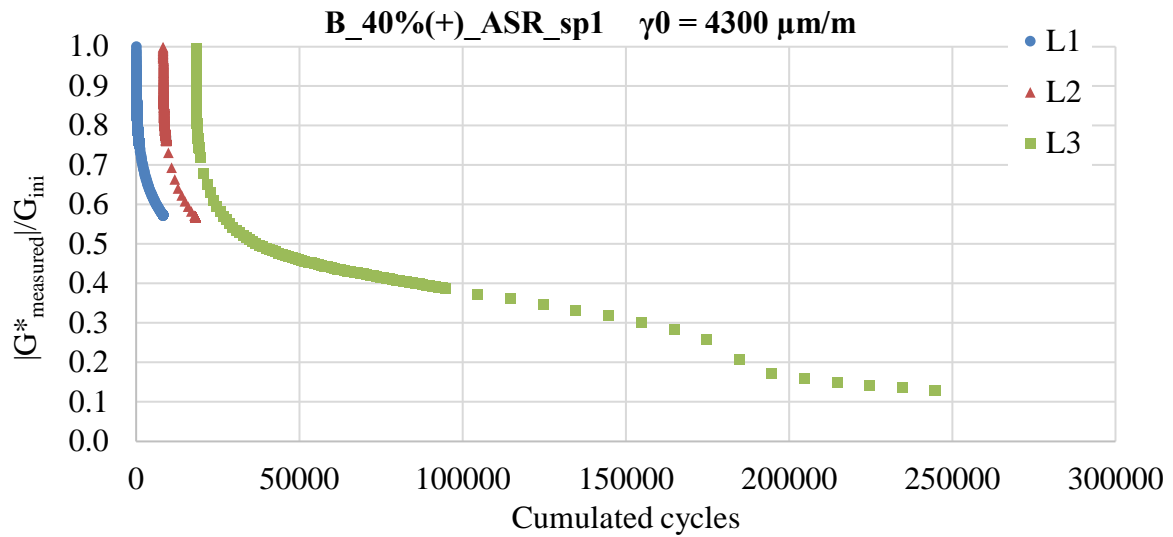
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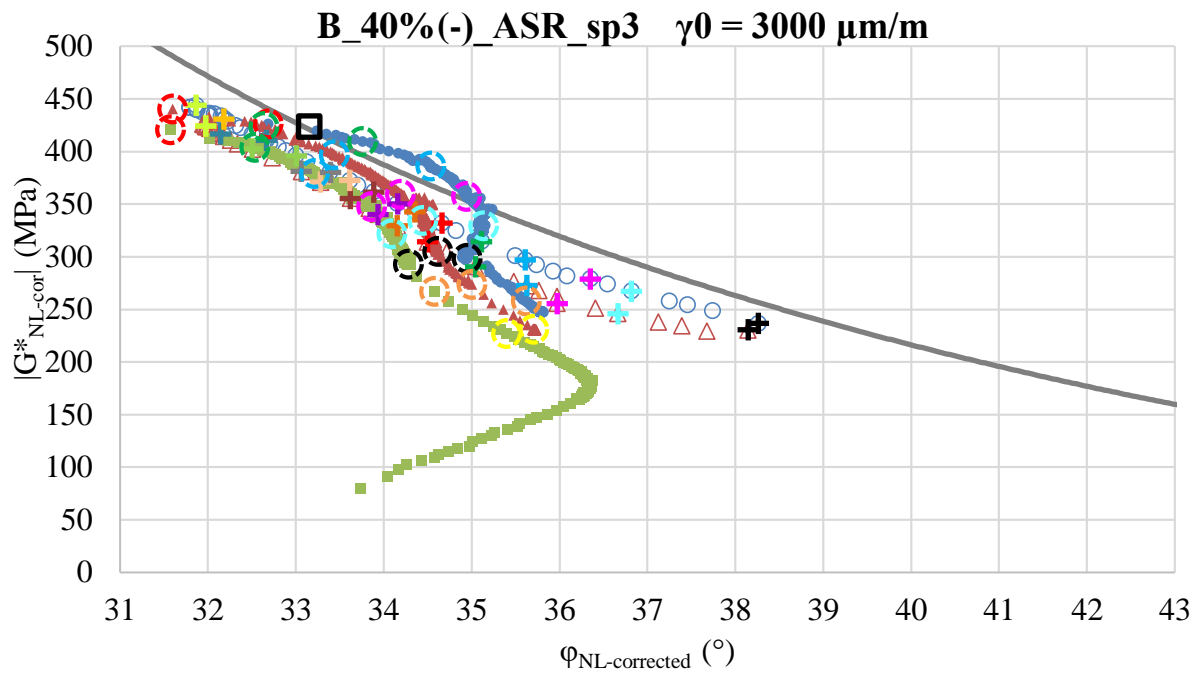
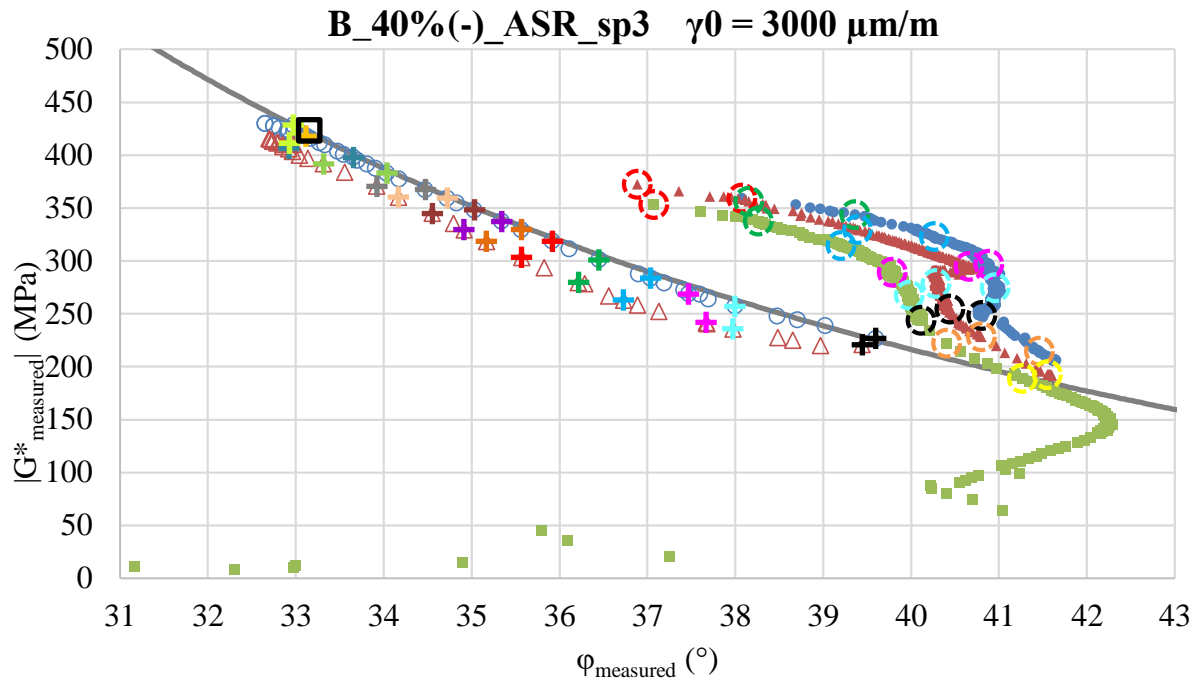


1.5.7.B\_40%(-)\_ASR

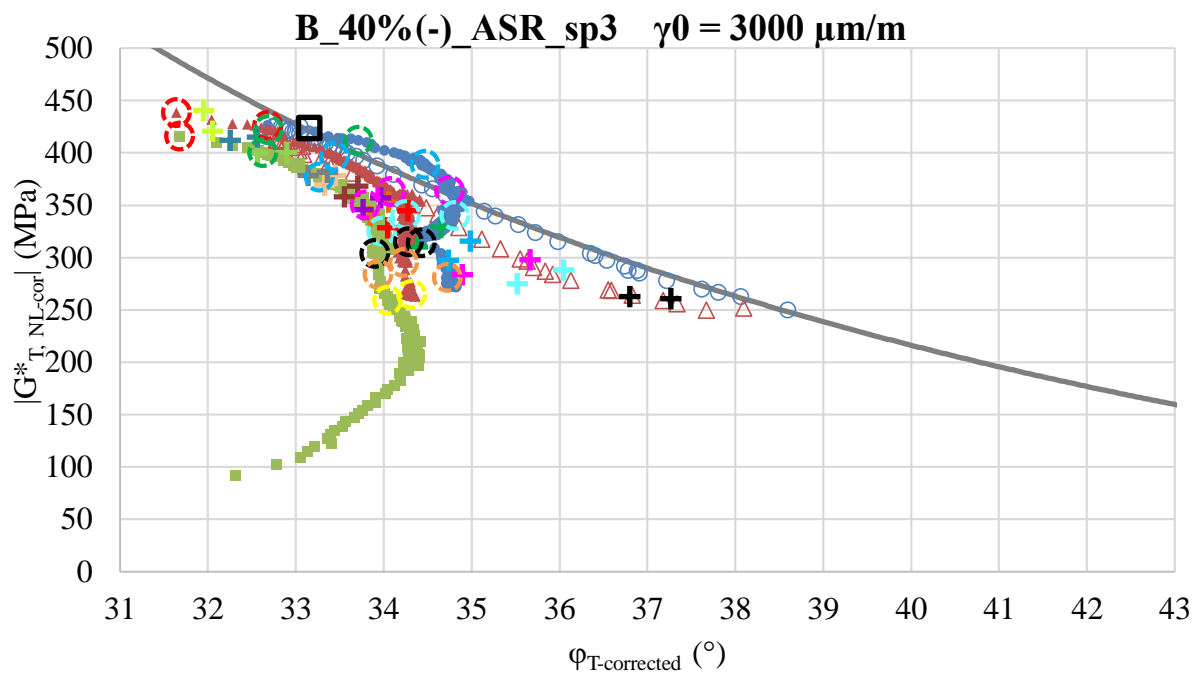
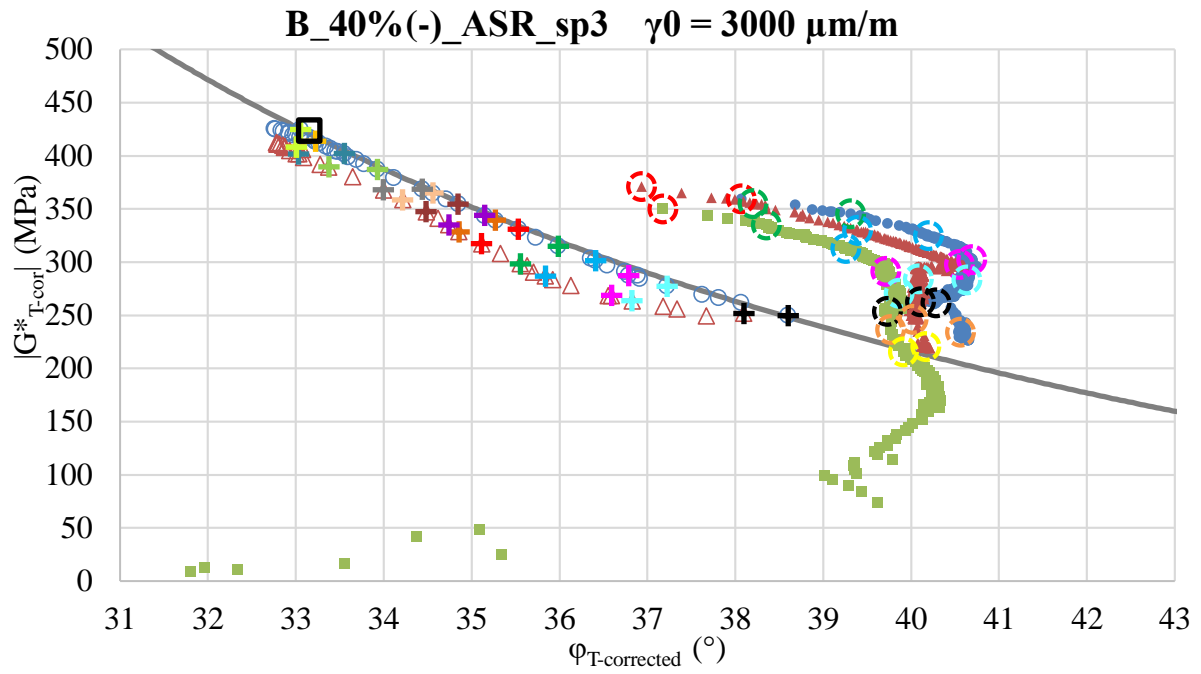
1.5.7.1. B\_40%(-)\_ASR\_sp3 (3000 $\mu\text{m/m}$ )

- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | ■ G*ini        | — 2S2P1D        |

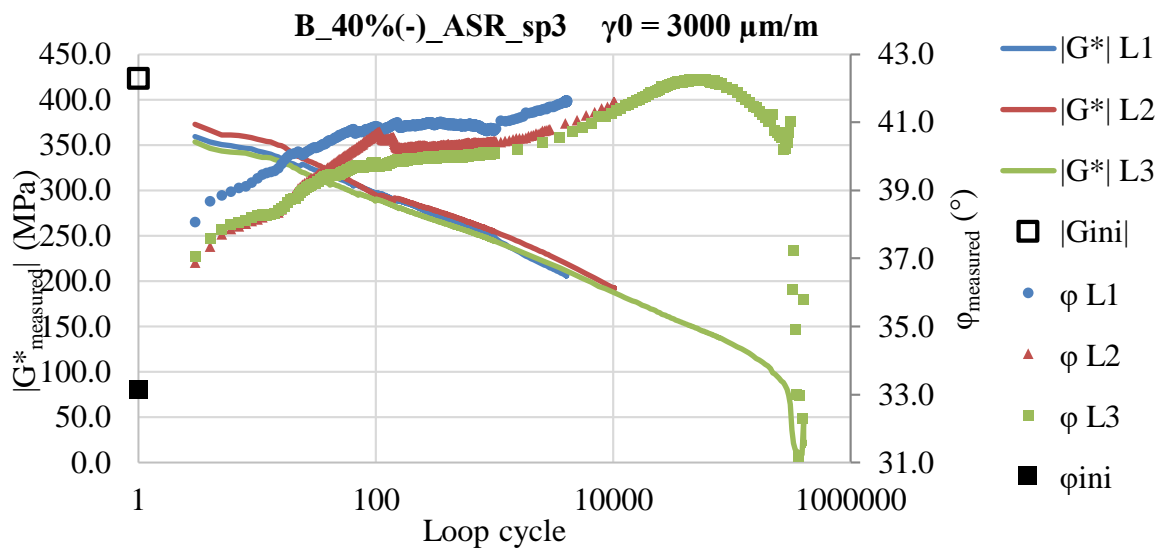
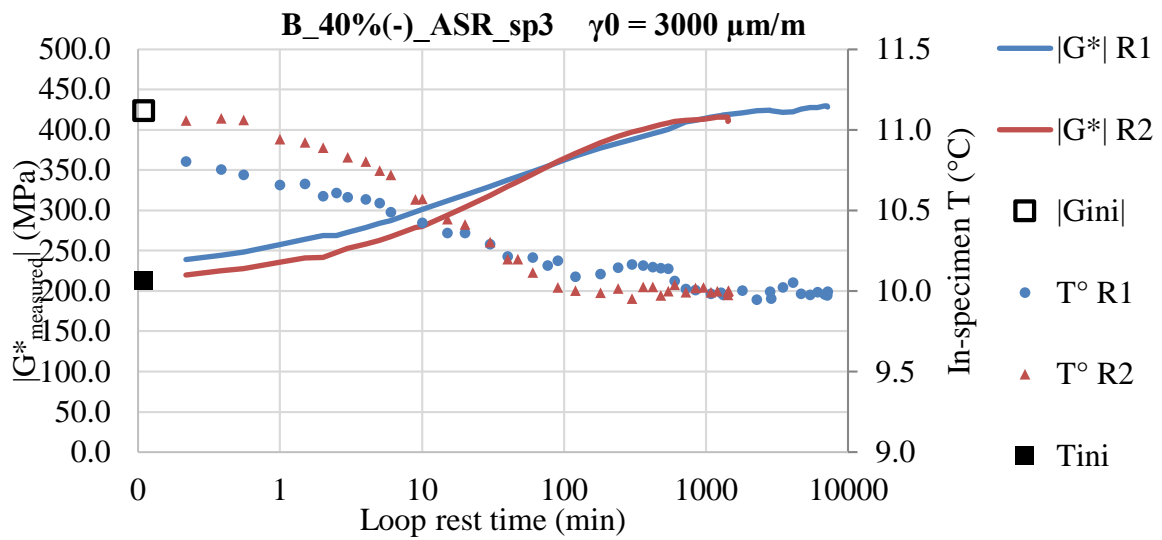
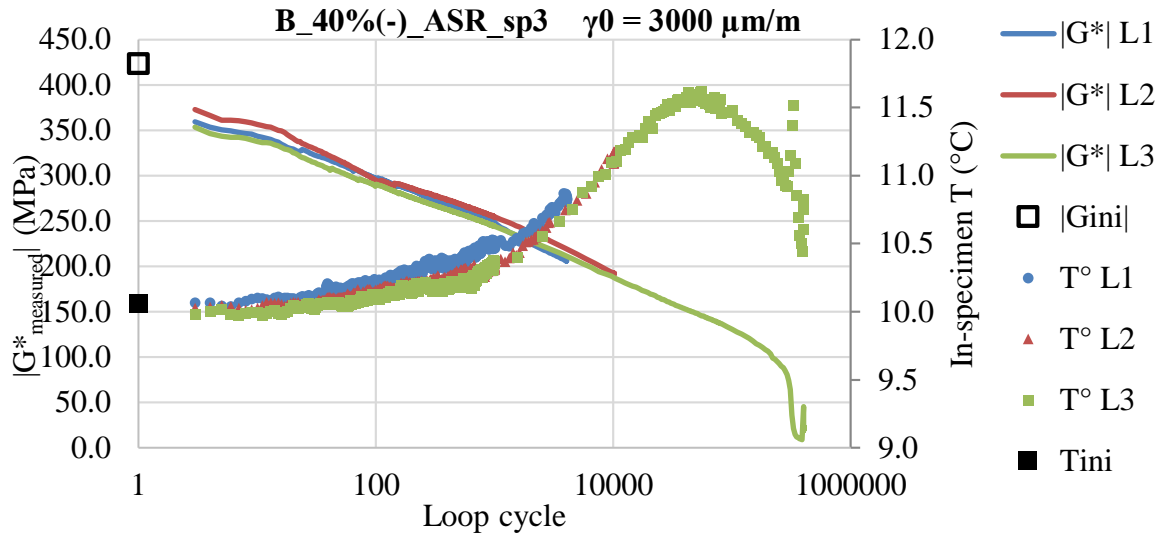
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



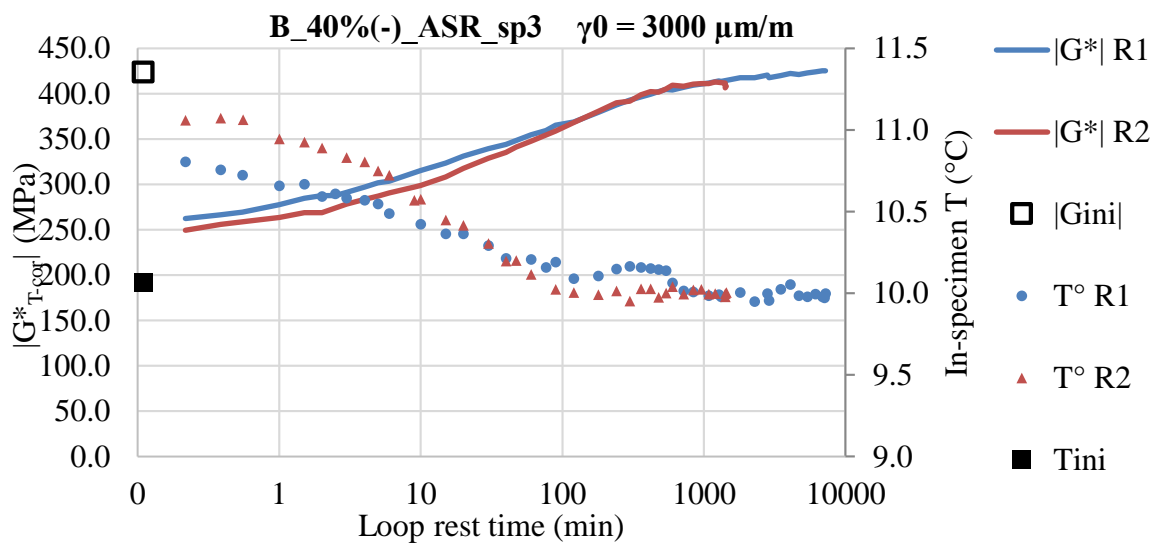
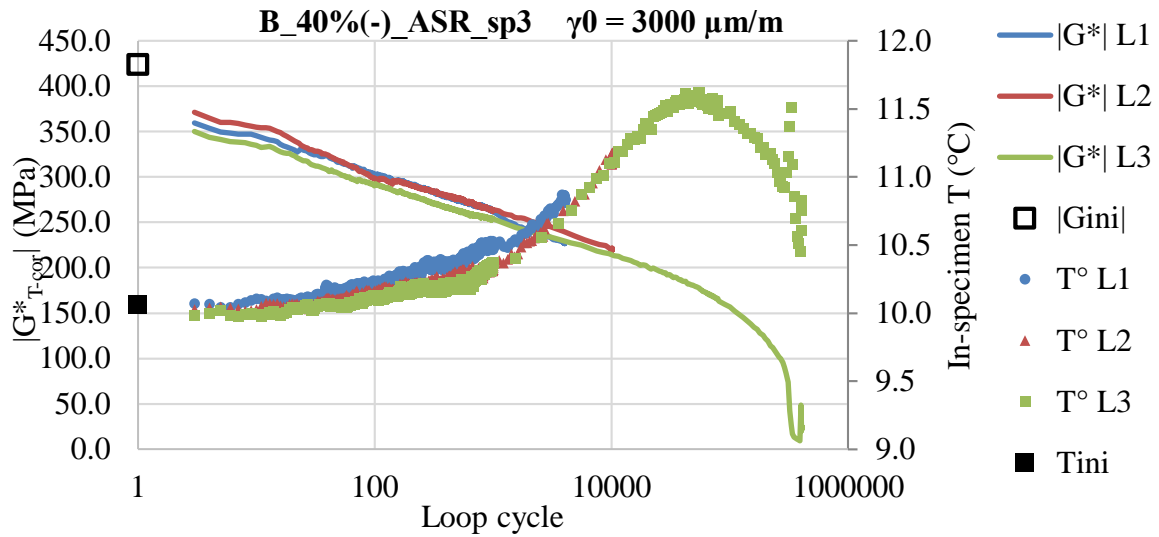
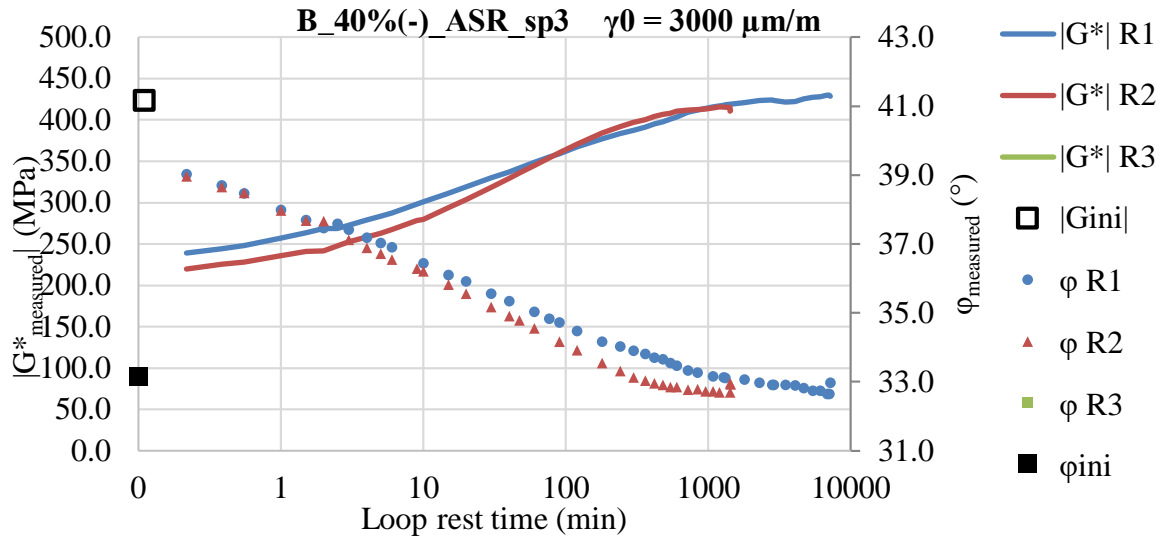
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



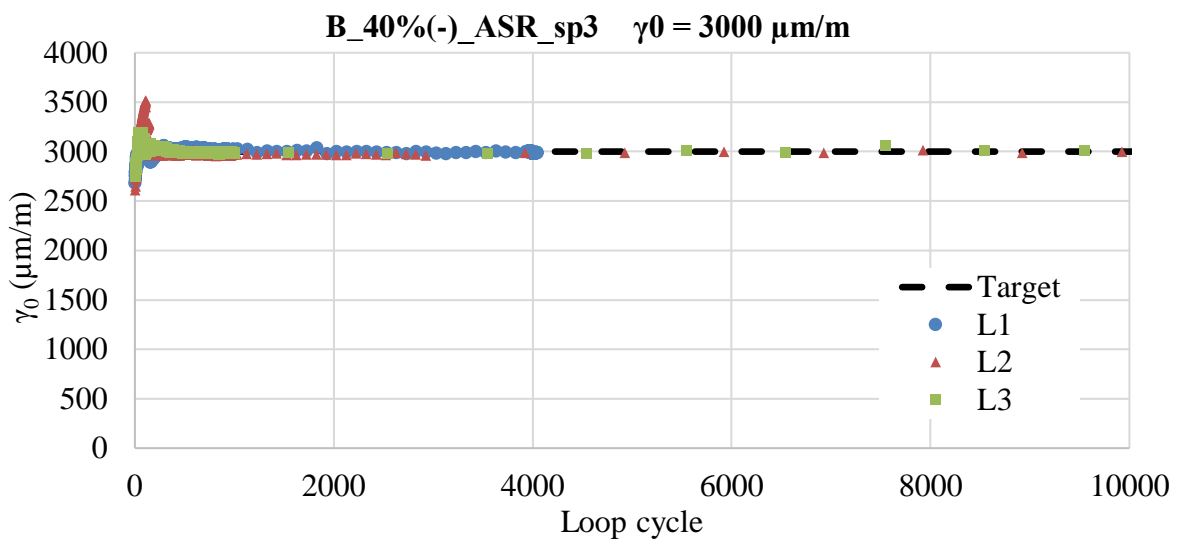
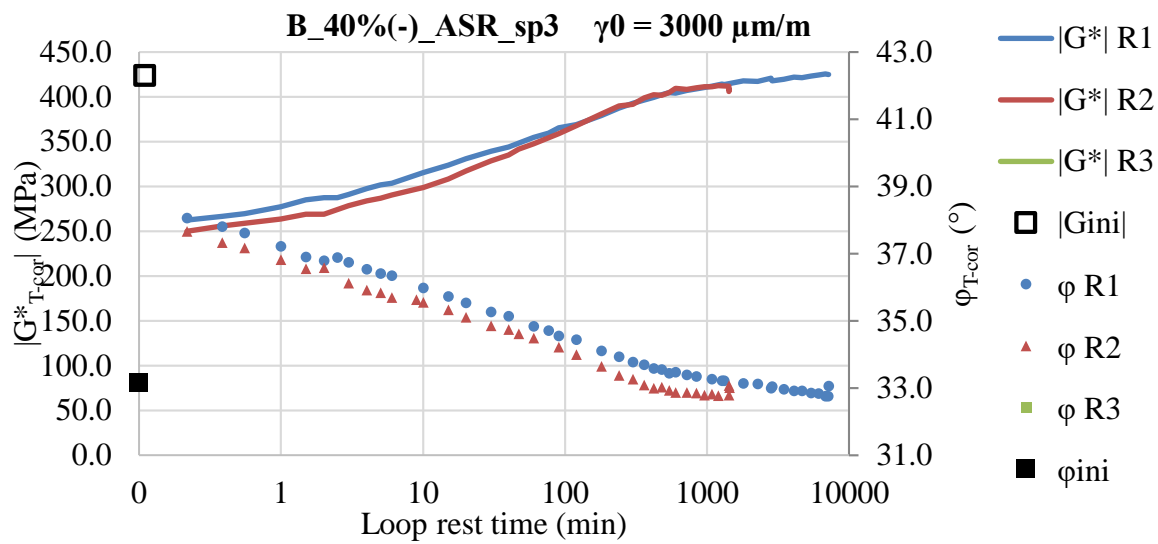
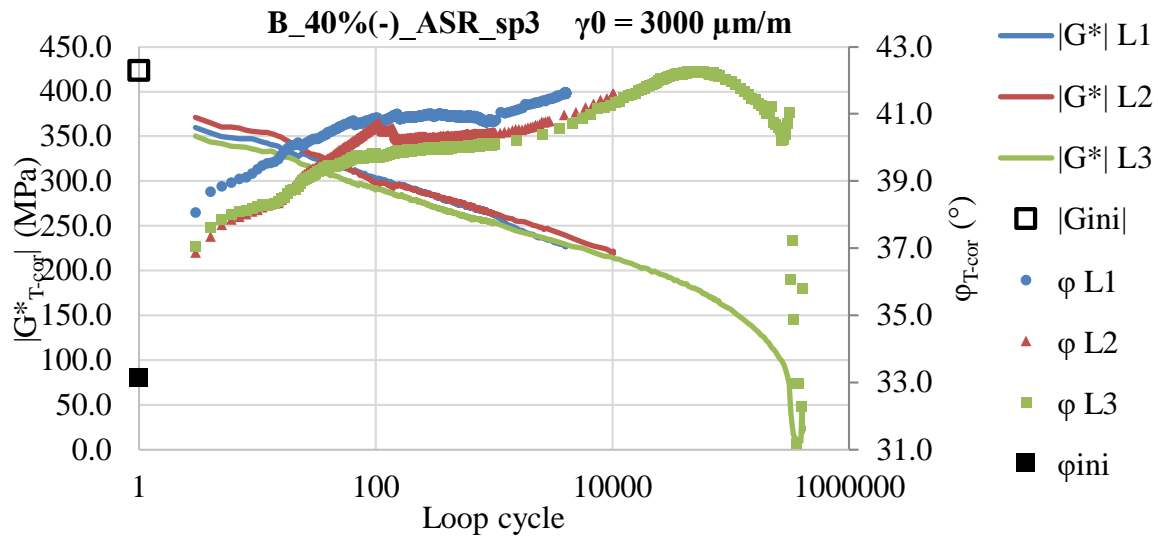
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

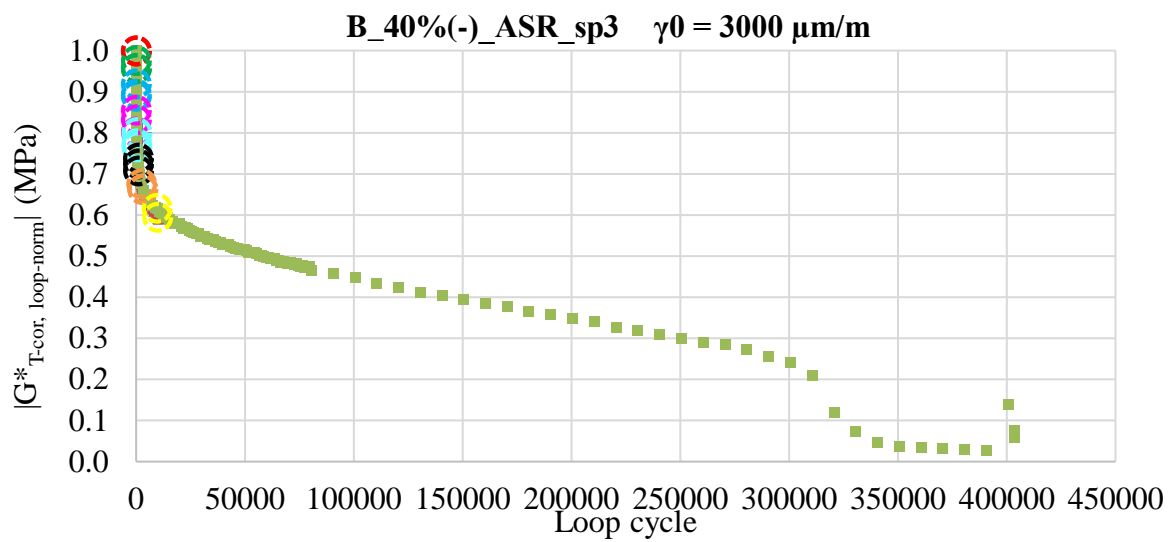
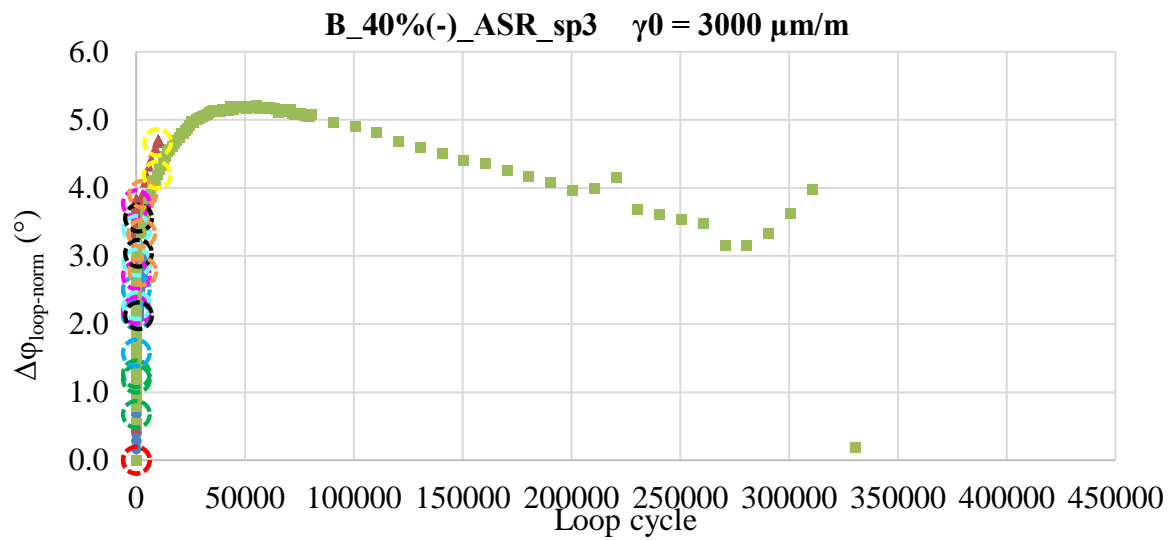
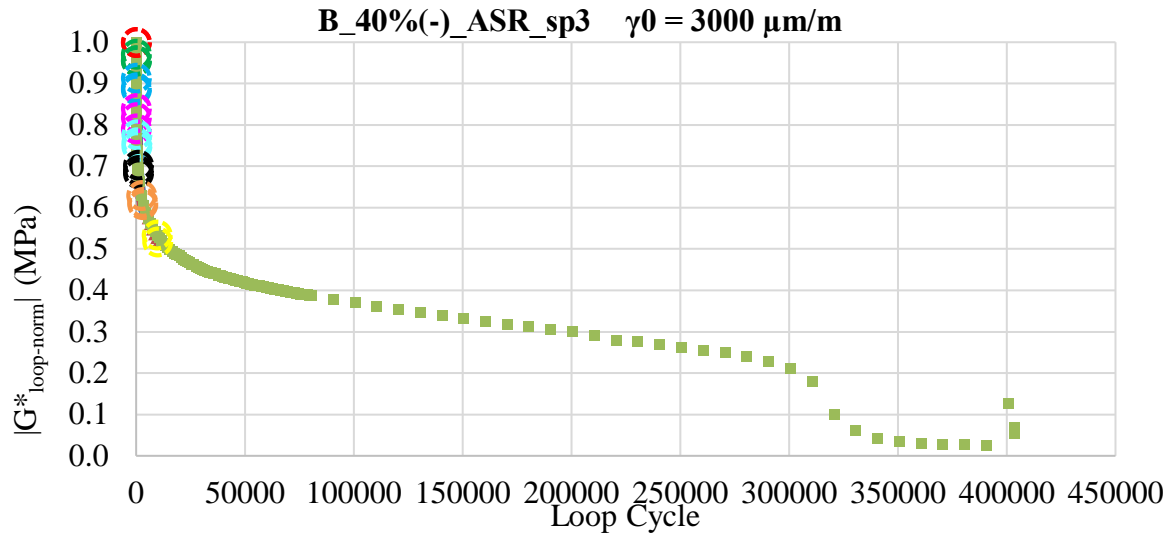


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

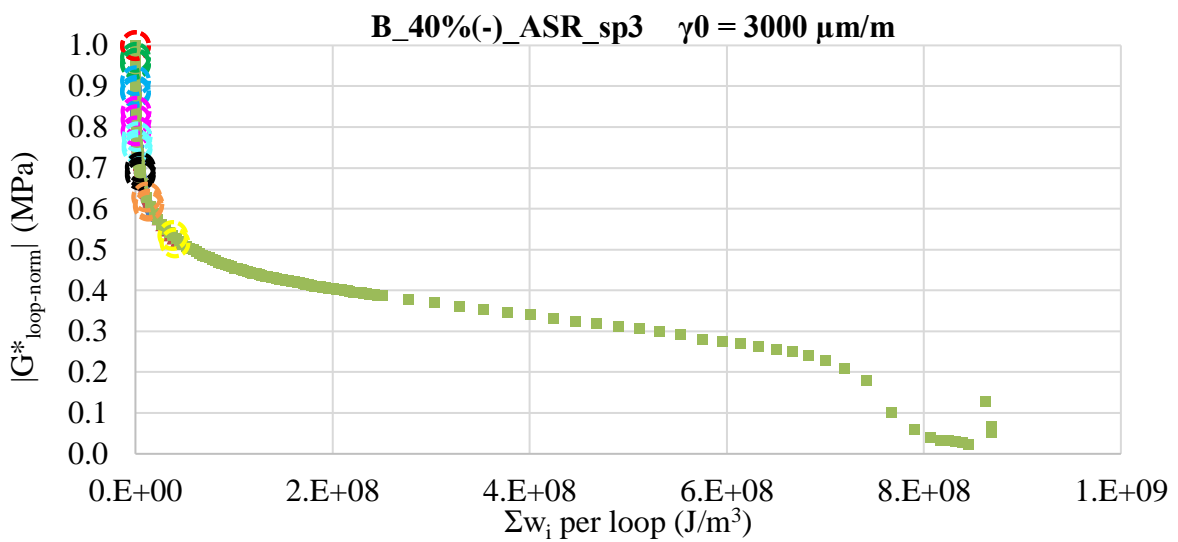
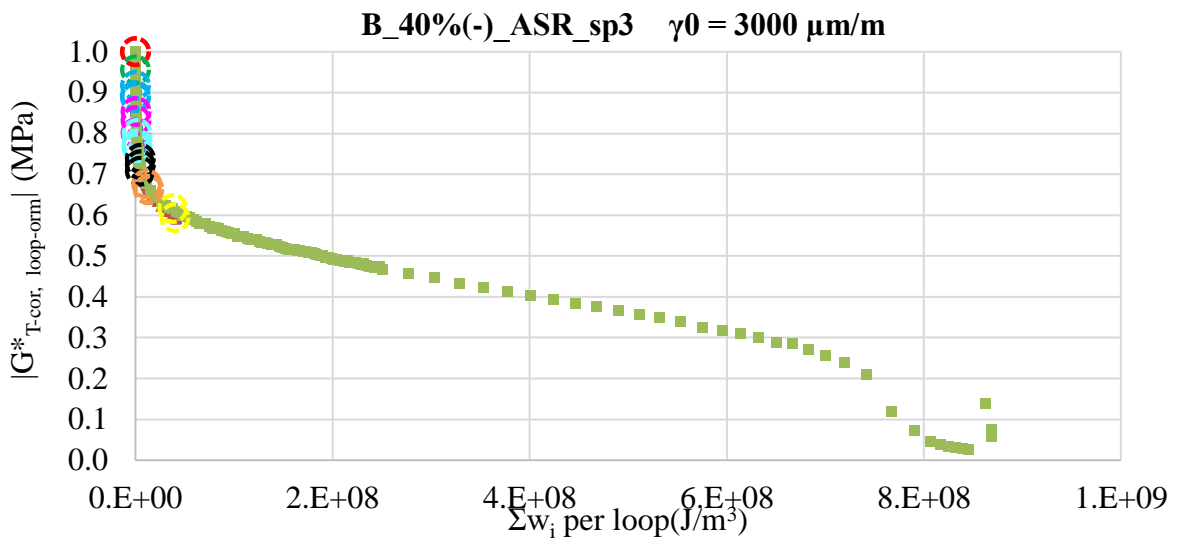
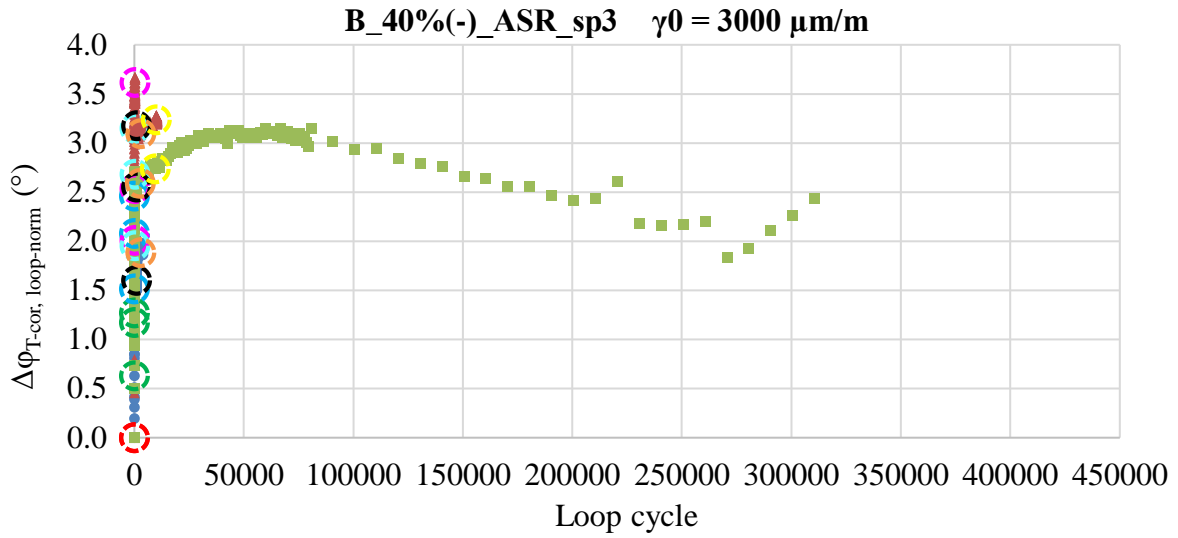




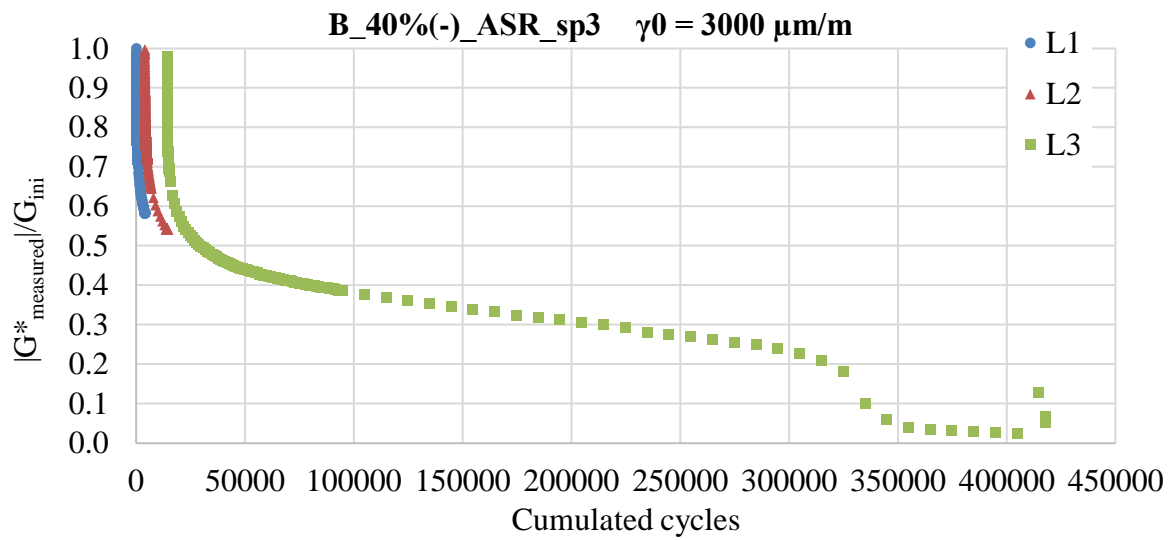
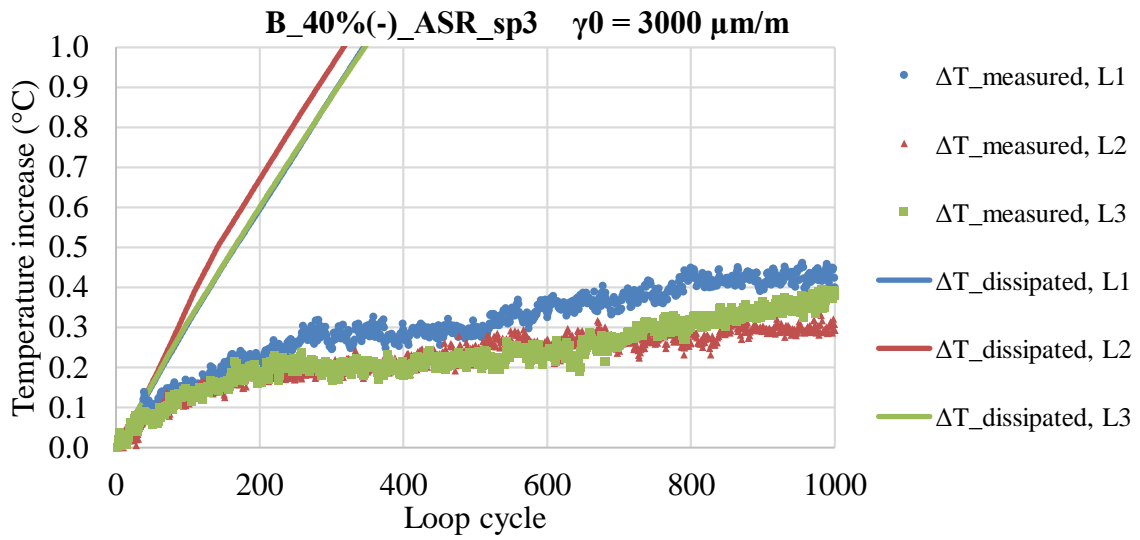
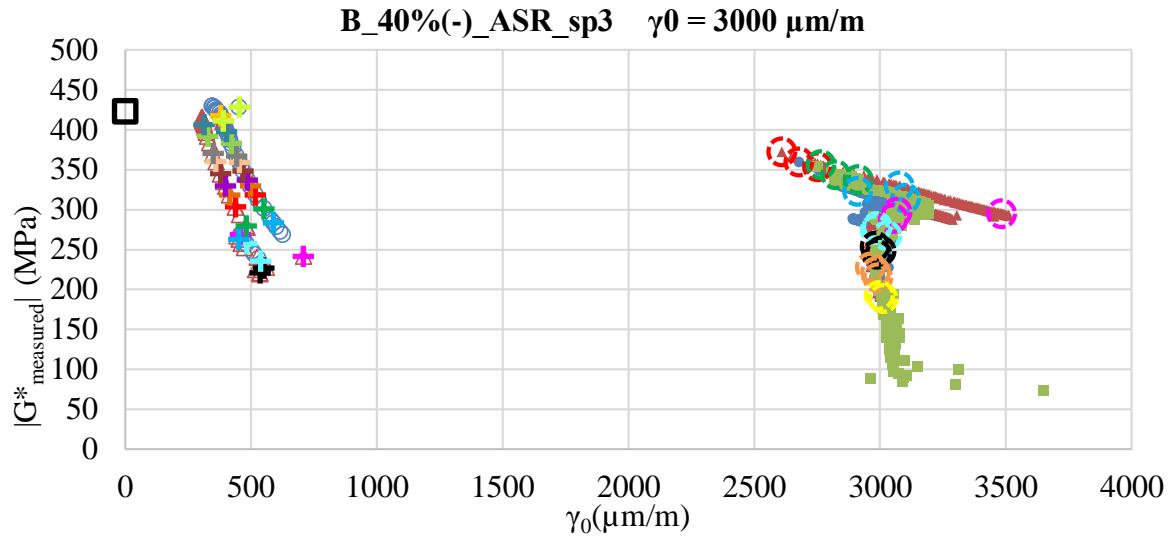
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



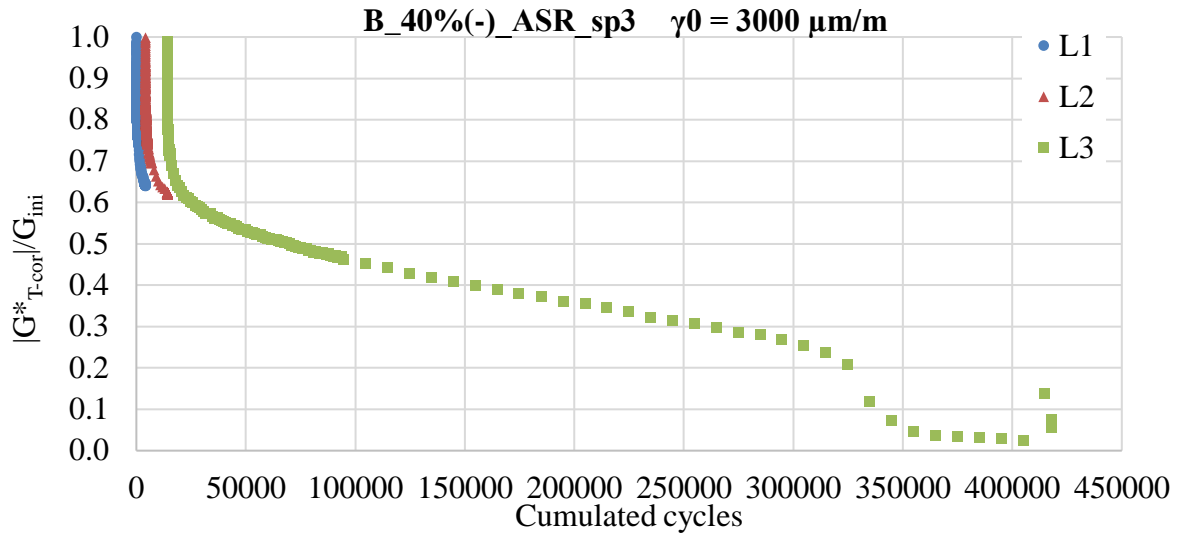
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

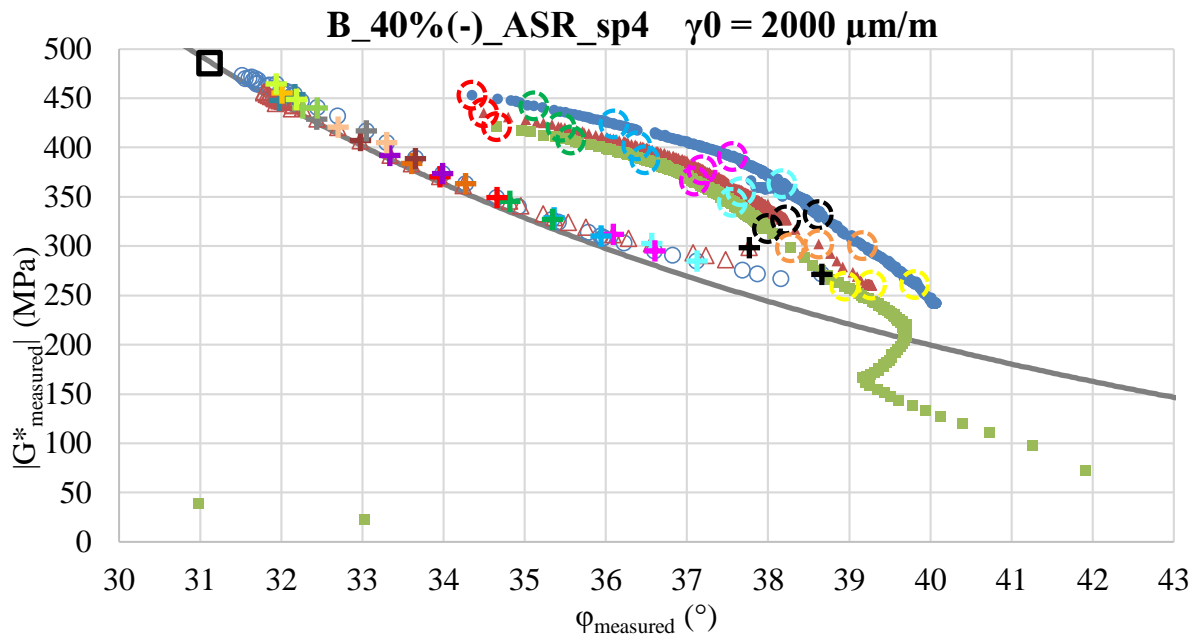


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

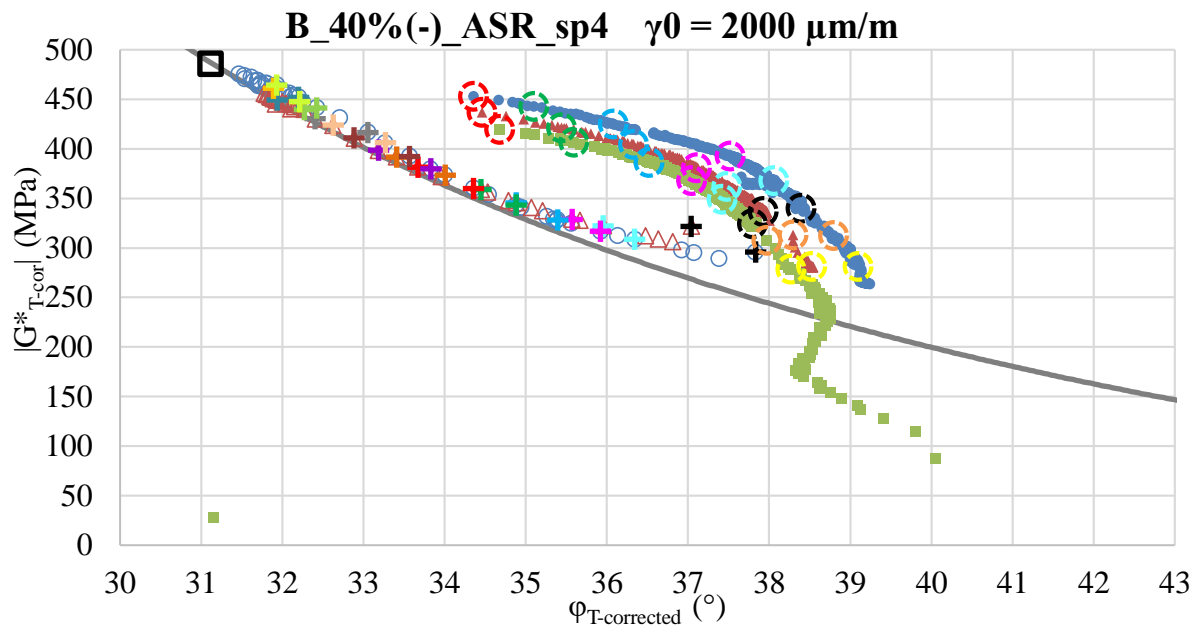
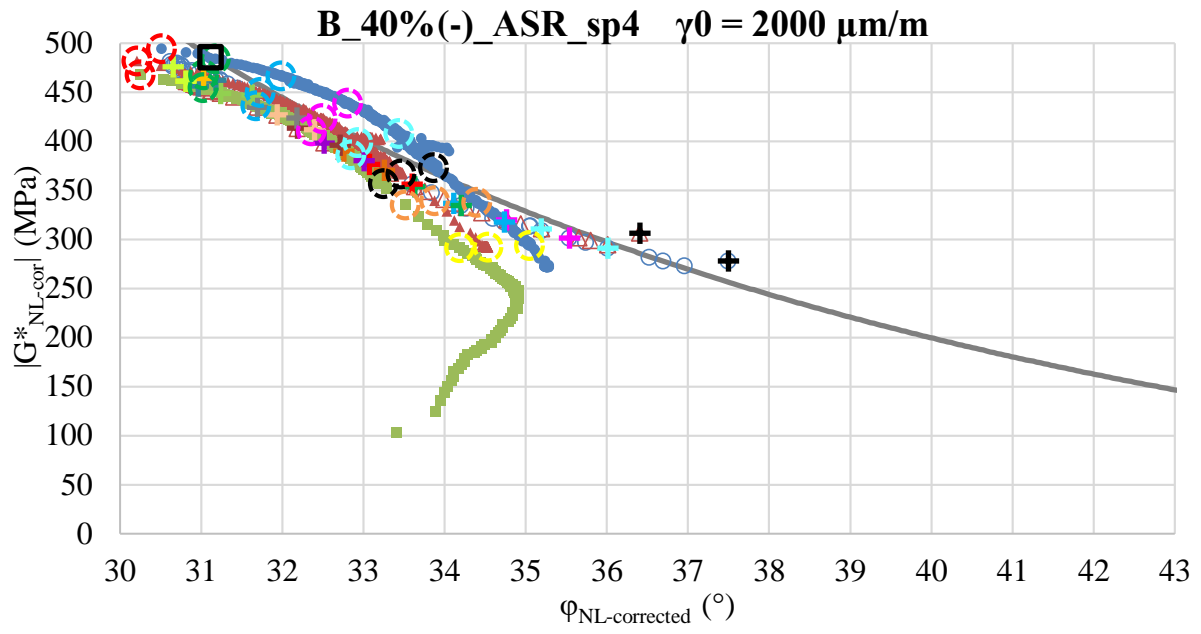


1.5.7.2. B\_40%(-)\_ASR\_sp4 (2000 $\mu\text{m/m}$ )

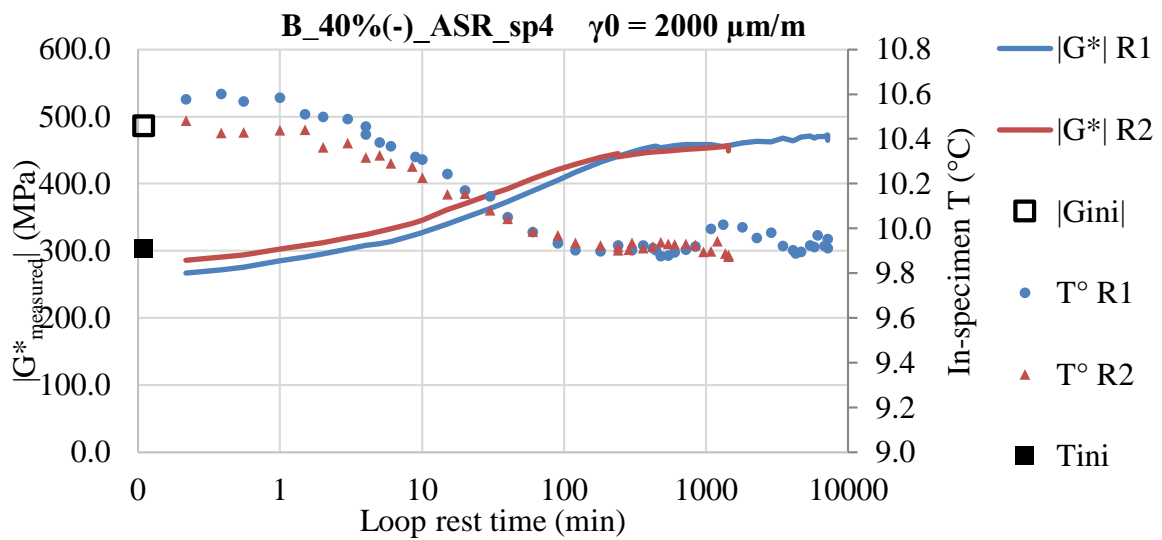
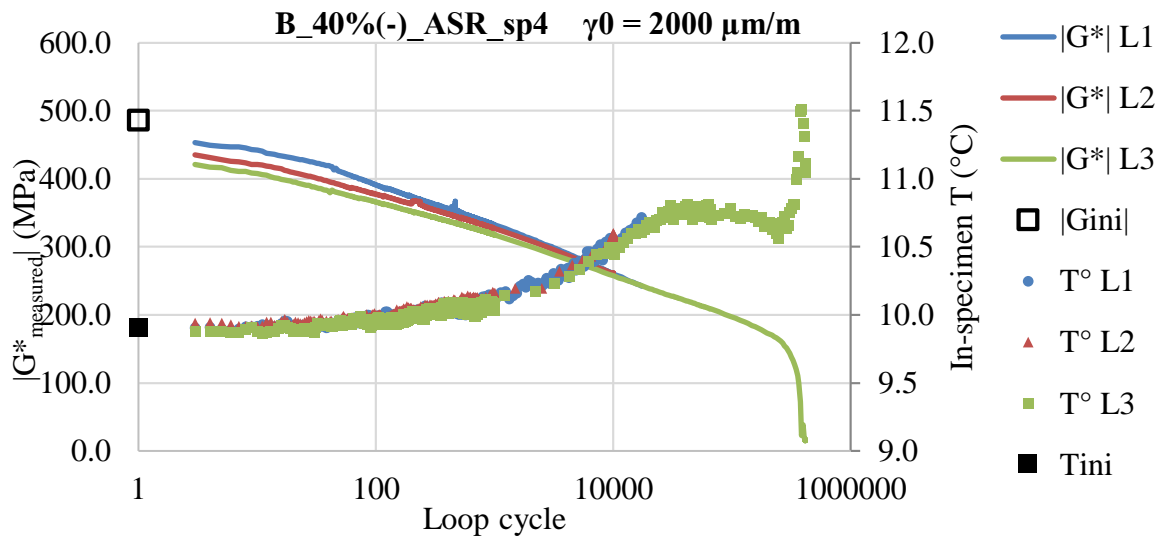
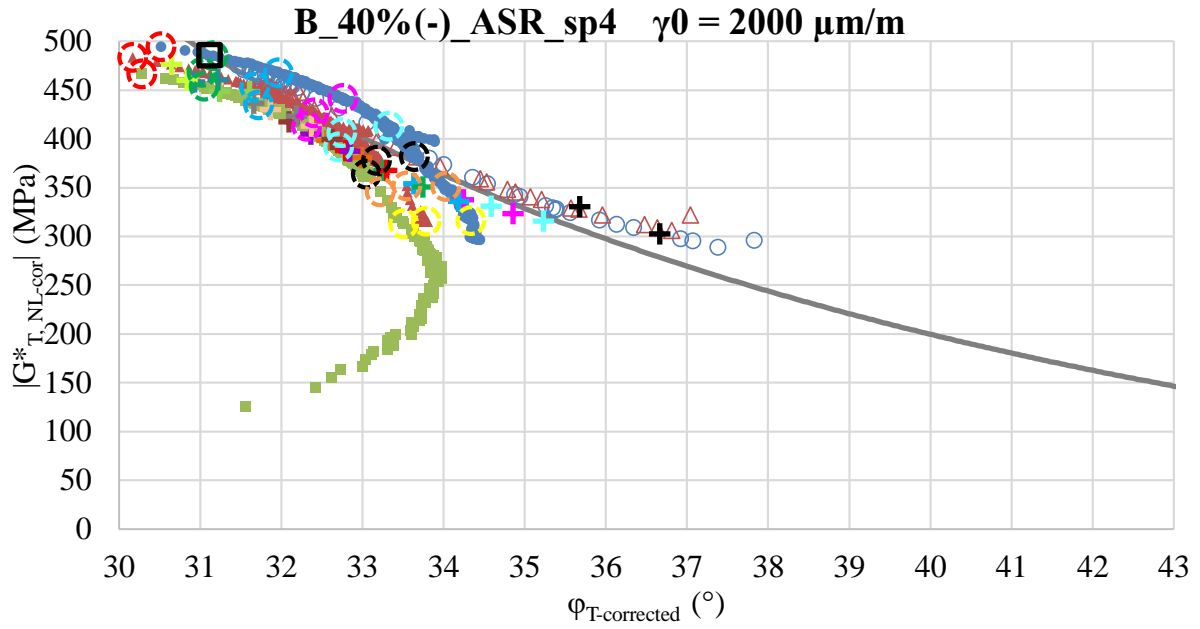
- |                 |                 |                 |                |                 |
|-----------------|-----------------|-----------------|----------------|-----------------|
| ○ R1            | △ R2            | ● L1            | ▲ L2           | ■ L3            |
| ⊕ Rest = 0min   | ⊕ Rest = 1min   | ⊕ Rest = 2min   | ⊕ Rest = 5min  | ⊕ Rest = 10min  |
| ⊕ Rest = 20min  | ⊕ Rest = 30min  | ⊕ Rest = 40min  | ⊕ Rest = 60min | ⊕ Rest = 90min  |
| ⊕ Rest = 120min | ⊕ Rest = 240min | ⊕ Rest = 480min | ⊕ Rest = 1 day | ⊕ Rest = 5 days |
| ⊕ Cycle 3       | ⊕ Cycle 10      | ⊕ Cycle 30      | ⊕ Cycle 100    | ⊕ Cycle 300     |
| ⊕ Cycle 1000    | ⊕ Cycle 3000    | ⊕ Cycle 10000   | □ G*ini        | — 2S2P1D        |



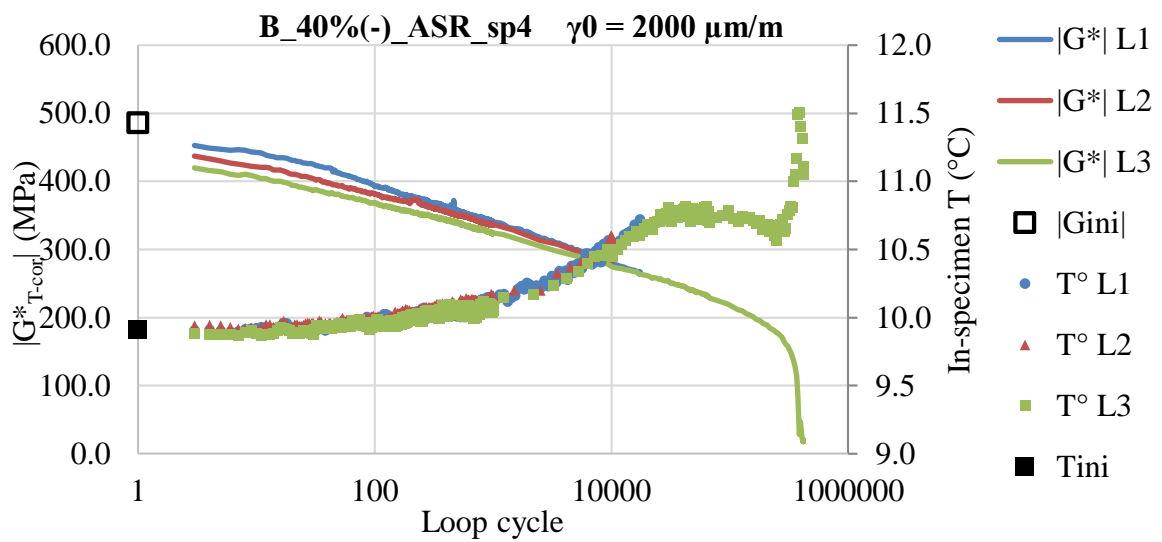
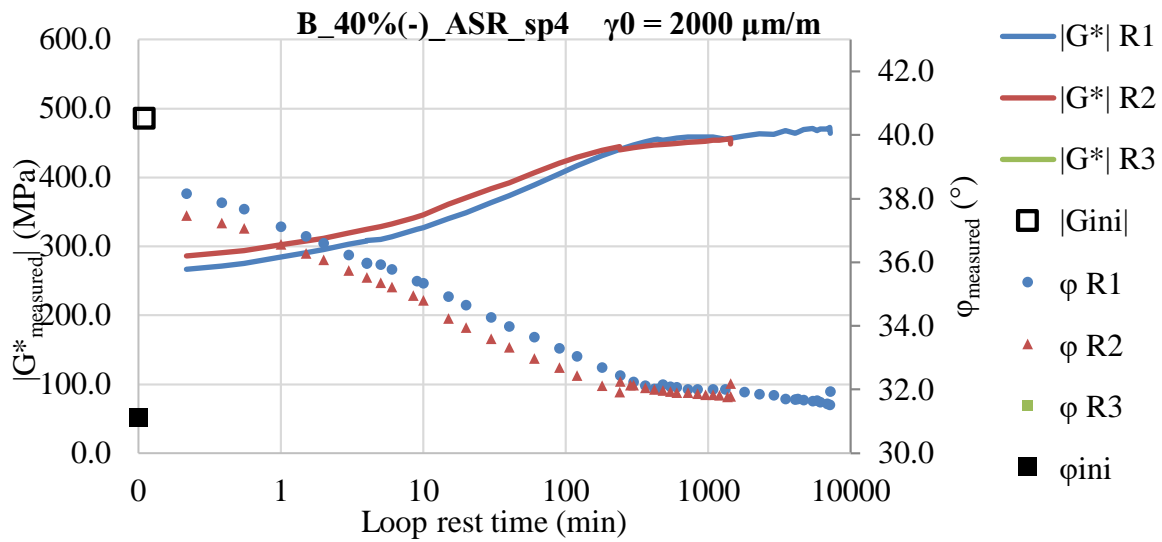
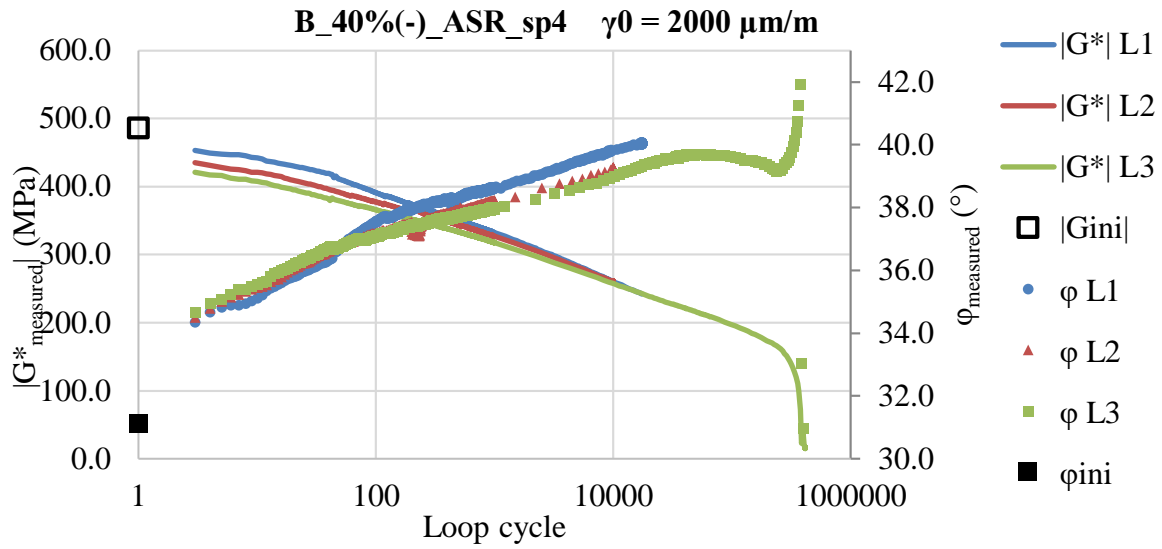
1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



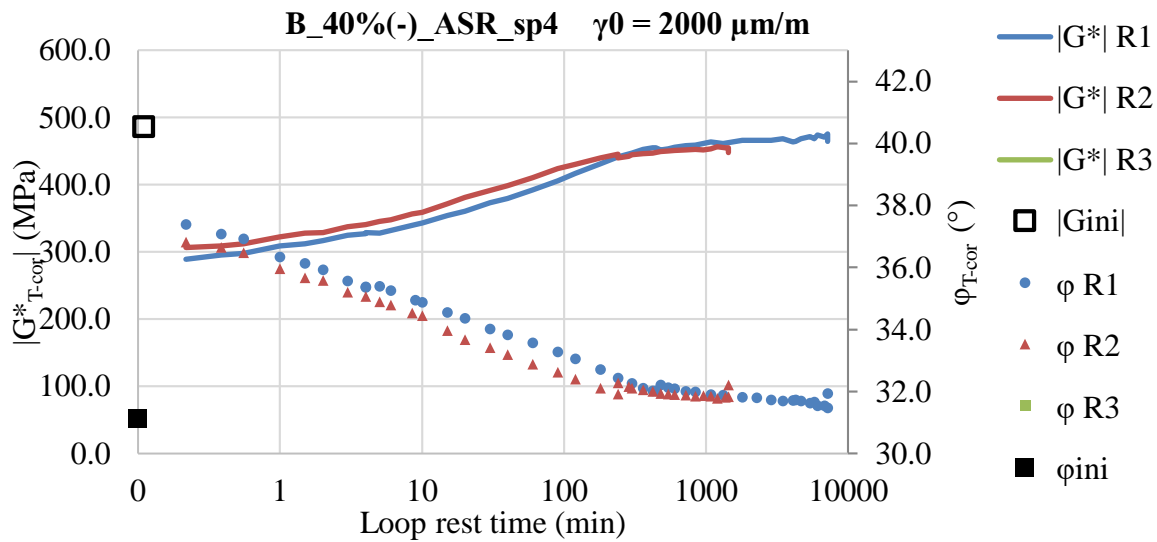
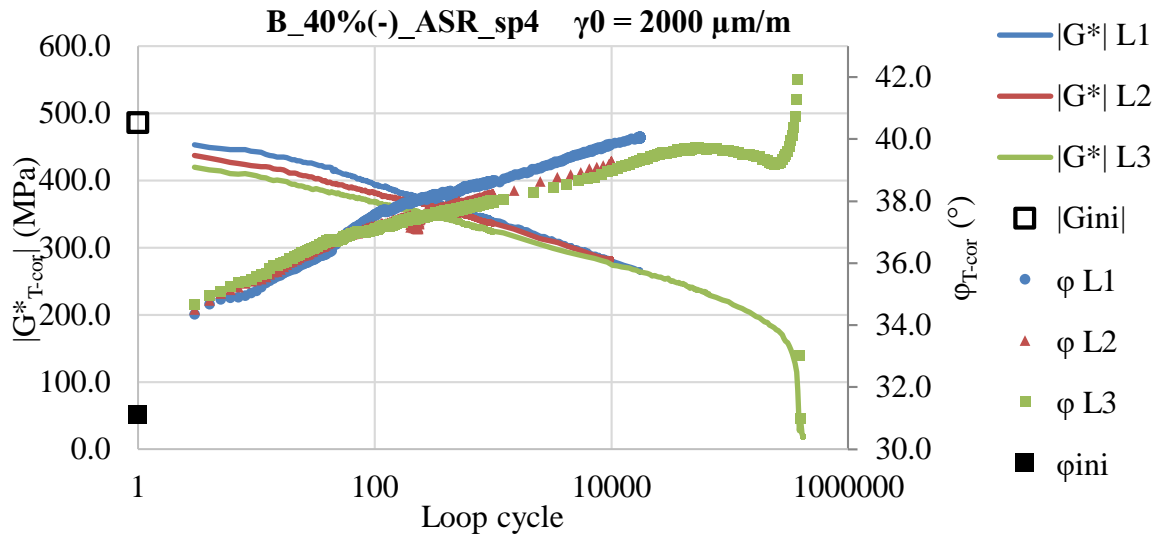
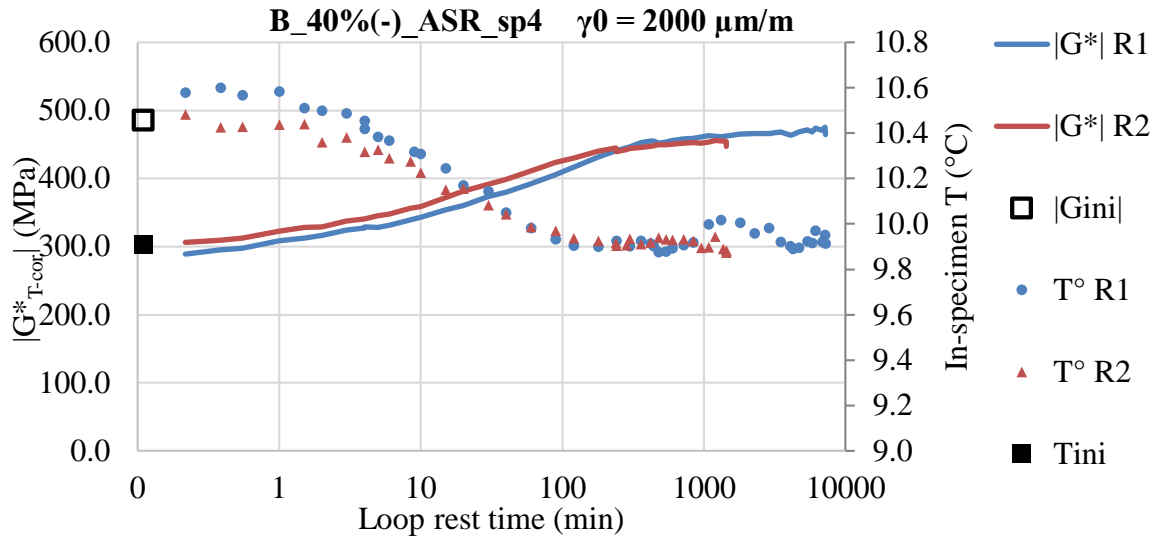
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

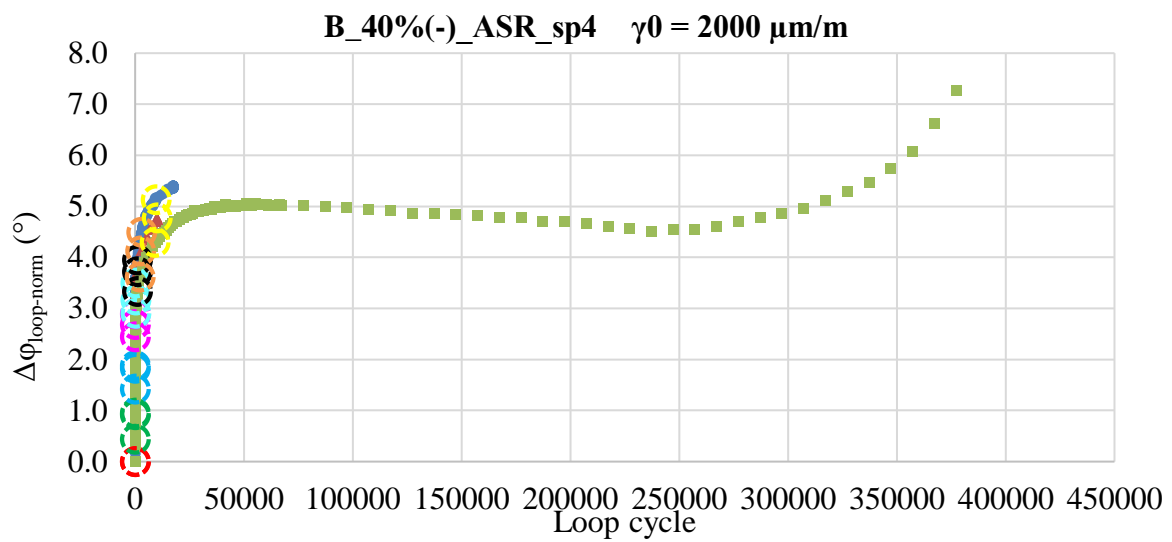
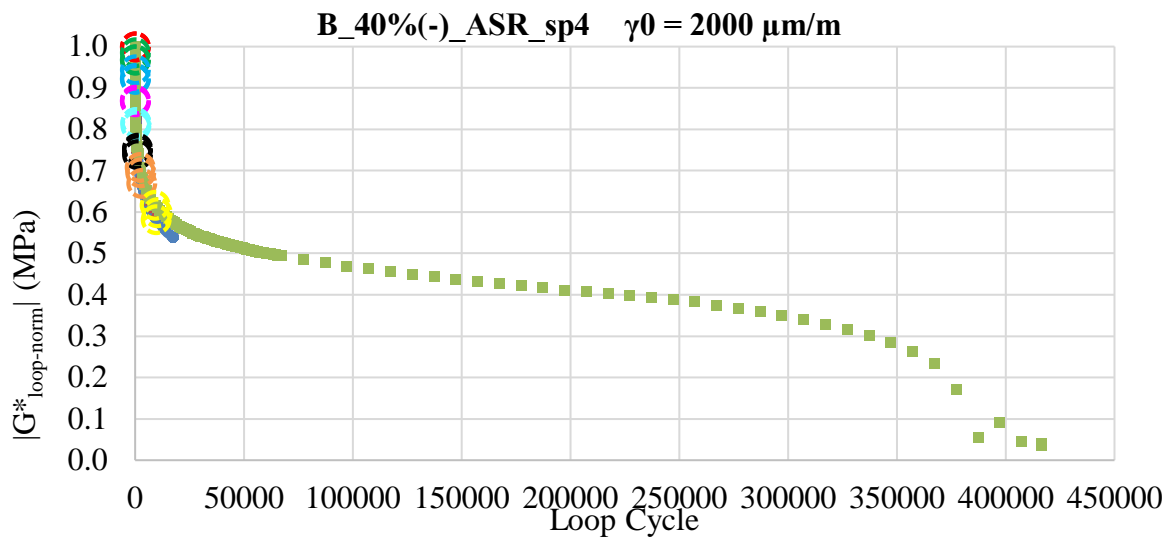
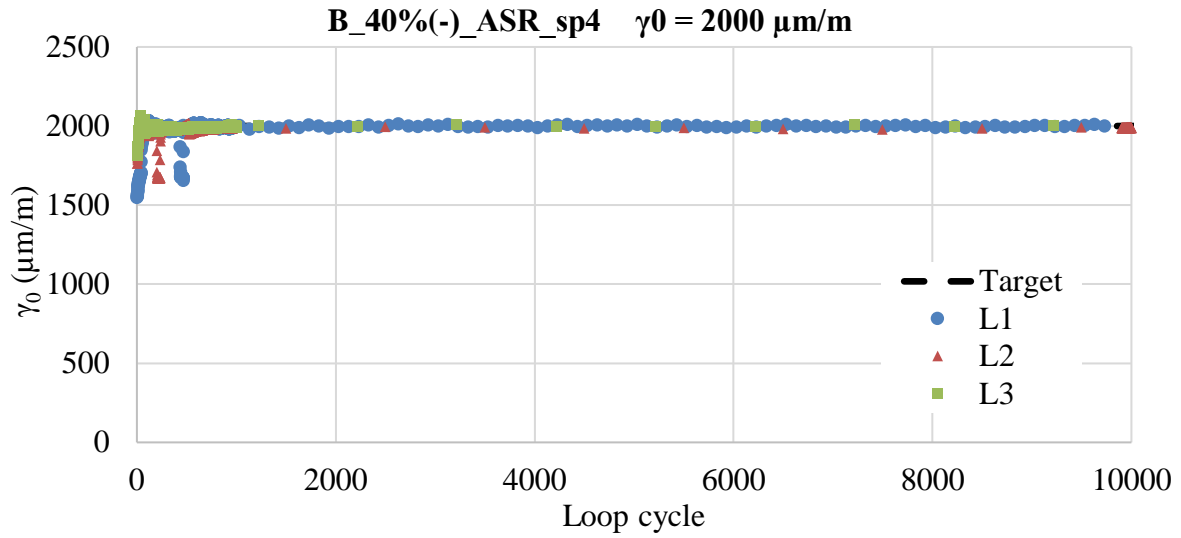


1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz

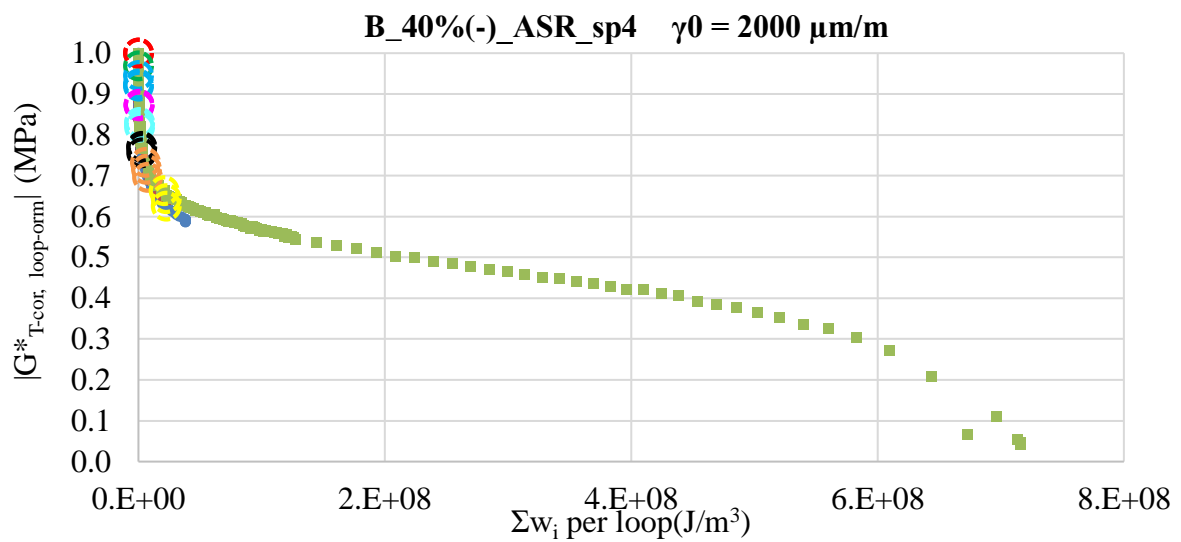
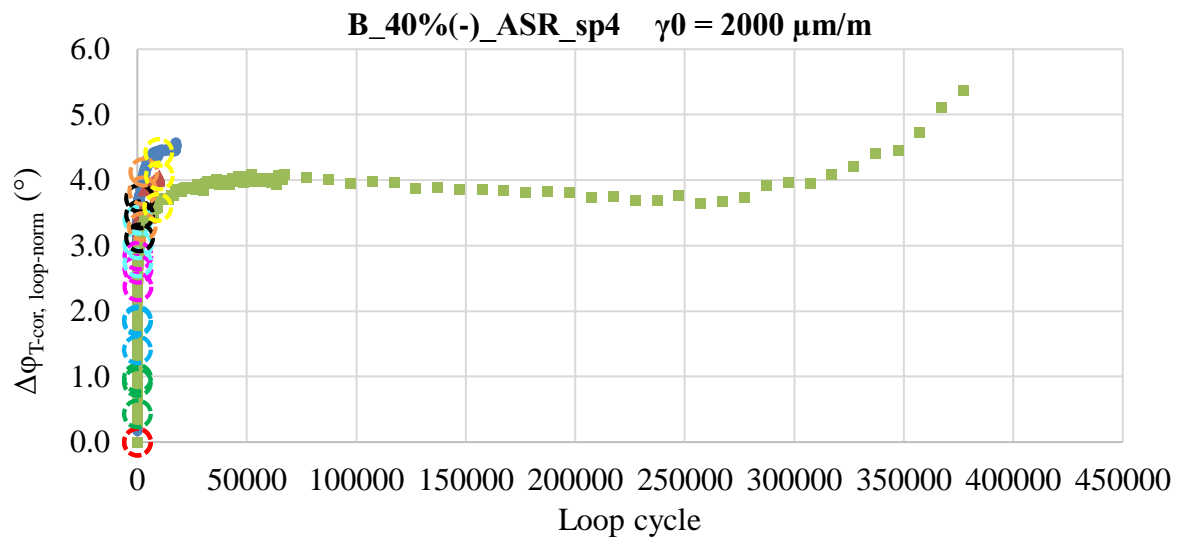
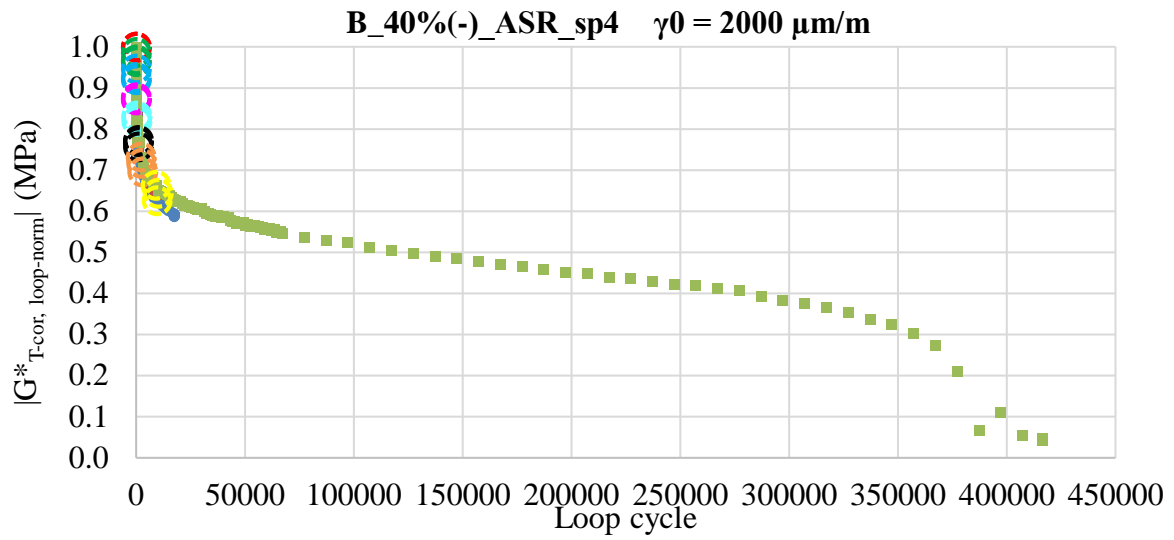




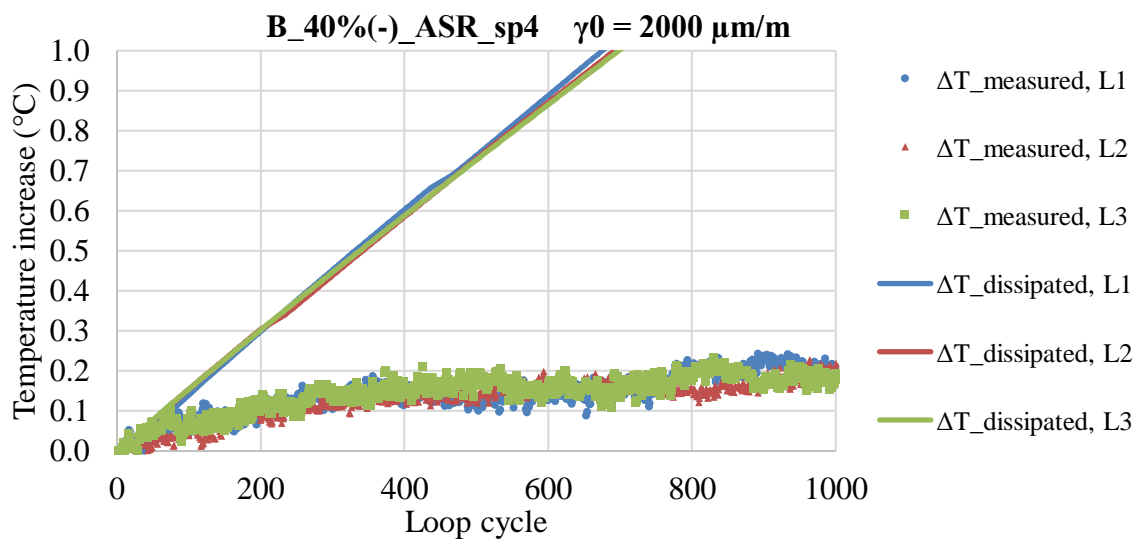
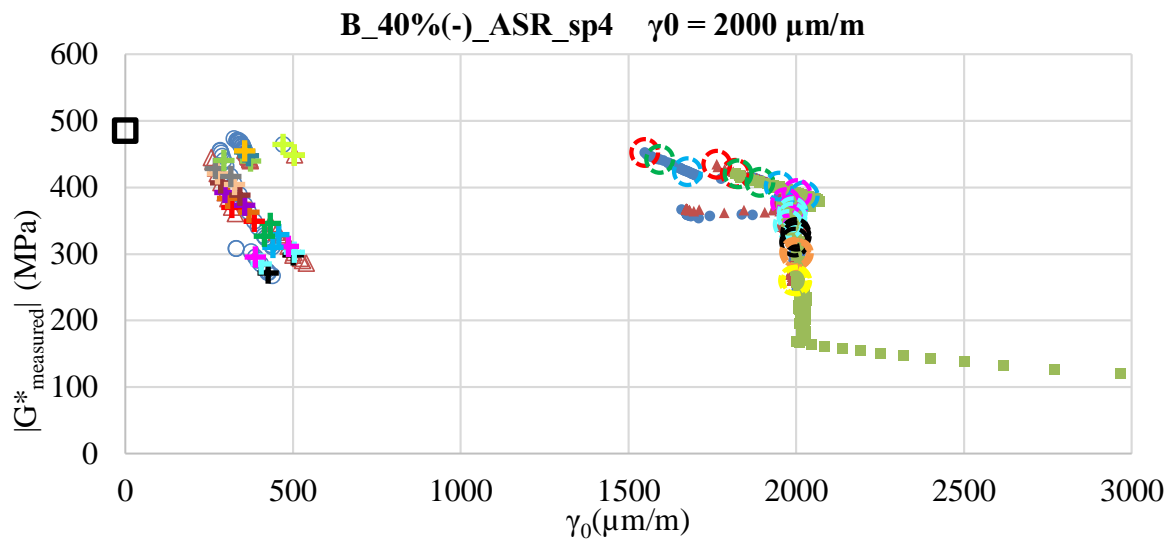
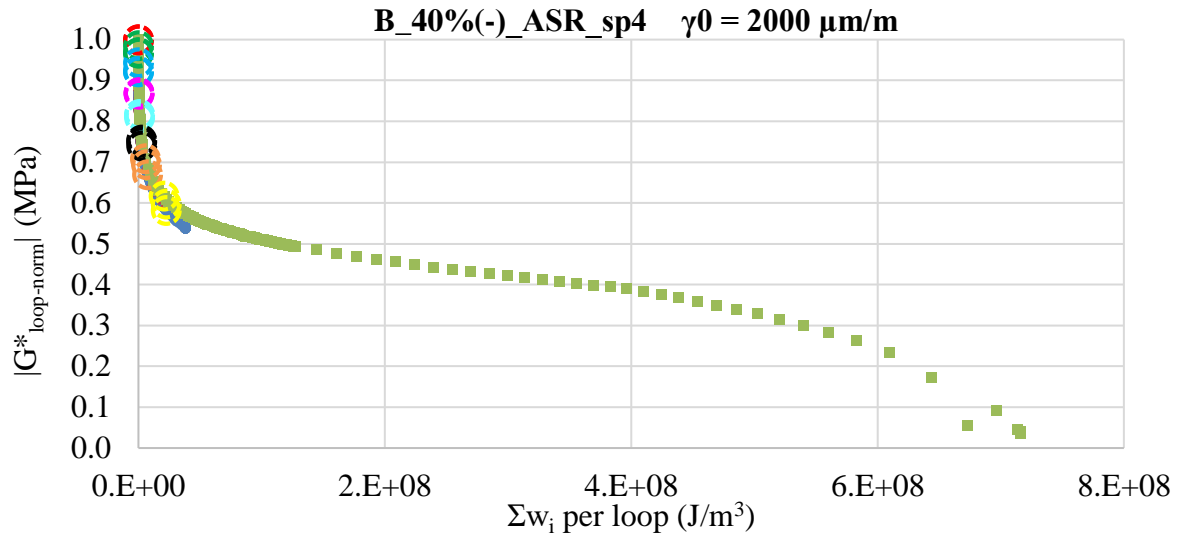
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



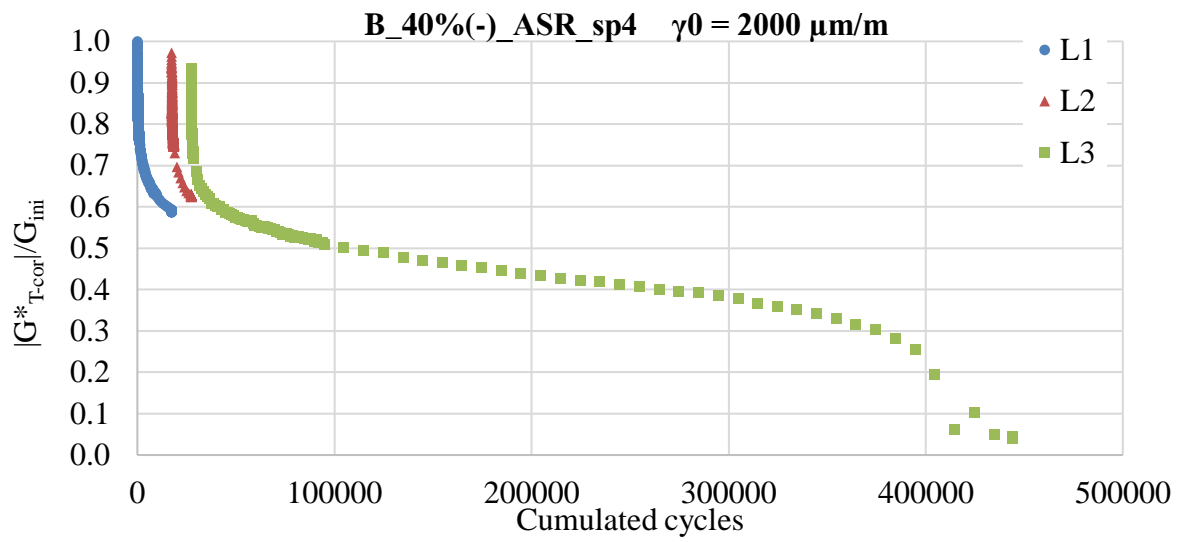
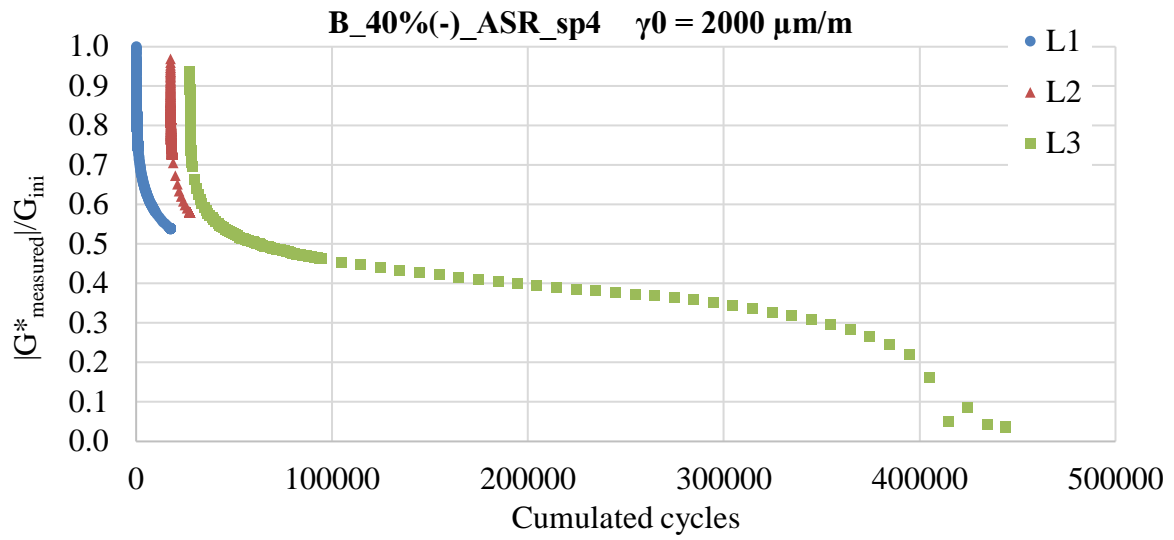
1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
 1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



1 Thermomechanical tests on bituminous binders  
1.5 Load and Rest Periods (LRP) tests with ASR at 10 C/10Hz



## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests

## **2. Thermomechanical tests on bituminous mixtures**

### 2.1. Complex modulus tests

#### 2.1.1. 2-Point Bending (2PB) test on trapezoidal specimen

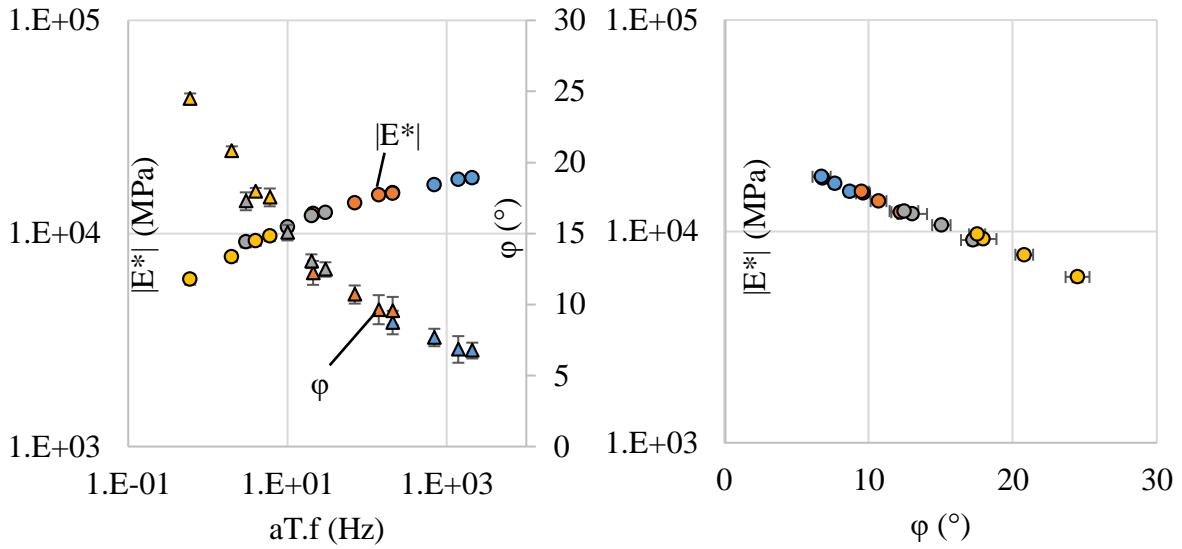
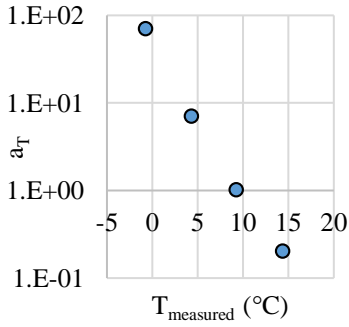
2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.2. B\_CO\_5.8

**B\_CO\_5.8**

T (°C)	a <sub>T</sub>
-0.68	70
4.36	7
9.29	1
14.40	0.2

Total : 4 specimens		Average value VC = 4.98 %			Standard deviation VC = 0.31 %		
T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	15442	8.7	-0.64	611	0.4	0.02
0	10	16851	7.7	-0.66	641	0.3	0.06
0	20	17892	6.8	-0.67	643	0.3	0.07
0	30	18129	6.8	-0.74	790	0.6	0.05
5	3	12325	12.2	4.23	538	0.6	0.03
5	10	13896	10.7	4.42	520	0.5	0.03
5	20	15132	9.6	4.39	547	0.5	0.06
5	30	15415	9.5	4.39	575	0.5	0.04
10	3	9098	17.3	9.21	500	0.8	0.04
10	10	10710	15.1	9.49	458	0.6	0.03
10	20	12081	13.0	9.30	484	1.0	0.47
10	30	12477	12.5	9.16	476	1.0	0.50
15	3	6081	24.5	14.12	332	0.8	0.05
15	10	7756	20.8	14.62	379	0.6	0.03
15	20	9198	17.9	14.34	440	0.9	0.62
15	30	9683	17.5	14.51	456	0.6	0.09



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.3. B\_CO\_4.8

**B\_CO\_4.8**

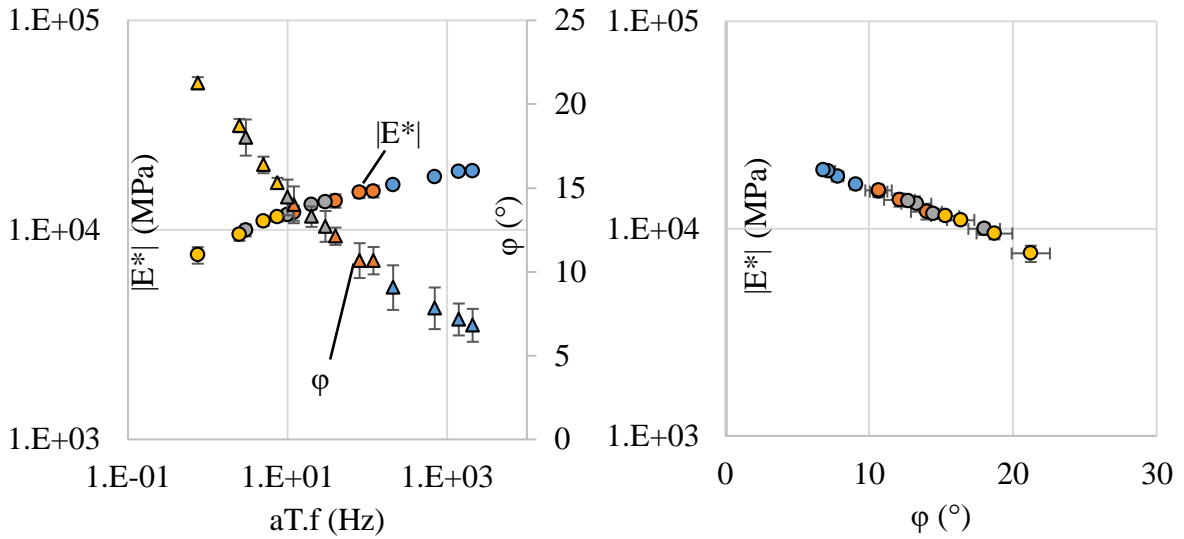
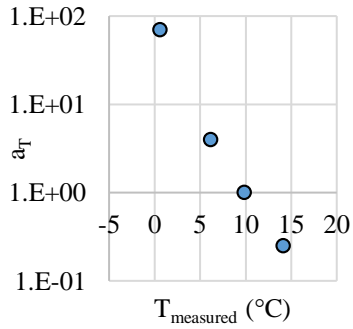
T (°C)	a <sub>T</sub>
0.57	70
6.14	4
9.84	1
14.11	0.3

Total :  
3 specimens

Average value  
VC = 5.57 %

Standard deviation  
VC = 0.4 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	16360	9.1	0.53	656	0.4	0.30
0	10	17841	7.8	0.58	617	0.4	0.31
0	20	18940	7.2	0.61	592	0.5	0.35
0	30	19119	6.8	0.57	559	0.3	0.32
5	3	12045	14.0	5.86	989	1.1	0.33
5	10	13761	12.1	6.15	1005	1.1	0.35
5	20	15077	10.7	6.12	910	0.6	0.33
5	30	15274	10.7	6.43	992	0.9	0.44
10	3	9961	18.0	9.57	648	1.1	0.00
10	10	11802	14.4	9.73	680	0.5	0.43
10	20	13184	13.3	9.99	641	1.0	0.02
10	30	13570	12.7	10.06	685	0.8	0.07
15	3	7584	21.3	13.41	687	1.3	0.64
15	10	9477	18.7	14.38	605	1.2	0.07
15	20	11000	16.4	14.34	574	1.0	0.05
15	30	11500	15.3	14.31	569	1.0	0.08



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

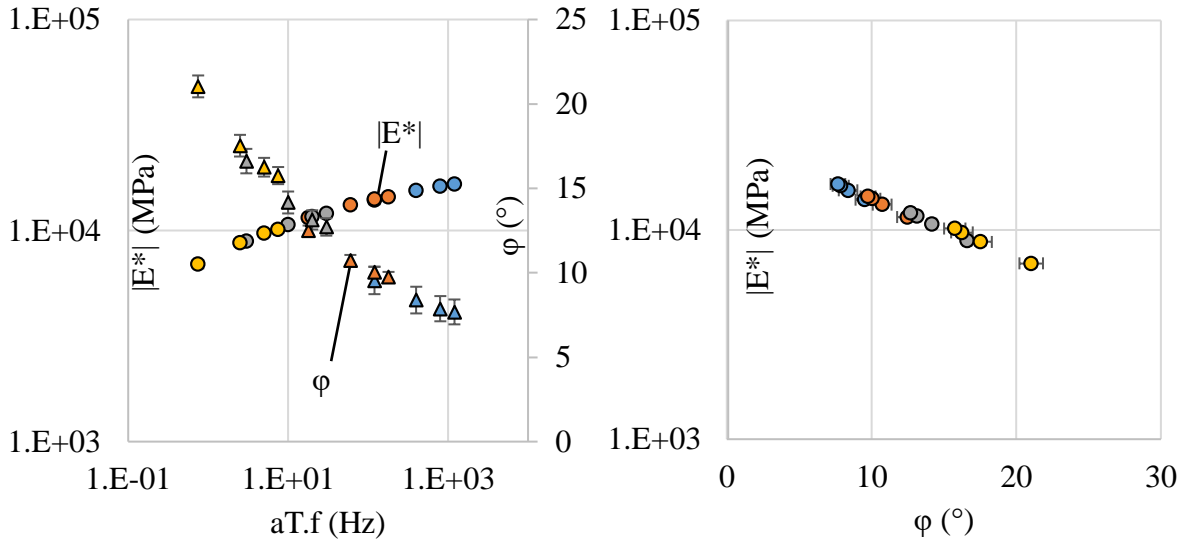
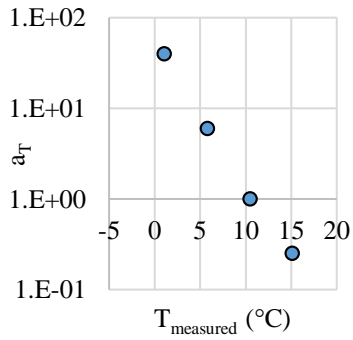
2.1.1.4. Bm\_CO\_5.8

**Bm\_CO\_5.8**

T (°C)	a <sub>T</sub>
1.08	40
5.80	6
10.49	1
15.12	0.3

Total :  
4 specimens

		Average value VC = 5 %			Standard deviation VC = 0.36 %		
T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	13936	9.5	1.07	628	0.6	0.51
0	10	15443	8.4	1.07	640	0.6	0.56
0	20	16232	7.9	1.09	580	0.6	0.56
0	30	16553	7.7	1.10	534	0.5	0.56
5	3	11510	12.5	5.80	488	0.7	0.34
5	10	13198	10.7	5.80	514	0.6	0.38
5	20	14076	10.0	5.80	465	0.6	0.37
5	30	14440	9.8	5.81	432	0.5	0.35
10	3	8882	16.6	10.51	181	0.3	0.22
10	10	10681	14.2	10.46	201	0.3	0.24
10	20	11623	13.1	10.48	188	0.3	0.25
10	30	12039	12.7	10.50	174	0.3	0.24
15	3	6918	21.0	15.15	303	0.8	0.05
15	10	8752	17.5	15.10	354	0.8	0.05
15	20	9720	16.3	15.11	354	0.7	0.04
15	30	10144	15.8	15.13	349	0.7	0.04



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C



2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

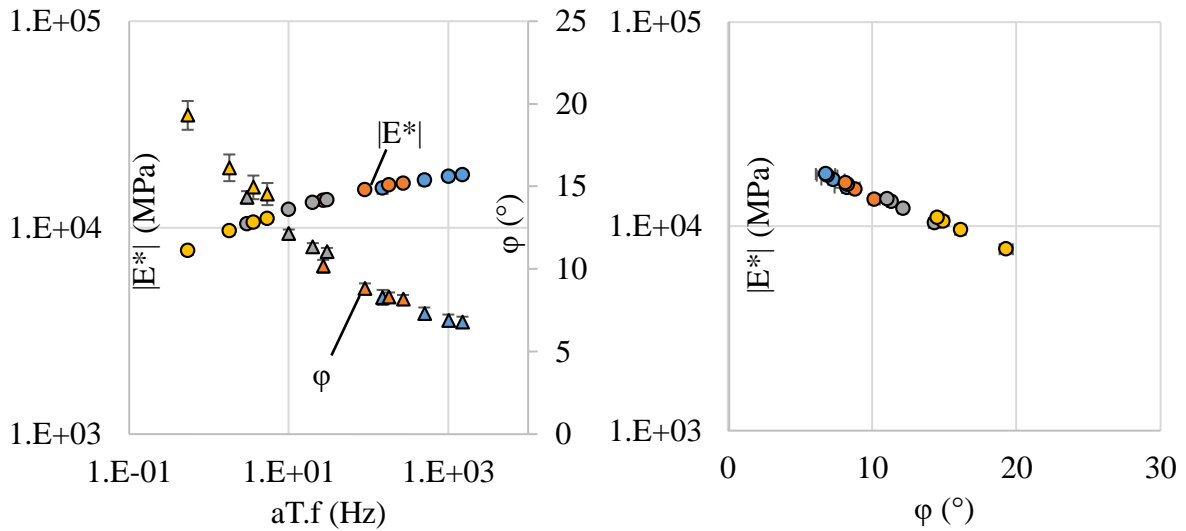
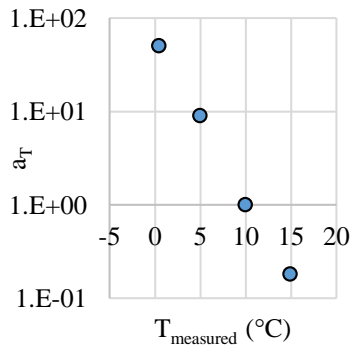
2.1.1.5. Bm\_CO\_4.8

**Bm\_CO\_4.8**

T (°C)	a <sub>r</sub>
0.42	50
4.98	9
9.97	1
14.89	0.2

Total :  
4 specimens

		Average value VC = 6.51 %			Standard deviation VC = 0.11 %		
T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	15494	8.3	0.42	908	0.9	0.55
0	10	16959	7.3	0.41	928	0.8	0.60
0	20	17730	6.9	0.41	862	0.7	0.57
0	30	18045	6.8	0.43	815	0.7	0.57
5	3	13553	10.2	4.99	518	0.4	0.11
5	10	15205	8.8	4.97	522	0.3	0.06
5	20	16033	8.3	4.97	533	0.2	0.08
5	30	16366	8.2	4.99	547	0.2	0.10
10	3	10401	14.3	10.00	384	0.4	0.09
10	10	12257	12.1	9.95	415	0.3	0.07
10	20	13205	11.3	9.96	431	0.3	0.07
10	30	13608	11.0	9.98	440	0.3	0.09
15	3	7730	19.3	14.90	352	0.5	0.08
15	10	9629	16.1	14.87	388	0.4	0.09
15	20	10615	14.9	14.89	411	0.4	0.09
15	30	11058	14.5	14.91	425	0.3	0.08



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests

#### 2.1.1.6. S\_CO\_5.8

#### S\_CO\_5.8

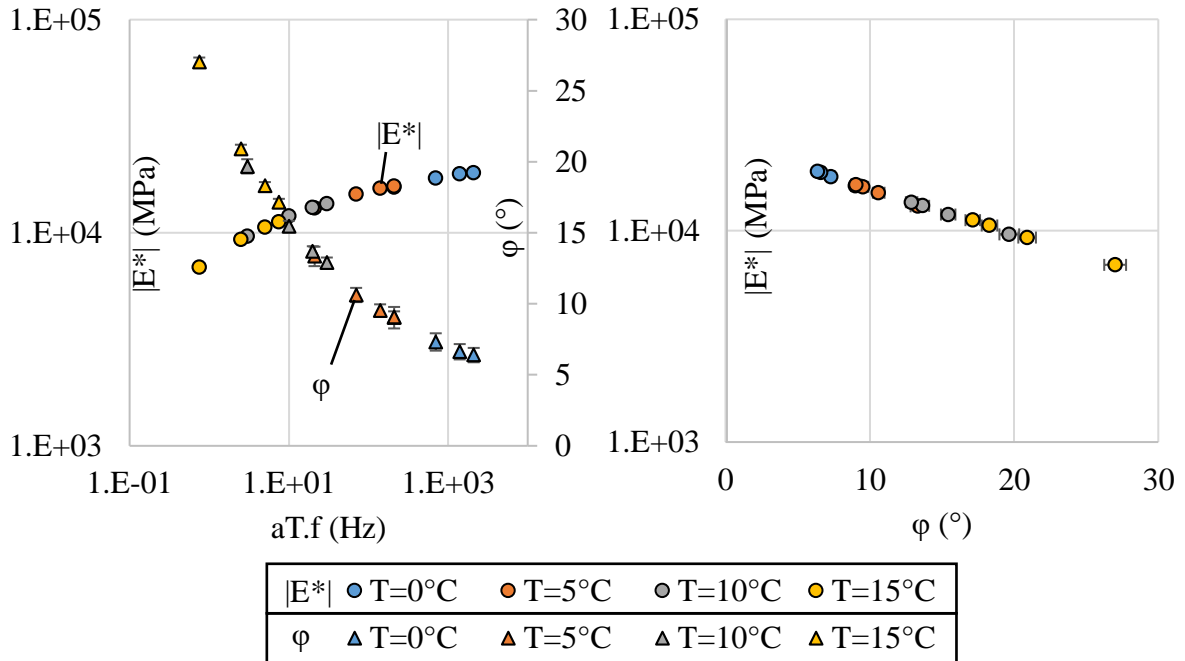
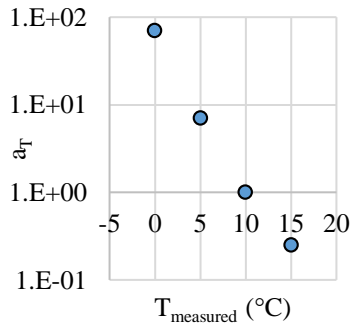
T (°C)	a <sub>T</sub>
-0.05	70
5.03	7
9.99	1
15.05	0.3

Total :  
4 specimens

Average value  
VC = 5.23 %

Standard deviation  
VC = 0.16 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	16294	9.0	-0.04	474	0.3	0.02
0	10	18024	7.3	-0.02	543	0.3	0.02
0	20	18814	6.6	-0.04	578	0.3	0.04
0	30	19091	6.4	-0.07	595	0.2	0.01
5	3	13039	13.3	5.03	527	0.5	0.00
5	10	15115	10.6	5.05	596	0.4	0.01
5	20	16121	9.5	5.01	632	0.4	0.01
5	30	16533	9.1	5.01	654	0.4	0.01
10	3	9604	19.7	9.99	189	0.7	0.04
10	10	11923	15.4	10.00	281	0.5	0.04
10	20	13110	13.7	10.00	334	0.4	0.02
10	30	13642	12.9	9.98	361	0.4	0.04
15	3	6888	27.0	15.04	270	0.8	0.04
15	10	9278	20.9	15.05	341	0.6	0.02
15	20	10582	18.3	15.03	384	0.5	0.01
15	30	11209	17.1	15.07	411	0.5	0.09



2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

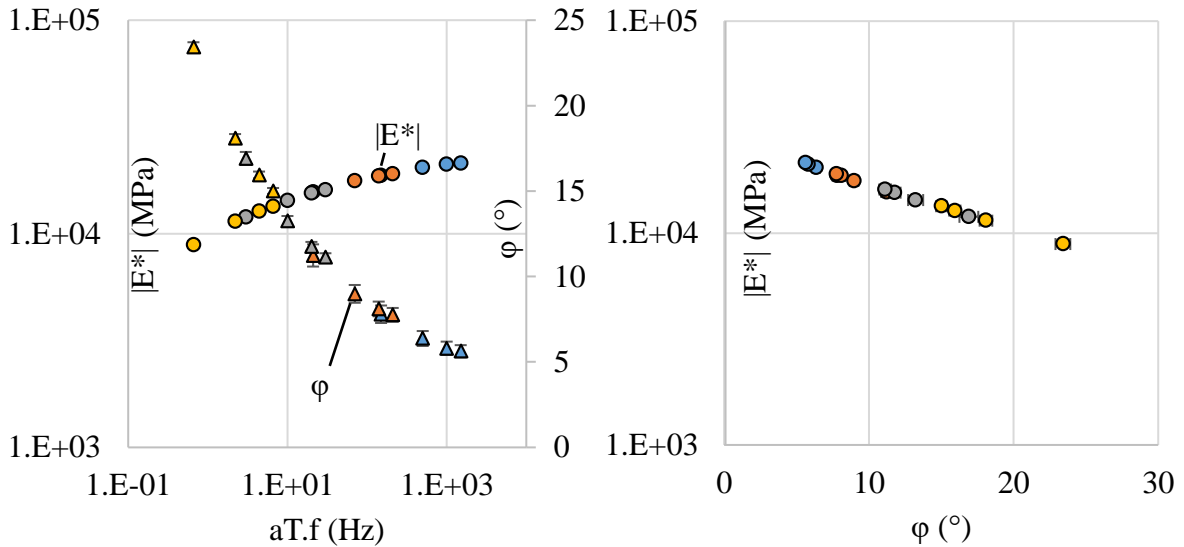
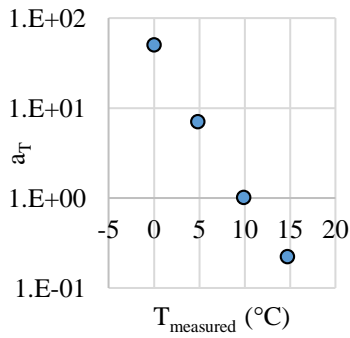
2.1.1.7. S\_CO\_4.8

**S\_CO\_4.8**

T (°C)	a <sub>T</sub>
0.03	50
4.88	7
9.90	1
14.73	0.2

Total :  
2 specimens

		Average value VC = 5.96 %			Standard deviation VC = 0.01 %		
T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	18690	7.8	0.07	12	0.3	0.00
0	10	20349	6.4	0.00	79	0.2	0.00
0	20	21105	5.8	0.02	119	0.2	0.00
0	30	21389	5.6	0.01	152	0.2	0.00
5	3	15621	11.2	4.92	51	0.4	0.00
5	10	17653	9.0	4.85	17	0.3	0.00
5	20	18618	8.1	4.86	60	0.3	0.00
5	30	19022	7.8	4.88	89	0.2	0.00
10	3	11925	16.9	9.92	197	0.7	0.00
10	10	14309	13.2	9.88	136	0.5	0.00
10	20	15508	11.8	9.89	93	0.4	0.00
10	30	16050	11.1	9.89	60	0.4	0.00
15	3	8873	23.4	14.75	122	0.5	0.00
15	10	11436	18.1	14.70	87	0.4	0.00
15	20	12764	15.9	14.73	53	0.4	0.00
15	30	13389	15.0	14.74	29	0.4	0.00



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.8. Sm\_CO\_5.8

**Sm\_CO\_5.8**

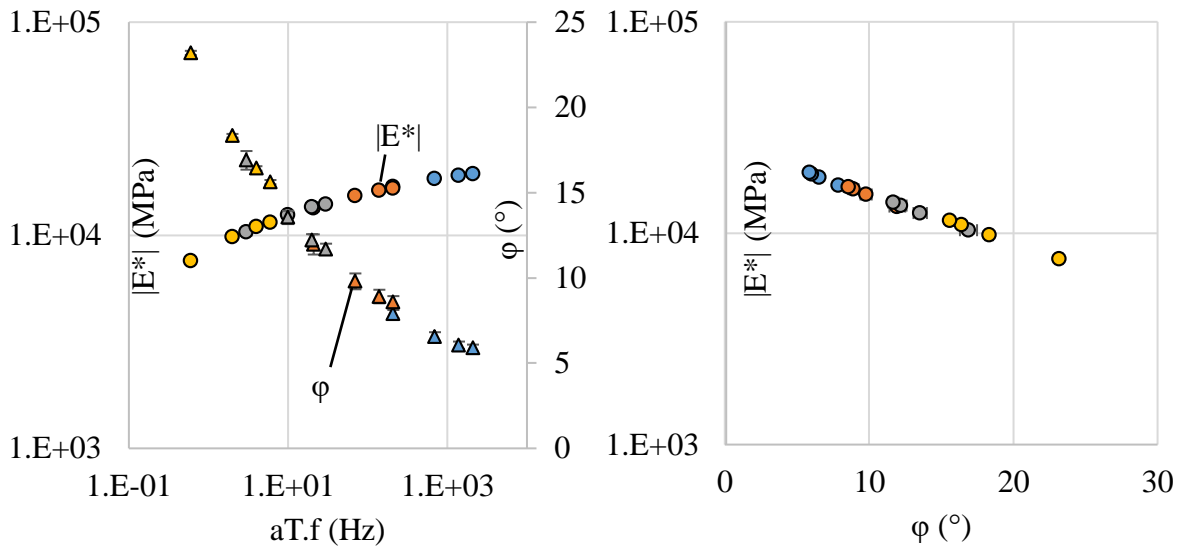
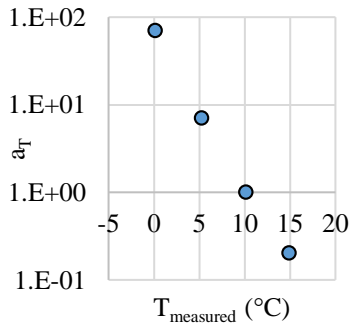
T (°C)	a <sub>T</sub>
0.13	70
5.23	7
10.11	1
14.90	0.2

Total :  
2 specimens

Average value  
VC = 4.49 %

Standard deviation  
VC = 0.29 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	16820	7.9	0.17	92	0.1	0.51
0	10	18378	6.6	0.08	93	0.1	0.46
0	20	19072	6.1	0.12	57	0.1	0.47
0	30	19332	5.9	0.14	42	0.1	0.49
5	3	13367	12.0	5.24	391	0.5	0.53
5	10	15249	9.8	5.22	410	0.4	0.56
5	20	16174	8.9	5.21	380	0.4	0.54
5	30	16558	8.6	5.25	362	0.3	0.53
10	3	10330	16.9	10.14	357	0.6	0.52
10	10	12451	13.5	10.09	343	0.5	0.54
10	20	13515	12.2	10.10	335	0.4	0.52
10	30	13982	11.7	10.12	327	0.4	0.51
15	3	7577	23.2	14.93	88	0.2	0.19
15	10	9792	18.3	14.88	123	0.3	0.17
15	20	10942	16.4	14.90	105	0.2	0.16
15	30	11472	15.6	14.90	95	0.2	0.16



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.9. Sm\_CO\_4.8

**Sm\_CO\_4.8**

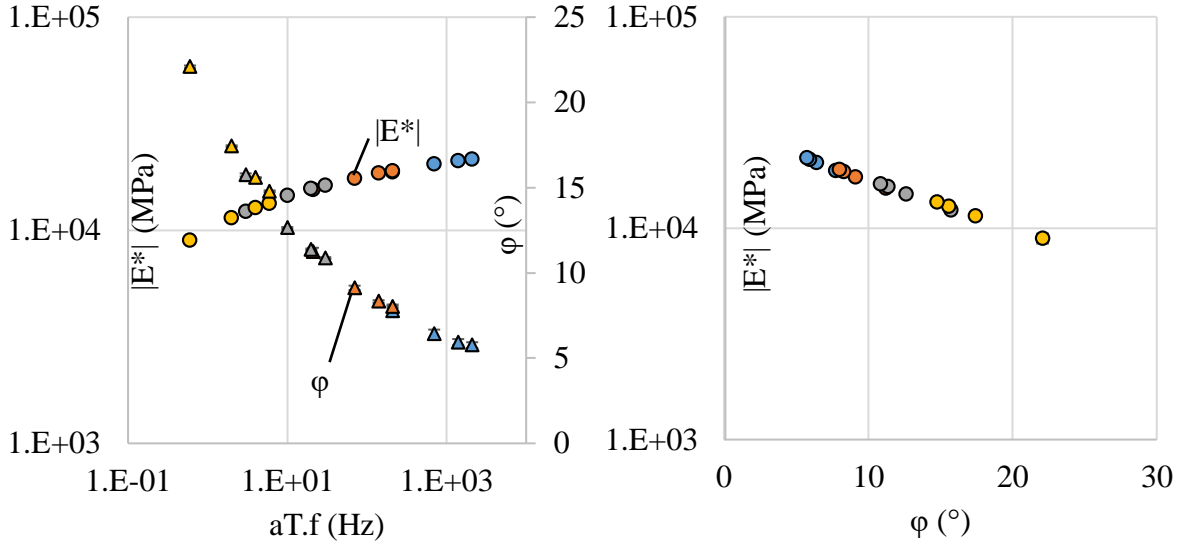
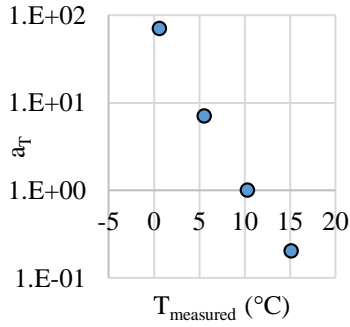
T (°C)	a <sub>T</sub>
0.64	70
5.57	7
10.29	1
15.12	0.2

Total :  
4 specimens

**Average value**  
VC = 4.56 %

**Standard deviation**  
VC = 0.19 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	18680	7.8	0.66	458	0.1	0.07
0	10	20373	6.4	0.61	506	0.0	0.07
0	20	21152	5.9	0.62	538	0.0	0.06
0	30	21452	5.8	0.64	558	0.1	0.08
5	3	15430	11.2	5.60	377	0.1	0.08
5	10	17492	9.1	5.55	434	0.1	0.08
5	20	18473	8.3	5.56	467	0.1	0.08
5	30	18892	8.0	5.58	489	0.1	0.08
10	3	12180	15.7	10.33	312	0.2	0.06
10	10	14518	12.6	10.27	369	0.1	0.06
10	20	15684	11.4	10.27	404	0.1	0.06
10	30	16201	10.9	10.30	426	0.1	0.05
15	3	8935	22.1	15.14	247	0.4	0.05
15	10	11418	17.4	15.11	285	0.3	0.08
15	20	12706	15.6	15.12	317	0.2	0.07
15	30	13312	14.8	15.13	337	0.2	0.07



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.10. Bm\_BI\_5.8

**Bm\_BI\_5.8**

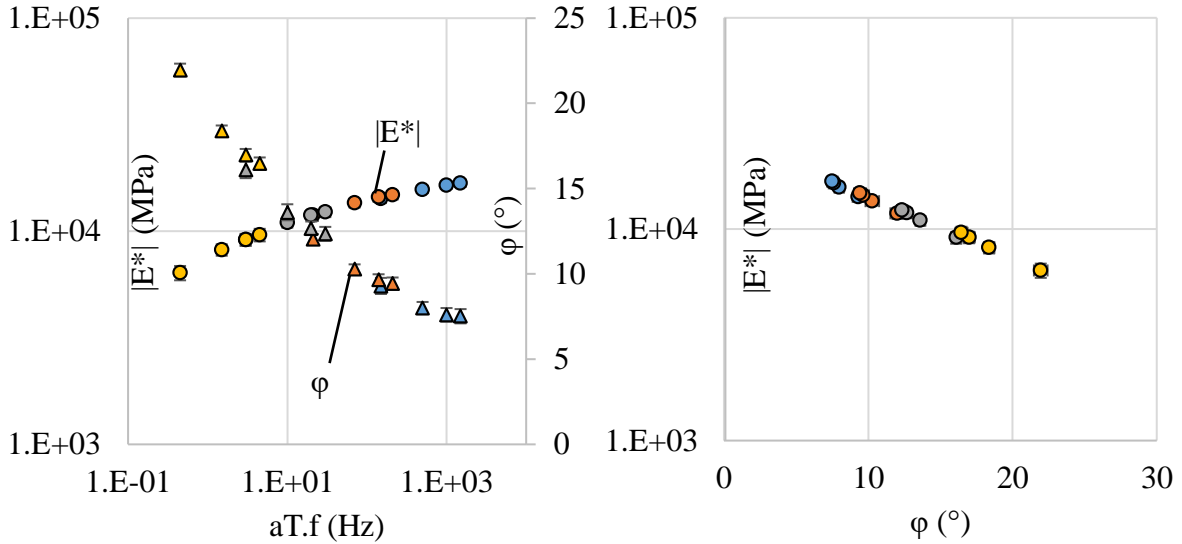
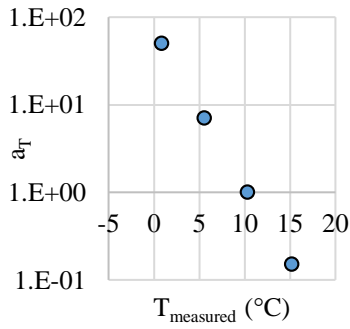
T (°C)	a <sub>T</sub>
0.86	50
5.56	7
10.34	1
15.21	0.2

Total :  
4 specimens

**Average value**  
VC = 5.09 %

**Standard deviation**  
VC = 0.13 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	14225	9.3	0.92	664	0.4	0.19
0	10	15726	8.0	0.79	614	0.3	0.08
0	20	16477	7.6	0.83	621	0.3	0.13
0	30	16802	7.5	0.88	639	0.4	0.17
5	3	11887	12.0	5.61	694	0.5	0.17
5	10	13572	10.3	5.50	646	0.5	0.10
5	20	14443	9.7	5.55	681	0.4	0.14
5	30	14783	9.4	5.59	688	0.4	0.16
10	3	9120	16.1	10.39	584	0.3	0.19
10	10	10962	13.6	10.27	561	0.3	0.13
10	20	11900	12.7	10.33	612	0.3	0.17
10	30	12307	12.3	10.37	655	0.4	0.17
15	3	6380	22.0	15.27	493	0.5	0.24
15	10	8183	18.4	15.13	505	0.4	0.15
15	20	9153	17.0	15.19	572	0.4	0.19
15	30	9616	16.5	15.25	651	0.4	0.22



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.11. Bm\_CR\_5.8

**Bm\_CR\_5.8**

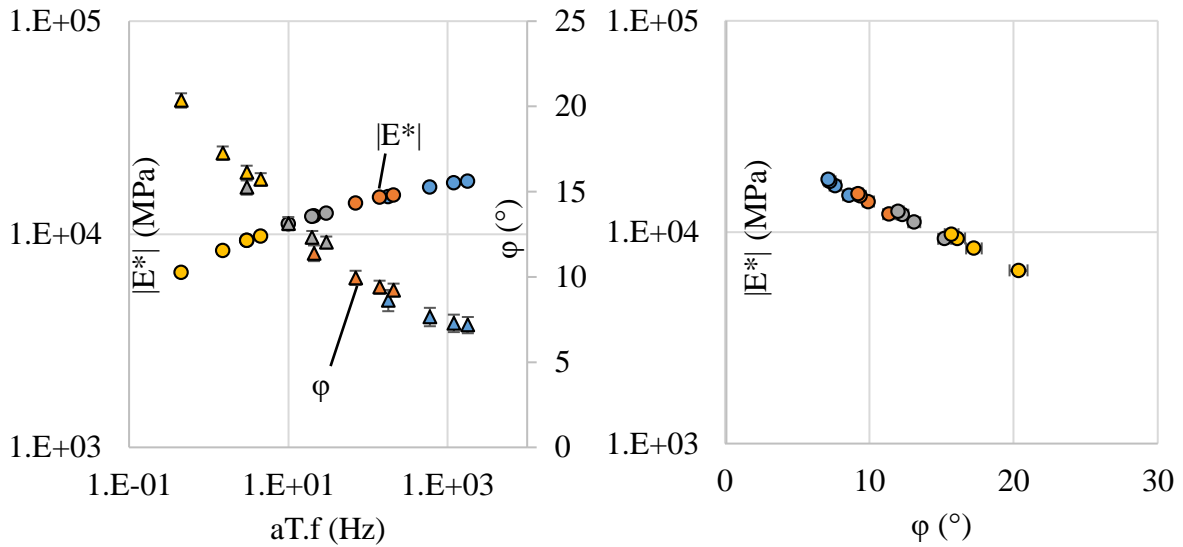
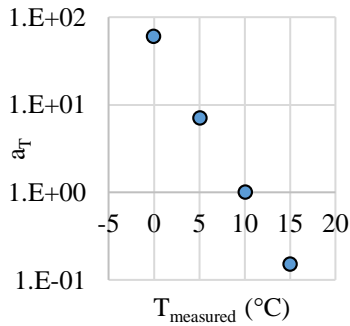
T (°C)	a <sub>T</sub>
-0.03	60
5.09	7
10.07	1
15.04	0.2

Total :  
4 specimens

Average value  
VC = 4.58 %

Standard deviation  
VC = 0.31 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	14959	8.6	-0.02	404	0.4	0.07
0	10	16619	7.6	-0.06	417	0.4	0.09
0	20	17418	7.3	-0.02	416	0.4	0.07
0	30	17730	7.2	-0.03	424	0.4	0.07
5	3	12173	11.4	5.10	296	0.4	0.00
5	10	13969	9.9	5.08	321	0.4	0.00
5	20	14864	9.4	5.08	335	0.4	0.00
5	30	15240	9.2	5.09	336	0.3	0.00
10	3	9305	15.2	10.08	249	0.5	0.01
10	10	11149	13.1	10.04	278	0.4	0.02
10	20	12104	12.3	10.08	297	0.4	0.00
10	30	12532	12.0	10.07	306	0.4	0.03
15	3	6599	20.3	15.05	244	0.6	0.01
15	10	8384	17.3	15.00	285	0.5	0.02
15	20	9346	16.1	15.03	312	0.5	0.01
15	30	9791	15.7	15.05	320	0.5	0.01



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.12. Bm\_HL\_5.8

**Bm\_HL\_5.8**

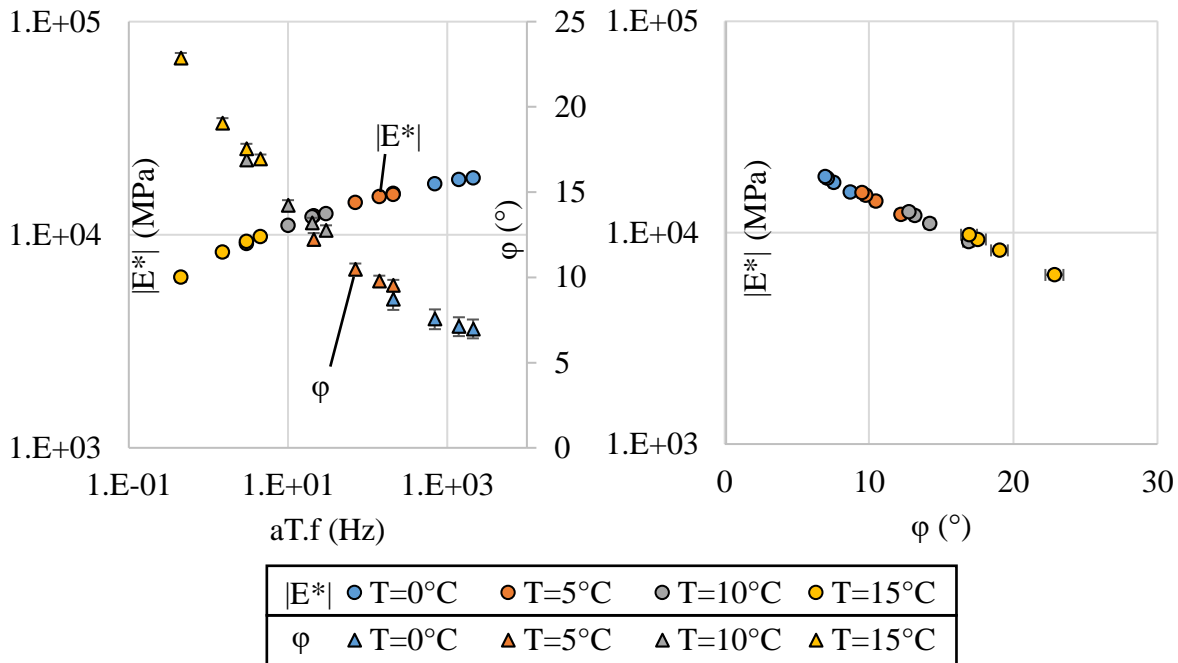
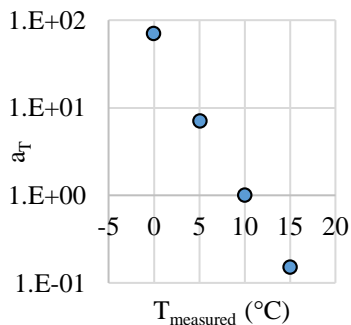
T (°C)	a <sub>T</sub>
-0.03	70
5.06	7
10.01	1
15.00	0.2

Total :  
4 specimens

Average value  
VC = 4.3 %

Standard deviation  
VC = 0.13 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	15577	8.7	-0.02	222	0.3	0.00
0	10	17271	7.5	-0.05	261	0.3	0.03
0	20	18075	7.1	-0.03	284	0.3	0.01
0	30	18378	7.0	-0.02	304	0.3	0.01
5	3	12199	12.2	5.08	180	0.3	0.01
5	10	14085	10.5	5.04	221	0.3	0.00
5	20	15029	9.8	5.06	247	0.3	0.00
5	30	15429	9.5	5.06	259	0.3	0.04
10	3	9061	16.9	10.03	194	0.4	0.02
10	10	11045	14.2	10.00	226	0.3	0.01
10	20	12064	13.2	10.01	247	0.3	0.02
10	30	12529	12.8	10.01	258	0.3	0.02
15	3	6310	22.9	15.02	310	0.6	0.01
15	10	8246	19.0	14.99	357	0.6	0.01
15	20	9288	17.5	15.00	383	0.6	0.02
15	30	9773	16.9	14.99	392	0.6	0.02





2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.13. Bm\_BE\_5.8

**Bm\_BE\_5.8**

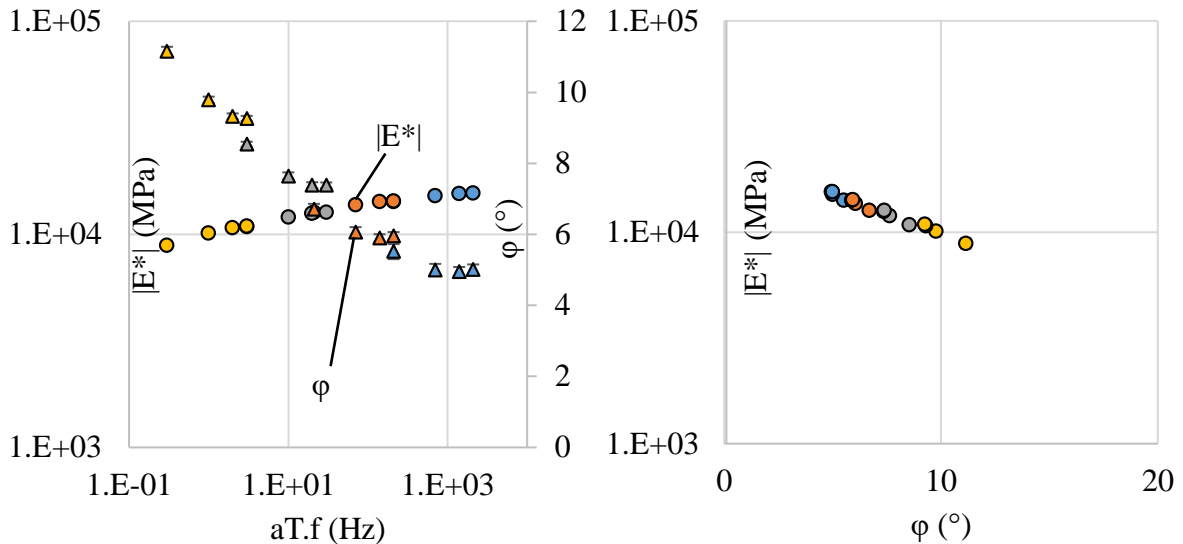
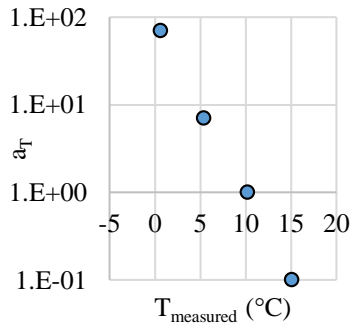
T (°C)	a <sub>T</sub>
0.64	70
5.35	7
10.19	1
15.10	0.1

Total :  
4 specimens

Average value  
VC = 4.36 %

Standard deviation  
VC = 0.18 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	14167	5.5	0.66	264	0.1	0.09
0	10	15118	5.0	0.62	254	0.1	0.07
0	20	15513	5.0	0.63	256	0.1	0.07
0	30	15599	5.0	0.65	258	0.1	0.09
5	3	12666	6.7	5.35	244	0.1	0.09
5	10	13723	6.1	5.35	227	0.1	0.09
5	20	14178	5.9	5.34	237	0.1	0.08
5	30	14296	5.9	5.36	237	0.1	0.08
10	3	10841	8.5	10.21	224	0.1	0.03
10	10	12009	7.6	10.18	228	0.1	0.00
10	20	12529	7.4	10.18	236	0.1	0.00
10	30	12694	7.4	10.19	237	0.1	0.01
15	3	8860	11.2	15.11	216	0.2	0.03
15	10	10102	9.8	15.10	211	0.2	0.03
15	20	10697	9.3	15.11	221	0.1	0.04
15	30	10900	9.3	15.10	230	0.2	0.04



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.14. S\_BI\_5.8

**S\_BI\_5.8**

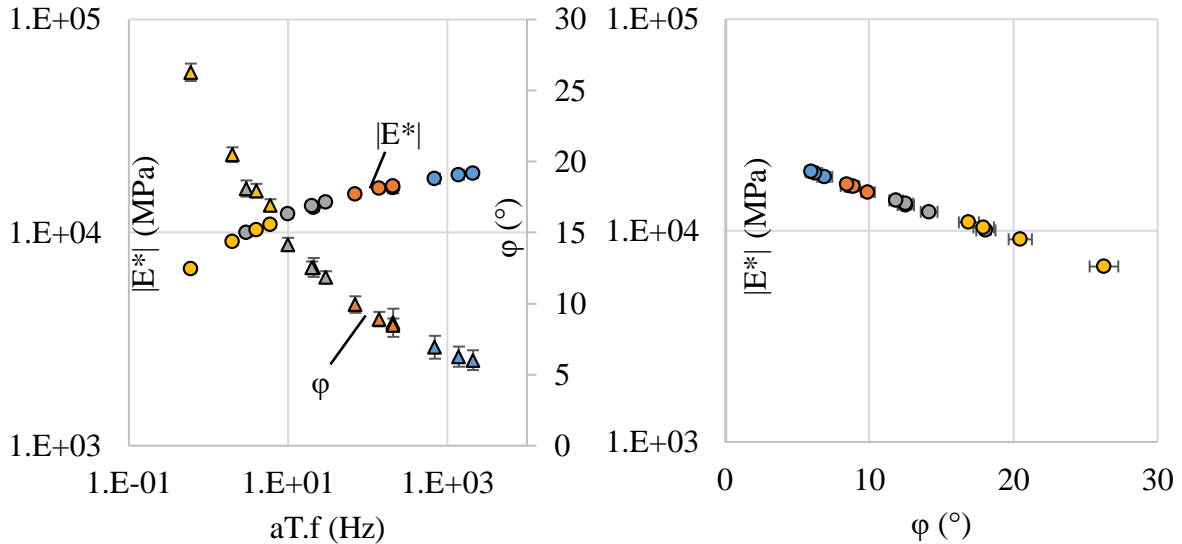
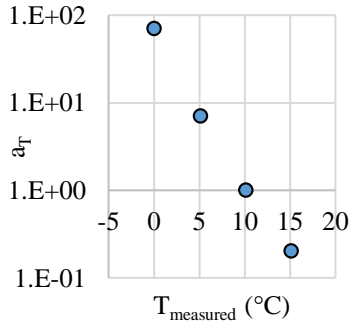
T (°C)	a <sub>T</sub>
0.02	70
5.16	7
10.11	1
15.11	0.2

Total :  
4 specimens

**Average value**  
VC = 4.44 %

**Standard deviation**  
VC = 0.11 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	16243	8.7	0.04	962	0.6	0.10
0	10	17950	6.9	0.00	969	0.5	0.08
0	20	18710	6.3	0.03	977	0.5	0.06
0	30	18960	6.0	0.03	970	0.4	0.09
5	3	13176	12.5	5.18	620	0.6	0.00
5	10	15188	9.9	5.14	688	0.5	0.03
5	20	16152	8.9	5.16	716	0.4	0.02
5	30	16537	8.5	5.15	728	0.4	0.00
10	3	10006	18.1	10.12	456	0.7	0.03
10	10	12255	14.2	10.09	535	0.6	0.02
10	20	13390	12.5	10.10	583	0.5	0.04
10	30	13884	11.9	10.13	593	0.5	0.05
15	3	6765	26.3	15.12	283	1.0	0.00
15	10	9090	20.5	15.10	349	0.8	0.04
15	20	10337	17.9	15.10	385	0.7	0.02
15	30	10922	16.9	15.13	412	0.7	0.01



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

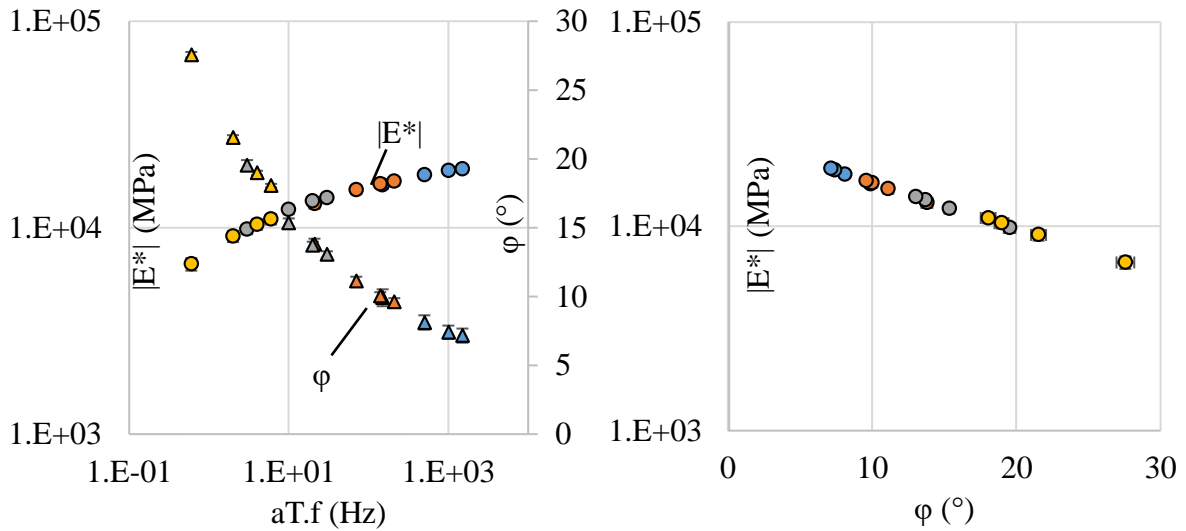
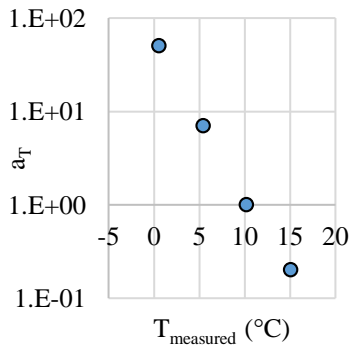
2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.15. S\_CR\_5.8

**S\_CR\_5.8**

T (°C)	a <sub>T</sub>
0.54	50
5.42	7
10.19	1
15.10	0.2

Total : 4 specimens		Average value VC = 5.12 %			Standard deviation VC = 0.36 %		
T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	16079	9.9	0.54	684	0.2	0.02
0	10	17997	8.1	0.53	709	0.2	0.02
0	20	18876	7.4	0.53	711	0.2	0.02
0	30	19211	7.2	0.54	722	0.1	0.02
5	3	13041	13.8	5.44	680	0.4	0.08
5	10	15256	11.1	5.40	729	0.3	0.06
5	20	16314	10.0	5.40	751	0.3	0.07
5	30	16757	9.6	5.42	760	0.2	0.08
10	3	9822	19.5	10.20	528	0.4	0.06
10	10	12222	15.4	10.18	593	0.3	0.06
10	20	13427	13.7	10.19	623	0.3	0.07
10	30	13973	13.1	10.20	637	0.3	0.06
15	3	6659	27.6	15.11	467	0.6	0.09
15	10	9081	21.5	15.10	565	0.5	0.09
15	20	10378	19.0	15.09	606	0.5	0.09
15	30	10997	18.1	15.11	632	0.5	0.10



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

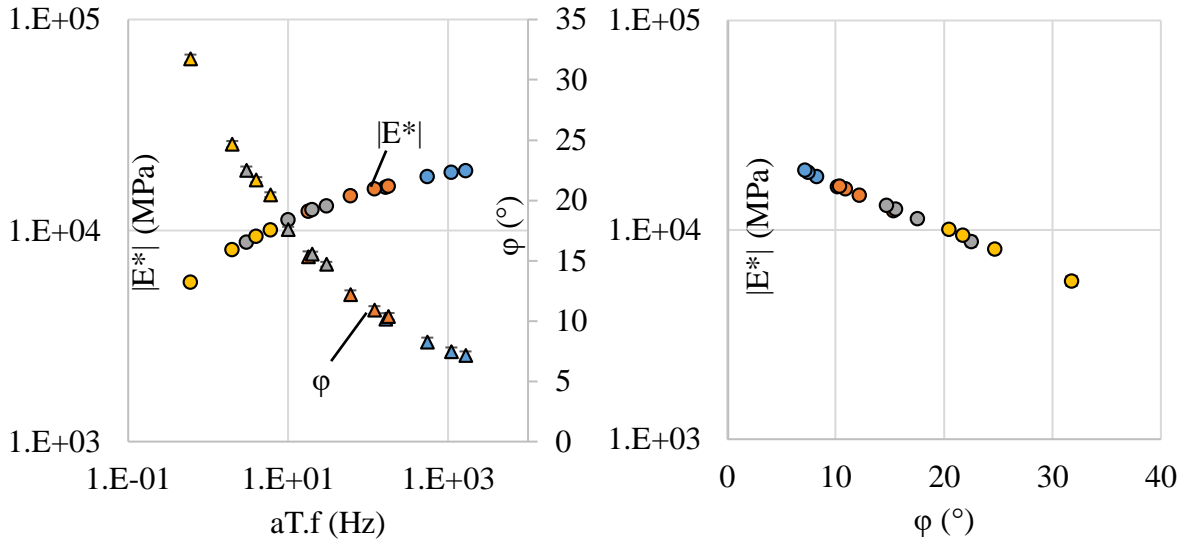
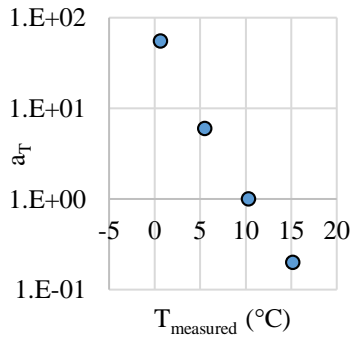
2.1.1.16. S\_HL\_5.8

**S\_HL\_5.8**

T (°C)	a <sub>T</sub>
0.65	55
5.51	6
10.32	1
15.15	0.2

Total :  
4 specimens

		Average value VC = 5.21 %			Standard deviation VC = 0.32 %		
T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	16070	10.2	0.67	184	0.3	0.12
0	10	17977	8.2	0.63	184	0.3	0.09
0	20	18867	7.5	0.63	196	0.2	0.11
0	30	19215	7.2	0.67	201	0.2	0.11
5	3	12332	15.3	5.54	136	0.3	0.05
5	10	14602	12.2	5.48	145	0.2	0.05
5	20	15718	10.9	5.49	156	0.2	0.05
5	30	16198	10.4	5.52	166	0.2	0.04
10	3	8786	22.5	10.36	120	0.4	0.02
10	10	11261	17.6	10.29	116	0.4	0.02
10	20	12526	15.5	10.30	111	0.3	0.01
10	30	13107	14.7	10.33	112	0.3	0.00
15	3	5699	31.8	15.19	108	0.5	0.11
15	10	8096	24.7	15.13	127	0.4	0.09
15	20	9406	21.7	15.14	135	0.3	0.09
15	30	10037	20.5	15.16	140	0.3	0.10



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

2 Thermomechanical tests on bituminous mixtures  
2.1 Complex modulus tests

2.1.1.17. S\_BE\_5.8

**S\_BE\_5.8**

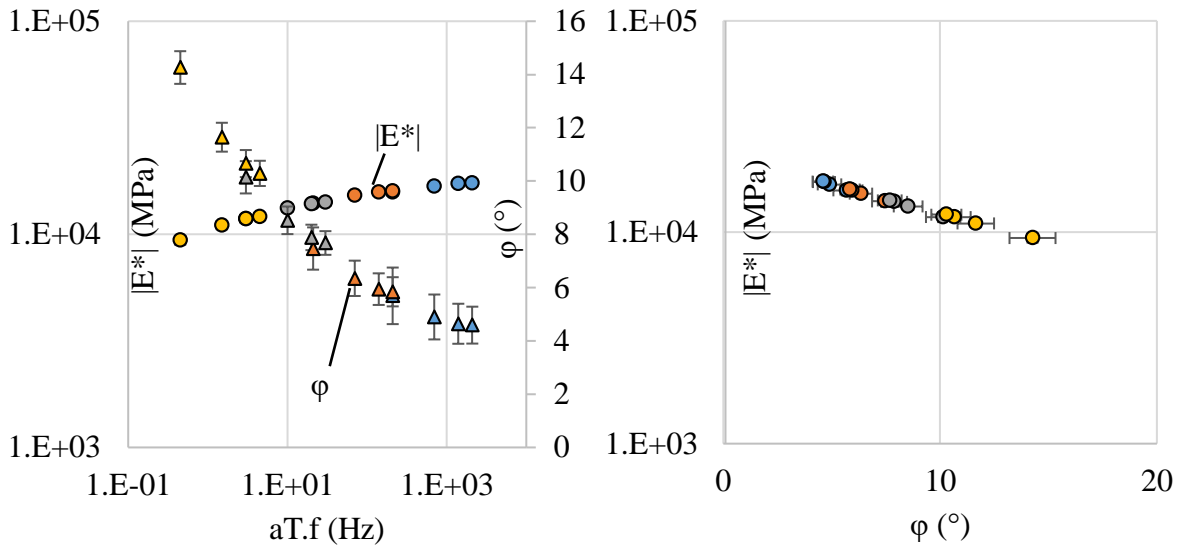
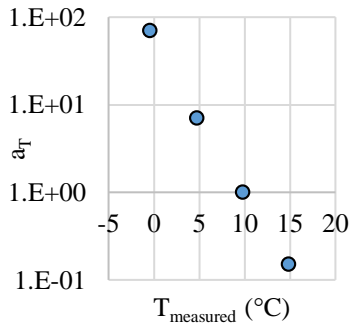
T (°C)	a <sub>T</sub>
-0.44	70
4.75	7
9.80	1
14.87	0.2

Total :  
4 specimens

**Average value**  
VC = 4.93 %

**Standard deviation**  
VC = 0.68 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	15786	5.7	-0.42	538	0.6	0.01
0	10	16845	4.9	-0.45	533	0.5	0.00
0	20	17280	4.6	-0.44	531	0.5	0.01
0	30	17374	4.6	-0.43	532	0.5	0.03
5	3	13995	7.5	4.76	446	0.6	0.01
5	10	15228	6.3	4.72	455	0.5	0.00
5	20	15777	5.9	4.74	461	0.5	0.01
5	30	15932	5.8	4.76	461	0.4	0.01
10	3	11807	10.1	9.81	492	0.8	0.02
10	10	13253	8.5	9.80	496	0.7	0.01
10	20	13922	7.9	9.79	496	0.6	0.01
10	30	14152	7.7	9.82	496	0.5	0.00
15	3	9390	14.3	14.87	456	1.1	0.00
15	10	11013	11.6	14.85	462	0.8	0.00
15	20	11799	10.7	14.87	463	0.8	0.01
15	30	12106	10.3	14.89	463	0.7	0.01



E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests

#### 2.1.1.18. B\_CO(+)\_5.8

#### B\_CO(+)\_5.8

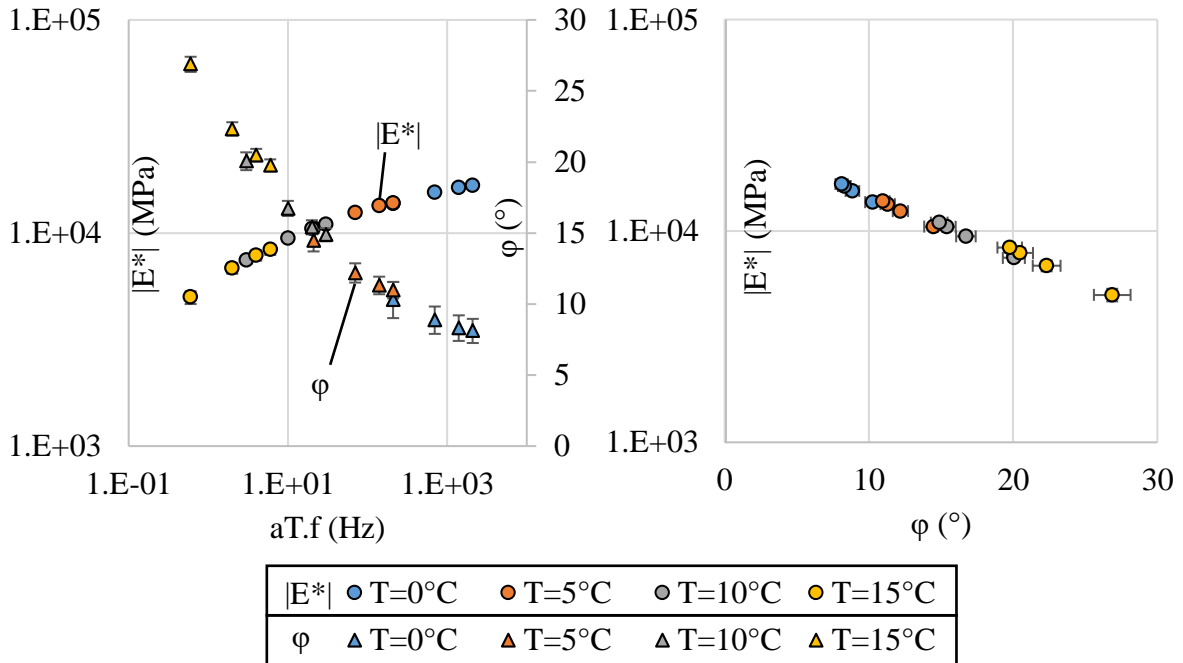
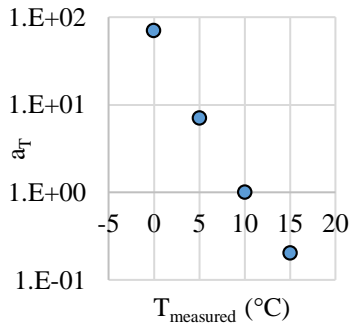
T (°C)	a <sub>T</sub>
-0.02	70
5.04	7
10.00	1
15.01	0.2

Total :  
4 specimens

Average value  
VC = 4.74 %

Standard deviation  
VC = 0.65 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	13683	10.3	-0.02	224	0.5	0.01
0	10	15443	8.9	-0.05	279	0.5	0.03
0	20	16310	8.3	-0.03	323	0.4	0.02
0	30	16661	8.1	0.00	352	0.4	0.01
5	3	10486	14.5	5.06	245	0.6	0.02
5	10	12410	12.2	5.02	306	0.5	0.00
5	20	13385	11.3	5.03	335	0.5	0.01
5	30	13814	11.0	5.05	357	0.5	0.01
10	3	7453	20.1	10.01	295	0.8	0.00
10	10	9430	16.7	9.99	343	0.7	0.01
10	20	10465	15.4	10.00	369	0.6	0.01
10	30	10944	14.9	10.02	383	0.6	0.01
15	3	4984	26.9	15.04	343	1.3	0.01
15	10	6840	22.3	14.99	400	1.0	0.01
15	20	7857	20.5	15.00	432	0.9	0.02
15	30	8343	19.8	15.02	446	0.9	0.01



## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests

2.1.1.19. B\_CO(-)\_5.8

#### B\_CO(-)\_5.8

T (°C)	a <sub>T</sub>
0.58	50
5.32	7
10.15	1
14.99	0.2

Total :  
4 specimens

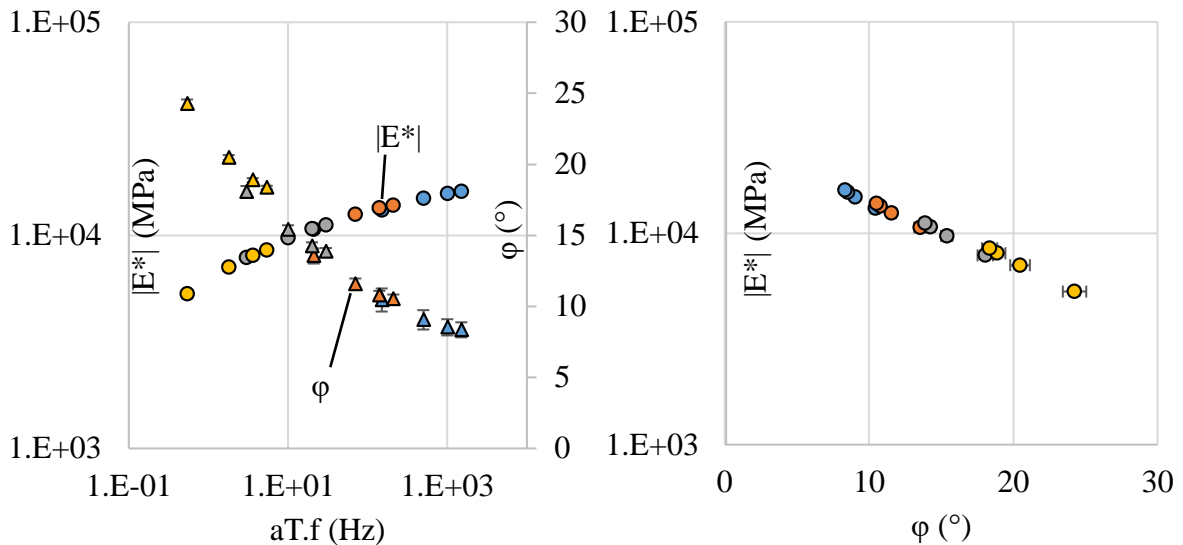
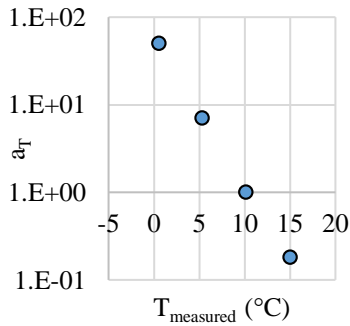
**Average value**

VC = 4.8 %

**Standard deviation**

VC = 0.1 %

T <sub>targeted</sub> (°C)	f (Hz)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)	E*  (MPa)	φ (°)	T <sub>measured</sub> (°C)
0	3	13108	10.4	0.59	293	0.3	0.03
0	10	14819	9.1	0.57	297	0.2	0.05
0	20	15657	8.5	0.57	305	0.1	0.05
0	30	16007	8.3	0.58	309	0.1	0.04
5	3	10651	13.5	5.33	289	0.4	0.04
5	10	12478	11.6	5.30	304	0.3	0.04
5	20	13401	10.8	5.32	300	0.3	0.04
5	30	13810	10.5	5.32	307	0.2	0.04
10	3	7857	18.1	10.17	260	0.5	0.07
10	10	9724	15.4	10.15	276	0.4	0.06
10	20	10715	14.2	10.14	286	0.3	0.05
10	30	11161	13.9	10.15	293	0.3	0.04
15	3	5299	24.2	14.99	239	0.8	0.02
15	10	7063	20.5	14.98	266	0.7	0.02
15	20	8039	18.9	14.99	279	0.6	0.01
15	30	8495	18.4	14.99	286	0.5	0.02



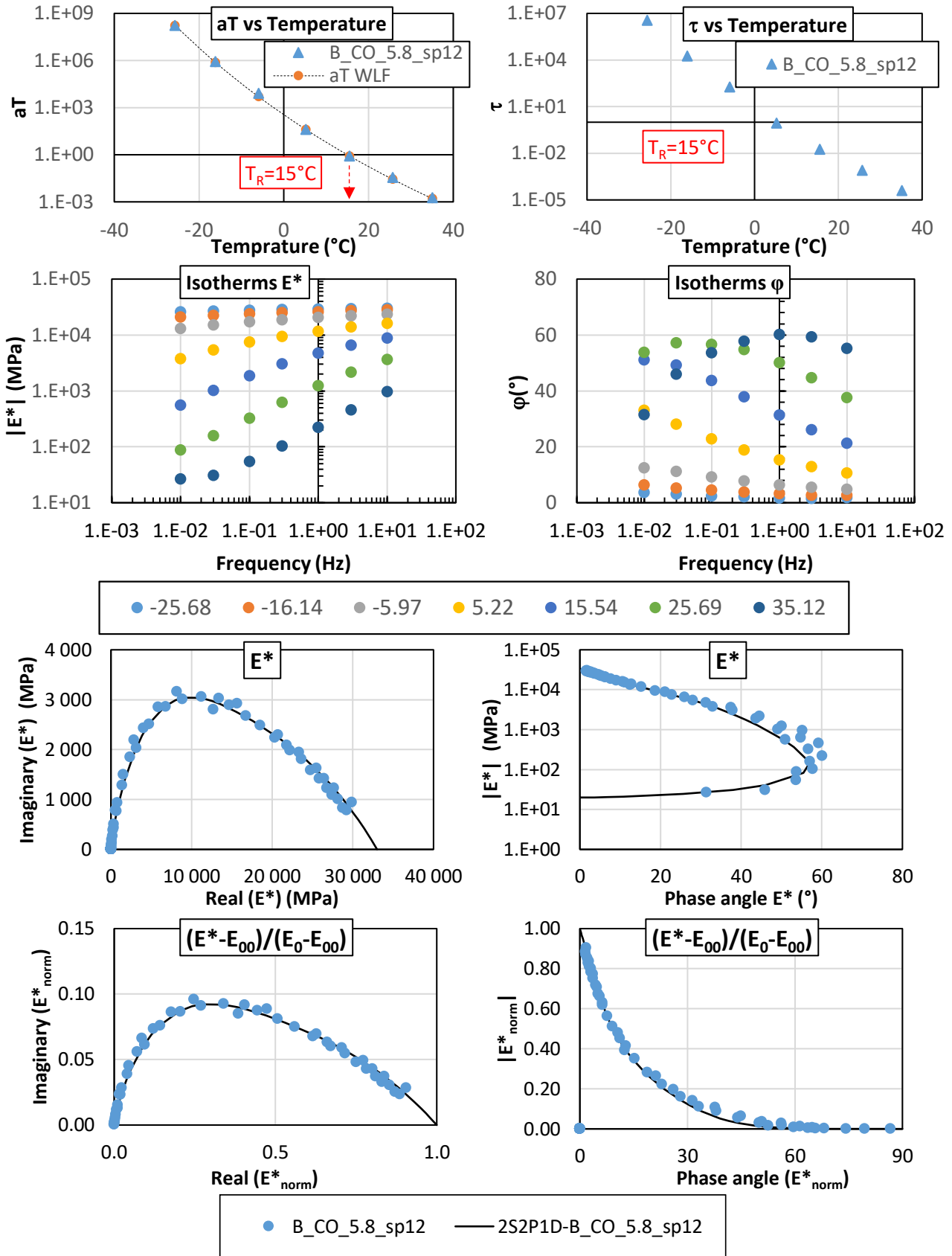
E*	● T=0°C	● T=5°C	● T=10°C	● T=15°C
φ	▲ T=0°C	▲ T=5°C	▲ T=10°C	▲ T=15°C

## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests

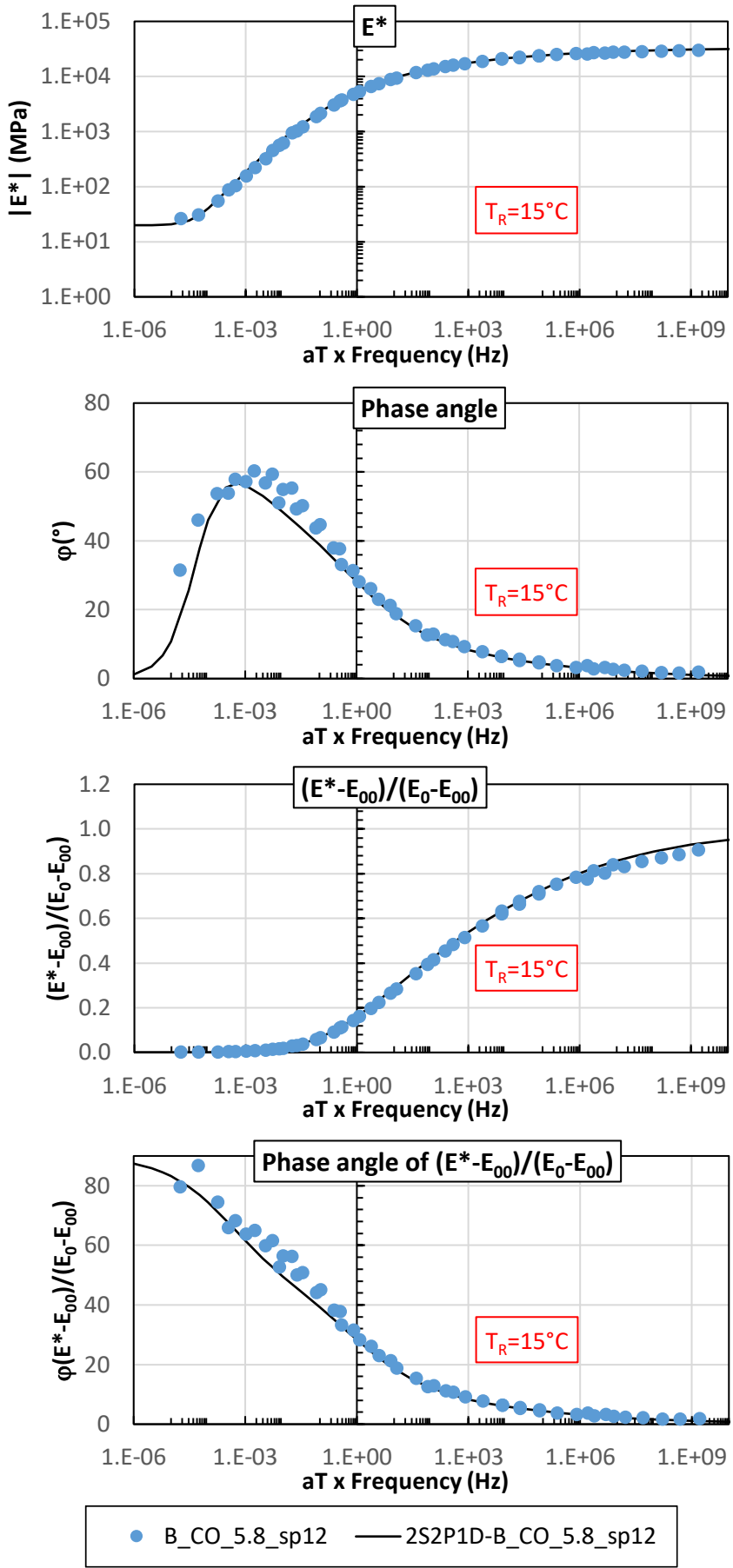
#### 2.1.2. Tension-compression (TC) test on cylindrical specimen

##### 2.1.2.1. B\_CO\_5.8\_sp12





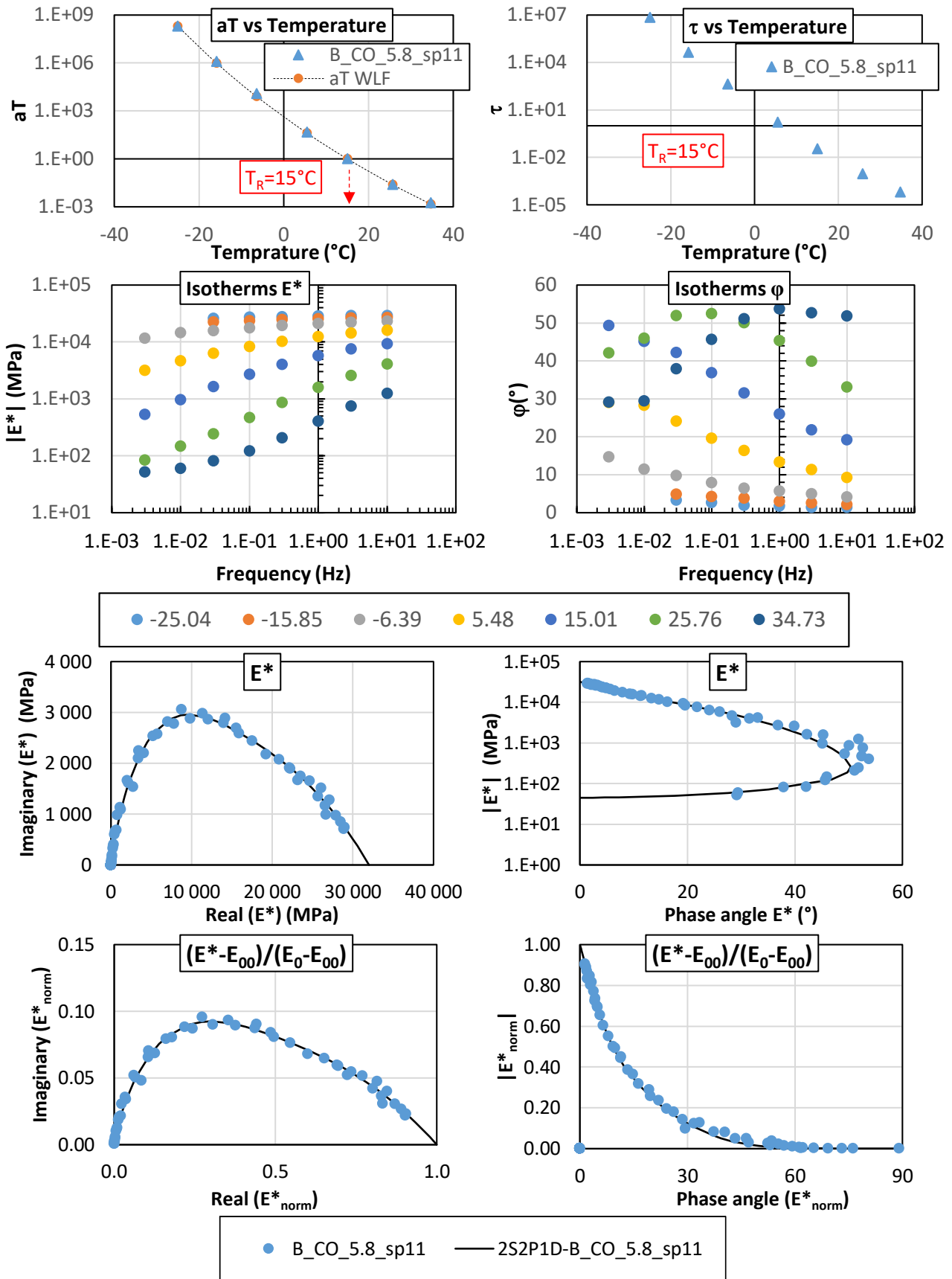
2 Thermomechanical tests on bituminous mixtures  
 2.1 Complex modulus tests



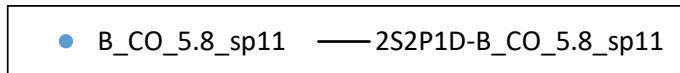
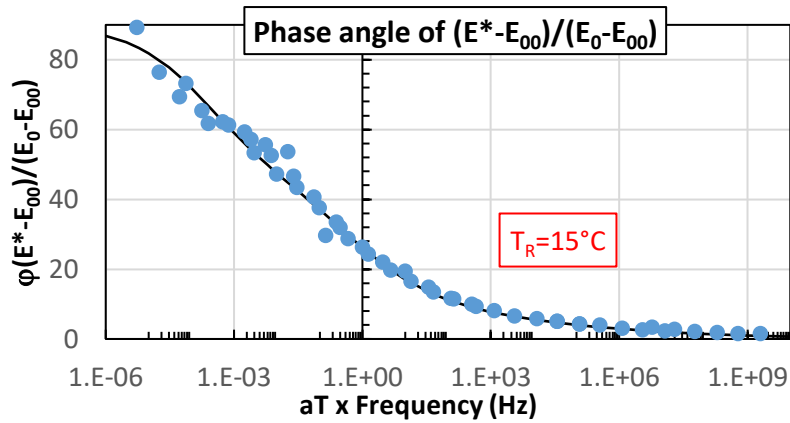
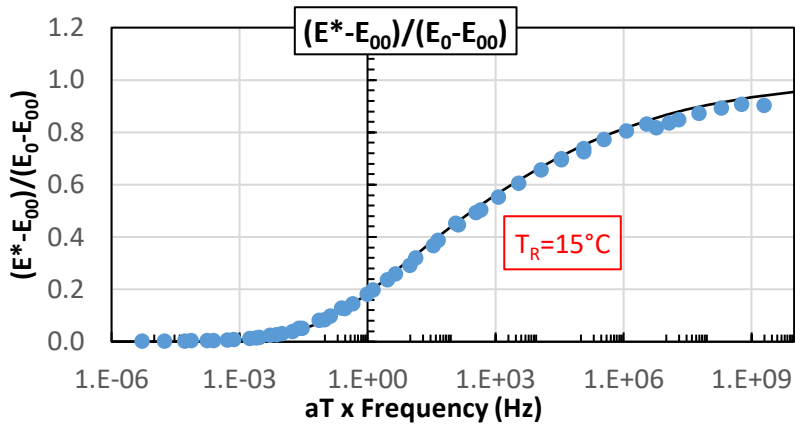
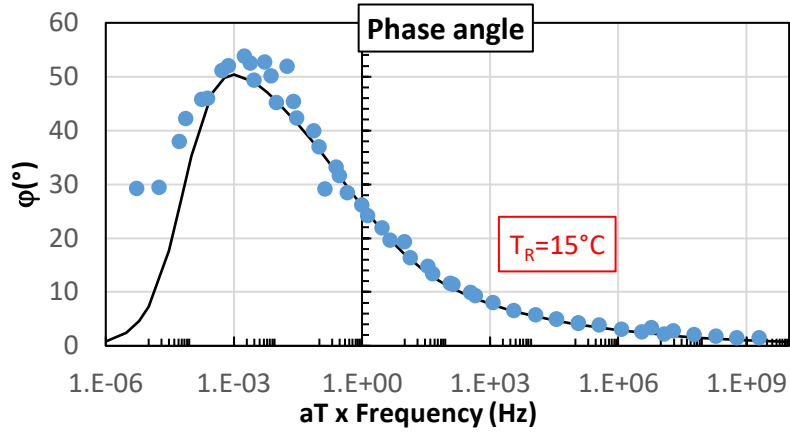
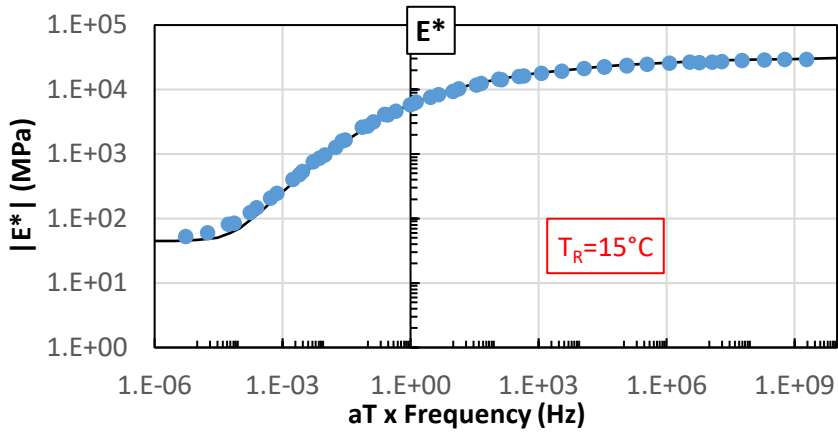
## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests

#### 2.1.2.2. B\_CO\_5.8\_sp11



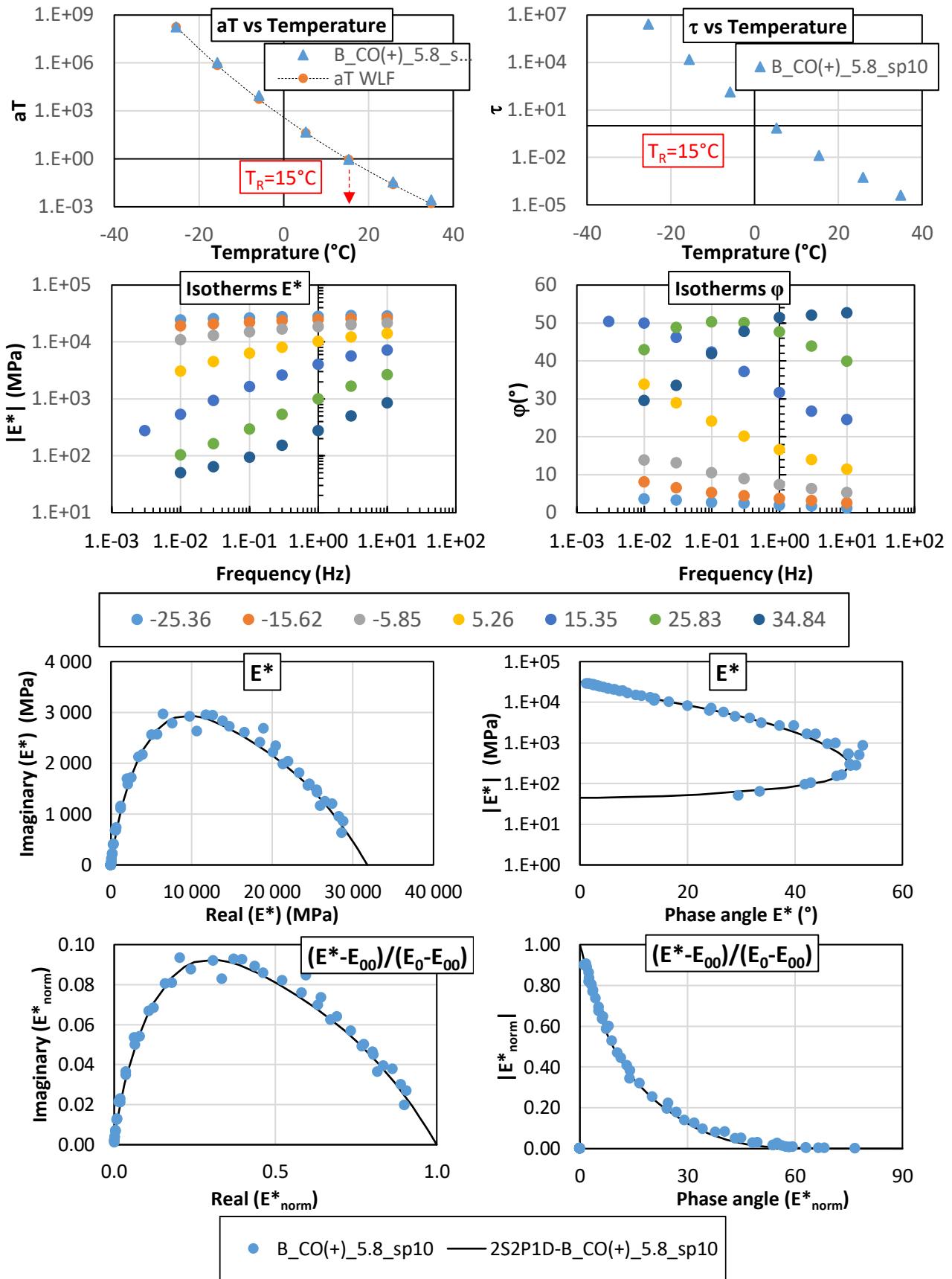
2 Thermomechanical tests on bituminous mixtures  
 2.1 Complex modulus tests



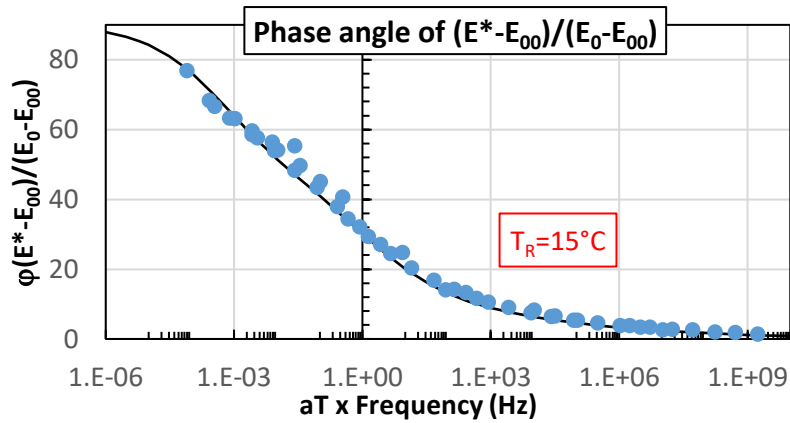
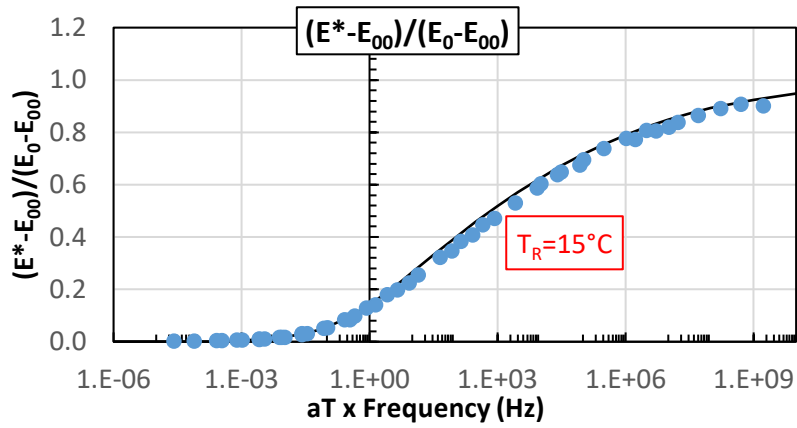
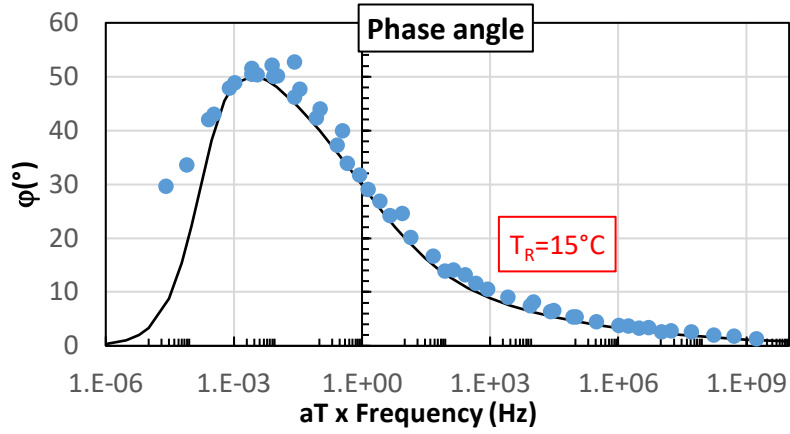
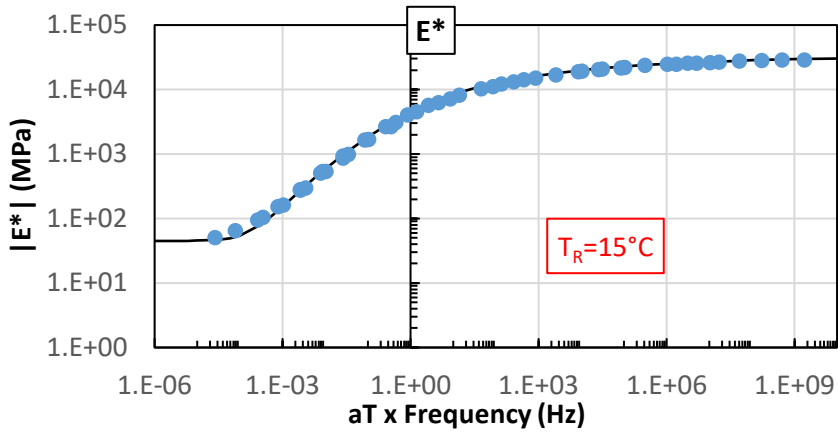
## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests

#### 2.1.2.3. B\_CO(+)\_5.8\_sp10



2 Thermomechanical tests on bituminous mixtures  
 2.1 Complex modulus tests

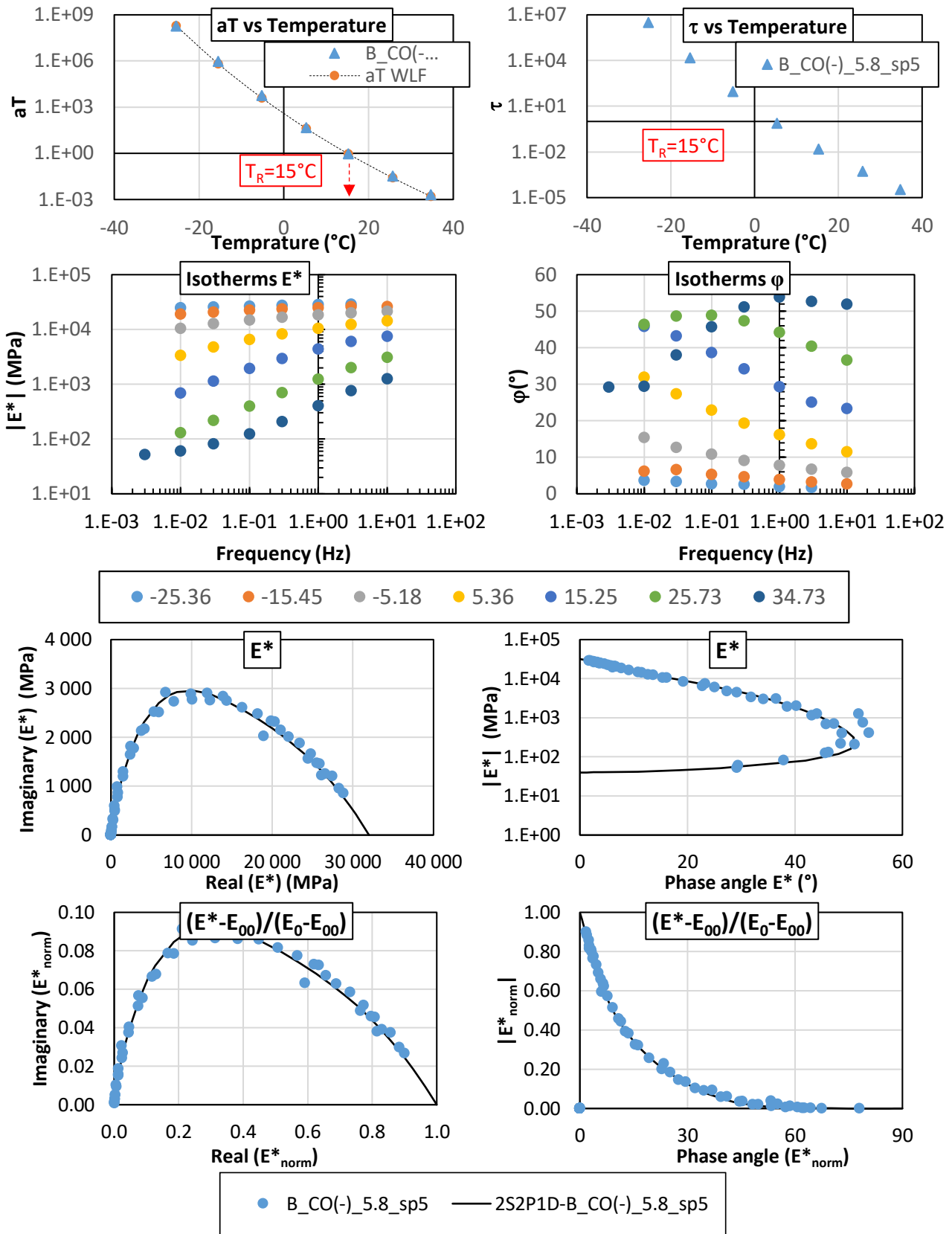


● B\_CO(+)\_5.8\_sp10 — 2S2P1D-B\_CO(+)\_5.8\_sp10

## 2 Thermomechanical tests on bituminous mixtures

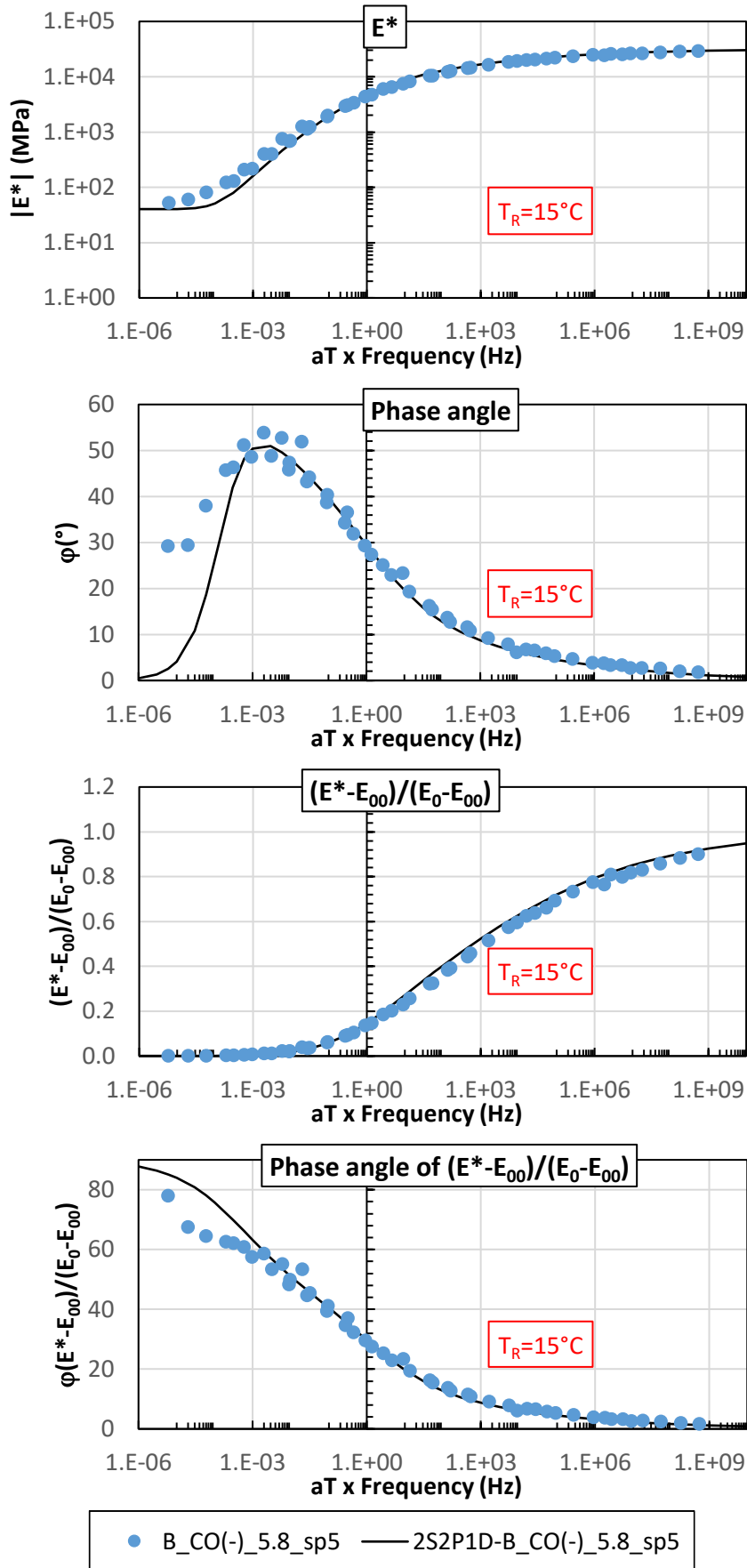
### 2.1 Complex modulus tests

#### 2.1.2.4. B\_CO(-)\_5.8\_sp5



## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests



## 2 Thermomechanical tests on bituminous mixtures

### 2.1 Complex modulus tests

#### 2.1.2.5. 2S2P1D model constants and WLF parameters

	2S2P1D constants							WLF parameters		
	<b>E<sub>00</sub></b> (MPa)	<b>E<sub>0</sub></b> (MPa)	<b>k</b> -	<b>h</b> -	<b>δ</b> -	<b>τ<sub>0</sub></b> (s)	<b>β</b> -	<b>T<sub>ref</sub></b> (°C)	<b>C<sub>1</sub></b> -	<b>C<sub>2</sub></b> (°C)
B_CO_5.8_sp11	45	32000	0.17	0.54	1.9	0.035	100	15	28.1	175.6
B_CO_5.8_sp12	20	33000	0.17	0.54	1.9	0.022	100	15	27.2	175.2
B_CO(+)_5.8_sp10	45	31800	0.17	0.54	1.9	0.015	100	15	27.9	177.1
B_CO(-)_5.8_sp5	40	32000	0.17	0.54	1.9	0.016	100	15	27.7	175.4



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

#### 2.2. Fatigue tests

##### 2.2.1.2PB test on trapezoidal specimen at 10°C/25Hz

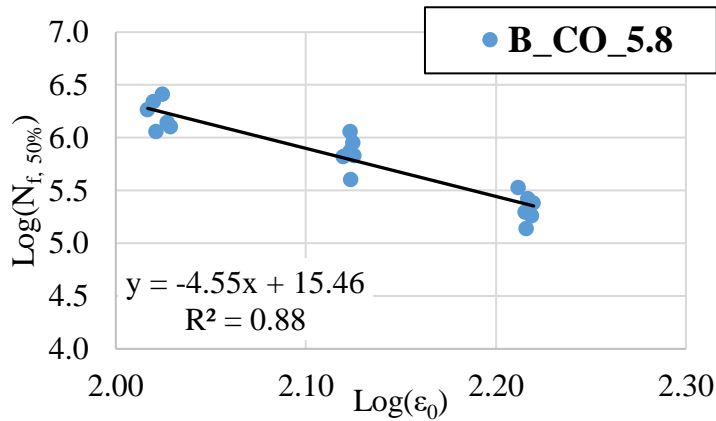
##### 2.2.1.1. B\_CO\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\varphi_{ini}$	$T_{ini}$	$N_f, 50\%$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	1	4.70	133	11203	14.9	9.1	891736
	2	5.00	133	11230	14.5	8.9	1143416
	3	5.20	133	11805	14.5	9.1	737903
	4	4.70	165	11960	15.4	9.5	263005
	5	4.70	163	11792	15.2	9.4	336592
	8	6.10	164	11265	14.9	8.7	137716
	9	4.20	164	11893	15.1	8.7	197628
	10	5.40	106	10680	15.7	9.8	1383847
	11	4.50	166	11967	15.1	9.6	182361
	12	5.50	166	12210	14.7	9.4	239979
	13	4.70	104	10572	16.5	9.8	1827698
	14	4.50	133	12030	14.4	9.2	398397
	15	4.80	105	12114	14.7	9.8	2195811
	16	5.00	105	12659	13.9	9.8	1134665
	18	5.50	133	11298	14.4	9.2	677085
	31	5.20	107	11548	14.3	9.1	1260750
	35	6.00	132	11171	14.2	8.5	664000
	36	5.40	106	11956	14.0	8.7	2578138

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.55</b>
a	15.46
b	-0.220
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>119.7</b>
$r^2$	0.875
S(LgN)	0.396
S(Lge)	0.0813
$S_N$	0.144
Loge	2.12
$S_0$	0.0387
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	4.7
Average VC (%)	5.06
SD VC (%)	0.52
$ E^*_{ini} $ (MPa)	11631
SD $ E^*_{ini} $ (MPa)	546
$\varphi_{ini}$	14.8
SD $\varphi_{ini}$ ( $^\circ$ )	0.6
$E2_{ini}$ (MPa)	2968
SD $E2_{ini}$ (MPa)	127
Confidence interval 1/b (P=97,5%)	0.91
$b_{min}$	-0.27
$b_{max}$	-0.18
$ \Delta b_{min} $	0.055
$ \Delta b_{max} $	0.037
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	113.5
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	126.1
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	6.1
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	6.5



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

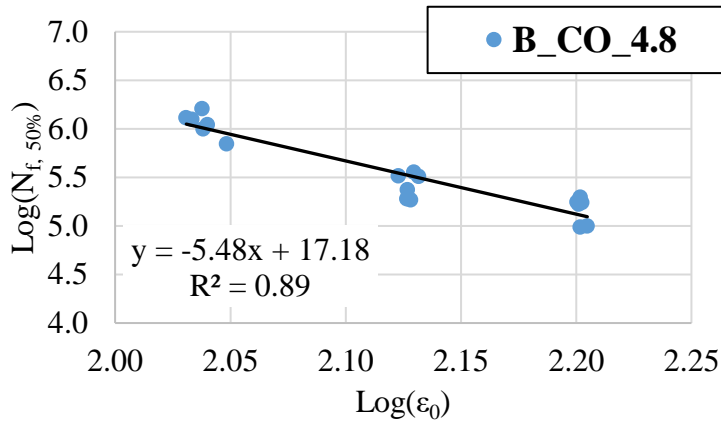
2.2.1.2. B\_CO\_4.8

Total 18	Sp. No.	VC (%)	$\epsilon_0$ ( $\mu\text{m/m}$ )	$ E^*_{ini} $ (MPa)	$\phi_{ini}$ ( $^\circ$ )	$T_{ini}$ ( $^\circ\text{C}$ )	$N_{f, 50\%}$ (cycle)
	1	5.80	134	11830	15.8	10.6	185922
	2	5.10	108	13243	13.6	10.3	1247162
	3	5.80	107	14759	11.3	9.3	1297394
	4	5.80	109	13400	12.8	10.3	1620414
	7	5.90	110	13222	12.6	9.3	1107322
	9	5.30	159	13806	12.8	9.4	174977
	11	5.70	159	13724	12.6	9.4	97063
	13	5.80	159	13371	12.7	9.4	166894
	14	5.90	134	13150	13.8	9.6	190441
	17	5.80	112	13468	12.5	9.9	703812
	18	6.40	109	13502	12.0	9.3	1003224
	21	5.00	135	13032	14.2	9.6	360604
	23	5.30	135	10638	16.9	10.6	325352
	24	5.40	159	13743	12.8	9.3	175926
	27	5.80	160	13459	12.4	9.3	99914
	29	5.60	159	13550	13.0	9.4	199002
	31	5.50	134	12612	14.3	9.8	236900
	32	5.80	133	13743	13.8	9.8	328164

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-5.48</b>
a	17.18
b	-0.182
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>109.6</b>
$r^2$	0.887
S(LgN)	0.402
S(Lg $\epsilon$ )	0.0691
$S_N$	0.139
Log $\epsilon$	2.12
$S_0$	0.0522
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	4.8
Average VC (%)	5.65
SD VC (%)	0.33
$ E^*_{ini} $ (MPa)	13236
SD $ E^*_{ini} $ (MPa)	870
$\phi_{ini}$	13.3
SD $\phi_{ini}$ ( $^\circ$ )	1.3
$E2_{ini}$ (MPa)	3031
SD $E2_{ini}$ (MPa)	131
Confidence interval 1/b (P=97,5%)	1.04
$b_{min}$	-0.23
$b_{max}$	-0.15
$ \Delta b_{min} $	0.043
$ \Delta b_{max} $	0.029
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	103.3
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	116.3
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	6.3
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	6.7



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

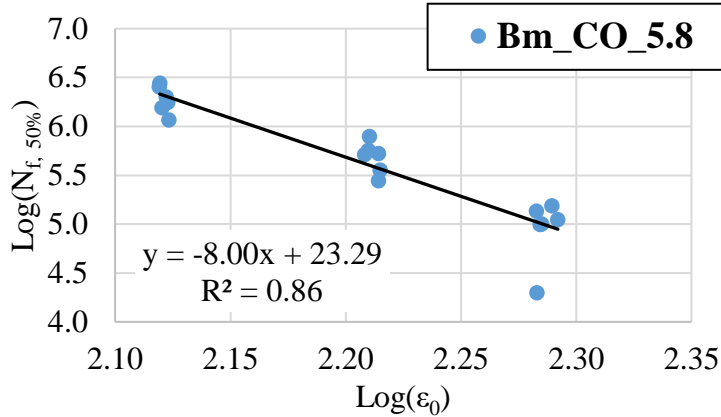
2.2.1.3. Bm\_CO\_5.8

Total 18	Sp. No.	VC (%)	$\epsilon_0$ ( $\mu\text{m/m}$ )	$ E^*_{ini} $ (MPa)	$\phi_{ini}$ ( $^\circ$ )	$T_{ini}$ ( $^\circ\text{C}$ )	$N_{f, 50\%}$ (cycle)
	1	5.00	192	11204	14.0	10.3	135680
	3	5.10	164	11751	13.2	10.1	357177
	4	5.00	164	11578	13.2	10.2	276752
	7	4.70	193	12035	13.1	10.3	98453
	8	5.20	132	12132	12.3	9.8	2765256
	11	5.40	162	11574	13.0	10.1	511604
	14	5.00	133	11226	13.1	9.8	1163451
	15	5.50	193	11916	13.2	10.2	100787
	19	4.90	133	11438	13.4	10.1	1993619
	20	4.80	195	11865	13.3	10.3	154313
	21	5.10	196	11302	13.6	10.2	110780
	24	5.10	132	11621	12.4	9.8	1548935
	26	5.70	192	11348	13.7	10.3	19718
	27	4.90	132	11901	13.3	10.1	2530389
	32	5.80	162	11410	13.4	10.3	782645
	33	5.60	162	11652	13.0	10.2	567261
	34	5.10	133	11432	13.1	10.1	1766402
	35	5.00	164	10889	13.3	10.3	529217

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-8.00</b>
a	23.29
b	-0.125
$\epsilon_6$ ( $\mu\text{def}$ )	<b>144.8</b>
$r^2$	0.861
S(LgN)	0.599
S(Lg $\epsilon$ )	0.0694
$S_N$	0.230
Log $\epsilon$	2.21
$S_0$	0.0655
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	5.5
Average VC (%)	5.16
SD VC (%)	0.31
$ E^*_{ini} $ (MPa)	11571
SD $ E^*_{ini} $ (MPa)	324
$\phi_{ini}$	13.2
SD $\phi_{ini}$ ( $^\circ$ )	0.4
$E2_{ini}$ (MPa)	2644
SD $E2_{ini}$ (MPa)	75
Confidence interval 1/b (P=97,5%)	1.70
$b_{min}$	-0.16
$b_{max}$	-0.10
$ \Delta b_{min} $	0.034
$ \Delta b_{max} $	0.022
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	137.6
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	152.3
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	7.2
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	7.5



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

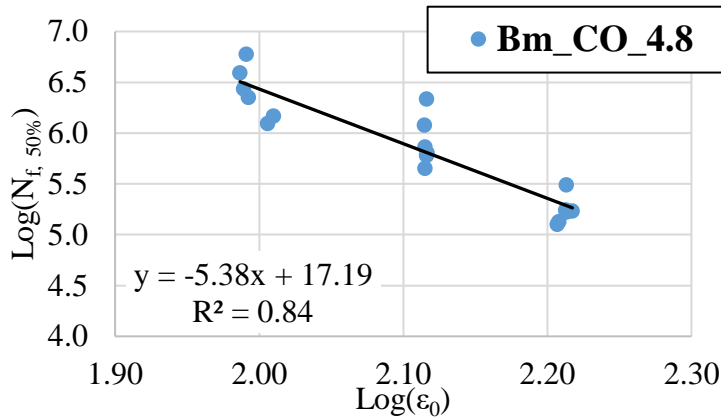
2.2.1.4. Bm\_CO\_4.8

Total 18	Sp. No.	VC (%)	$\epsilon_0$ ( $\mu\text{m/m}$ )	$ E^*_{ini} $ (MPa)	$\phi_{ini}$ ( $^\circ$ )	$T_{ini}$ ( $^\circ\text{C}$ )	$N_{f, 50\%}$ (cycle)
	1	6.32	165	12218	13.1	10.0	170793
	4	5.52	163	13605	12.1	10.0	167801
	5	5.42	161	13618	12.6	10.0	126959
	7	5.44	161	13776	12.3	10.0	135168
	9	5.54	131	13169	12.5	10.0	598323
	11	6.25	164	13088	13.3	10.0	307960
	15	6.43	97	13153	11.3	10.0	3932991
	18	5.43	130	13674	12.3	10.0	1202301
	19	5.07	98	14923	11.3	10.0	2736396
	20	7.25	130	14030	12.0	10.0	727069
	23	5.75	163	13526	12.4	10.0	175992
	24	6.24	130	14115	11.9	10.0	450300
	27	5.43	98	14824	11.1	10.0	5967718
	28	4.82	102	14178	11.4	10.0	1476954
	29	5.54	98	14070	11.0	10.0	2236390
	31	6.14	131	13464	11.7	10.0	636405
	33	5.23	131	13540	11.8	10.0	2172789
	34	4.41	101	13912	12.2	10.0	1239029

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-5.38</b>
a	17.19
b	-0.186
$\epsilon_6$ ( $\mu\text{def}$ )	<b>120.4</b>
$r^2$	0.844
S(LgN)	0.534
S(Lg $\epsilon$ )	0.0911
$S_N$	0.218
Log $\epsilon$	2.11
$S_0$	0.0537
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	5.5
Average VC (%)	5.68
SD VC (%)	0.67
$ E^*_{ini} $ (MPa)	13716
SD $ E^*_{ini} $ (MPa)	629
$\phi_{ini}$	12.0
SD $\phi_{ini}$ ( $^\circ$ )	0.7
$E2_{ini}$ (MPa)	2847
SD $E2_{ini}$ (MPa)	111
Confidence interval 1/b (P=97,5%)	1.23
$b_{min}$	-0.24
$b_{max}$	-0.15
$ \Delta b_{min} $	0.055
$ \Delta b_{max} $	0.035
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	113.2
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	128.1
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	7.2
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	7.7



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

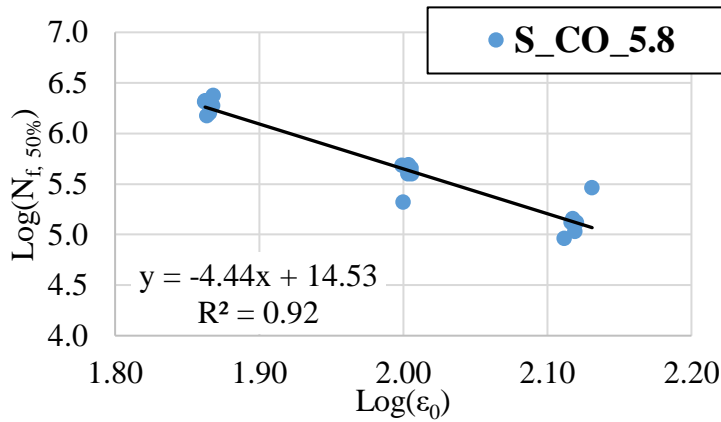
2.2.1.5. S\_CO\_5.8

Total 18	Sp. No.	VC (%)	$\epsilon_0$ ( $\mu\text{m/m}$ )	$ E^*_{ini} $ (MPa)	$\phi_{ini}$ ( $^\circ$ )	$T_{ini}$ ( $^\circ\text{C}$ )	$N_{f, 50\%}$ (cycle)
	1	5.40	74	13326	12.5	10.1	1876336
	4	5.40	129	13576	13.4	10.3	91604
	7	5.10	131	12749	13.9	10.3	130555
	8	5.60	74	13440	12.5	10.0	2349520
	9	4.00	100	14774	12.9	10.0	480150
	10	5.70	132	12329	14.2	10.5	106962
	11	5.30	101	13615	12.5	10.0	454307
	13	5.30	73	13521	12.5	10.1	1580354
	14	5.10	73	14142	12.8	10.1	2034572
	18	5.10	101	13808	12.9	10.0	396256
	19	6.30	135	7736	16.9	10.6	289753
	26	5.30	73	14050	12.9	10.1	1490752
	28	5.90	131	10693	15.2	10.5	142032
	29	4.70	73	14110	12.9	10.0	2097868
	30	5.40	101	13451	12.7	10.0	395791
	32	5.60	101	13089	12.6	10.0	486670
	34	5.10	100	14478	13.1	10.0	208446
	38	6.10	132	11758	15.2	10.5	130970

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.44</b>
a	14.53
b	-0.225
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>83.4</b>
$r^2$	0.916
S(LgN)	0.497
S(Lg $\epsilon$ )	0.1071
$S_N$	0.148
Log $\epsilon$	2.00
$S_0$	0.0430
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	3.7
Average VC (%)	5.36
SD VC (%)	0.52
$ E^*_{ini} $ (MPa)	13036
SD $ E^*_{ini} $ (MPa)	1648
$\phi_{ini}$	13.4
SD $\phi_{ini}$ ( $^\circ$ )	1.2
$E2_{ini}$ (MPa)	2993
SD $E2_{ini}$ (MPa)	231
Confidence interval 1/b (P=97,5%)	0.71
$b_{min}$	-0.27
$b_{max}$	-0.19
$ \Delta b_{min} $	0.043
$ \Delta b_{max} $	0.031
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	78.5
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	88.6
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	4.9
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	5.2



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

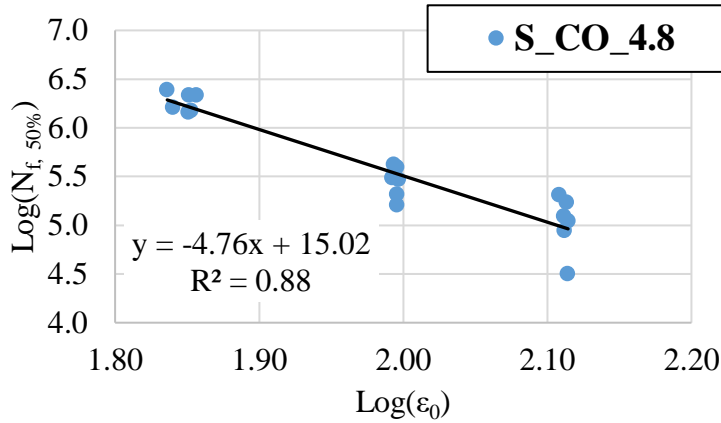
#### 2.2.1.6. S\_CO\_4.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_{f, 50\%}$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	1	5.98	99	15552	11.2	10.1	394837
	3	5.49	128	16308	12.0	9.8	204414
	9	5.14	72	16370	11.6	10.0	2167509
	11	6.24	99	15402	11.8	9.9	207199
	12	4.72	98	16519	11.4	10.0	305587
	13	5.97	130	16037	11.6	10.0	170767
	14	6.18	71	15903	11.0	10.0	2161759
	16	6.46	130	15574	12.0	9.8	31546
	17	6.23	71	15873	11.0	10.1	1489243
	18	5.81	99	15582	11.7	10.1	294510
	19	4.41	71	17133	11.0	10.1	1435275
	20	6.21	99	15125	11.5	10.0	160715
	22	6.11	69	15833	10.3	10.0	1604612
	23	6.13	99	15258	11.3	9.9	419740
	24	5.95	129	15748	11.6	10.0	87545
	25	6.26	130	15493	11.7	9.8	110815
	26	6.25	129	15438	12.1	9.8	123379
	27	6.21	69	15561	11.2	10.0	2453222

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.76</b>
a	15.02
b	-0.210
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>78.8</b>
$r^2$	0.883
S(LgN)	0.564
S(Lg $\epsilon$ )	0.1114
$S_N$	0.199
Log $\epsilon$	1.99
$S_0$	0.0605
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	4.6
Average VC (%)	5.87
SD VC (%)	0.57
$ E^*_{ini} $ (MPa)	15817
SD $ E^*_{ini} $ (MPa)	503
$\phi_{ini}$	11.5
SD $\phi_{ini}$ ( $^\circ$ )	0.4
$E2_{ini}$ (MPa)	3141
SD $E2_{ini}$ (MPa)	139
Confidence interval 1/b (P=97,5%)	0.92
$b_{min}$	-0.26
$b_{max}$	-0.18
$ \Delta b_{min} $	0.050
$ \Delta b_{max} $	0.034
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	72.8
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	85.3
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	6.0
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	6.5



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

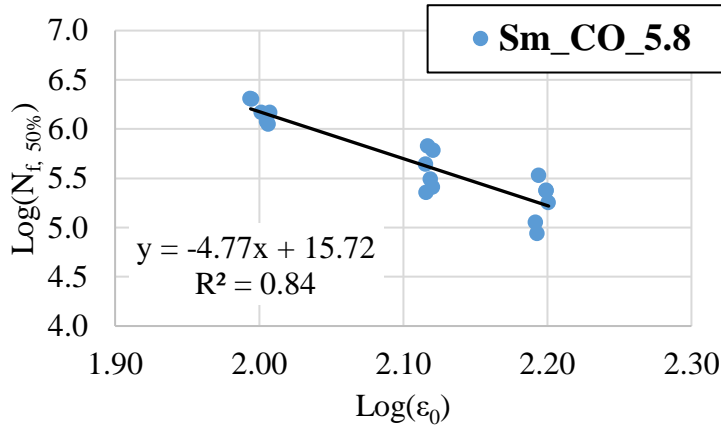
2.2.1.7. Sm\_CO\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_{f, 50\%}$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	35	4.63	131	13318	12.0	10.3	674988
	28	4.01	132	13381	12.5	10.3	613112
	34	4.49	131	13749	11.9	10.1	228689
	18	4.22	131	13805	12.4	10.1	309673
	1	4.73	99	13927	11.3	9.8	2011483
	16	3.93	102	13854	11.4	9.8	1474375
	9	4.57	100	14259	11.1	9.8	1480628
	25	4.05	101	14316	11.1	9.8	1193455
	12	4.45	99	14115	10.9	9.8	2040162
	5	4.24	102	13495	11.6	9.8	1126836
	29	4.84	131	13291	12.2	10.1	440019
	23	3.57	132	13825	12.3	10.1	256475
	31	4.69	156	13709	12.5	10.2	113662
	13	3.95	159	13718	12.3	10.2	179116
	11	4.55	156	14315	11.7	10.1	86979
	10	4.13	158	13517	12.2	10.1	240663
	3	4.92	156	13106	13.0	10.3	338948
	6	5.03	158	12925	13.0	10.3	235416

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.77</b>
a	15.72
b	-0.210
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>108.9</b>
$r^2$	0.839
S(LgN)	0.429
S(Lg $\epsilon$ )	0.0824
$S_N$	0.178
Log $\epsilon$	2.11
$S_0$	0.0551
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	5.8
Average VC (%)	4.39
SD VC (%)	0.40
$ E^*_{ini} $ (MPa)	13701
SD $ E^*_{ini} $ (MPa)	405
$\phi_{ini}$	11.9
SD $\phi_{ini}$ ( $^\circ$ )	0.6
$E_{2ini}$ (MPa)	2833
SD $E_{2ini}$ (MPa)	96
Confidence interval 1/b (P=97,5%)	1.11
$b_{min}$	-0.27
$b_{max}$	-0.17
$ \Delta b_{min} $	0.064
$ \Delta b_{max} $	0.040
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	101.4
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	117.0
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	7.5
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	8.1



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

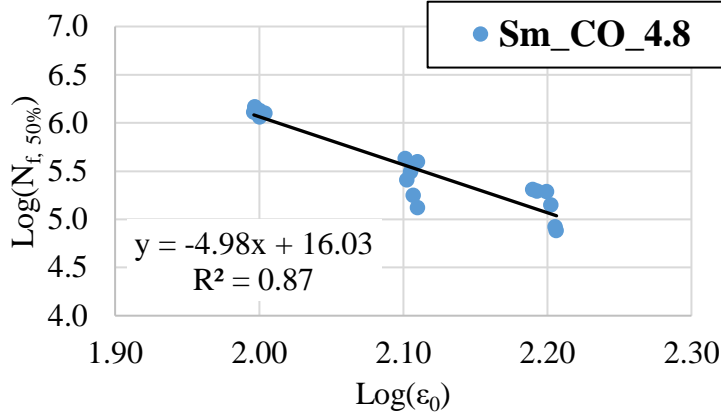
2.2.1.8. Sm\_CO\_4.8

Total 18	Sp. No.	VC (%)	$\epsilon_0$ ( $\mu\text{m/m}$ )	$ E^*_{ini} $ (MPa)	$\phi_{ini}$ ( $^\circ$ )	$T_{ini}$ ( $^\circ\text{C}$ )	$N_{f, 50\%}$ (cycle)
	17	3.85	99	16370	11.0	10.3	1471905
	11	4.23	100	16048	11.1	10.3	1351044
	10	4.60	99	16089	10.8	10.2	1286627
	7	4.54	100	16381	10.8	10.2	1155857
	14	4.23	101	16246	11.1	10.3	1267301
	12	4.44	100	15742	11.1	10.3	1357209
	18	4.06	127	16755	10.9	10.3	255207
	19	4.35	127	15838	11.3	10.3	308785
	1	5.21	129	14670	11.4	10.3	131917
	5	4.02	129	15551	11.5	10.3	394041
	8	4.79	126	16410	11.0	10.2	427529
	4	4.33	128	15388	11.3	10.2	178089
	20	4.05	156	17145	11.2	10.2	196979
	3	4.32	161	15453	11.8	10.2	76064
	22	7.04	158	14036	11.5	10.3	193562
	21	6.73	161	13546	11.8	10.3	83122
	15	3.02	159	16003	11.5	9.9	140196
	16	5.11	155	15703	11.9	9.9	202810

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.98</b>
a	16.03
b	-0.201
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>103.0</b>
$r^2$	0.867
S(LgN)	0.450
S(Lg $\epsilon$ )	0.0842
$S_N$	0.169
Log $\epsilon$	2.10
$S_0$	0.0589
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	5.6
Average VC (%)	4.61
SD VC (%)	0.96
$ E^*_{ini} $ (MPa)	15743
SD $ E^*_{ini} $ (MPa)	905
$\phi_{ini}$	11.3
SD $\phi_{ini}$ ( $^\circ$ )	0.3
$E2_{ini}$ (MPa)	3081
SD $E2_{ini}$ (MPa)	144
Confidence interval 1/b (P=97,5%)	1.03
$b_{min}$	-0.25
$b_{max}$	-0.17
$ \Delta b_{min} $	0.053
$ \Delta b_{max} $	0.034
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	95.7
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	110.9
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	7.3
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	7.8





2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

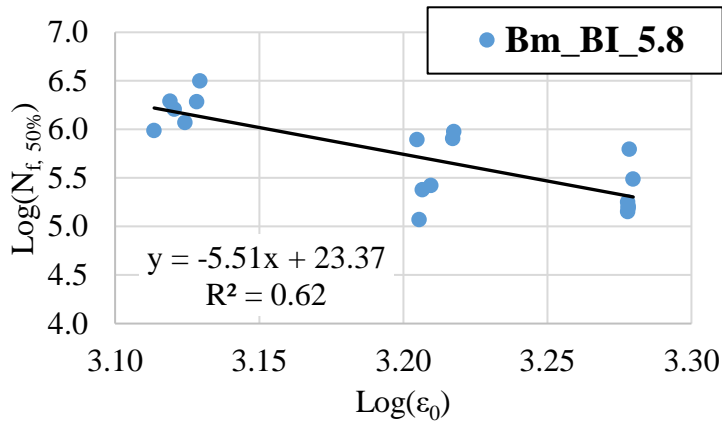
2.2.1.9. Bm\_BI\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_f, 50\%$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	1	4.27	1897	11407	14.0	10.2	140898
	5	3.68	1320	12317	13.1	10.2	1591355
	6	4.46	1344	11629	13.0	10.2	1910617
	9	5.99	1603	11903	13.3	10.2	781606
	11	4.58	1898	11758	13.5	10.1	153610
	12	3.76	1316	11521	13.6	10.2	1936631
	15	4.54	1899	11587	14.2	10.2	620882
	16	5.04	1348	11026	13.3	10.4	3131159
	17	4.20	1898	11342	13.8	10.1	160000
	19	4.30	1610	10423	14.2	10.2	237469
	21	4.67	1897	11581	13.4	10.2	176704
	23	4.71	1905	11412	13.8	10.2	303682
	25	5.02	1620	11412	13.6	10.3	262385
	28	4.99	1299	11772	13.0	10.2	967437
	31	4.87	1332	11681	12.7	10.2	1168288
	34	4.56	1650	11430	13.8	10.3	940543
	211	4.41	1649	11051	14.2	10.3	798131
	331	4.74	1606	11898	13.7	10.3	117012

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-5.51</b>
a	23.37
b	-0.182
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>1424.0</b>
$r^2$	0.623
S(LgN)	0.459
S(Lg $\epsilon$ )	0.0658
$S_N$	0.291
Log $\epsilon$	3.20
$S_0$	0.0871
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	103.8
Average VC (%)	4.60
SD VC (%)	0.52
$ E^*_{ini} $ (MPa)	11508
SD $ E^*_{ini} $ (MPa)	408
$\phi_{ini}$	13.6
SD $\phi_{ini}$ ( $^\circ$ )	0.4
$E2_{ini}$ (MPa)	2698
SD $E2_{ini}$ (MPa)	87
Confidence interval 1/b (P=97,5%)	2.27
$b_{min}$	-0.31
$b_{max}$	-0.13
$ \Delta b_{min} $	0.127
$ \Delta b_{max} $	0.053
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	1290.9
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	1570.8
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	133.1
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	146.8



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

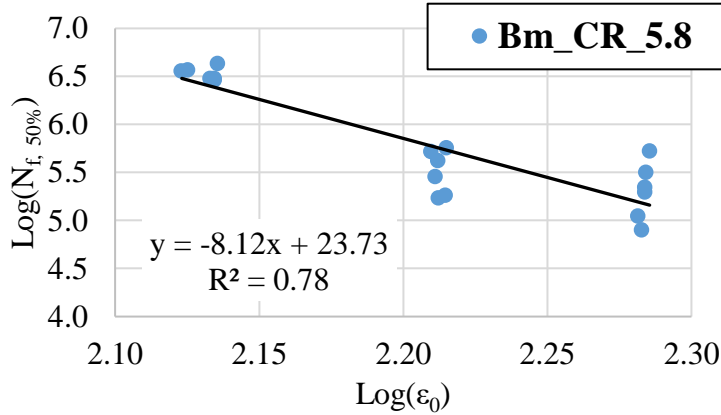
2.2.1.10. Bm\_CR\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_{f, 50\%}$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	3	4.53	164	11717	14.0	10.0	572120
	6	4.30	162	12521	13.8	10.0	525125
	8	4.75	136	11621	14.1	10.0	3008963
	9	4.09	163	12588	13.6	10.0	418480
	11	4.39	191	12638	14.2	10.1	111493
	13	4.41	192	11451	14.9	10.0	198941
	15	4.09	163	11978	14.2	10.0	171501
	16	4.26	136	12093	14.1	10.0	3024254
	20	4.69	164	11669	14.1	10.0	182602
	21	4.20	137	11482	14.2	10.0	4338194
	24	4.27	133	12372	13.5	10.0	3719200
	26	4.16	192	11876	14.7	10.0	79854
	27	4.60	192	11692	14.7	10.1	317086
	28	4.32	193	11378	14.5	10.0	532461
	29	5.01	133	12252	13.6	10.0	3623773
	30	4.38	163	12168	13.7	10.0	285973
	32	4.36	192	11226	15.0	10.0	221579
	34	3.95	136	11892	14.2	10.0	2916669

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-8.12</b>
a	23.73
b	-0.123
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>152.1</b>
$r^2$	0.782
S(LgN)	0.590
S(Lg $\epsilon$ )	0.0642
$S_N$	0.284
Log $\epsilon$	2.21
$S_0$	0.0730
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	6.3
Average VC (%)	4.37
SD VC (%)	0.26
$ E^*_{ini} $ (MPa)	11923
SD $ E^*_{ini} $ (MPa)	432
$\phi_{ini}$	14.2
SD $\phi_{ini}$ ( $^\circ$ )	0.4
$E2_{ini}$ (MPa)	2914
SD $E2_{ini}$ (MPa)	74
Confidence interval 1/b (P=97,5%)	2.28
$b_{min}$	-0.17
$b_{max}$	-0.10
$ \Delta b_{min} $	0.048
$ \Delta b_{max} $	0.027
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	143.9
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	160.8
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	8.2
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	8.7



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

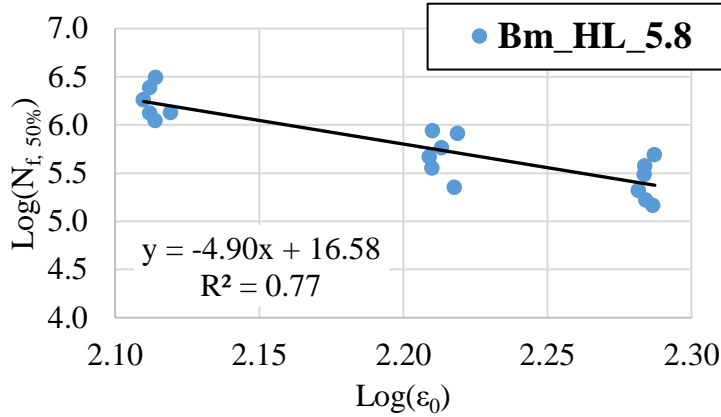
2.2.1.11. Bm\_HL\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_{f, 50\%}$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	2	5.02	162	9865	15.9	10.0	873199
	4	4.11	129	12254	13.5	10.0	2456457
	5	4.69	193	10218	16.3	10.0	145945
	6	3.60	132	11907	14.5	10.0	1340838
	9	4.32	130	12273	13.6	10.0	3132184
	10	5.20	162	9806	16.5	10.0	468577
	11	4.85	192	9893	17.2	10.0	166865
	12	3.44	130	12601	14.6	10.0	1112043
	13	5.58	192	9702	16.9	9.9	304651
	14	4.43	129	12752	13.6	10.0	1332132
	15	4.33	129	12356	13.9	10.0	1820155
	17	5.73	191	9805	16.5	9.9	209092
	61	6.42	194	9359	17.0	10.0	489133
	91	5.19	192	9754	17.0	10.0	376996
	121	5.26	162	9715	16.9	9.9	357900
	141	5.94	163	9507	16.0	9.9	579839
	274	3.70	165	12085	14.1	10.5	225913
	314	4.00	166	11983	14.4	10.5	817815

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.90</b>
a	16.58
b	-0.204
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>144.4</b>
$r^2$	0.773
S(LgN)	0.402
S(Lg $\epsilon$ )	0.0722
$S_N$	0.198
Log $\epsilon$	2.20
$S_0$	0.0551
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	7.5
Average VC (%)	4.77
SD VC (%)	0.85
$ E^*_{ini} $ (MPa)	10880
SD $ E^*_{ini} $ (MPa)	1310
$\phi_{ini}$	15.5
SD $\phi_{ini}$ ( $^\circ$ )	1.4
$E2_{ini}$ (MPa)	2873
SD $E2_{ini}$ (MPa)	129
Confidence interval 1/b (P=97,5%)	1.41
$b_{min}$	-0.29
$b_{max}$	-0.16
$ \Delta b_{min} $	0.082
$ \Delta b_{max} $	0.046
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	134.7
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	154.8
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	9.7
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	10.4



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

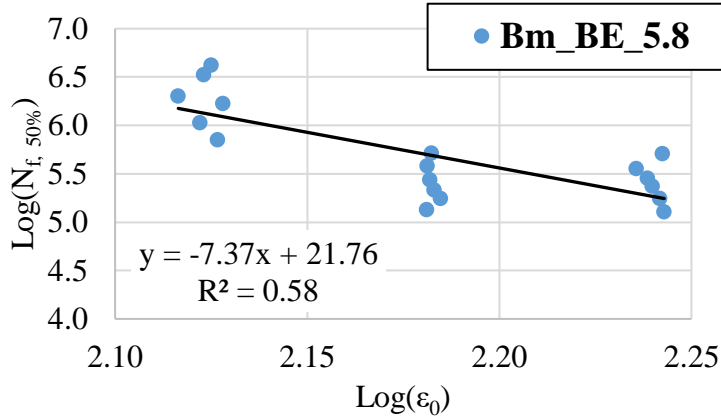
2.2.1.12. Bm\_BE\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_{f, 50\%}$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	1	4.17	172	12456	8.1	10.2	358160
	3	4.49	175	11521	8.9	10.2	511760
	5	4.25	152	10901	8.6	10.2	274977
	8	4.52	173	12290	8.1	10.2	284414
	11	5.25	174	10903	8.8	10.2	234852
	14	3.92	131	12105	8.0	10.3	2002362
	17	3.76	152	11847	8.5	10.3	134865
	20	4.43	134	11499	7.9	10.1	708626
	24	4.29	153	11331	9.0	10.5	175794
	25	4.13	175	11147	9.2	10.2	128359
	27	4.85	134	11652	8.2	10.4	1694169
	28	5.82	175	10710	9.1	10.2	176820
	30	4.03	132	12388	8.5	10.2	1073446
	31	4.59	152	11362	8.3	10.2	216568
	33	4.27	133	12082	8.0	10.2	4201532
	36	3.99	152	11321	9.1	10.5	383963
	38	4.79	152	11538	8.5	10.3	518509
	40	4.02	133	12113	8.3	10.4	3354094

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-7.37</b>
a	21.76
b	-0.136
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>138.1</b>
$r^2$	0.585
S(LgN)	0.473
S(Lg $\epsilon$ )	0.0491
$S_N$	0.314
Log $\epsilon$	2.18
$S_0$	0.0984
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	8.5
Average VC (%)	4.42
SD VC (%)	0.51
$ E^*_{ini} $ (MPa)	11620
SD $ E^*_{ini} $ (MPa)	533
$\phi_{ini}$	8.5
SD $\phi_{ini}$ ( $^\circ$ )	0.4
$E2_{ini}$ (MPa)	1719
SD $E2_{ini}$ (MPa)	66
Confidence interval 1/b (P=97,5%)	3.29
$b_{min}$	-0.25
$b_{max}$	-0.09
$ \Delta b_{min} $	0.109
$ \Delta b_{max} $	0.042
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	127.1
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	150.1
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	11.0
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	11.9



## 2 Thermomechanical tests on bituminous mixtures

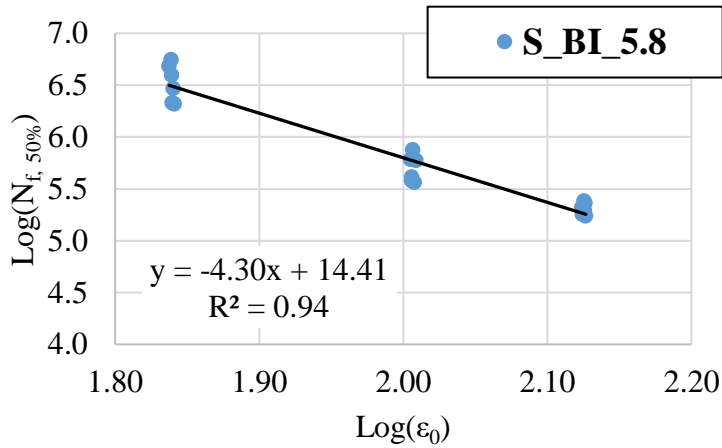
### 2.2 Fatigue tests

#### 2.2.1.13. S\_BI\_5.8

18	-	(%)	( $\mu\text{m}/\text{m}$ )	(MPa)	( $^{\circ}$ )	( $^{\circ}\text{C}$ )	(cycle)
3	4.70	102	13780	13.6	10.1	363444	
5	5.20	69	13791	12.8	10.1	5505327	
7	4.54	133	13203	13.7	10.1	207098	
9	5.31	69	13169	13.0	10.1	2905559	
11	5.12	134	13177	13.5	10.1	192734	
13	4.89	134	13214	13.5	10.1	227495	
15	5.07	102	13167	13.2	10.1	746369	
16	4.56	101	14201	13.4	10.1	606722	
20	4.60	69	13600	13.3	10.1	4815337	
24	5.42	101	13251	13.1	10.1	409907	
26	5.29	102	13029	13.2	10.1	588725	
29	4.85	133	13125	13.6	10.1	178207	
30	4.59	101	14060	13.3	10.1	375507	
31	5.35	69	13749	12.7	10.1	2114293	
34	4.55	69	13045	12.8	10.1	3913826	
35	5.22	134	13518	13.3	10.1	172439	
36	4.93	134	12946	13.3	10.1	239759	
37	4.97	69	13430	13.3	10.1	2081562	

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.30</b>
a	14.41
b	-0.232
$\epsilon_6$ ( $\mu\text{def}$ )	<b>89.9</b>
$r^2$	0.937
S(LgN)	0.536
S(Lg $\epsilon$ )	0.1207
$S_N$	0.138
Log $\epsilon$	1.99
$S_0$	0.0342
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	3.3
Average VC (%)	4.95
SD VC (%)	0.31
$ E^*_{\text{ini}} $ (MPa)	13414
SD $ E^*_{\text{ini}} $ (MPa)	371
$\phi_{\text{ini}}$	13.3
SD $\phi_{\text{ini}}$ ( $^{\circ}$ )	0.3
$E2_{\text{ini}}$ (MPa)	3082
SD $E2_{\text{ini}}$ (MPa)	104
Confidence interval 1/b (P=97,5%)	0.59
$b_{\text{min}}$	-0.27
$b_{\text{max}}$	-0.20
$ \Delta b_{\text{min}} $	0.037
$ \Delta b_{\text{max}} $	0.028
$\epsilon_{6, \text{min}}$ ( $\mu\text{def}$ ) (P=95%)	85.5
$\epsilon_{6, \text{max}}$ ( $\mu\text{def}$ ) (P=95%)	94.4
$ \Delta\epsilon_{6, \text{min}} $ ( $\mu\text{def}$ )	4.3
$ \Delta\epsilon_{6, \text{max}} $ ( $\mu\text{def}$ )	4.5



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

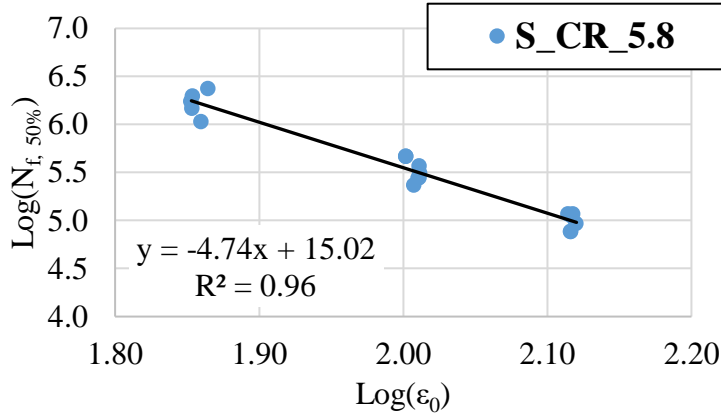
2.2.1.14. S\_CR\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_f, 50\%$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	1	5.20	102	13894	13.6	10.2	232524
	6	4.87	103	13710	13.9	10.2	277912
	7	5.24	131	13505	14.0	10.3	76668
	8	4.98	130	13667	14.0	10.3	117914
	12	4.96	73	13173	13.4	10.3	2354468
	13	5.05	103	13374	13.7	10.2	314860
	14	4.65	71	13479	13.7	10.3	1980972
	16	4.87	102	13324	13.9	10.2	277384
	18	5.16	71	13113	13.5	10.3	1732781
	19	4.84	131	13174	14.5	10.3	112067
	21	5.17	131	13573	14.1	10.3	117458
	23	5.49	103	13016	13.7	10.2	368494
	25	4.73	100	13383	14.1	10.2	466276
	28	4.68	132	12972	14.7	10.3	93705
	30	5.08	71	13422	13.4	10.2	1480380
	25	4.73	100	13383	14.1	10.2	466276
	36	5.14	72	13778	13.1	10.3	1070981
	40	4.65	131	13430	14.3	10.3	77281

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.74</b>
a	15.02
b	-0.211
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>80.4</b>
$r^2$	0.958
S(LgN)	0.505
S(Lg $\epsilon$ )	0.1044
$S_N$	0.106
Log $\epsilon$	2.00
$S_0$	0.0346
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	2.7
Average VC (%)	4.97
SD VC (%)	0.24
$ E^*_{ini} $ (MPa)	13409
SD $ E^*_{ini} $ (MPa)	257
$\phi_{ini}$	13.9
SD $\phi_{ini}$ ( $^\circ$ )	0.4
$E2_{ini}$ (MPa)	3220
SD $E2_{ini}$ (MPa)	93
Confidence interval 1/b (P=97,5%)	0.52
$b_{min}$	-0.24
$b_{max}$	-0.19
$ \Delta b_{min} $	0.026
$ \Delta b_{max} $	0.021
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	76.8
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	84.1
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	3.6
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	3.7



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

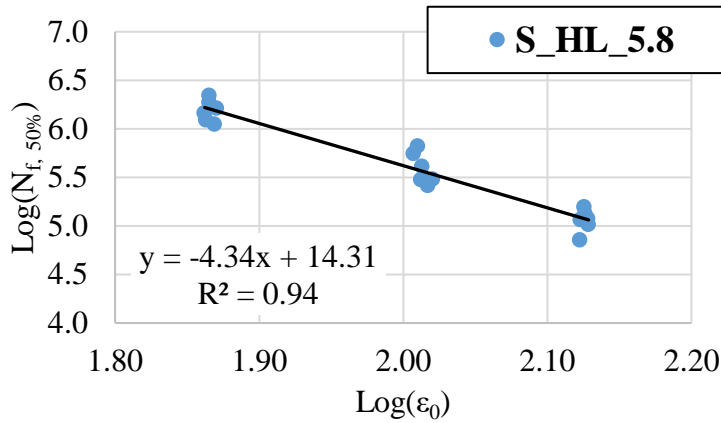
2.2.1.15. S\_HL\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_{f, 50\%}$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	4	4.77	74	12971	14.7	10.5	1635464
	5	5.07	73	13375	14.3	10.5	1453859
	6	5.67	73	13226	14.1	10.2	2209803
	7	4.62	134	12985	14.1	10.3	157878
	8	5.80	73	12949	14.1	10.2	1235631
	9	5.30	133	12775	14.4	10.4	72171
	13	5.73	133	13187	14.0	10.3	116993
	14	4.38	103	13317	14.4	10.3	300629
	16	4.68	74	13189	14.5	10.2	1113972
	18	4.82	134	13097	14.8	10.4	119375
	20	5.56	102	13565	13.7	10.3	559907
	32	3.70	105	13850	14.0	10.0	305853
	35	3.70	102	13693	14.9	9.9	667050
	108	5.10	104	13651	14.5	10.0	262741
	113	5.84	134	12616	14.2	10.2	104364
	161	4.70	103	14232	14.6	10.0	412165
	181	4.05	73	14130	13.9	10.2	1870456
	193	4.34	134	13155	14.5	10.2	133629

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.34</b>
a	14.31
b	-0.230
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>81.8</b>
$r^2$	0.939
S(LgN)	0.491
S(Lg $\epsilon$ )	0.1095
$S_N$	0.125
Log $\epsilon$	2.00
$S_0$	0.0385
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	3.3
Average VC (%)	4.88
SD VC (%)	0.69
$ E^*_{ini} $ (MPa)	13331
SD $ E^*_{ini} $ (MPa)	445
$\phi_{ini}$	14.3
SD $\phi_{ini}$ ( $^\circ$ )	0.3
$E2_{ini}$ (MPa)	3302
SD $E2_{ini}$ (MPa)	129
Confidence interval 1/b (P=97,5%)	0.59
$b_{min}$	-0.27
$b_{max}$	-0.20
$ \Delta b_{min} $	0.036
$ \Delta b_{max} $	0.027
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	77.4
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	86.4
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	4.4
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	4.6



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

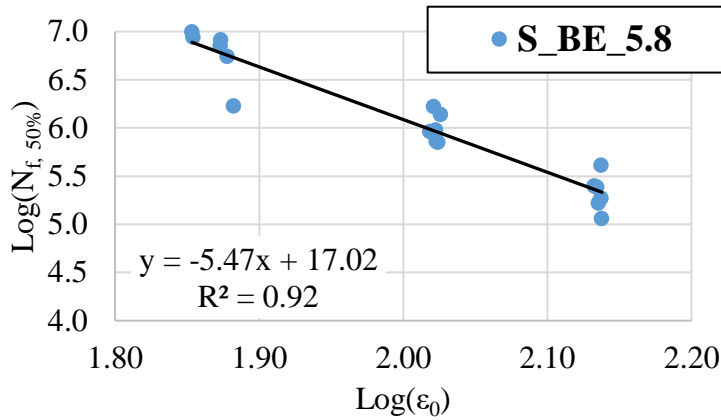
2.2.1.16. S\_BE\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_{f, 50\%}$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	2	4.85	76	14213	7.8	9.7	1696675
	4	4.87	71	13760	8.1	9.7	9913360
	6	5.35	106	13126	8.4	10.0	1380885
	7	5.51	72	14301	7.6	9.7	8745789
	8	5.39	106	13220	8.2	9.7	708415
	9	5.72	105	13147	9.0	10.1	730322
	10	4.71	136	13126	8.2	9.8	243829
	12	4.50	137	13777	8.7	9.8	115487
	13	5.43	75	13819	7.8	9.7	7120086
	14	4.60	136	13969	8.6	9.8	250795
	15	5.70	137	13530	8.1	9.8	185802
	16	4.70	105	14000	8.6	10.0	955383
	17	5.42	137	13710	8.4	9.8	409487
	22	5.27	105	13822	7.7	9.8	1670972
	25	4.78	75	13431	8.0	9.7	8224579
	27	4.59	137	14777	8.2	9.8	167273
	28	4.79	104	14155	8.1	9.8	916969
	34	5.12	76	14339	8.1	9.7	5528699

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-5.47</b>
a	17.02
b	-0.183
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>103.7</b>
$r^2$	0.917
S(LgN)	0.643
S(Lg $\epsilon$ )	0.1127
$S_N$	0.191
Log $\epsilon$	2.01
$S_0$	0.0452
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	3.9
Average VC (%)	5.07
SD VC (%)	0.41
$ E^*_{ini} $ (MPa)	13790
SD $ E^*_{ini} $ (MPa)	470
$\phi_{ini}$	8.2
SD $\phi_{ini}$ ( $^\circ$ )	0.4
$E2_{ini}$ (MPa)	1969
SD $E2_{ini}$ (MPa)	92
Confidence interval 1/b (P=97,5%)	0.87
$b_{min}$	-0.22
$b_{max}$	-0.16
$ \Delta b_{min} $	0.035
$ \Delta b_{max} $	0.025
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	98.5
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	109.2
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	5.2
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	5.5





2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

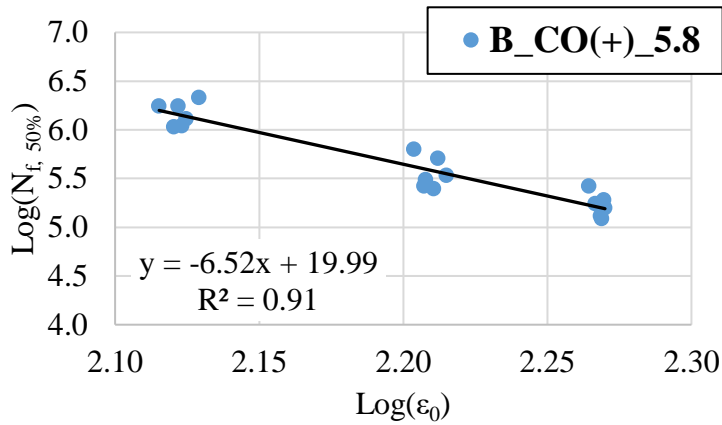
2.2.1.17. B\_CO(+)\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_f, 50\%$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	12	4.93	135	10156	16.1	9.9	2138198
	35	3.88	133	11115	16.4	9.9	1290706
	10	4.66	133	10378	16.0	9.6	1095838
	38	3.98	132	11260	16.3	9.6	1062561
	23	4.25	132	10590	16.3	10.1	1732006
	32	4.15	130	10908	16.5	10.1	1745087
	2	4.59	161	10703	16.5	9.7	263667
	6	4.20	160	10705	16.6	9.7	629544
	29	4.68	163	10595	16.4	10.1	504741
	24	3.85	161	11011	16.8	10.1	307326
	28	4.54	162	10693	16.6	10.1	246334
	1	4.00	164	11134	16.9	10.1	336346
	25	4.61	186	10552	17.0	10.1	156847
	37	3.87	184	10965	17.2	10.1	264152
	18	4.54	186	10250	17.1	10.1	129954
	3	3.90	186	10878	17.3	10.1	121104
	33	3.91	185	10483	17.5	10.1	173137
	39	3.94	186	10757	17.0	10.1	189311

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-6.52</b>
a	19.99
b	-0.153
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>139.9</b>
$r^2$	0.906
S(LgN)	0.422
S(Lg $\epsilon$ )	0.0616
$S_N$	0.133
Log $\epsilon$	2.20
$S_0$	0.0423
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	4.2
Average VC (%)	4.25
SD VC (%)	0.36
$ E^*_{ini} $ (MPa)	10730
SD $ E^*_{ini} $ (MPa)	307
$\phi_{ini}$	16.7
SD $\phi_{ini}$ ( $^\circ$ )	0.4
$E2_{ini}$ (MPa)	3083
SD $E2_{ini}$ (MPa)	121
Confidence interval 1/b (P=97,5%)	1.11
$b_{min}$	-0.18
$b_{max}$	-0.13
$ \Delta b_{min} $	0.032
$ \Delta b_{max} $	0.022
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	134.4
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	145.7
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	5.5
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	5.7



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

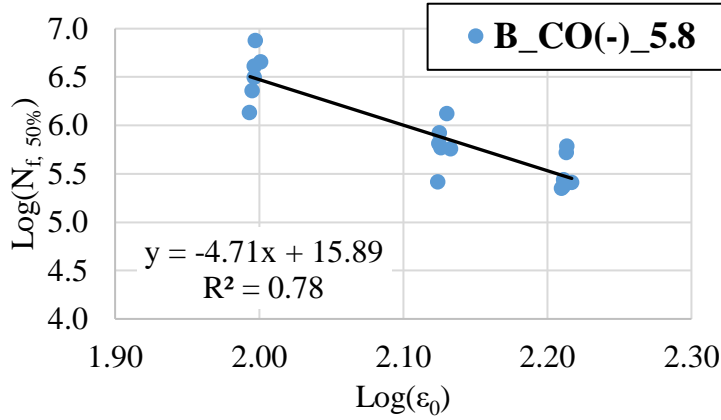
2.2.1.18. B\_CO(-)\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_f, 50\%$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	3	4.63	134	10091	15.4	10.2	589980
	4	4.58	99	10505	15.0	10.3	3120818
	5	4.55	136	10079	15.5	10.1	576075
	11	5.07	99	11040	14.1	10.3	4079678
	15	4.64	163	10665	15.6	10.5	526657
	16	4.83	133	11209	15.5	10.2	260606
	17	4.68	100	9881	15.1	10.4	4519105
	18	4.95	99	11031	15.0	10.4	2291072
	19	4.43	99	10781	15.2	10.3	1354378
	20	4.92	99	10934	14.8	10.3	7497495
	22	4.92	163	10671	16.0	10.4	233662
	24	4.70	165	10130	15.6	10.4	256409
	27	4.57	164	10740	15.1	10.4	608233
	28	4.85	133	10610	16.3	10.2	652634
	29	4.78	135	10181	15.5	10.2	1324752
	30	4.75	133	10786	15.5	10.1	837876
	31	4.85	163	10380	16.0	10.4	274147
	38	4.73	162	10787	15.7	10.5	223403

Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

<b>1/b</b>	<b>-4.71</b>
a	15.89
b	-0.212
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>126.1</b>
$r^2$	0.783
S(LgN)	0.486
S(Lg $\epsilon$ )	0.0914
$S_N$	0.234
Log $\epsilon$	2.11
$S_0$	0.0556
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	6.9
Average VC (%)	4.75
SD VC (%)	0.17
$ E^*_{ini} $ (MPa)	10583
SD $ E^*_{ini} $ (MPa)	383
$\phi_{ini}$	15.4
SD $\phi_{ini}$ ( $^\circ$ )	0.5
$E2_{ini}$ (MPa)	2808
SD $E2_{ini}$ (MPa)	116
Confidence interval 1/b (P=97,5%)	1.32
$b_{min}$	-0.29
$b_{max}$	-0.17
$ \Delta b_{min} $	0.082
$ \Delta b_{max} $	0.046
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	117.2
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	135.6
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	8.9
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	9.6

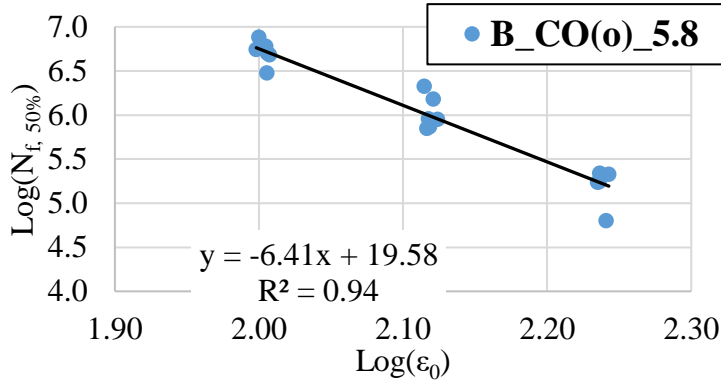


## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

#### 2.2.1.19. B\_CO(o)\_5.8

Total	Sp. No.	VC	$\epsilon_0$	$ E^*_{ini} $	$\phi_{ini}$	$T_{ini}$	$N_{f, 50\%}$
18	-	(%)	( $\mu\text{m/m}$ )	(MPa)	( $^\circ$ )	( $^\circ\text{C}$ )	(cycle)
	1	5.60	174	10128	16.6	10.2	62655
	2	6.12	131	10685	15.2	10.5	705408
	6	4.99	100	11437	14.4	10.1	7616107
	7	5.14	172	10622	16.5	10.4	173158
	8	4.48	132	11026	15.4	10.2	1520248
	10	5.66	101	11218	14.5	10.2	5972131
	11	4.87	133	10656	15.6	10.5	893797
	12	5.15	172	10696	16.9	10.2	217061
	14	5.40	101	11054	14.0	10.3	5022426
	16	4.94	172	10694	17.2	10.3	171210
	17	6.12	175	9869	16.9	10.3	211559
	20	5.18	101	11199	14.2	10.3	2993976
	22	4.31	131	10866	15.1	10.2	902148
	28	5.12	100	11569	14.5	10.2	5558484
	33	6.51	131	10659	14.9	10.2	728526
	34	4.52	130	10389	15.4	10.2	2117709
	36	6.12	102	10875	14.3	10.1	4812005
	37	5.67	173	10748	16.3	10.4	209666



Statistical analysis (NF EN 12697-24)

$$\text{Log}(N_f) = a + \frac{\text{Log}(\epsilon_0)}{b}$$

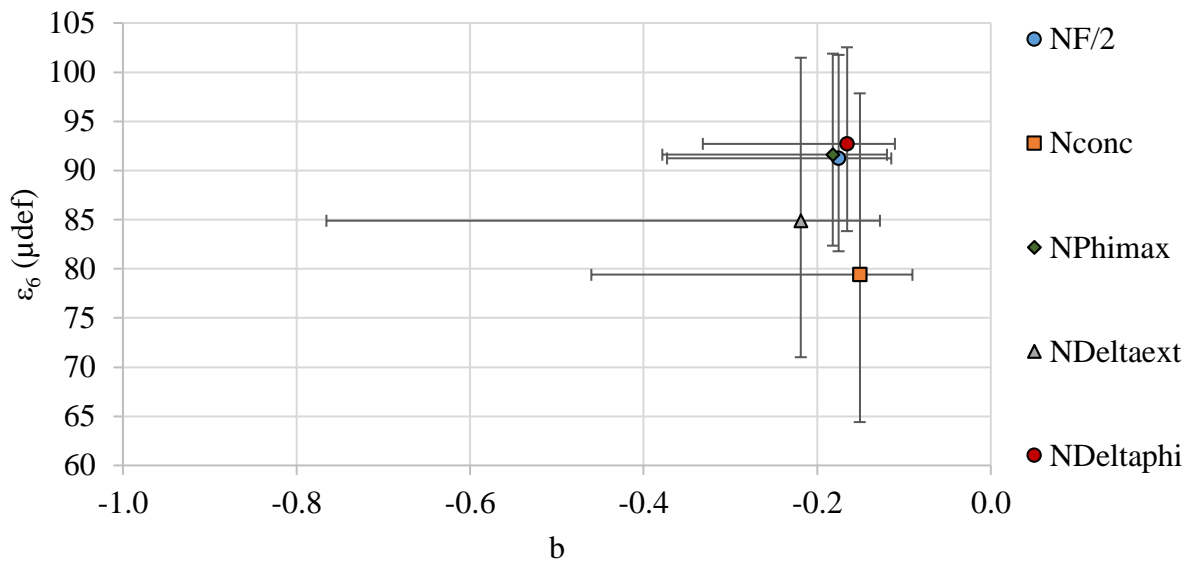
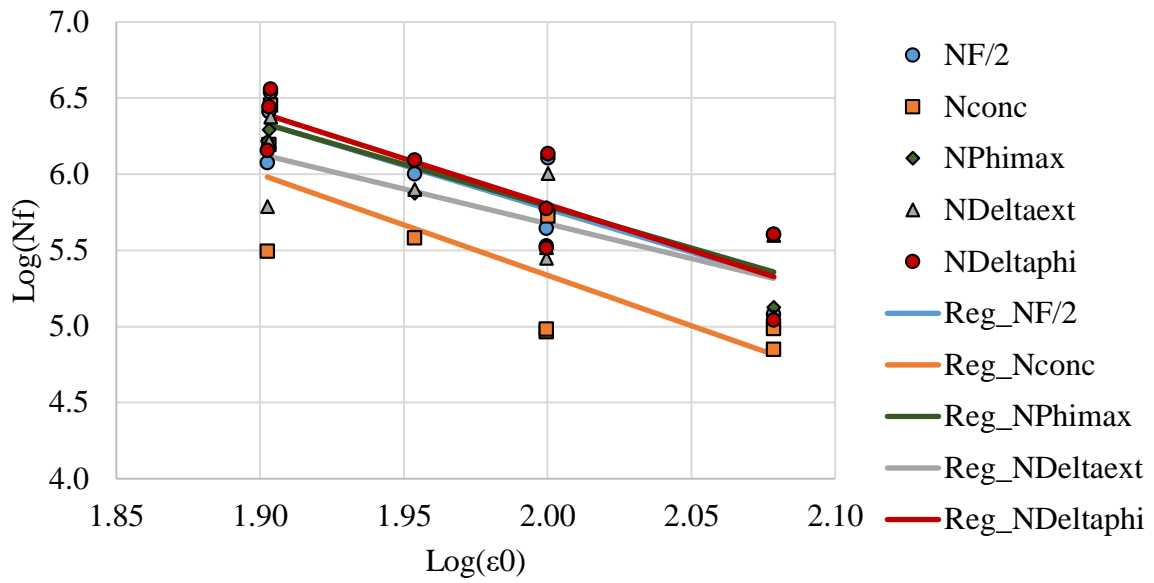
<b>1/b</b>	<b>-6.41</b>
a	19.58
b	-0.156
<b><math>\epsilon_6</math> (<math>\mu\text{def}</math>)</b>	<b>130.9</b>
$r^2$	0.936
S(LgN)	0.654
S(Lg $\epsilon$ )	0.0986
$S_N$	0.170
Log $\epsilon$	2.12
$S_0$	0.0402
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	3.8
Average VC (%)	5.33
SD VC (%)	0.62
$ E^*_{ini} $ (MPa)	10800
SD $ E^*_{ini} $ (MPa)	424
$\phi_{ini}$	15.4
SD $\phi_{ini}$ ( $^\circ$ )	1.1
$E_{2ini}$ (MPa)	2870
SD $E_{2ini}$ (MPa)	137
Confidence interval 1/b (P=97,5%)	0.89
$b_{min}$	-0.18
$b_{max}$	-0.14
$ \Delta b_{min} $	0.025
$ \Delta b_{max} $	0.019
$\epsilon_{6, min}$ ( $\mu\text{def}$ ) (P=95%)	126.0
$\epsilon_{6, max}$ ( $\mu\text{def}$ ) (P=95%)	136.1
$ \Delta\epsilon_{6, min} $ ( $\mu\text{def}$ )	5.0
$ \Delta\epsilon_{6, max} $ ( $\mu\text{def}$ )	5.2

## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

#### 2.2.2. TC test on cylindrical specimen at 10°C/10Hz

##### 2.2.2.1. B\_CO\_5.8



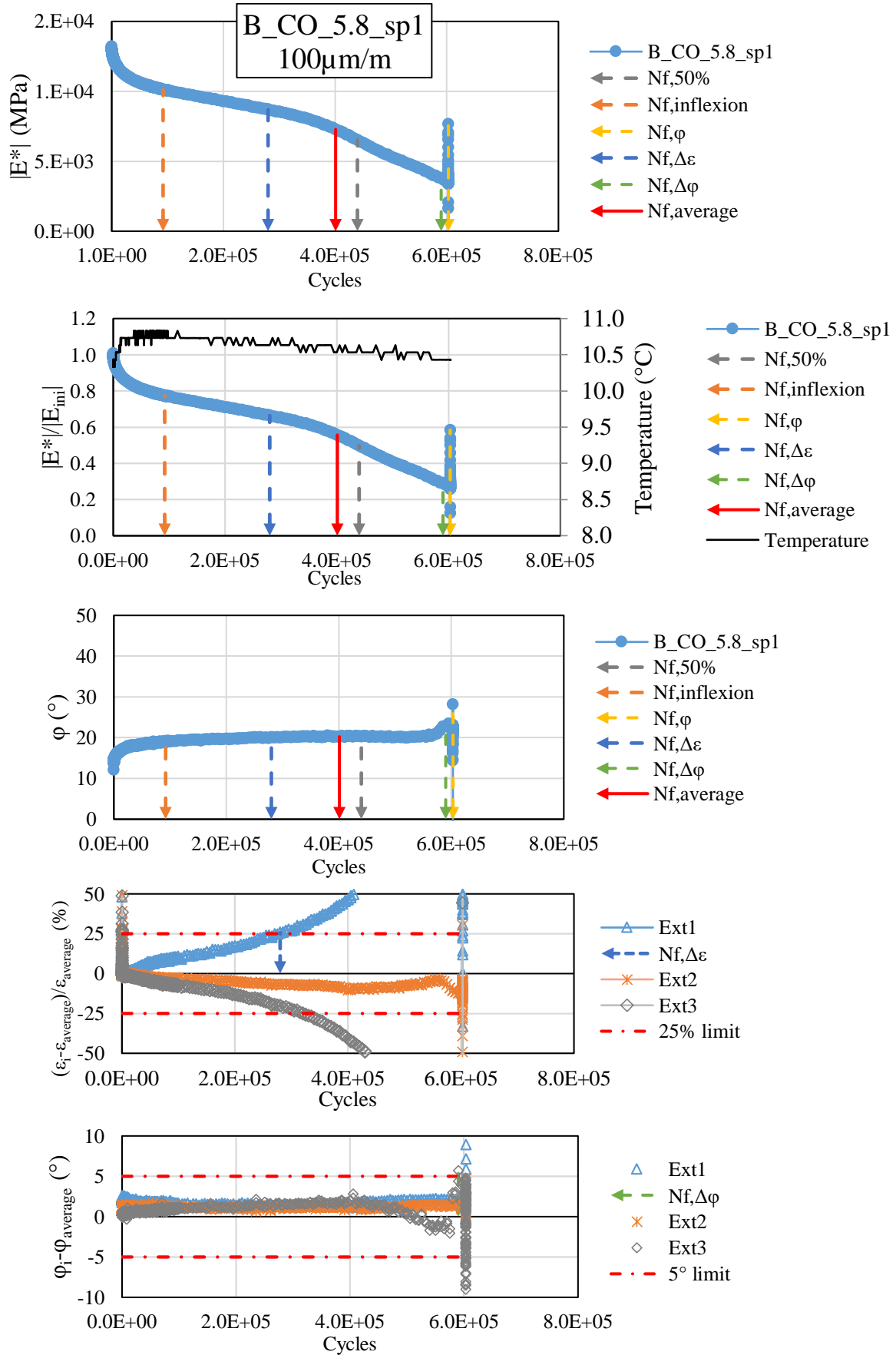
2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

	$N_{f, 50\%}$	$N_{f, 1st\ inflexion}$	$N_{f, \varphi_{max}}$	$N_{f, \Delta\epsilon_i}$	$N_{f, \Delta\varphi_i}$
1/b	-5.70	-6.62	-5.50	-4.57	-6.03
a	17.17	18.58	16.79	14.81	17.86
<b>b</b>	<b>-0.18</b>	<b>-0.15</b>	<b>-0.18</b>	<b>-0.22</b>	<b>-0.17</b>
$\epsilon_6$ ( $\mu\text{def}$ )	<b>91.22</b>	<b>79.39</b>	<b>91.60</b>	<b>84.88</b>	<b>92.71</b>
$r^2$	0.74	0.64	0.75	0.61	0.76
S(LgN)	0.46	0.58	0.44	0.41	0.48
S(Lg $\epsilon$ )	0.07	0.07	0.07	0.07	0.07
$S_N$	0.25	0.37	0.24	0.27	0.25
Log $\epsilon$	1.98	1.98	1.98	1.98	1.98
$S_0$	0.09	0.20	0.08	0.11	0.09
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	6.48	10.81	6.34	9.86	6.07
Average Vc (%)	4.67	4.67	4.67	4.67	4.67
SD Vc (%)	0.49	0.49	0.49	0.49	0.49
Average $E_{ini}$ (MPa)	12806	12806	12806	12806	12806
SD $E_{ini}$ (MPa)	533	533	533	533	533
Average $\varphi_{ini}$ ( $^\circ$ )	14.0	14.0	14.0	14.0	14.0
SD $\varphi_{ini}$ ( $^\circ$ )	0.5	0.5	0.5	0.5	0.5
Average $E_{2, ini}$ (MPa)	3097	3097	3097	3097	3097
SD $E_{2, ini}$ (MPa)	131	131	131	131	131
Confidence interval 1/b (P=97,5%)	3.02	4.45	2.86	3.26	3.02
bmin	-0.37	-0.46	-0.38	-0.77	-0.33
bmax	-0.11	-0.09	-0.12	-0.13	-0.11
$ \Delta b_{min} $	0.20	0.31	0.20	0.55	0.17
$ \Delta b_{max} $	0.06	0.06	0.06	0.09	0.06
$\epsilon_6$ min ( $\mu\text{def}$ ) (P=95%)	81.78	64.41	82.35	71.01	83.83
$\epsilon_6$ max ( $\mu\text{def}$ ) (P=95%)	101.75	97.84	101.88	101.47	102.53
$ \Delta\epsilon_{6min} $ ( $\mu\text{def}$ )	9.44	14.98	9.25	13.87	8.88
$ \Delta\epsilon_{6max} $ ( $\mu\text{def}$ )	10.53	18.46	10.28	16.59	9.82

## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

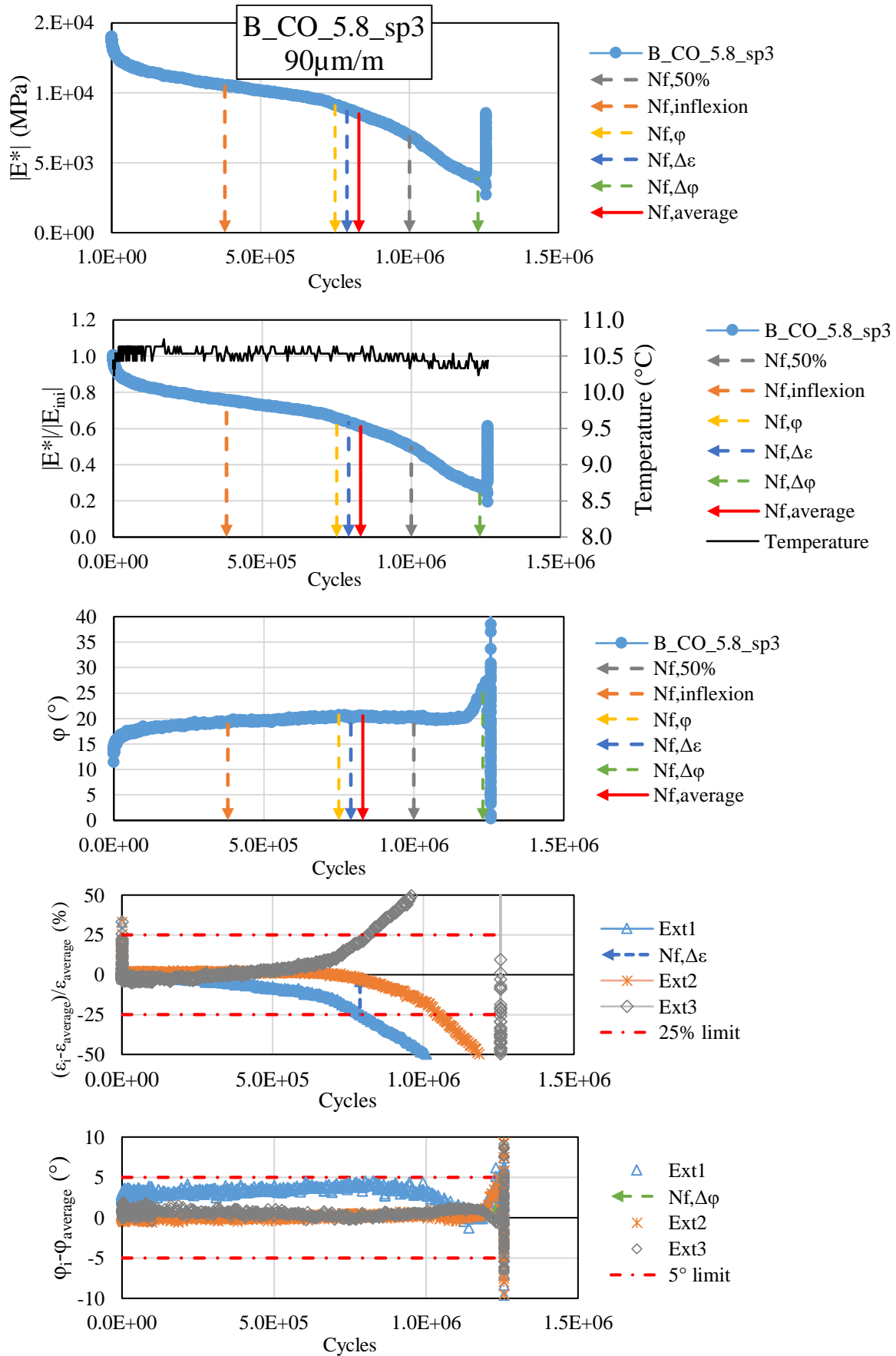
#### 2.2.2.1.1. B\_CO\_5.8\_sp1



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

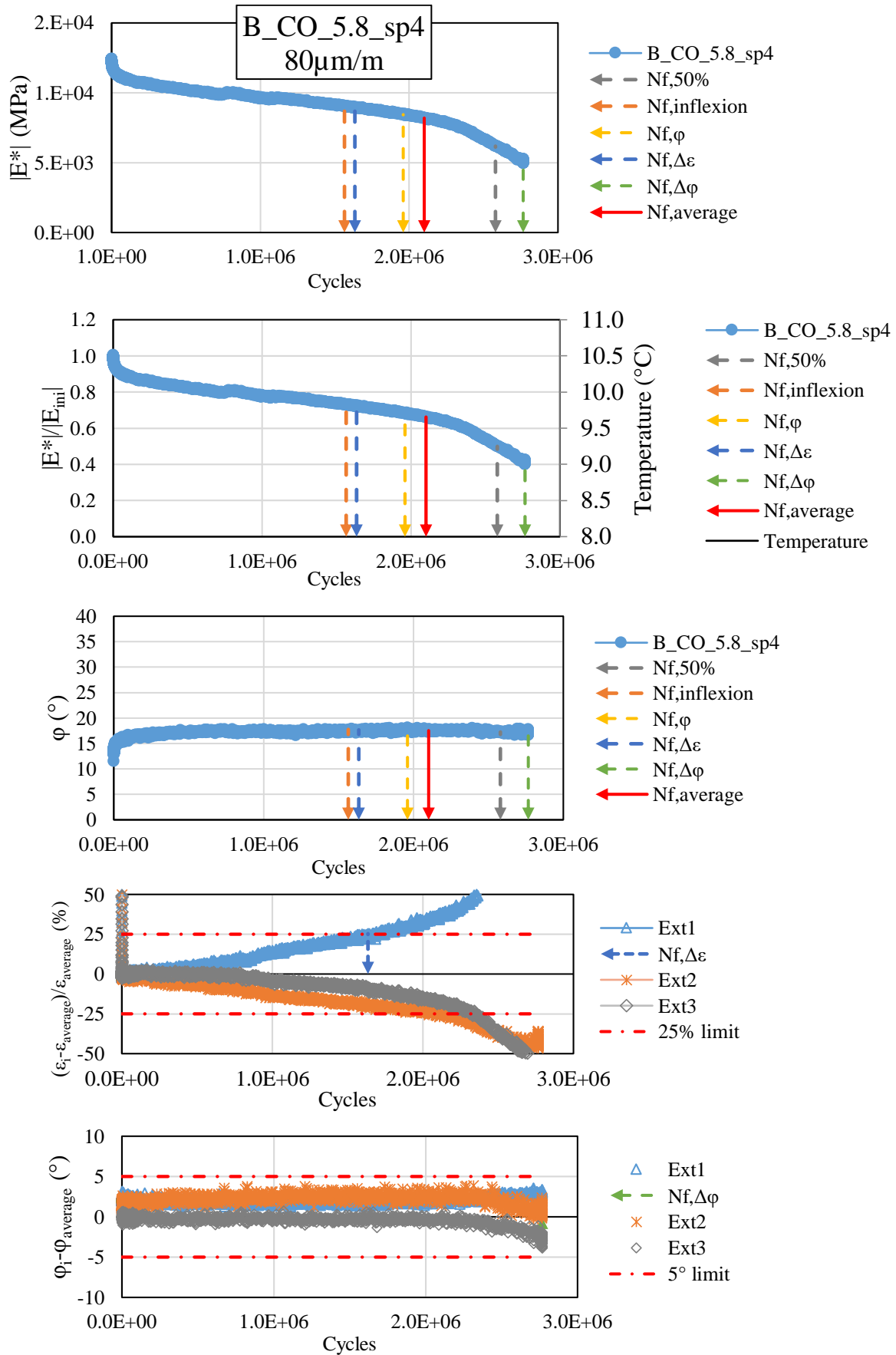
#### 2.2.2.1.2. B\_CO\_5.8\_sp3



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

#### 2.2.2.1.3. B\_CO\_5.8\_sp4

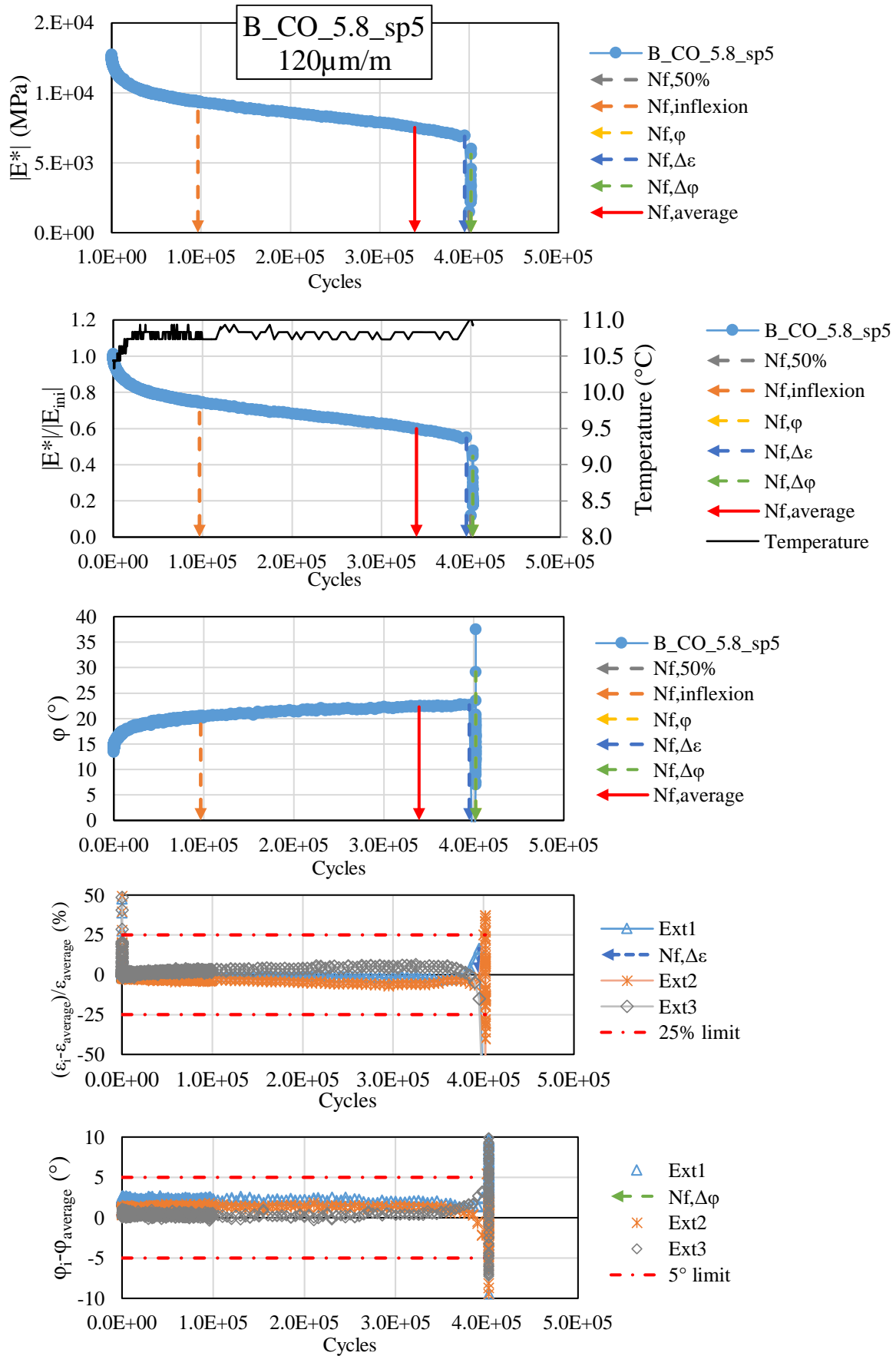




## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

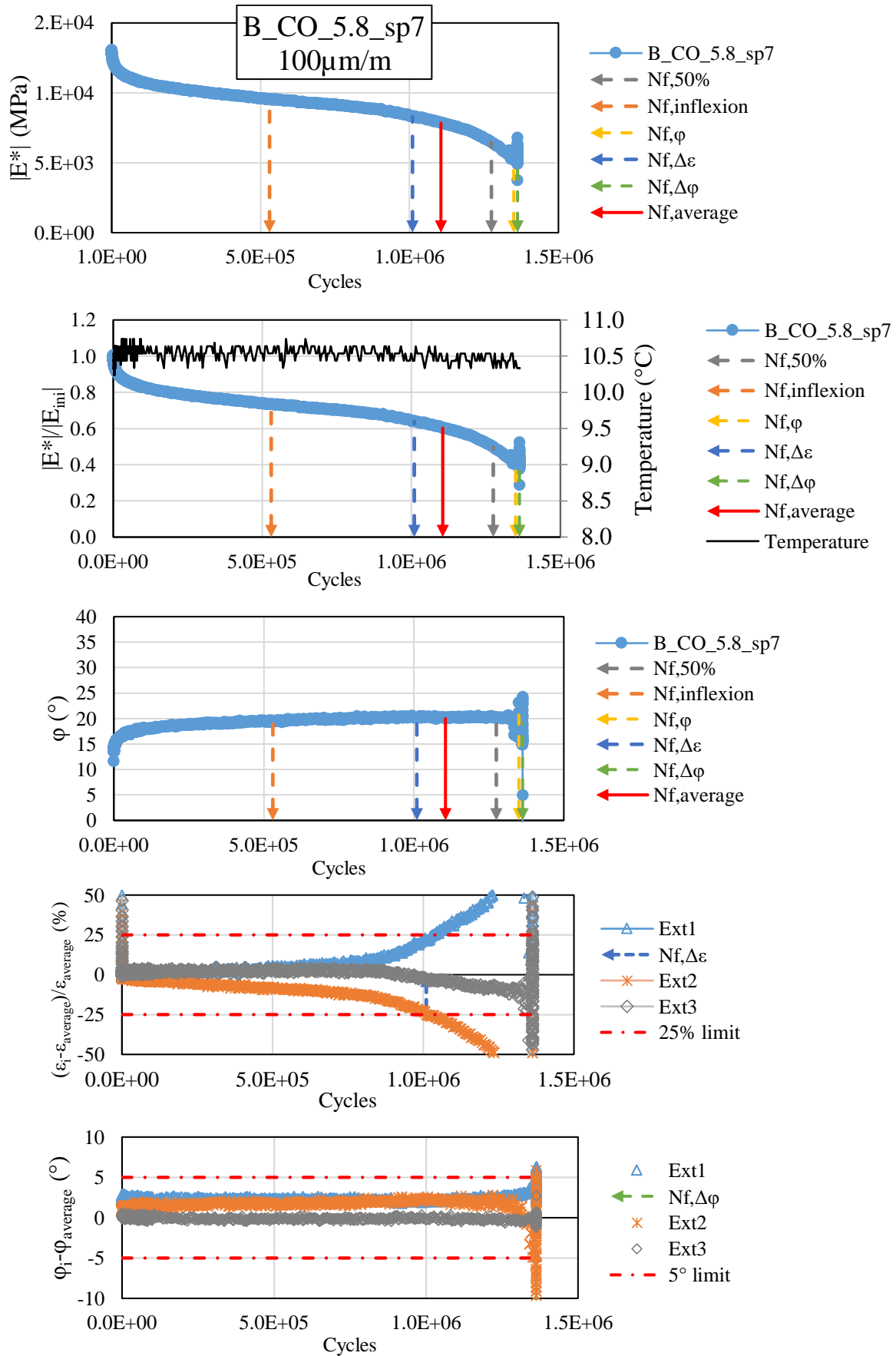
#### 2.2.2.1.4. B\_CO\_5.8\_sp5



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

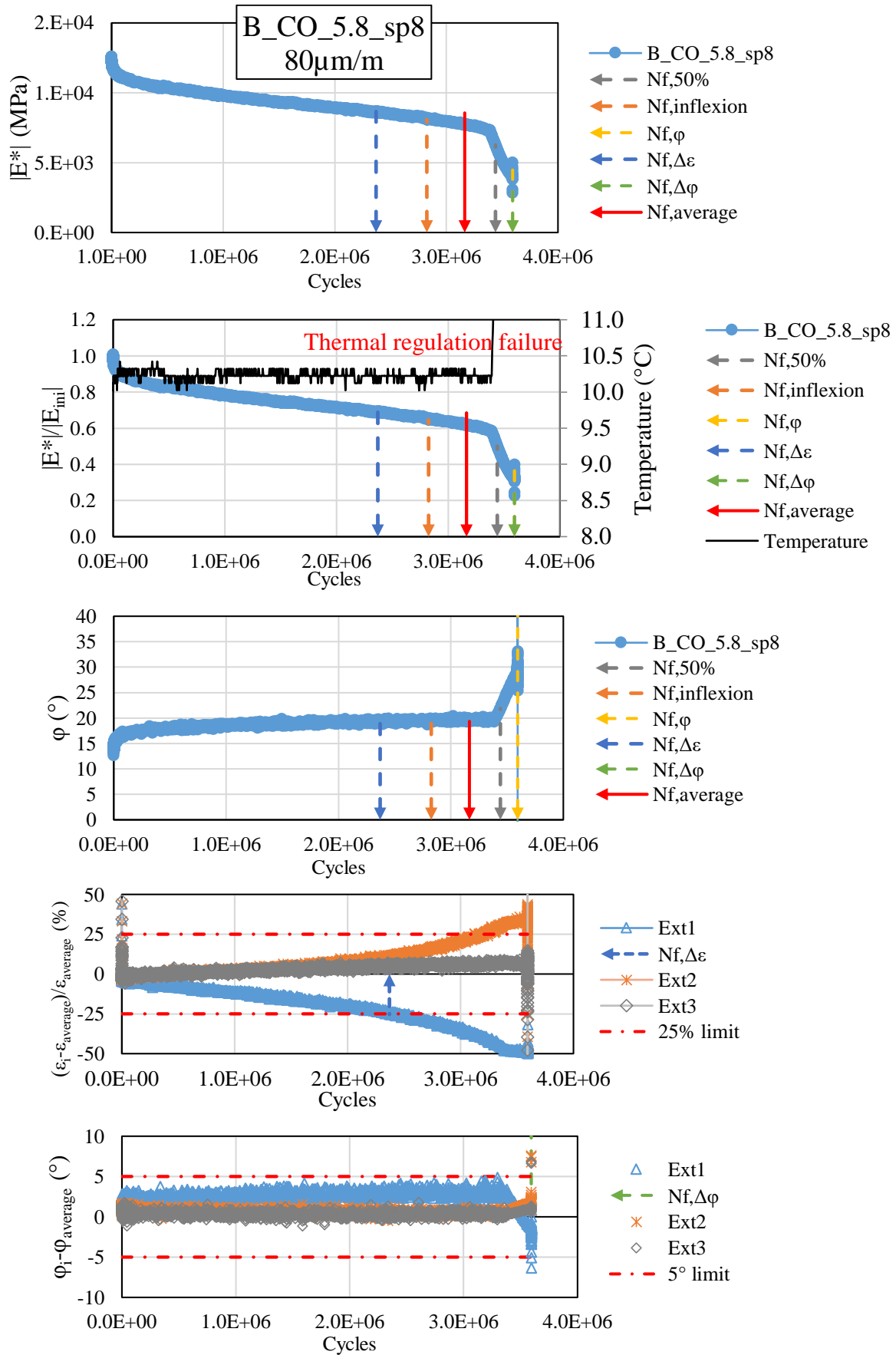
#### 2.2.2.1.5. B\_CO\_5.8\_sp7



## 2 Thermomechanical tests on bituminous mixtures

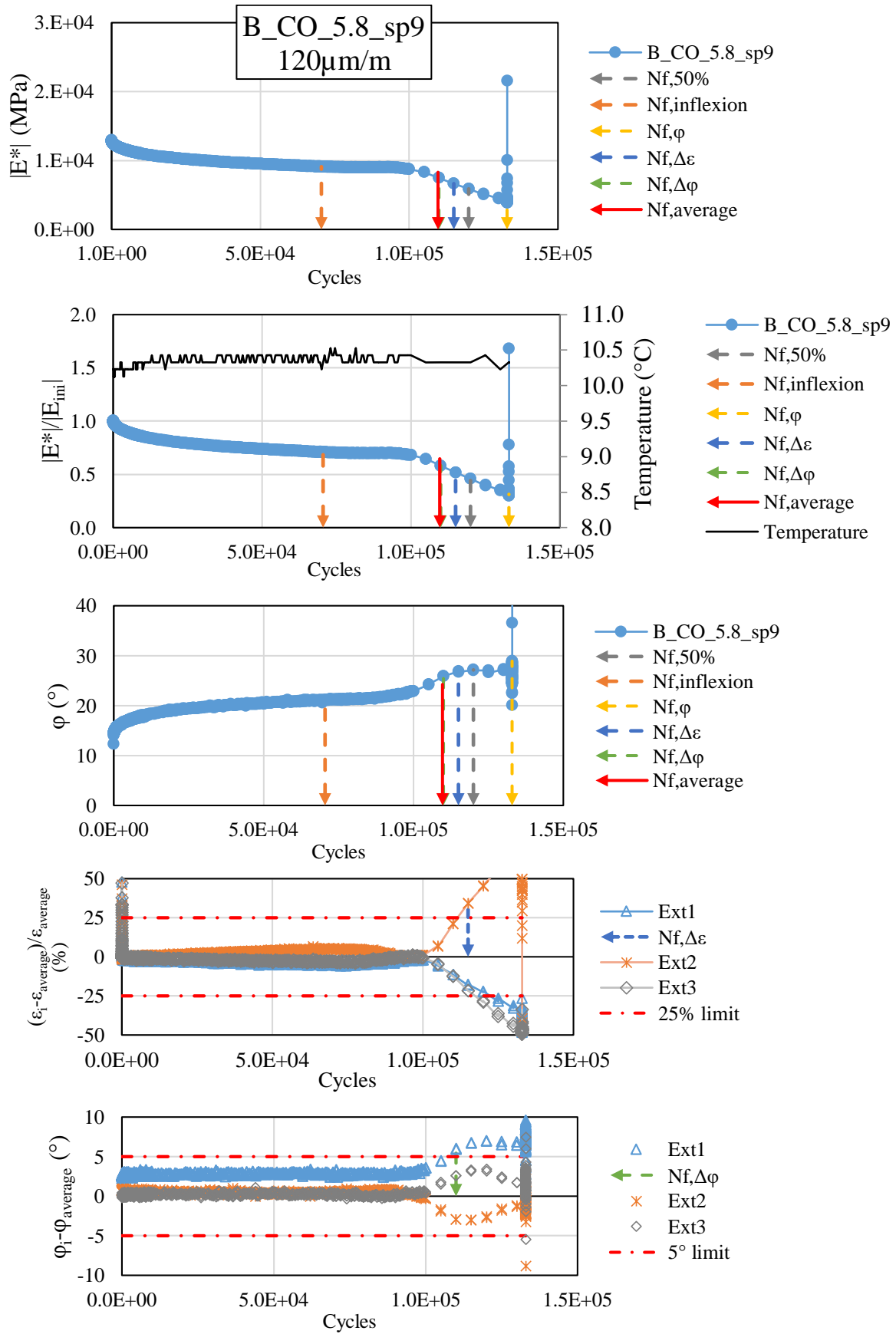
### 2.2 Fatigue tests

#### 2.2.2.1.6. B\_CO\_5.8\_sp8 (failed)



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

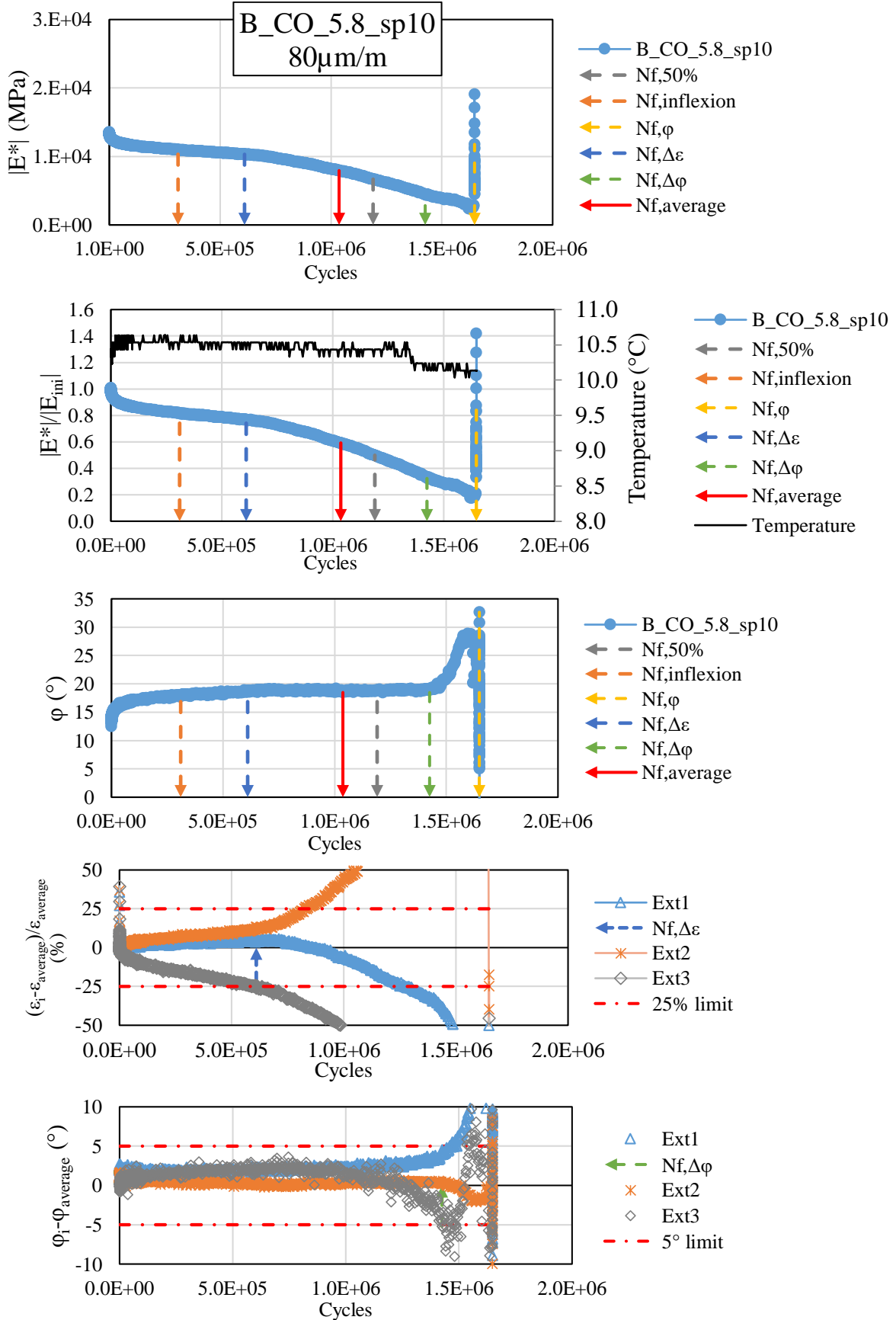
2.2.2.1.7. B\_CO\_5.8\_sp9



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

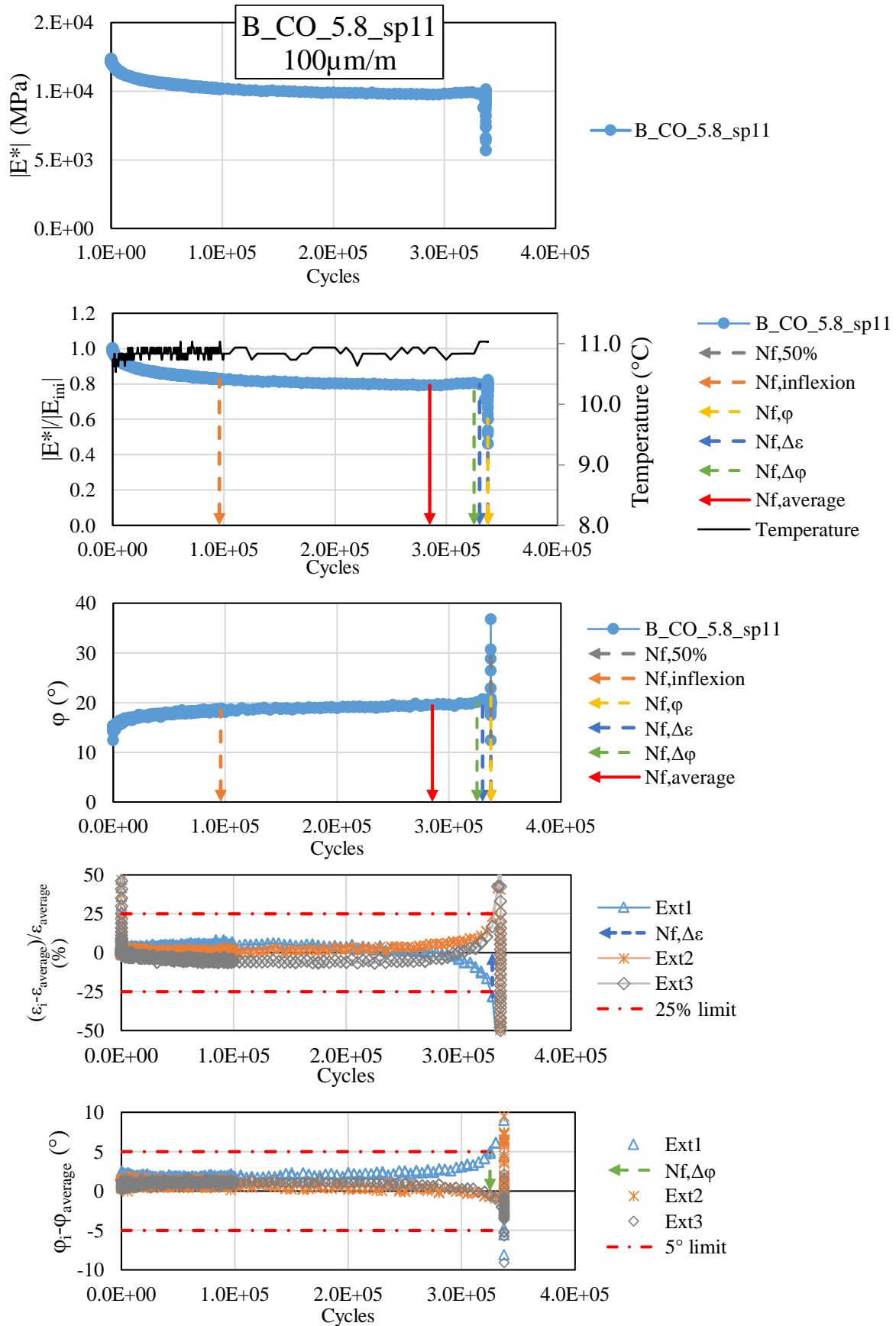
#### 2.2.2.1.8. B\_CO\_5.8\_sp10



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

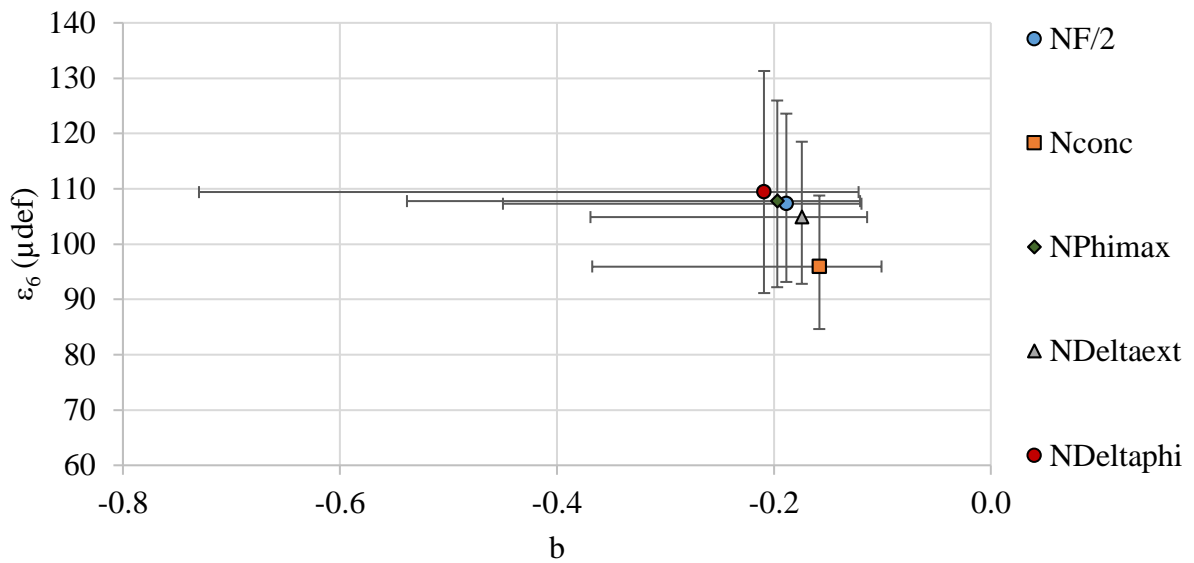
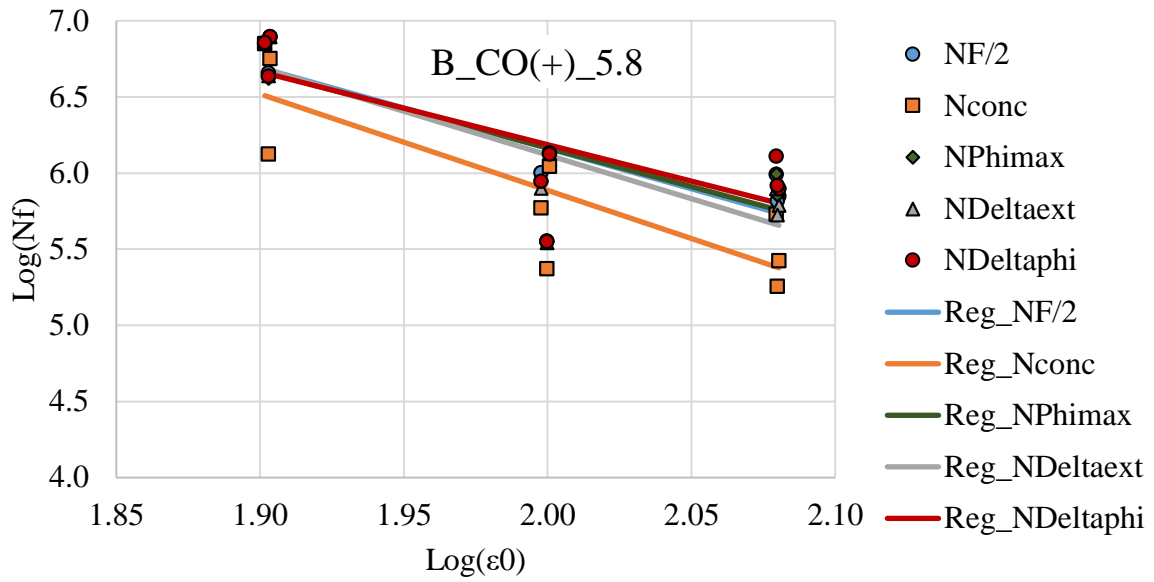
#### 2.2.2.1.9. B\_CO\_5.8\_sp11



#### 2.2.2.2. B\_CO(+)\_5.8

## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests



2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

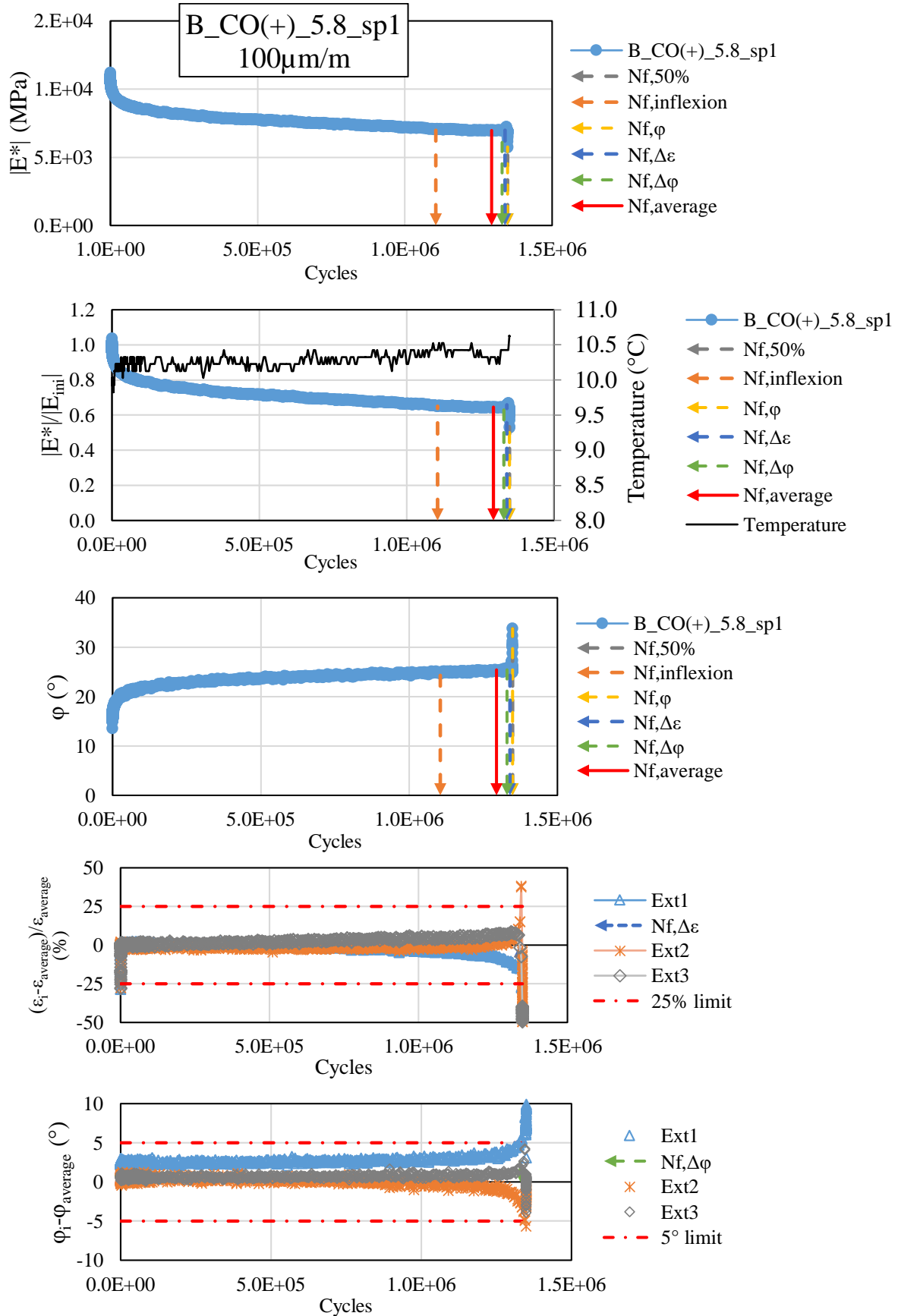
	$N_{f, 50\%}$	$N_{f, 1st\ inflexion}$	$N_{f, \phi_{max}}$	$N_{f, \Delta\epsilon_i}$	$N_{f, \Delta\phi_i}$
1/b	-5.31	-6.32	-5.08	-5.74	-4.79
a	16.77	18.53	16.32	17.60	15.76
b	-0.19	-0.16	-0.20	-0.17	-0.21
$\epsilon_6$ ( $\mu\text{def}$ )	107.29	95.95	107.77	104.87	109.39
$r^2$	0.70	0.71	0.67	0.74	0.61
S(LgN)	0.49	0.58	0.48	0.51	0.47
S(Lg $\epsilon$ )	0.08	0.08	0.08	0.08	0.08
$S_N$	0.28	0.33	0.30	0.28	0.31
Log $\epsilon$	1.99	1.99	1.99	1.99	1.99
$S_0$	0.11	0.11	0.11	0.10	0.12
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	9.86	7.83	10.94	8.33	13.00
Average Vc (%)	4.62	4.62	4.62	4.62	4.62
SD Vc (%)	0.26	0.26	0.26	0.26	0.26
Average $E_{ini}$ (MPa)	10404	10404	10404	10404	10404
SD $E_{ini}$ (MPa)	879	879	879	879	879
Average $\phi_{ini}$ ( $^\circ$ )	16.9	16.9	16.9	16.9	16.9
SD $\phi_{ini}$ ( $^\circ$ )	1.5	1.5	1.5	1.5	1.5
Average $E_{2, ini}$ (MPa)	3004	3004	3004	3004	3004
SD $E_{2, ini}$ (MPa)	62	62	62	62	62
Confidence interval 1/b (P=97,5%)	3.08	3.60	3.22	3.03	3.42
bmin	-0.45	-0.37	-0.54	-0.37	-0.73
bmax	-0.12	-0.10	-0.12	-0.11	-0.12
$\Delta\text{bmin}$	0.26	0.21	0.34	0.19	0.52
$\Delta\text{bmax}$	0.07	0.06	0.08	0.06	0.09
$\epsilon_6$ min ( $\mu\text{def}$ ) (P=95%)	93.15	84.64	92.20	92.81	91.14
$\epsilon_6$ max ( $\mu\text{def}$ ) (P=95%)	123.58	108.77	125.96	118.51	131.30
$\Delta\epsilon_6\text{min}$   ( $\mu\text{def}$ )	14.14	11.31	15.56	12.06	18.25
$\Delta\epsilon_6\text{max}$   ( $\mu\text{def}$ )	16.29	12.83	18.19	13.63	21.90



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

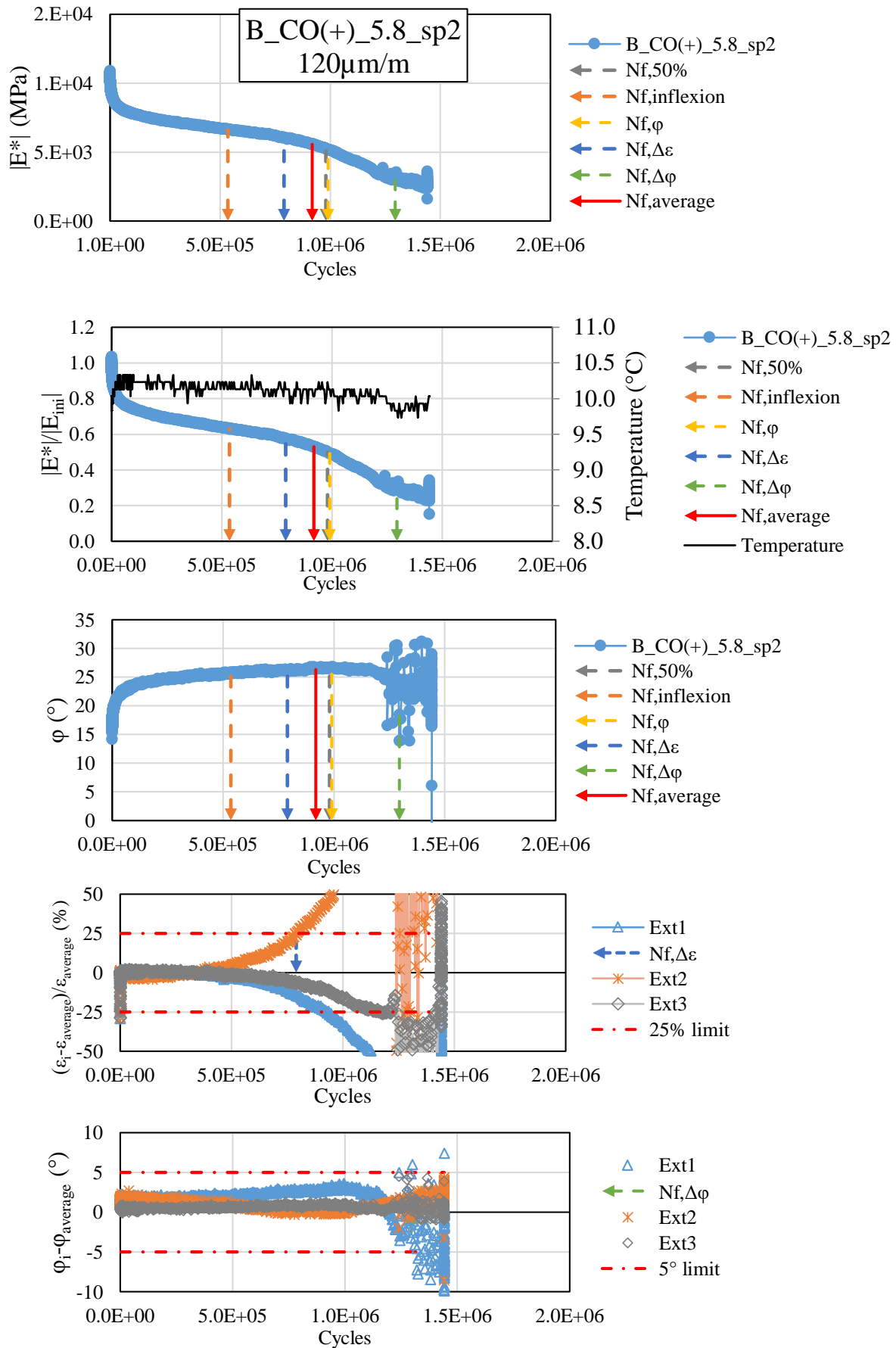
#### 2.2.2.2.1. B\_CO(+)\_5.8\_sp1



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

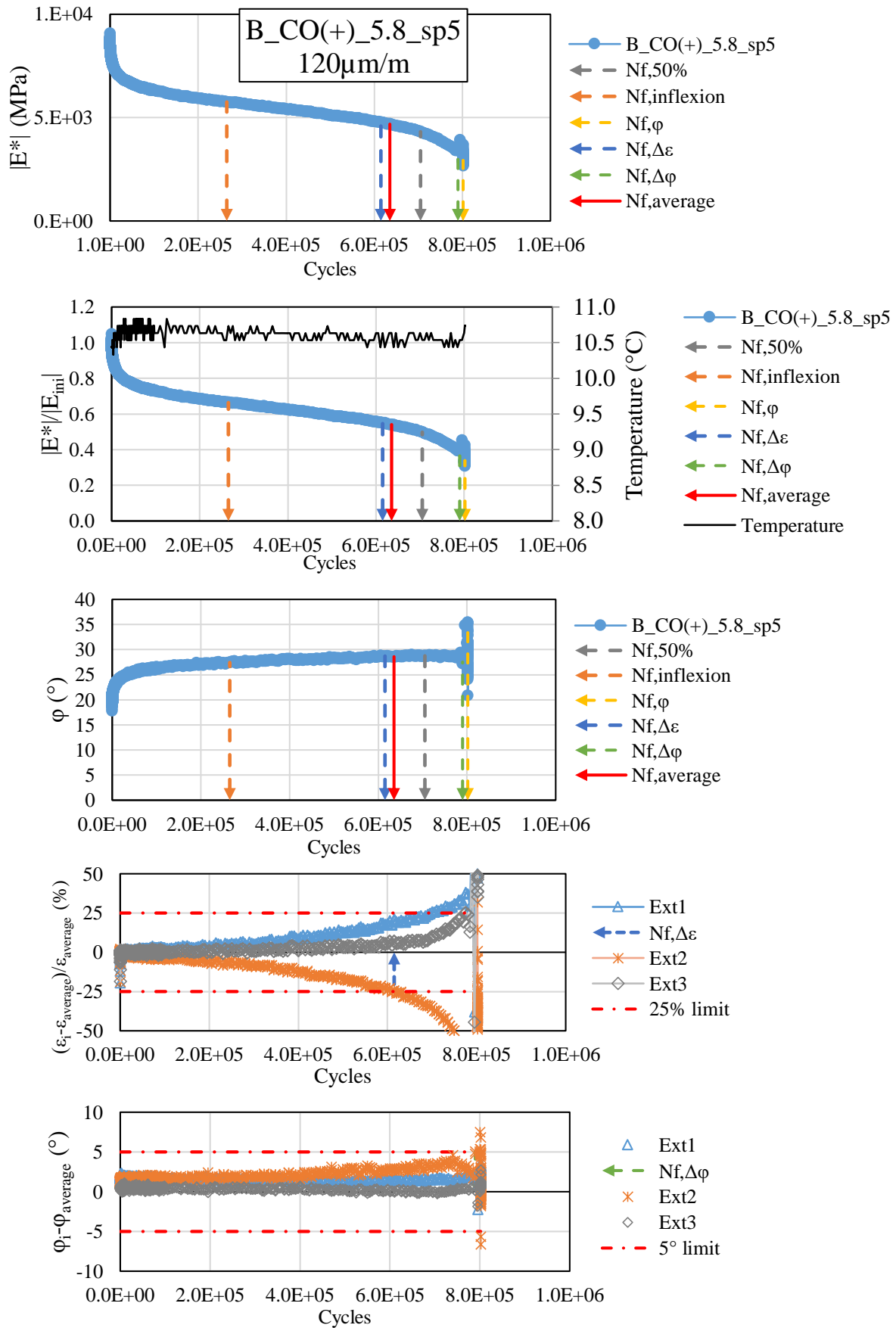
2.2.2.2.2. B\_CO(+)\_5.8\_sp2



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

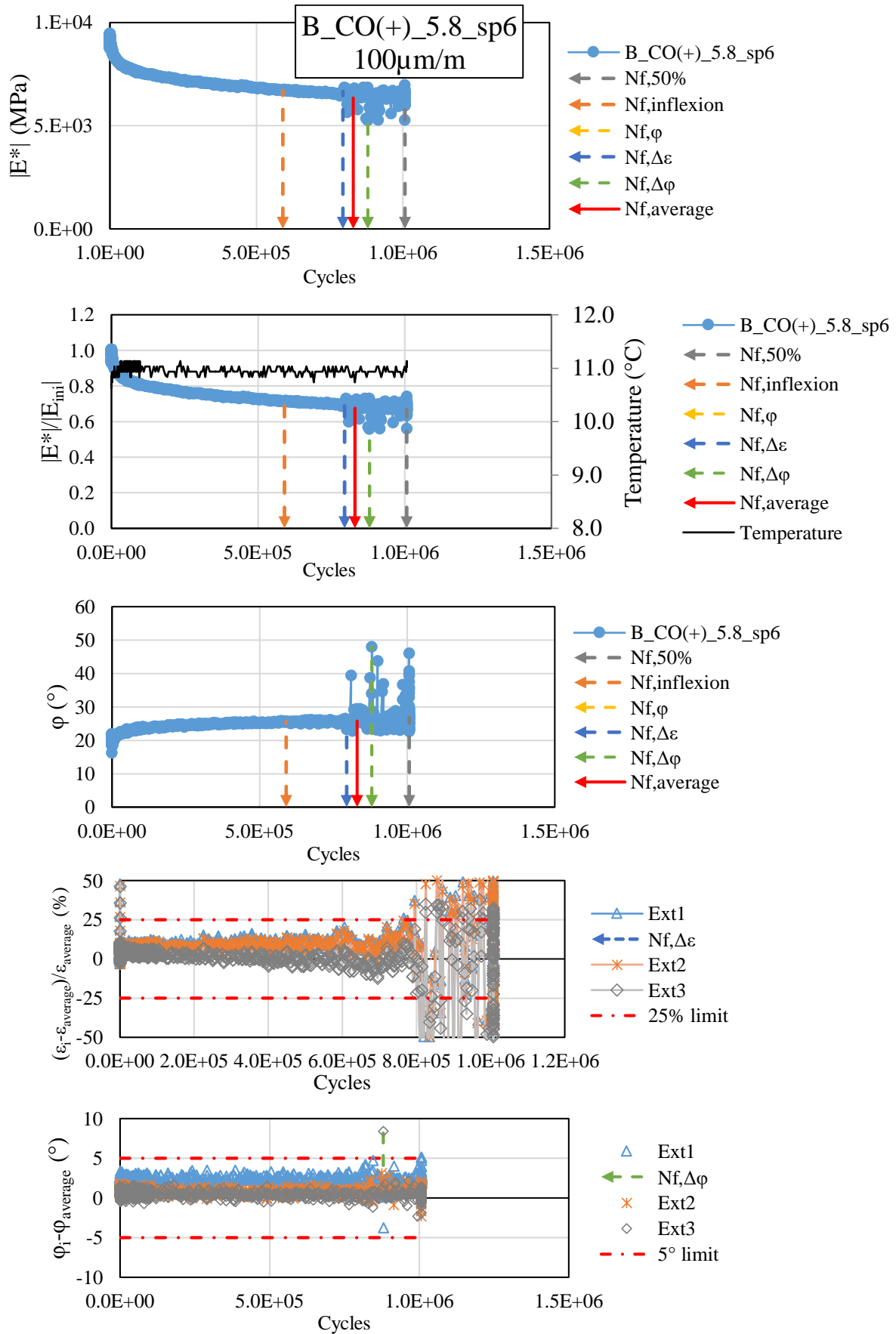
#### 2.2.2.2.3. B\_CO(+)\_5.8\_sp5



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

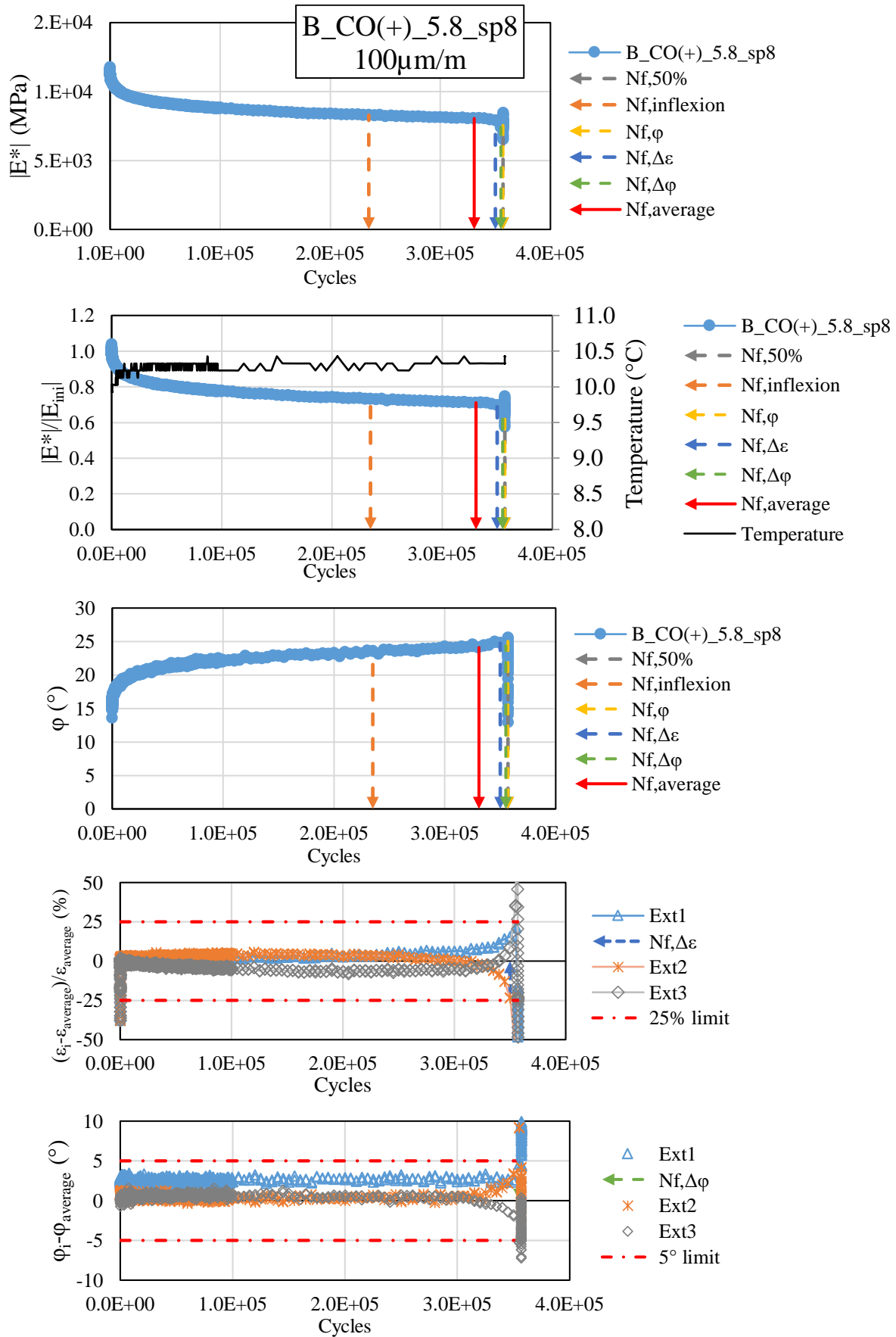
2.2.2.2.4. B\_CO(+)\_5.8\_sp6



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

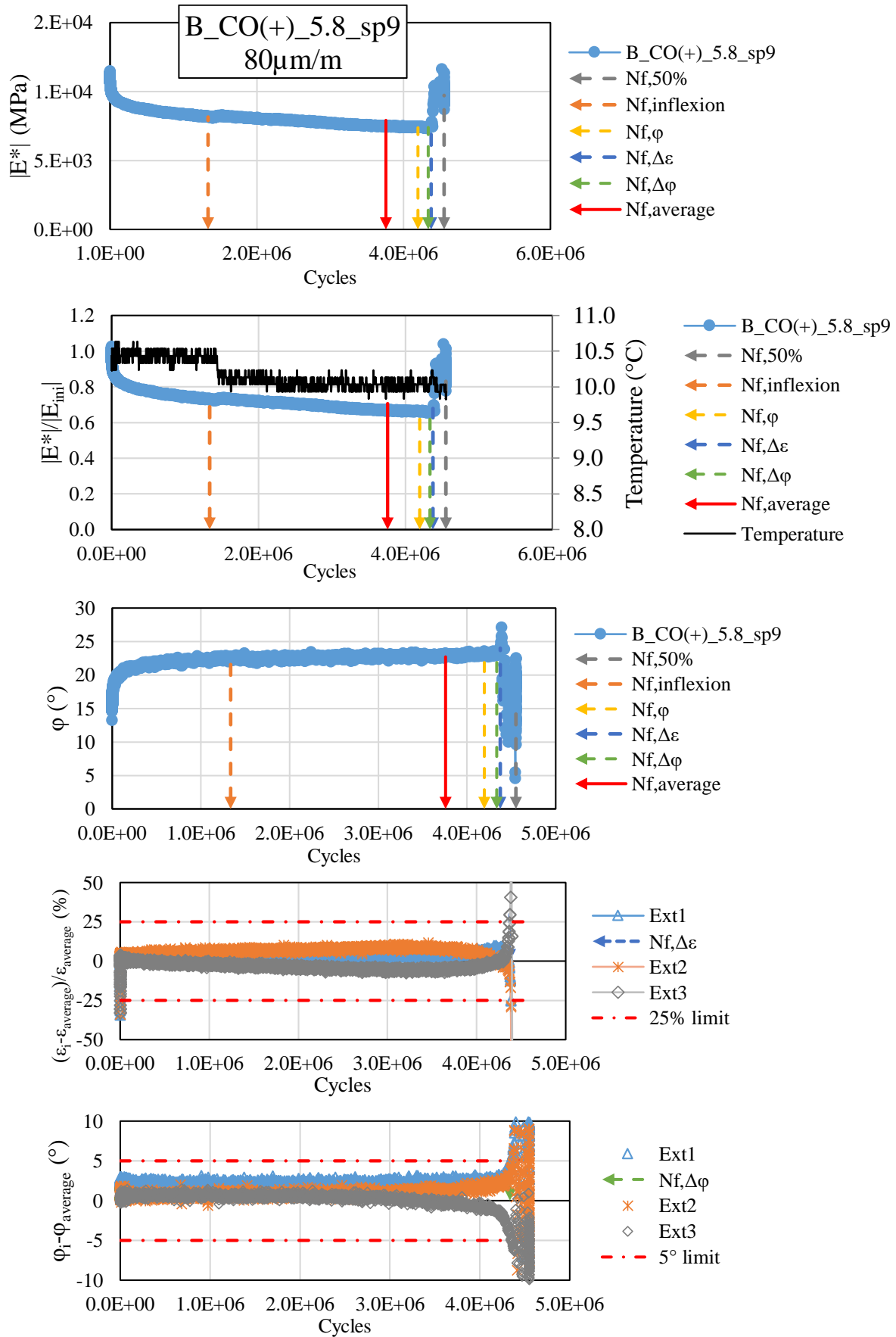
2.2.2.2.5. B\_CO(+)\_5.8\_sp8



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

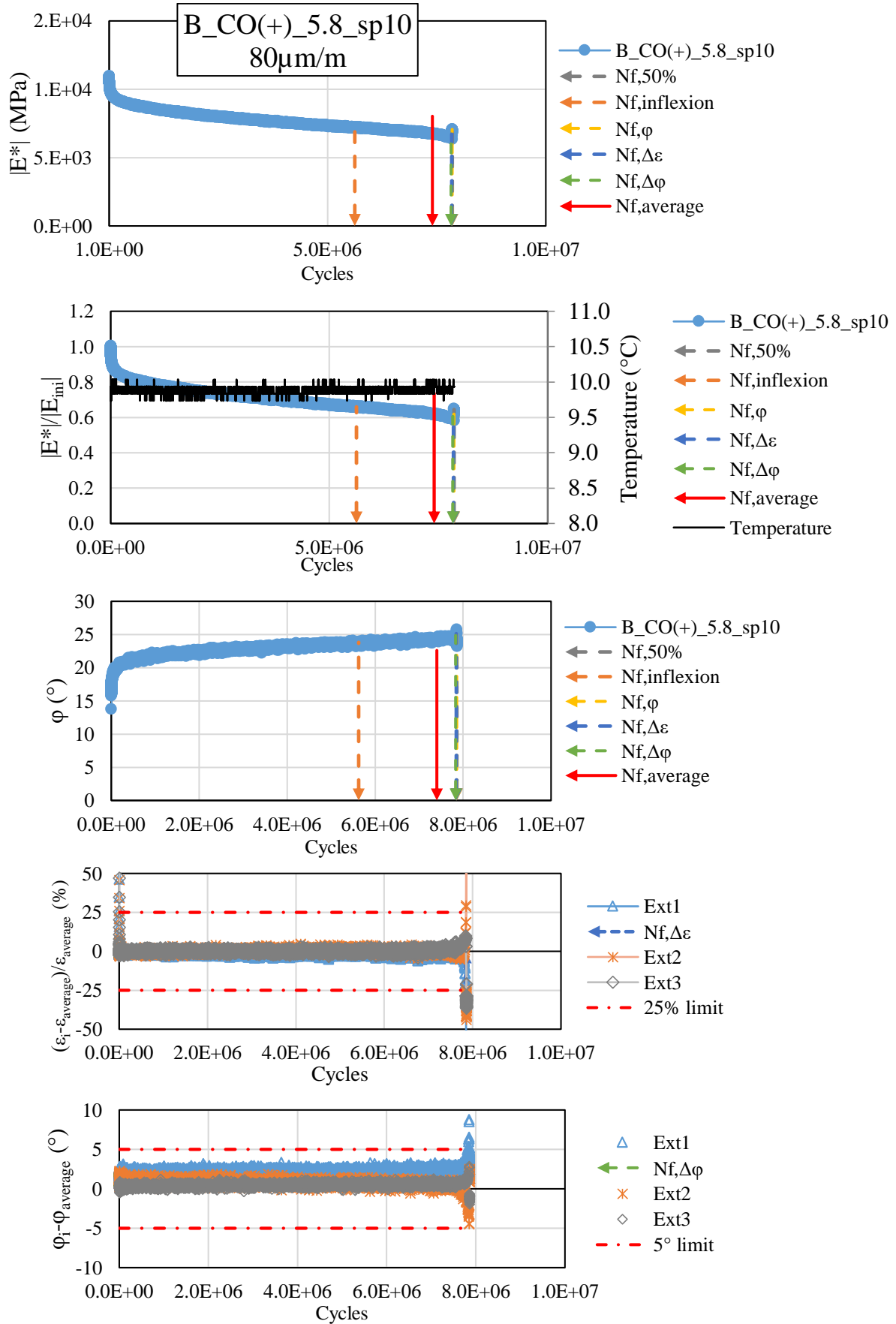
#### 2.2.2.2.6. B\_CO(+)\_5.8\_sp9



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

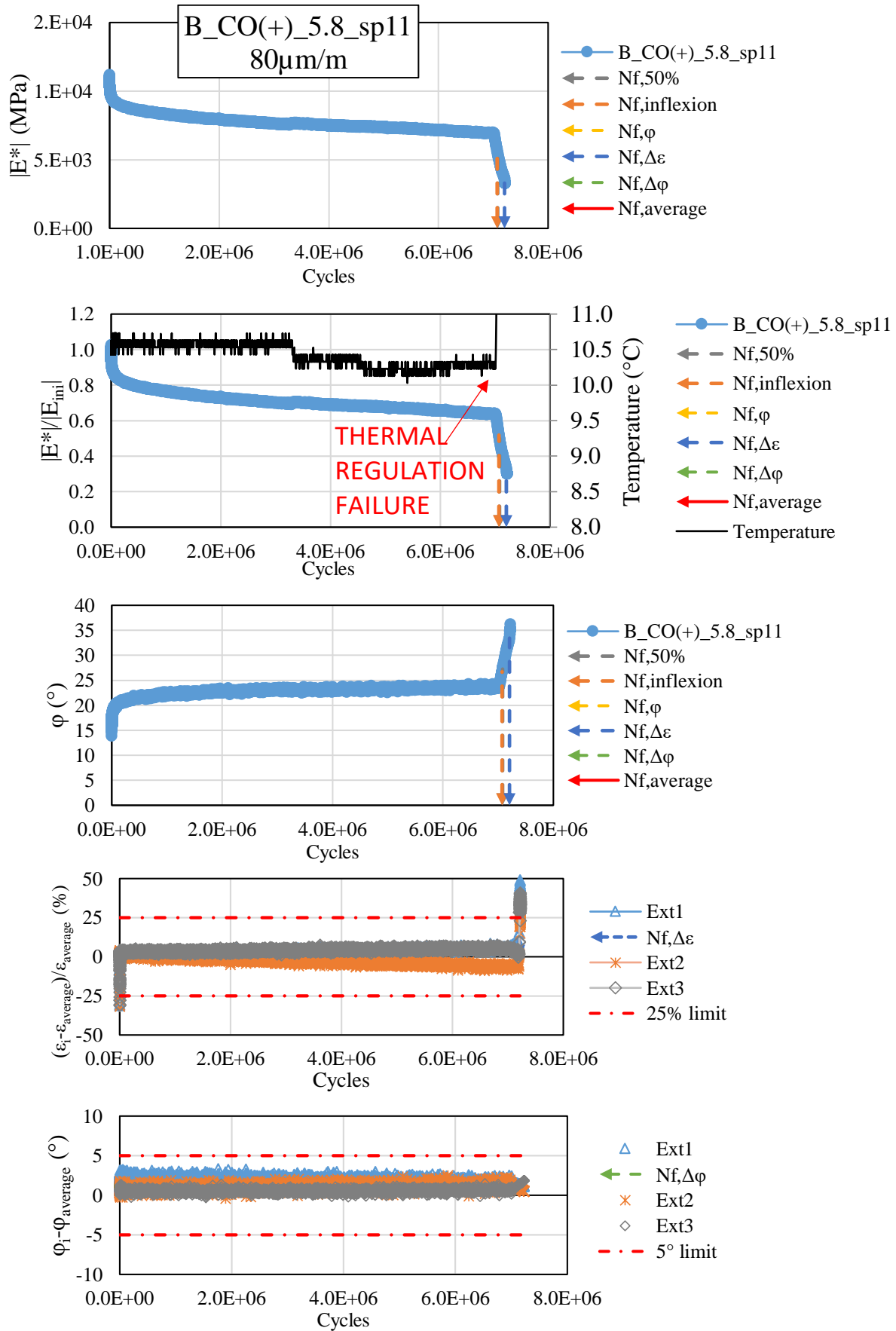
#### 2.2.2.2.7. B\_CO(+)\_5.8\_sp10



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

2.2.2.2.8. B\_CO(+)\_5.8\_sp11 (failed)

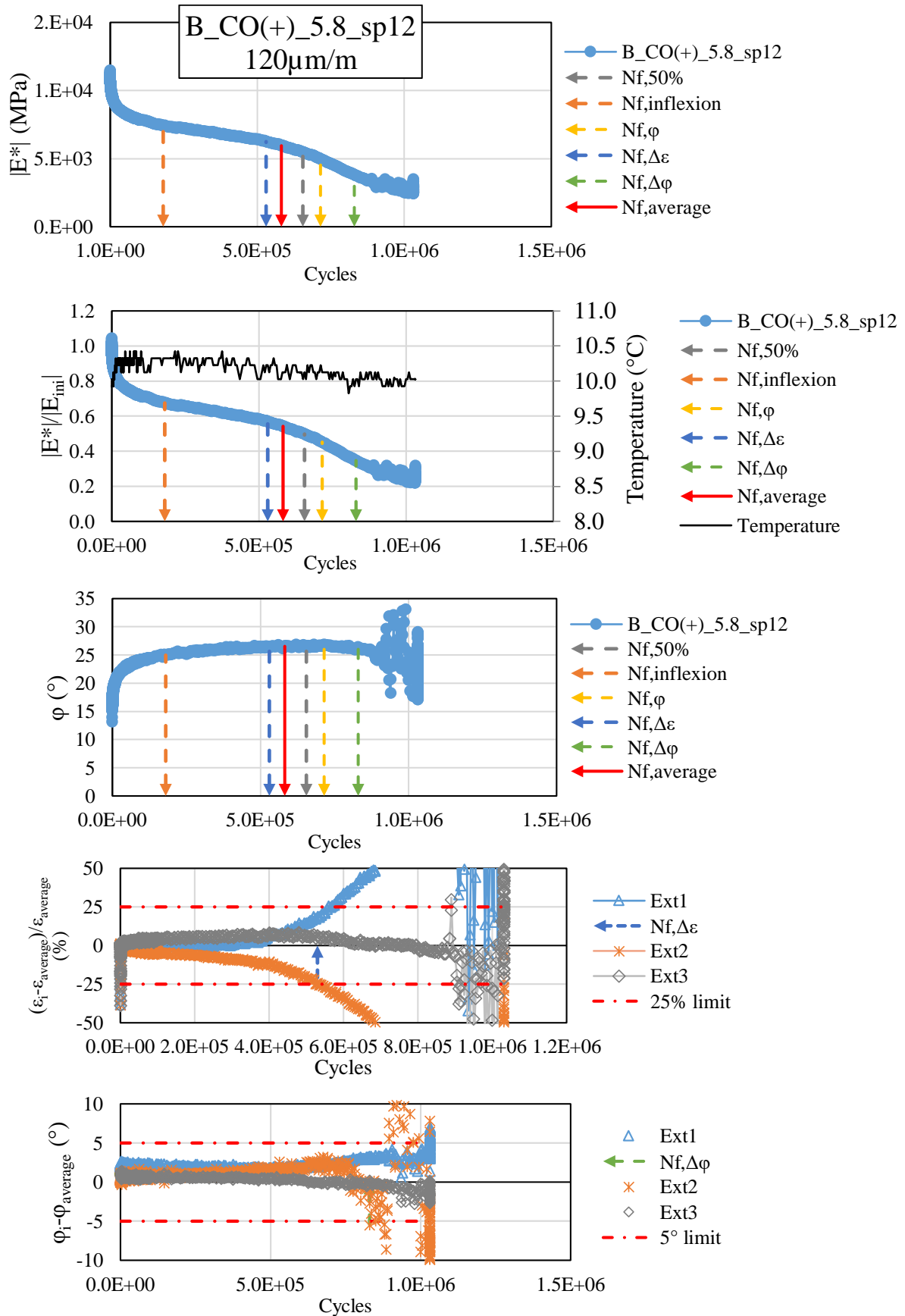




## 2 Thermomechanical tests on bituminous mixtures

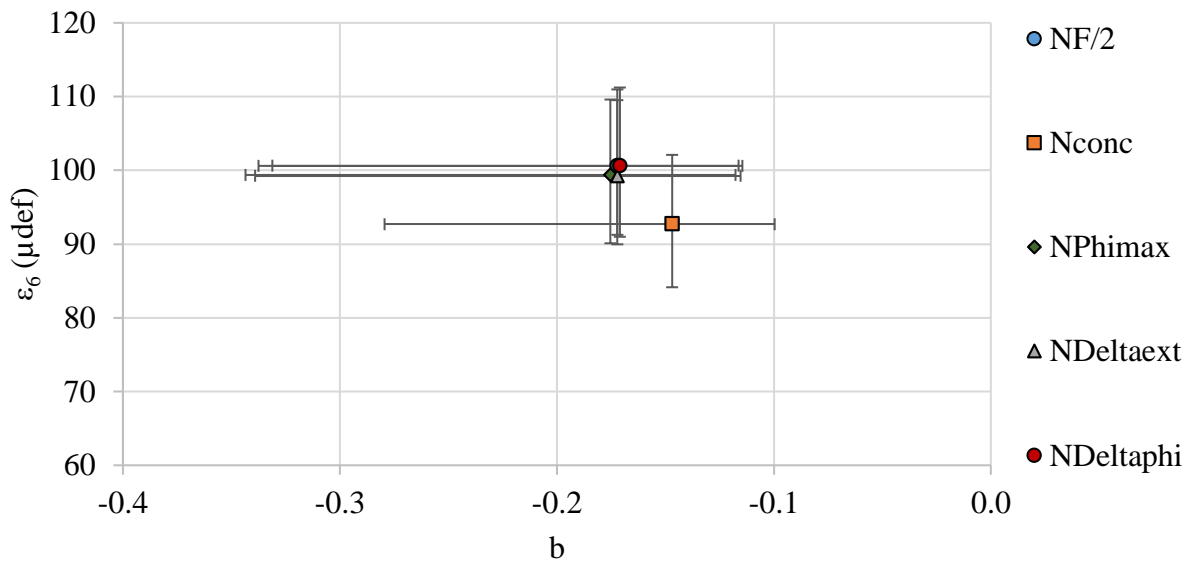
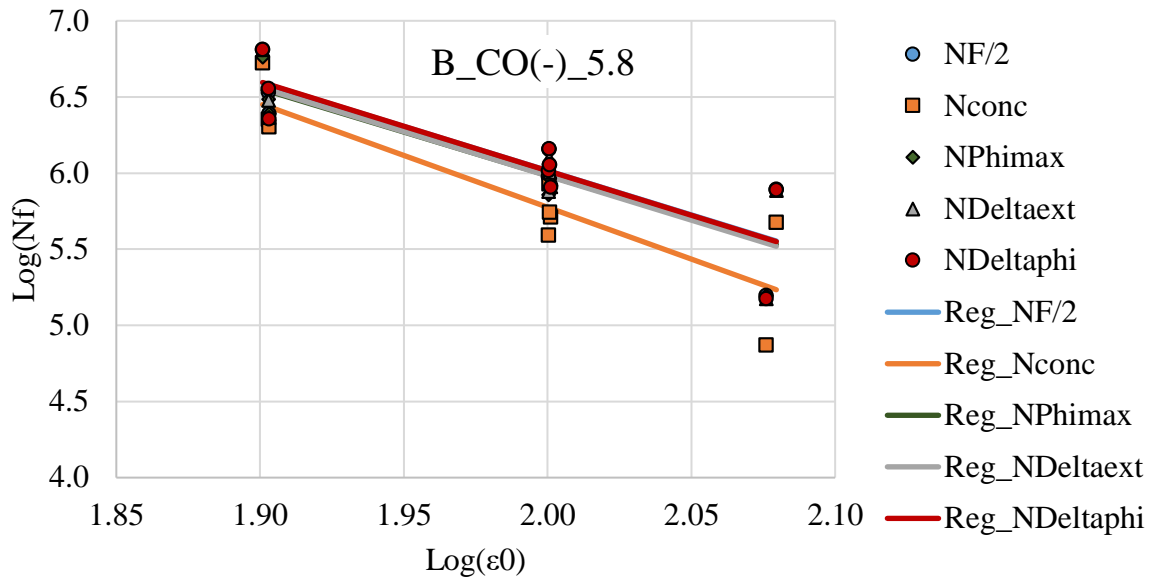
### 2.2 Fatigue tests

#### 2.2.2.2.9. B\_CO\_5.8\_sp12



#### 2.2.2.3. B\_CO(-)\_5.8

2 Thermomechanical tests on bituminous mixtures  
 2.2 Fatigue tests



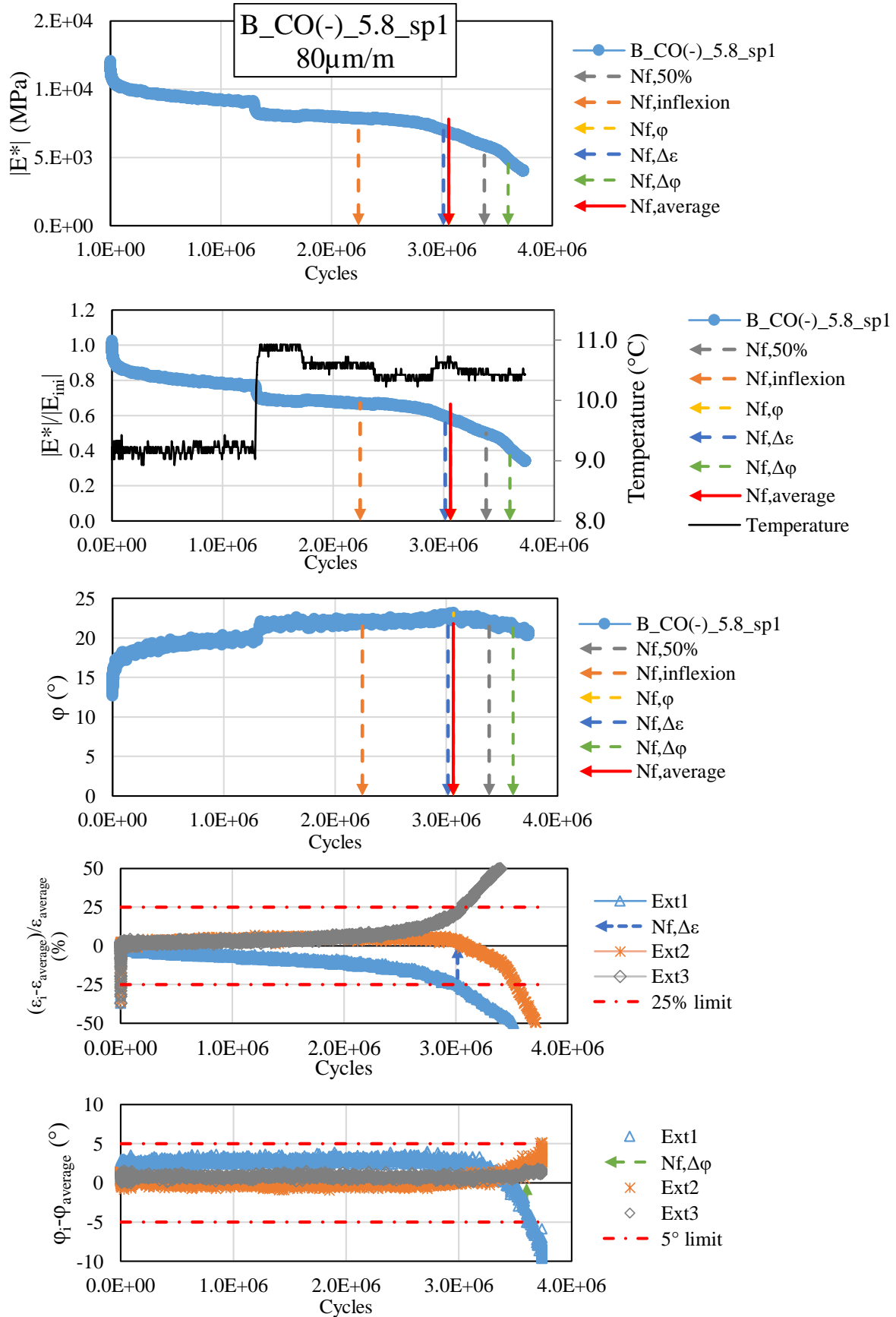
2 Thermomechanical tests on bituminous mixtures  
2.2 Fatigue tests

	$N_{f, 50\%}$	$N_{f, 1st\ inflexion}$	$N_{f, \phi_{max}}$	$N_{f, \Delta\epsilon_i}$	$N_{f, \Delta\phi_i}$
1/b	-5.81	-6.81	-5.70	-5.81	-5.85
a	17.64	19.39	17.39	17.60	17.71
b	-0.17	-0.15	-0.18	-0.17	-0.17
$\epsilon_6$ ( $\mu\text{def}$ )	100.63	92.69	99.38	99.26	100.60
$r^2$	0.78	0.78	0.77	0.77	0.77
S(LgN)	0.46	0.54	0.45	0.46	0.46
S(Lg $\epsilon$ )	0.07	0.07	0.07	0.07	0.07
$S_N$	0.23	0.27	0.23	0.24	0.24
Log $\epsilon$	1.98	1.98	1.98	1.98	1.98
$S_0$	0.08	0.09	0.08	0.08	0.08
$\Delta\epsilon_6$ ( $\mu\text{def}$ )	6.40	5.83	6.33	6.35	6.57
Average Vc (%)	4.99	4.99	4.99	4.99	4.99
SD Vc (%)	0.24	0.24	0.24	0.24	0.24
Average $E_{ini}$ (MPa)	11169	11169	11169	11169	11169
SD $E_{ini}$ (MPa)	452	452	452	452	452
Average $\phi_{ini}$ ( $^\circ$ )	15.5	15.5	15.5	15.5	15.5
SD $\phi_{ini}$ ( $^\circ$ )	0.7	0.7	0.7	0.7	0.7
Average $E_{2, ini}$ (MPa)	2975	2975	2975	2975	2975
SD $E_{2, ini}$ (MPa)	121	121	121	121	121
Confidence interval 1/b (P=97,5%)	2.79	3.23	2.79	2.86	2.89
bmin	-0.33	-0.28	-0.34	-0.34	-0.34
bmax	-0.12	-0.10	-0.12	-0.12	-0.11
$\Delta\text{bmin}$	0.16	0.13	0.17	0.17	0.17
$\Delta\text{bmax}$	0.06	0.05	0.06	0.06	0.06
$\epsilon_6$ min ( $\mu\text{def}$ ) (P=95%)	91.25	84.15	90.10	89.96	90.99
$\epsilon_6$ max ( $\mu\text{def}$ ) (P=95%)	110.97	102.10	109.60	109.52	111.23
$\Delta\epsilon_6\text{min}$   ( $\mu\text{def}$ )	9.38	8.54	9.27	9.30	9.61
$\Delta\epsilon_6\text{max}$   ( $\mu\text{def}$ )	10.34	9.41	10.23	10.26	10.63

## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

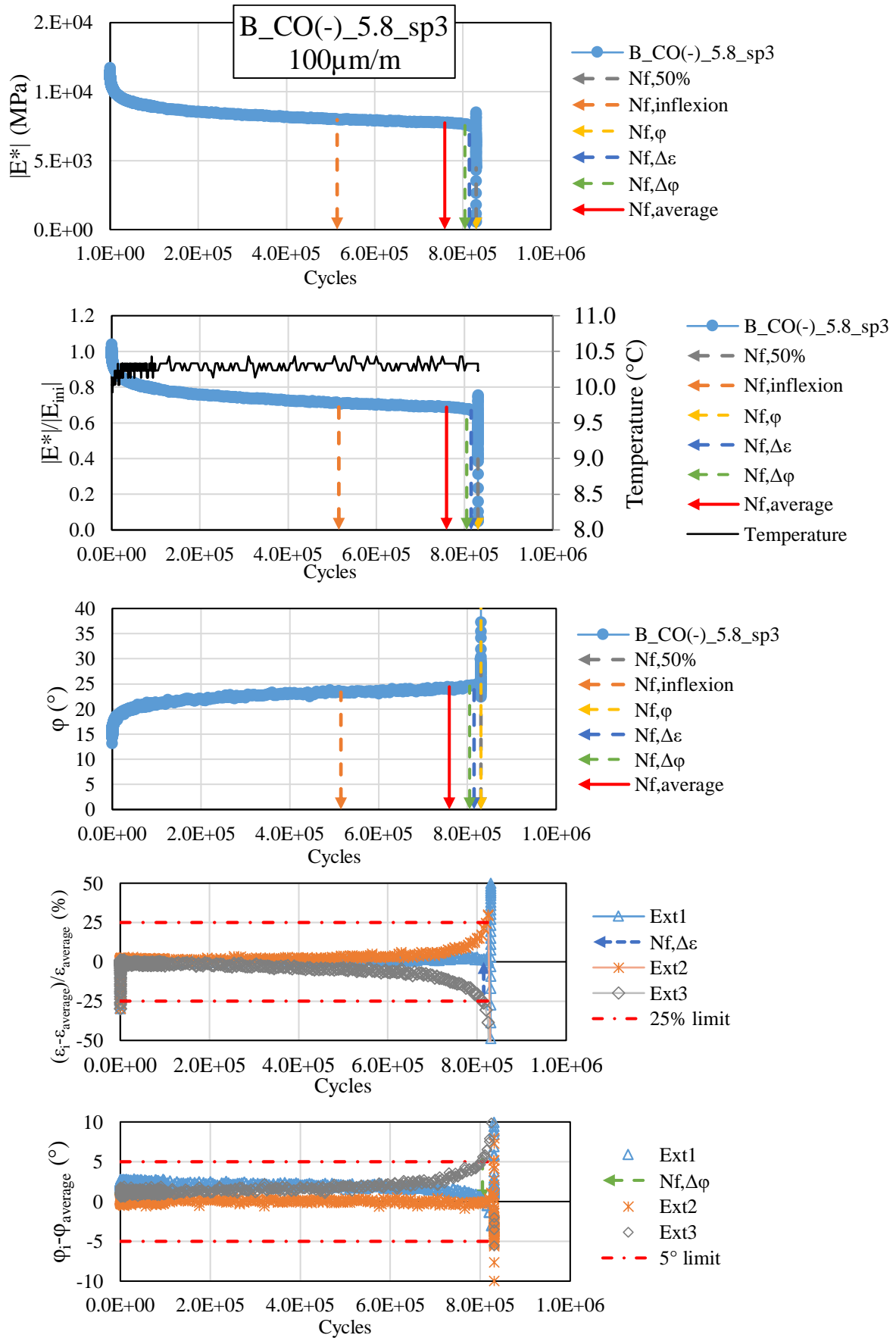
#### 2.2.2.3.1. B\_CO(-)\_5.8\_sp1



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

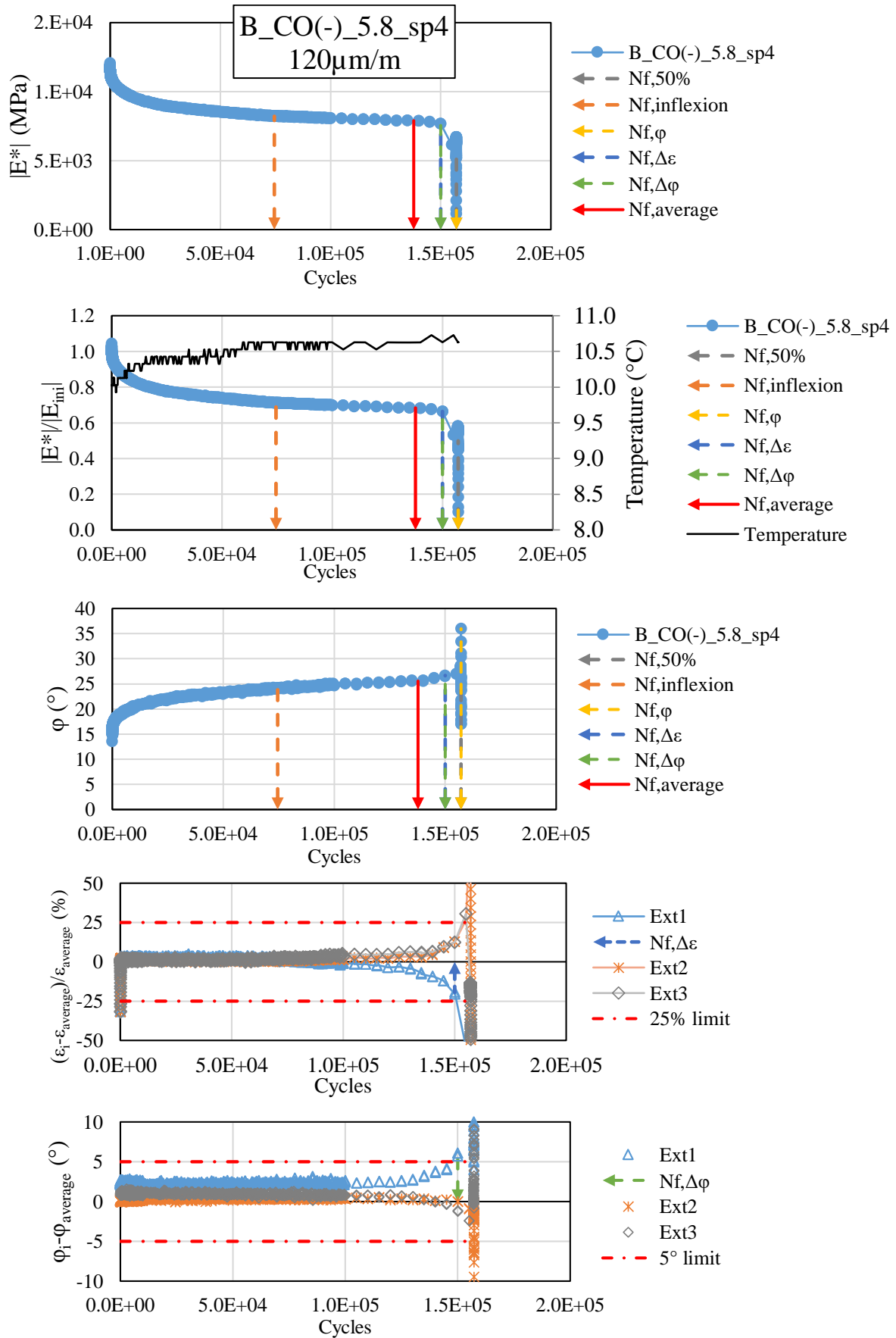
#### 2.2.2.3.2. B\_CO(-)\_5.8\_sp3



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

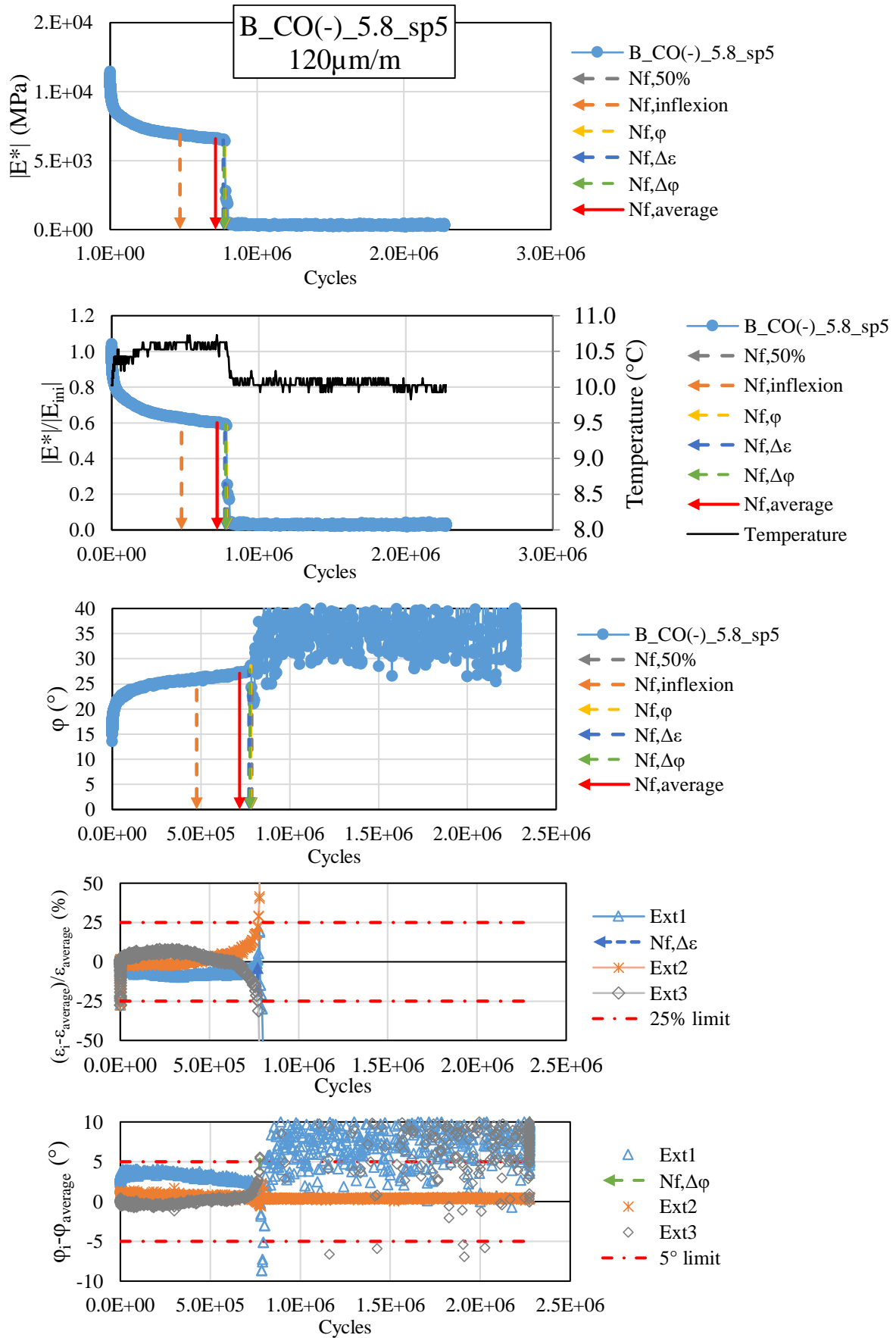
#### 2.2.2.3.3. B\_CO(-)\_5.8\_sp4



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

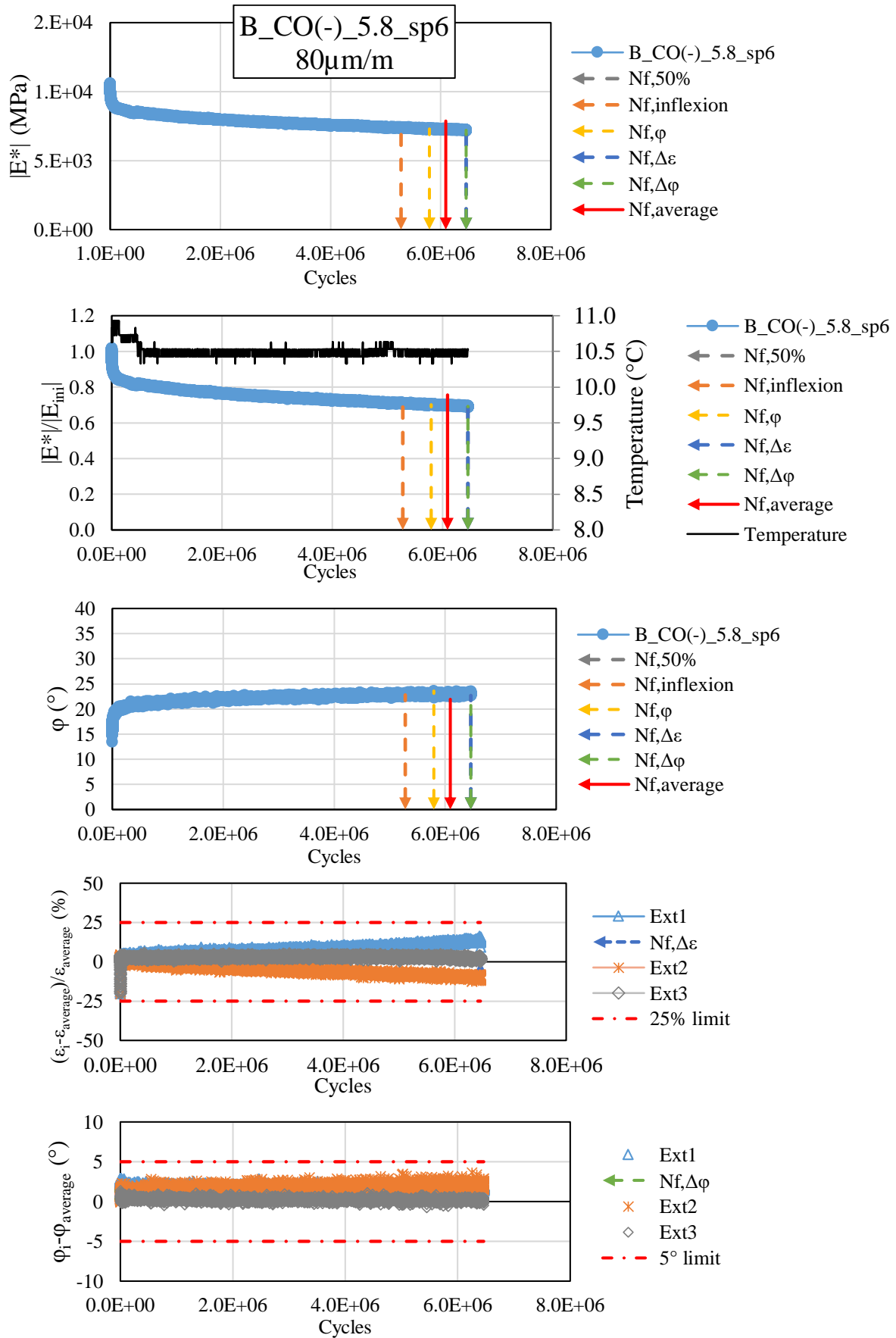
#### 2.2.2.3.4. B\_CO(-)\_5.8\_sp5



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

#### 2.2.2.3.5. B\_CO(-)\_5.8\_sp6

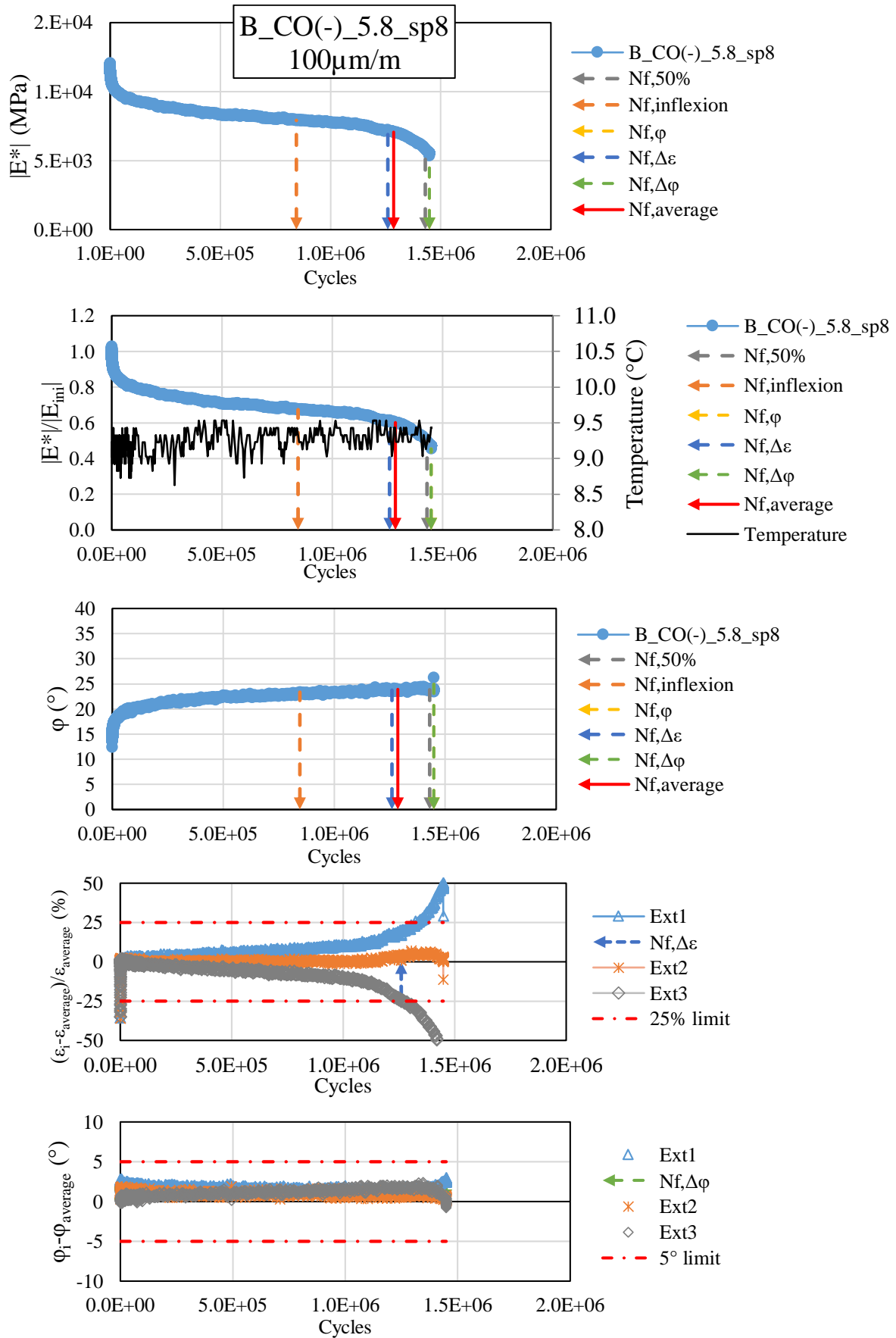




## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

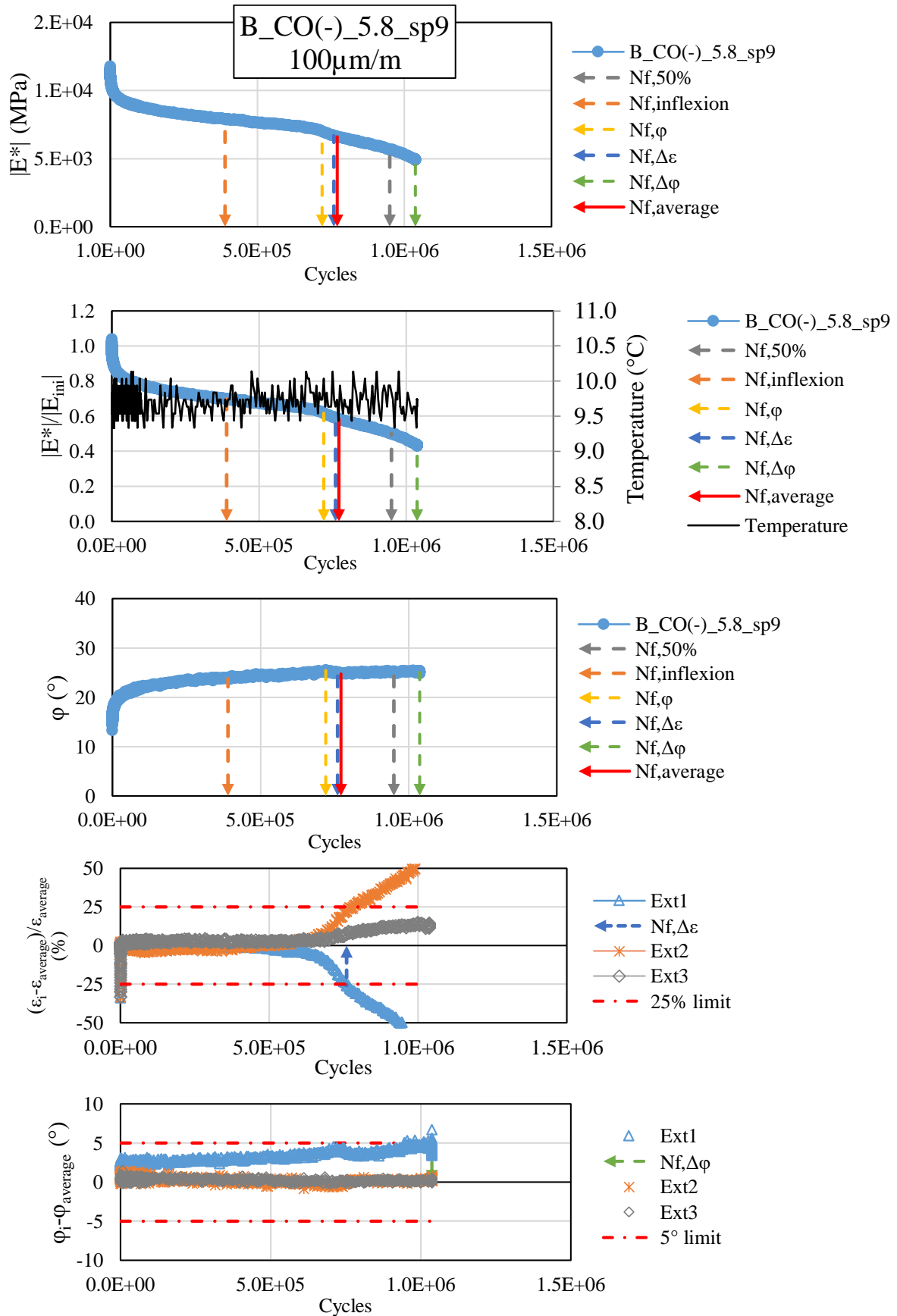
#### 2.2.2.3.6. B\_CO(-)\_5.8\_sp8



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

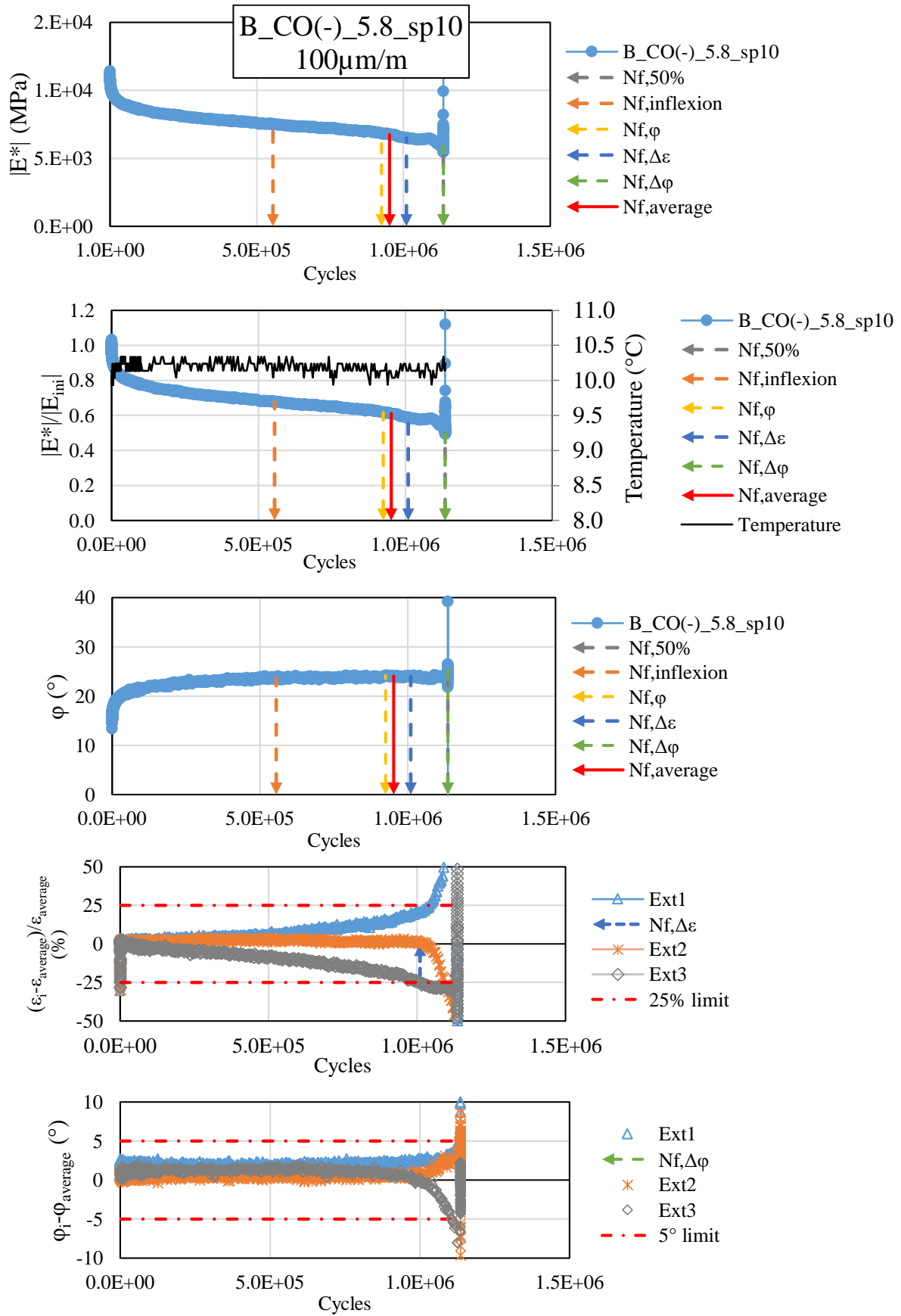
2.2.2.3.7. B\_CO(-)\_5.8\_sp9



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

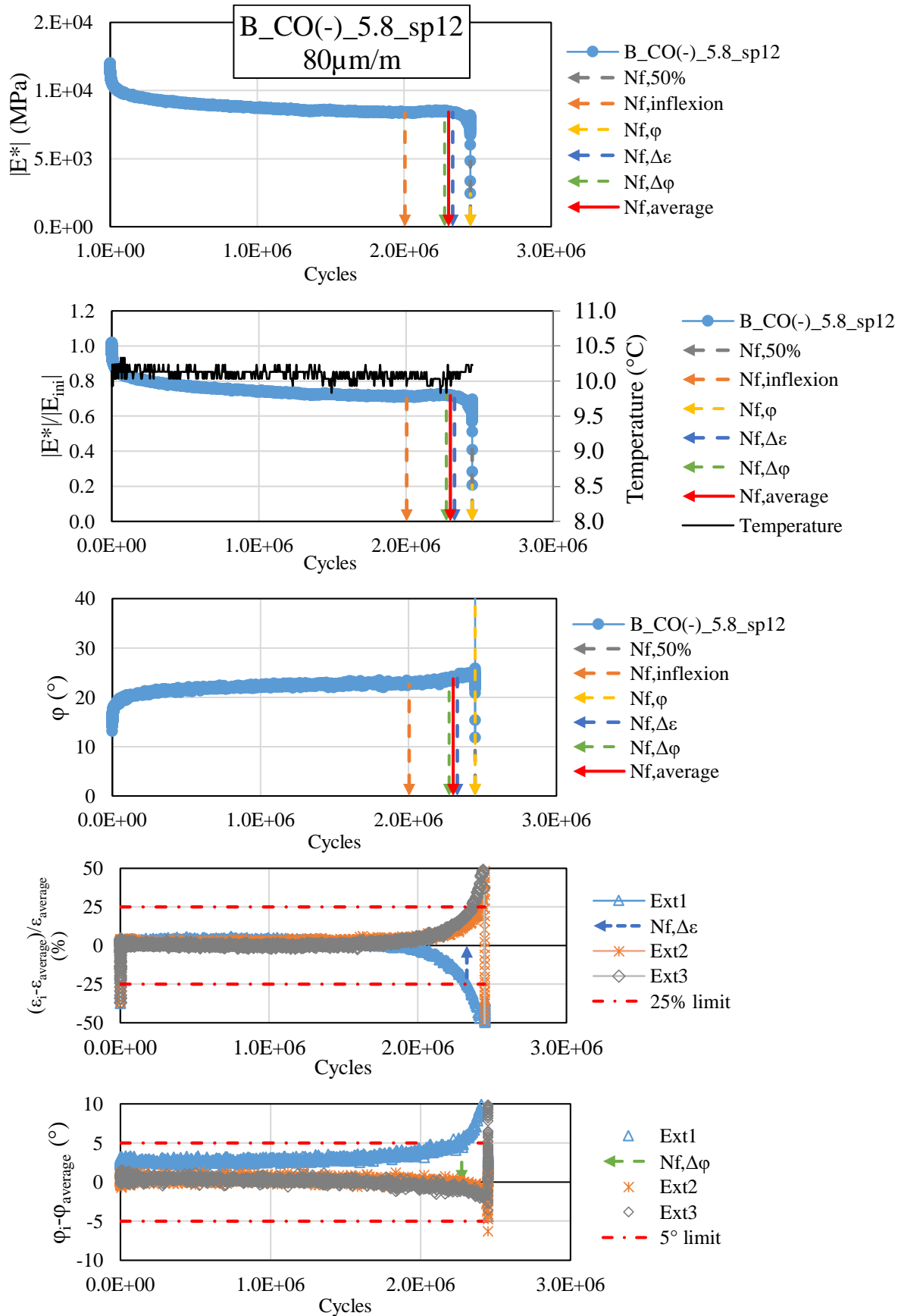
2.2.2.3.8. B\_CO(-)\_5.8\_sp10



## 2 Thermomechanical tests on bituminous mixtures

### 2.2 Fatigue tests

2.2.2.3.9. B\_CO(-)\_5.8\_sp12



2 Thermomechanical tests on bituminous mixtures  
2.3 Indirect Tensile Strength testMixture

2.3. Indirect Tensile Strength test

Mixture	ITSR (%)	ITS <sub>dry</sub> (MPa)		V <sub>Cdry</sub> (%)	ITS <sub>wet</sub> (MPa)		V <sub>Cwet</sub> (%)
		avg.	SD		avg.	SD	
B_CO_5.8	76%	890	14	6%	681	27	6%
B_CO_4.8	77%	900	14	10%	693	58	10%
Bm_CO_5.8	82%	1171	68	6%	959	46	6%
Bm_CO_4.8	81%	1103	43	10%	893	58	11%
S_CO_5.8	66%	850	30	9%	559	21	9%
S_CO_4.8	48%	888	31	12%	424	40	12%
Sm_CO_5.8	79%	1196	44	7%	943	17	7%
Sm_CO_4.8	76%	1195	16	10%	912	73	10%
Bm_BI_5.8	92%	1131	15	4%	1036	26	4%
Bm_CR_5.8	83%	1140	13	7%	951	43	7%
Bm_HL_5.8	91%	1104	37	2%	1005	13	2%
Bm_BE_5.8	77%	1404	95	7%	1083	93	7%
S_BI_5.8	82%	952	10	5%	778	14	5%
S_CR_5.8	86%	849	76	8%	734	20	8%
S_HL_5.8	85%	928	46	2%	790	29	2%
S_BE_5.8	76%	1188	51	8%	900	96	8%
B_CO(+)_5.8	88%	839	30	5%	740	4	5%
B_CO(-)_5.8	85%	804	32	6%	682	14	6%
B_CO(o)_5.8	79%	780	41	6%	616	22	7%

3 Thin film thermomechanical tests  
3.1 Complex modulus

Mixture	ITSdry (MPa)			$\rho_{dry}$ (g/L)	ITSwet (MPa)			$\rho_{wet}$ (g/L)	$\rho_{mix}$ (g/L)
	sp1	sp2	sp3		sp1	sp2	sp3		
B_CO_5.8	879	886	906	2234.8	650	695	698	2235.6	2387
B_CO_4.8	916	888	897	2182.6	734	719	627	2171.4	2426
Bm_CO_5.8	1093	1218	1202	2254.9	996	974	908	2253.2	2387
Bm_CO_4.8	1068	1151	1090	2178	954	887	839	2164.3	2426
S_CO_5.8	857	818	876	2168.3	561	537	579	2162.2	2387
S_CO_4.8	853	898	913	2143.7	378	450	443	2142.9	2426
Sm_CO_5.8	1225	1217	1145	2227.6	926	959	945	2223.7	2387
Sm_CO_4.8	1206	1201	1177	2182.2	990	845	901	2178.5	2426
Bm_BI_5.8	1123	1148	1122	2339.4	1043	1058	1008	2327.6	2427
Bm_CR_5.8	1152	1143	1126	2456.9	984	968	902	2448.1	2644
Bm_HL_5.8	1091	1146	1076	2428	993	1019	1004	2431.3	2488
Bm_BE_5.8	1310	1402	1499	2148	1074	995	1181	2138.2	2299
S_BI_5.8	963	946	947	2308.2	785	762	788	2307.3	2431
S_CR_5.8	794	816	936	2420.8	745	711	745	2413.7	2635
S_HL_5.8	963	875	945	2436.1	760	794	817	2431.1	2488
S_BE_5.8	1131	1205	1229	2156.6	802	993	904	2152.6	2335
B_CO(+)_5.8	872	830	815	2260.7	739	737	745	2257.3	2387
B_CO(-)_5.8	837	800	774	2239.6	680	670	697	2234.4	2387
B_CO(o)_5.8	796	811	734	2234.6	629	590	628	2231	2387

**3. Thin film thermomechanical tests**

3.1. Complex modulus

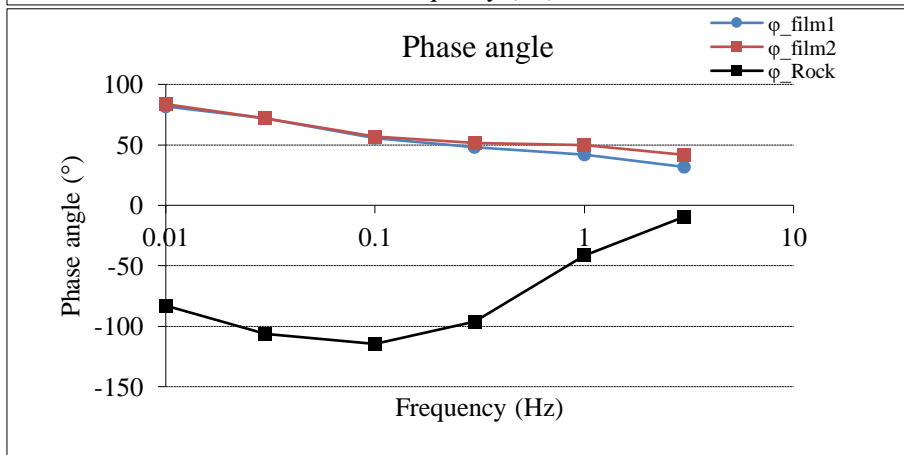
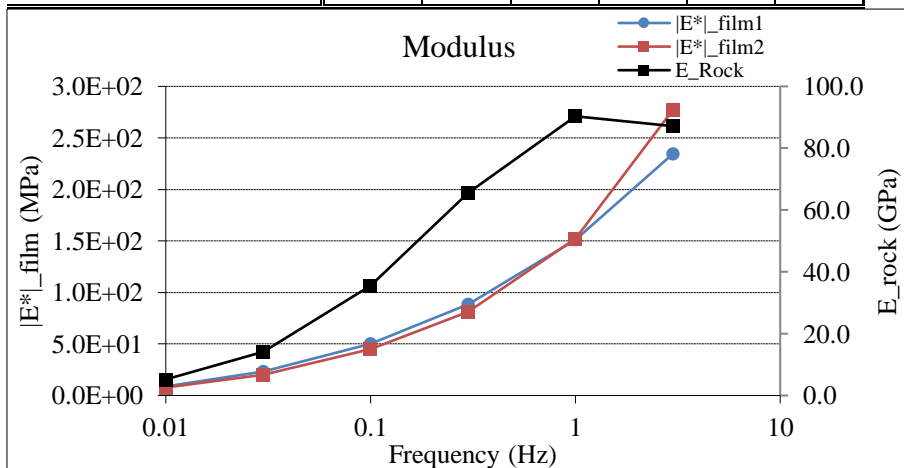
### 3 Thin film thermomechanical tests 3.1 Complex modulus

3.1.1.B\_CO\_300\_LD\_sp1

**B\_CO\_300\_LD\_sp1**

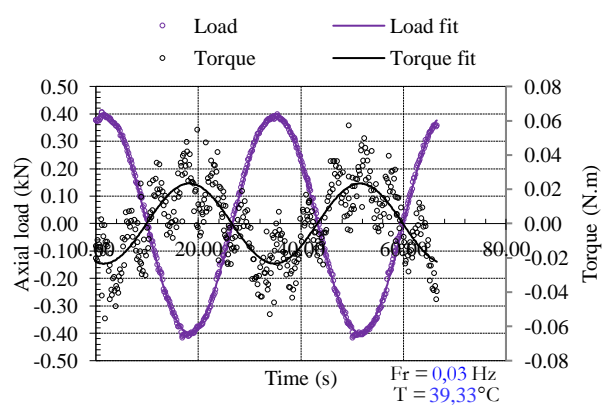
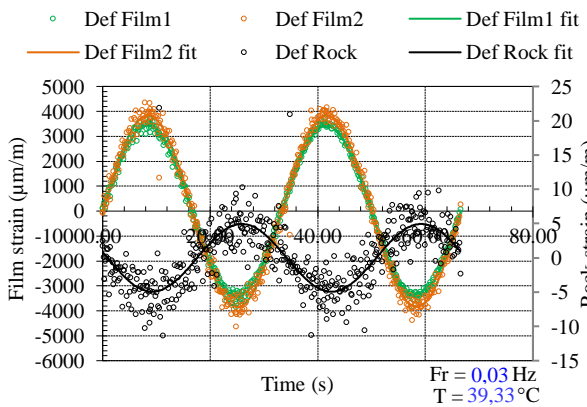
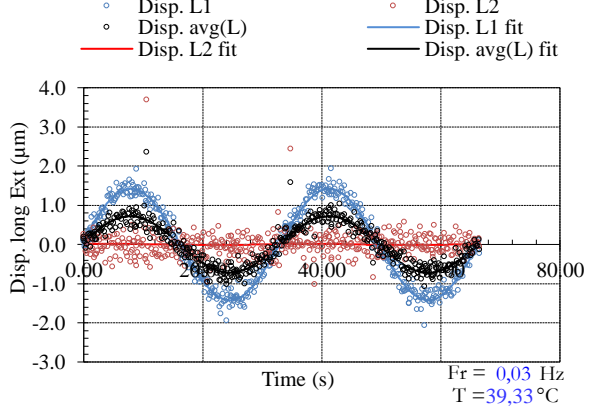
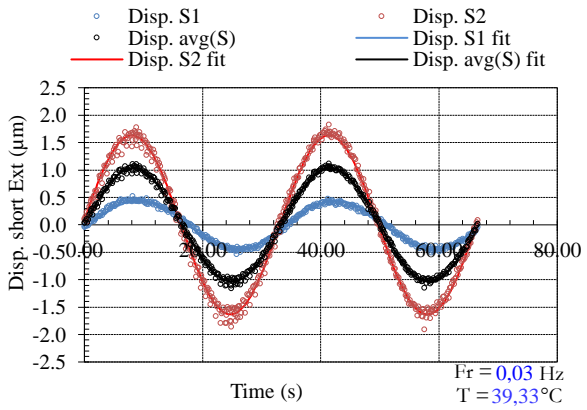
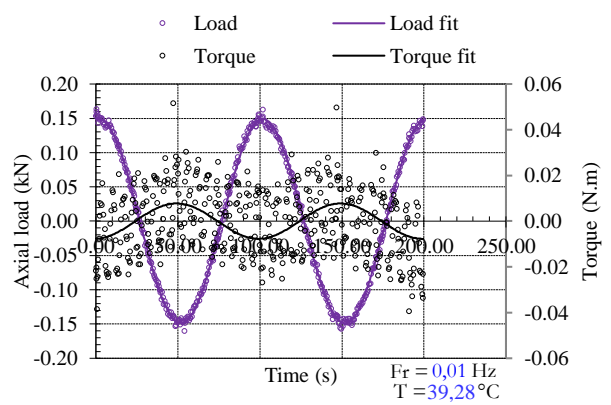
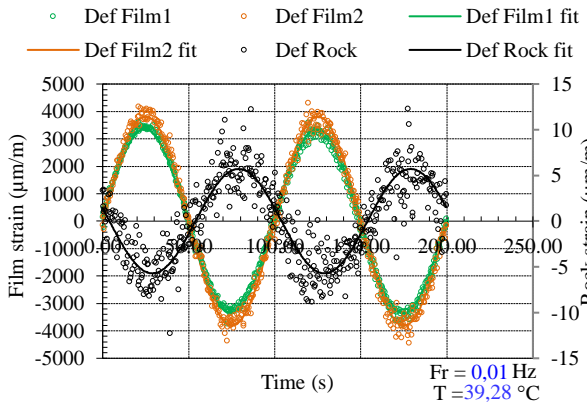
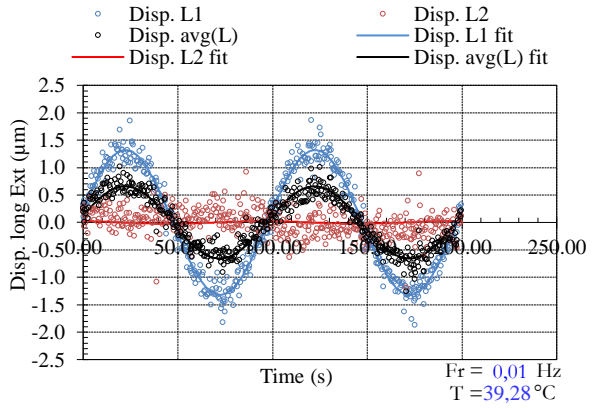
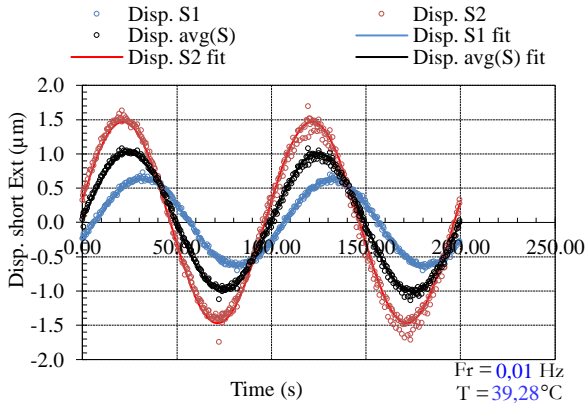
Temperature (°C) 39,3

Frequency (Hz)	0,01	0,03	0,1	0,3	1	3	
Disp. amplitude (µm)	Small Ext1	0,64	0,45	0,57	0,56	0,55	0,33
	Small Ext2	1,47	1,63	1,48	1,29	1,23	0,83
	Avg. Small Ext	1,01	1,03	1,02	0,92	0,89	0,58
	Long Ext1	1,32	1,42	1,41	1,42	1,95	1,71
	Long Ext2 (failed)	0,02	0,14	0,01	0,03	0,02	0,03
	Avg. Long Ext	0,66	0,67	0,71	0,72	0,98	0,86
	In 1cm length of 50GPa rock cylinder (calculated)	0,01	0,02	0,03	0,05	0,09	0,09
Phase angle (°)	Small Ext1	107,4	81,6	50,2	43,2	41,7	27,7
	Small Ext2	71,0	68,9	57,8	50,3	41,9	33,3
	Avg. Small Ext	81,8	71,7	55,7	48,2	41,8	31,7
	Long Ext1	74,2	67,7	51,4	35,7	22,9	16,5
	Long Ext2	334,5	298,5	58,3	29,5	188,1	85,3
	Avg. Long Ext	73,2	71,6	51,5	35,6	22,7	16,7



### 3 Thin film thermomechanical tests

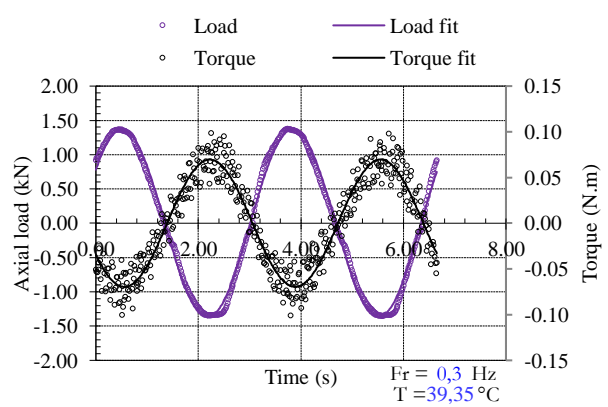
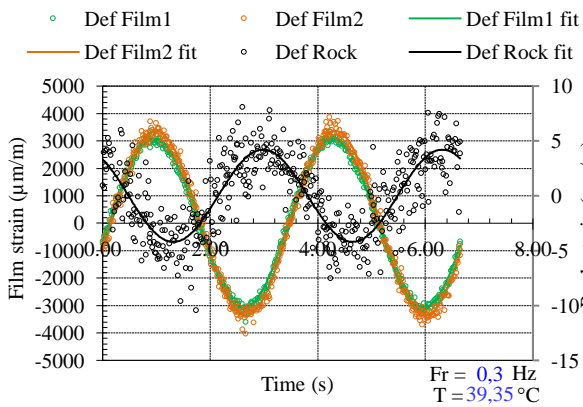
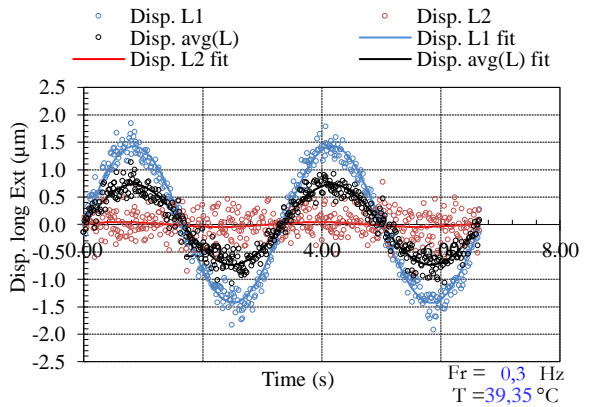
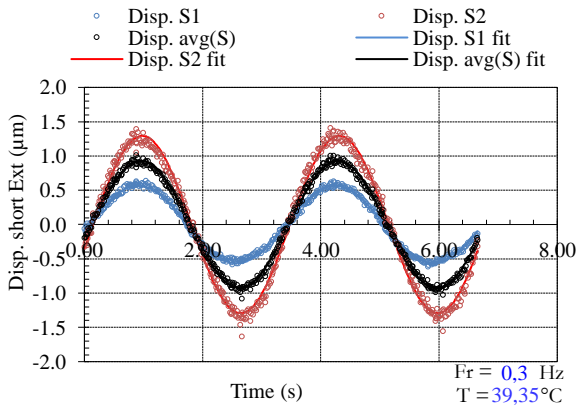
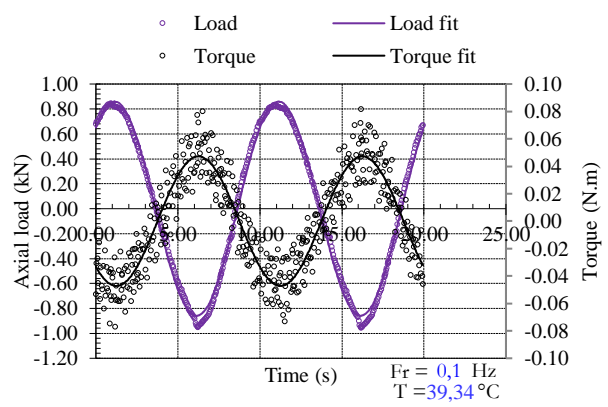
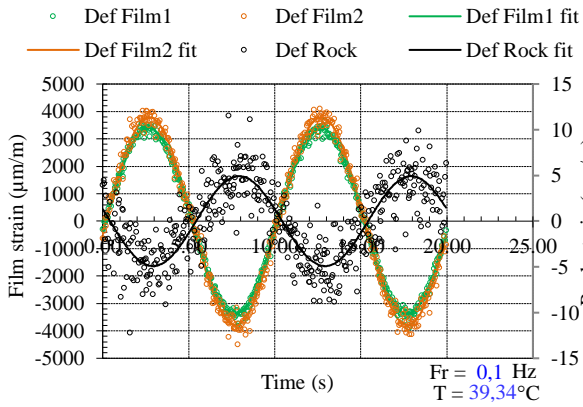
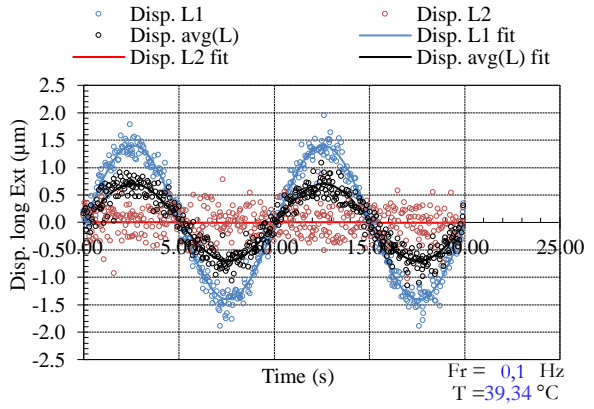
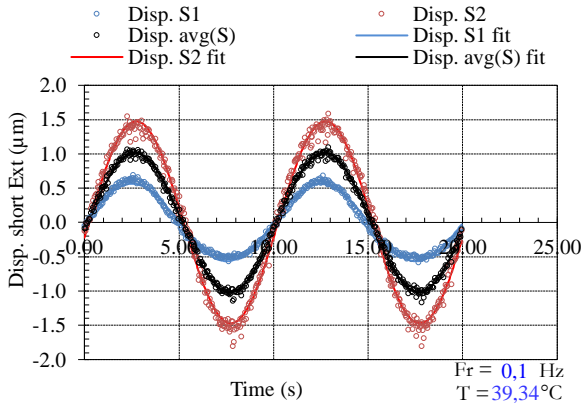
#### 3.1 Complex modulus





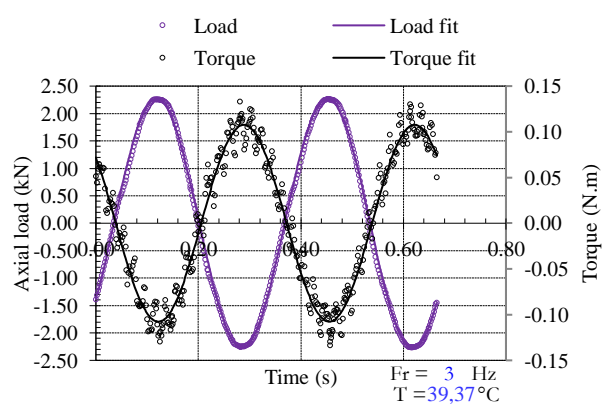
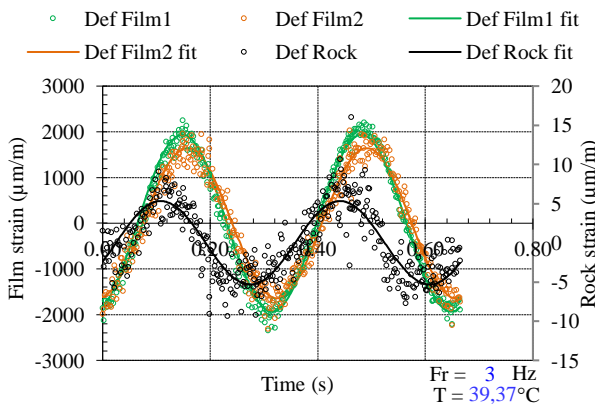
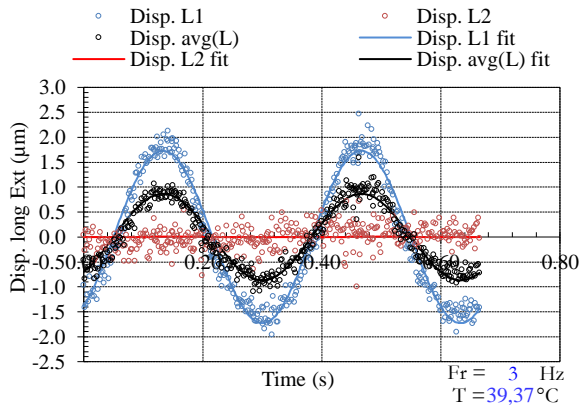
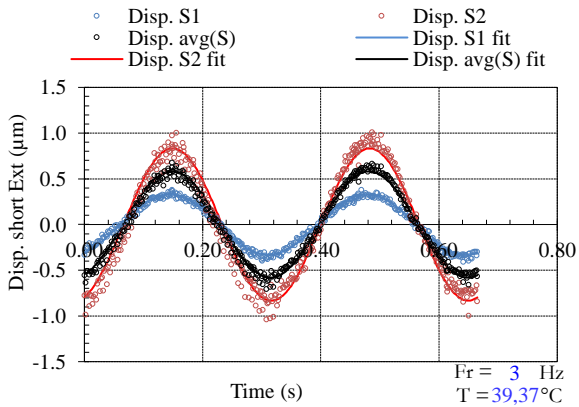
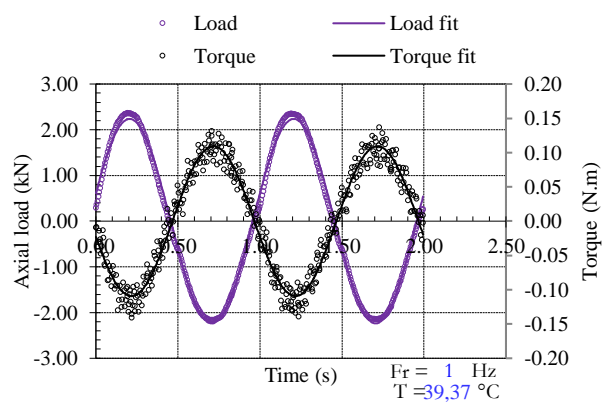
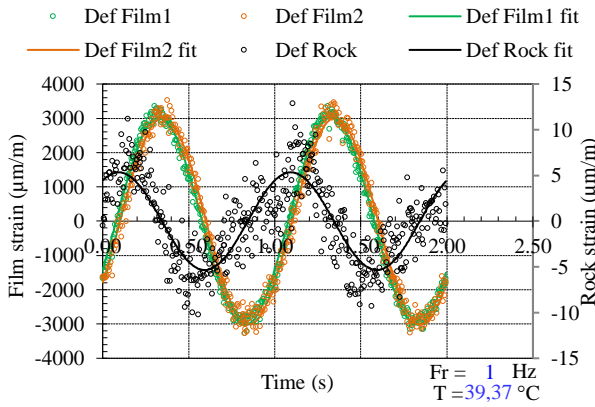
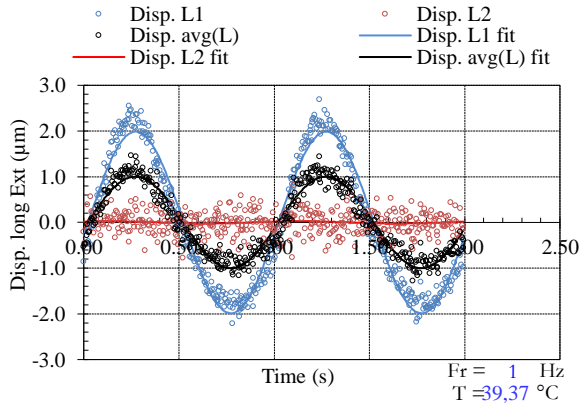
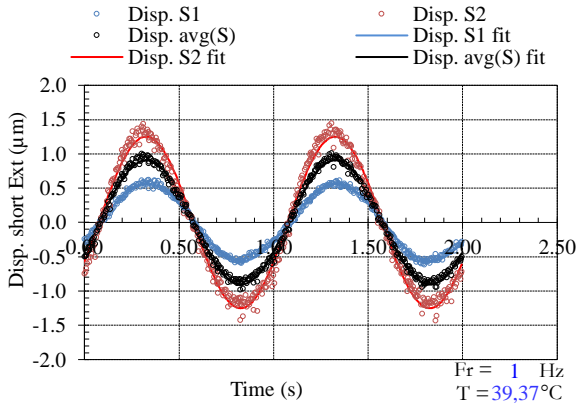
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus

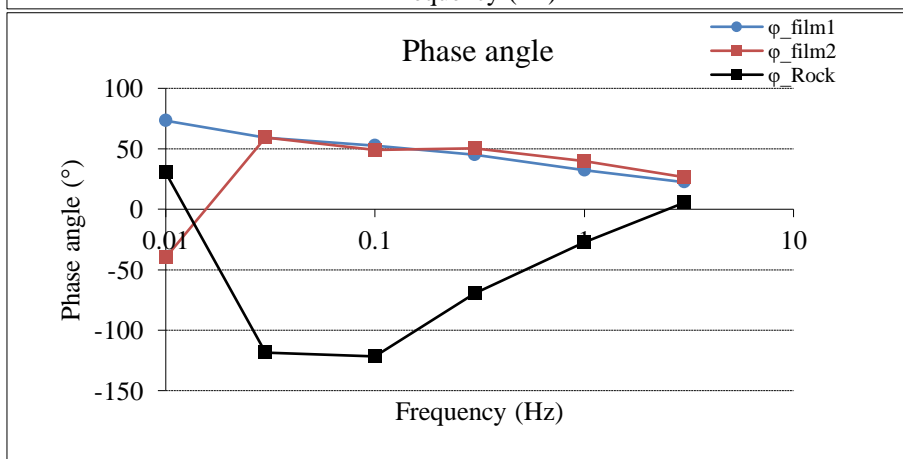
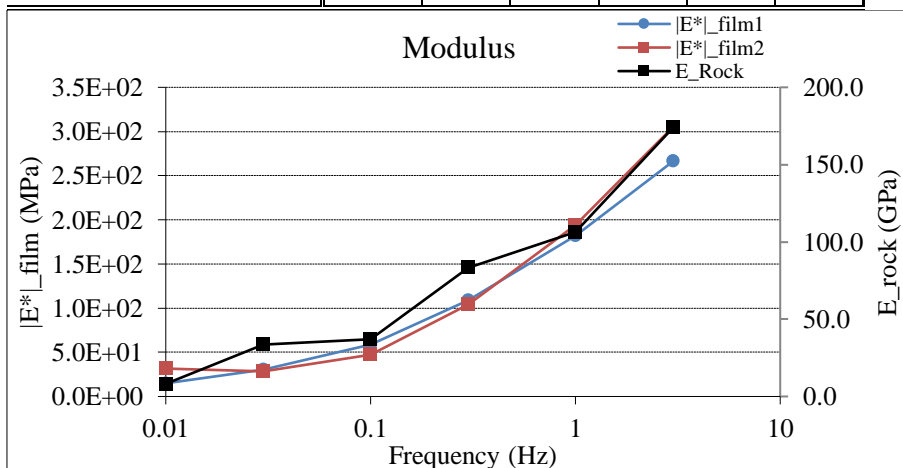


### 3 Thin film thermomechanical tests 3.1 Complex modulus

**B\_CO\_300\_LD\_sp1**

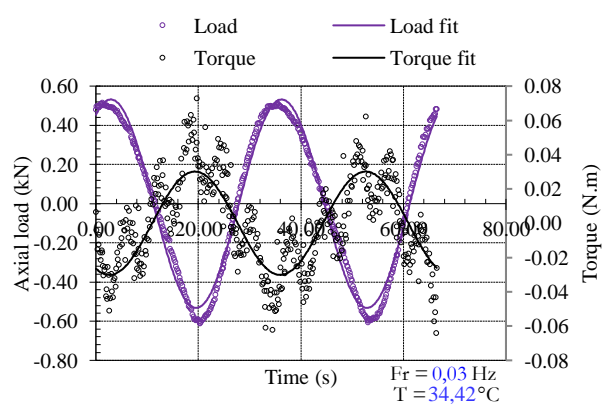
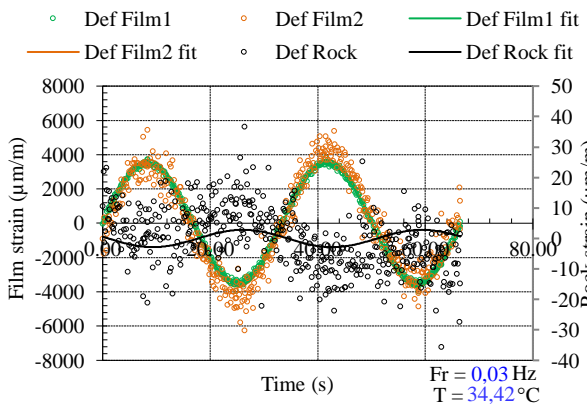
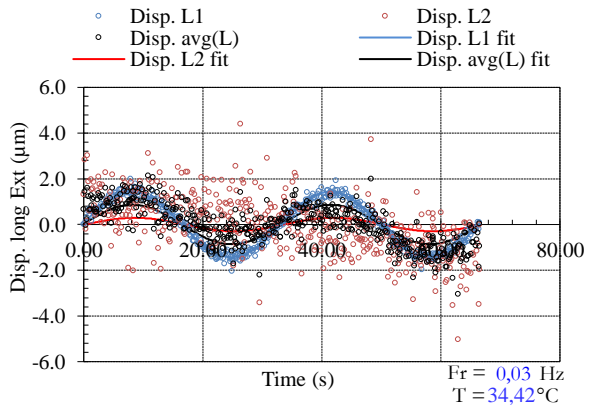
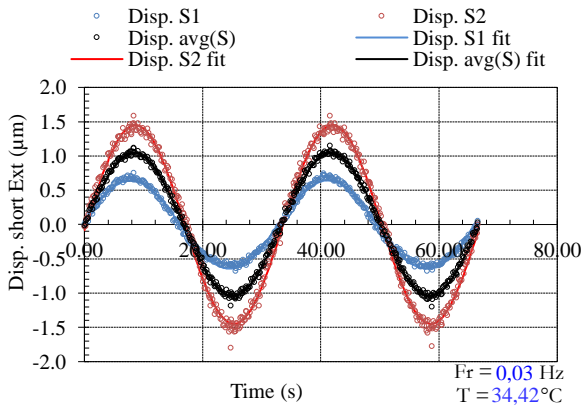
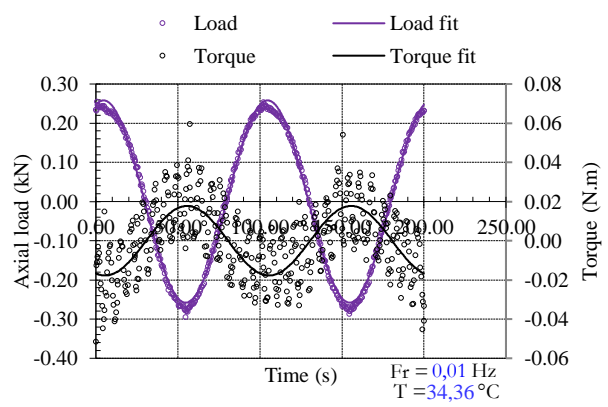
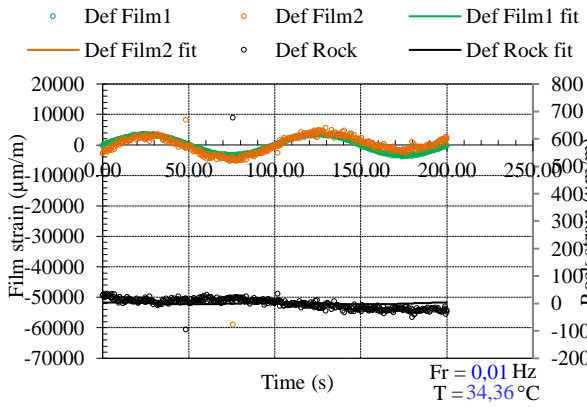
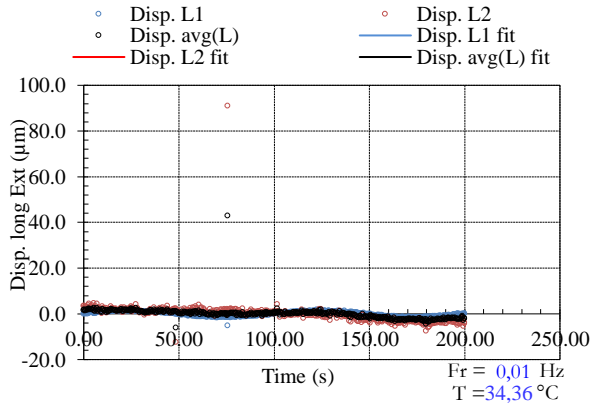
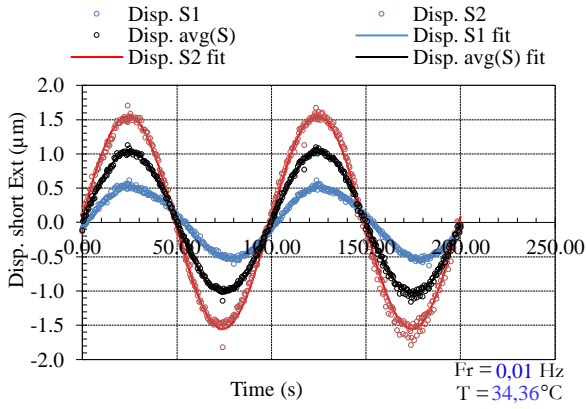
Temperature (°C) 34,4

Frequency (Hz)		0,01	0,03	0,1	0,3	1	3
Disp. amplitude (µm)	Small Ext1	0,52	0,64	0,71	0,60	0,48	0,10
	Small Ext2	1,55	1,45	1,30	1,18	1,10	0,20
	Avg. Small Ext	1,03	1,04	1,00	0,89	0,79	0,15
	Long Ext1	1,39	1,44	1,43	1,61	2,00	0,43
	Long Ext2 (failed)	4,06	0,26	1,46	0,07	0,11	0,16
	Avg. Long Ext	2,72	0,84	0,96	0,82	0,97	0,22
	In 1cm length of 50GPa rock cylinder (calculated)	0,01	0,02	0,04	0,06	0,10	0,03
Phase angle (°)	Small Ext1	83,0	53,5	50,2	45,9	32,5	18,9
	Small Ext2	70,0	61,8	53,6	44,6	32,3	24,1
	Avg. Small Ext	73,2	59,2	52,4	45,1	32,4	22,4
	Long Ext1	69,0	56,0	43,4	28,8	17,4	11,1
	Long Ext2	57,9	77,9	109,3	2,4	195,9	80,8
	Avg. Long Ext	63,5	59,0	92,9	28,5	17,1	15,4



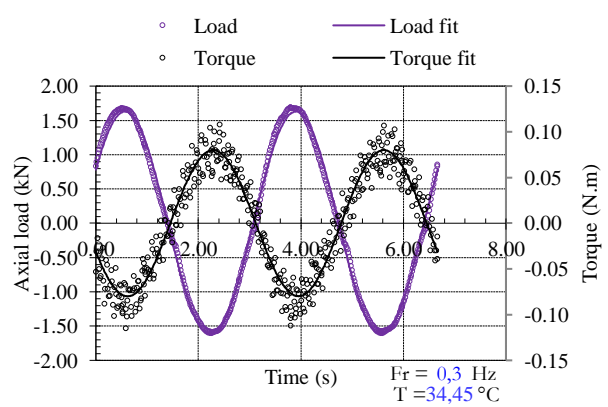
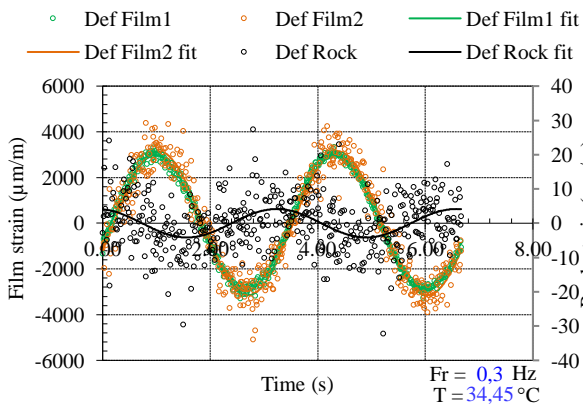
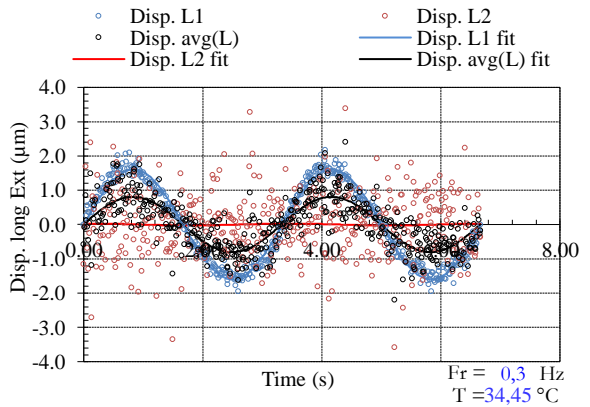
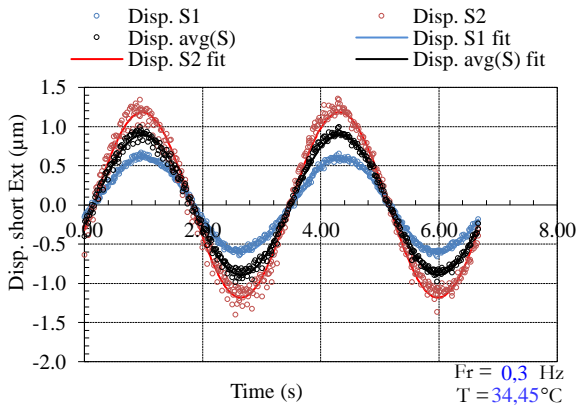
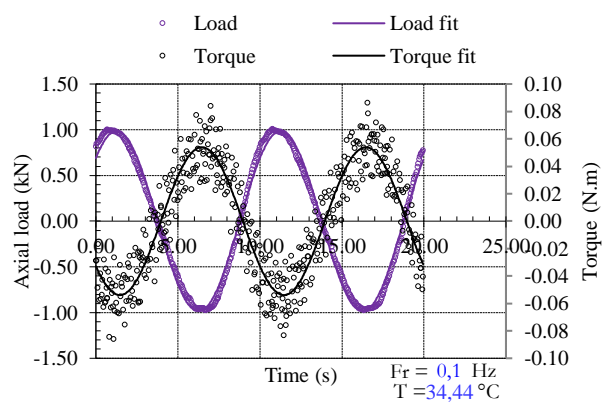
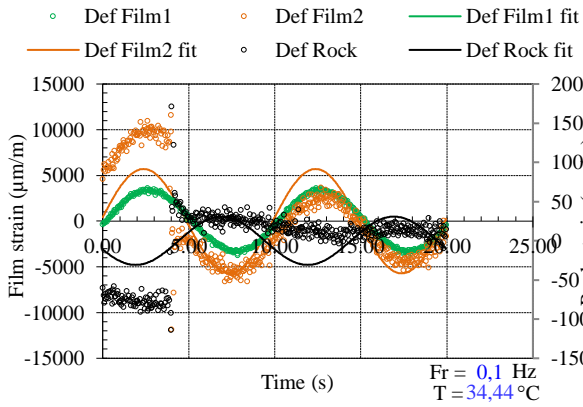
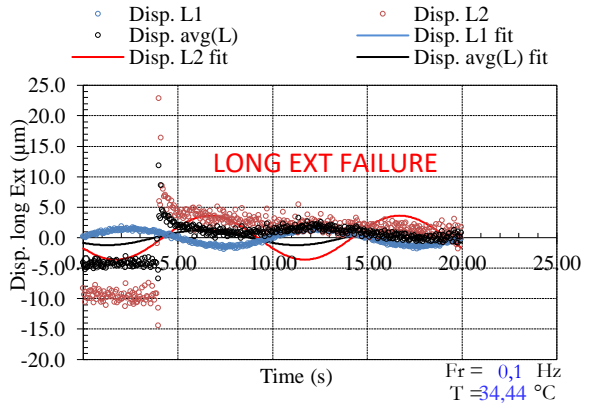
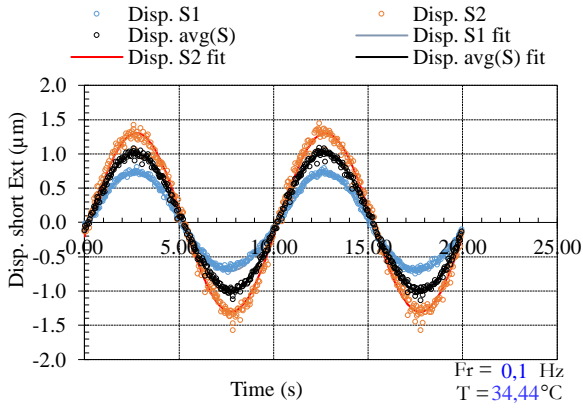
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



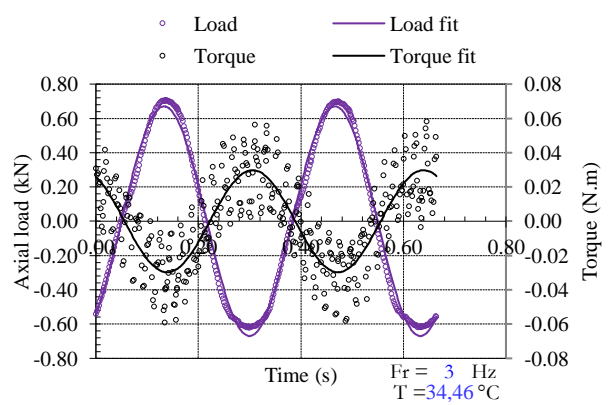
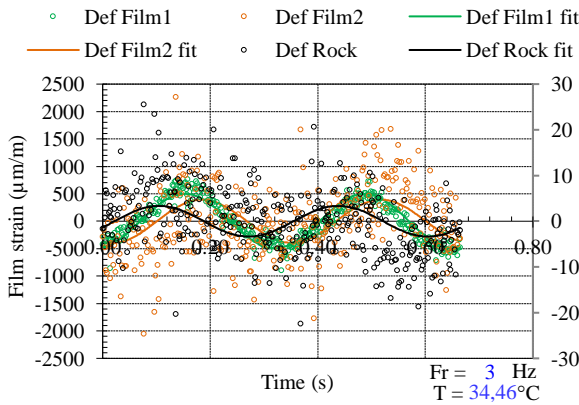
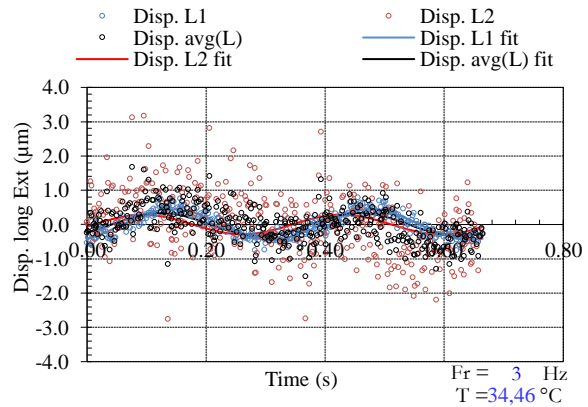
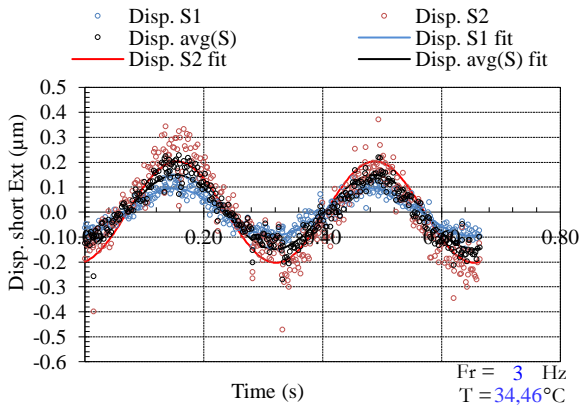
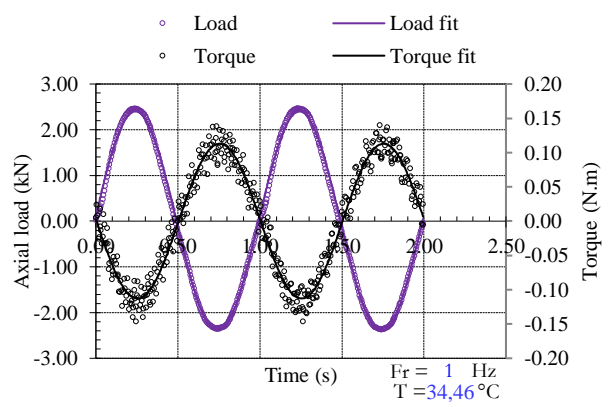
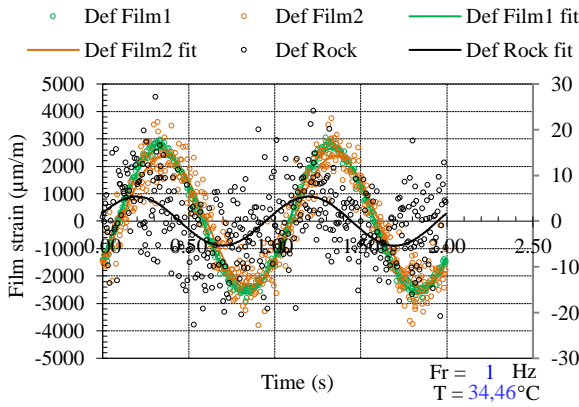
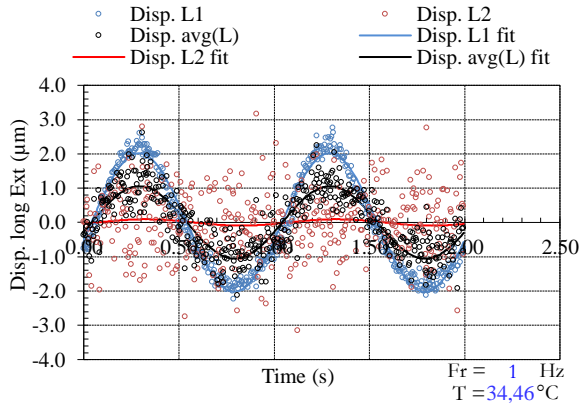
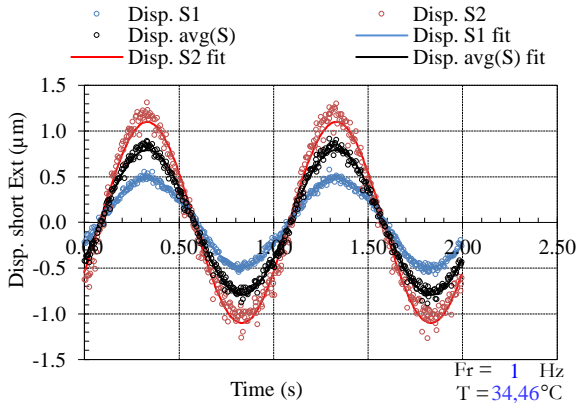
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus

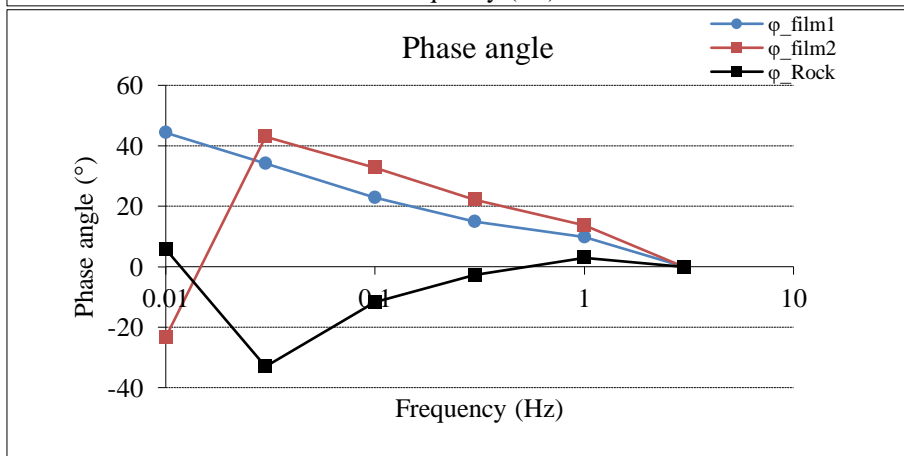
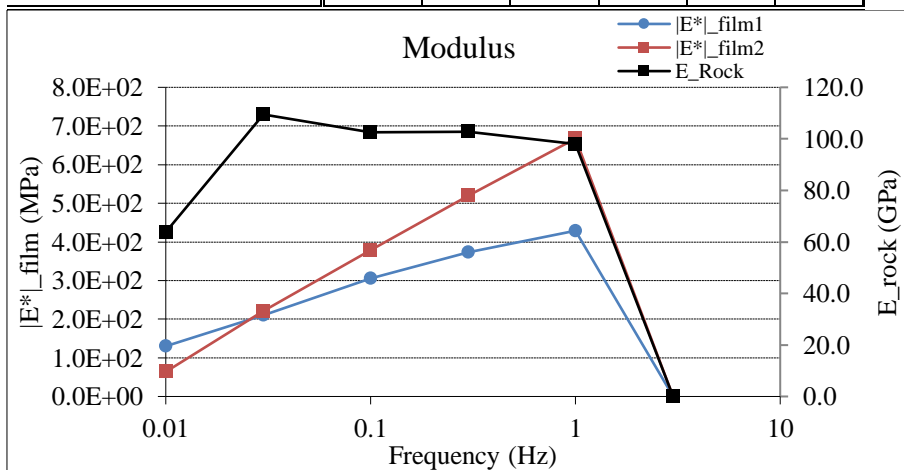


### 3 Thin film thermomechanical tests 3.1 Complex modulus

**B\_CO\_300\_LD\_sp1**

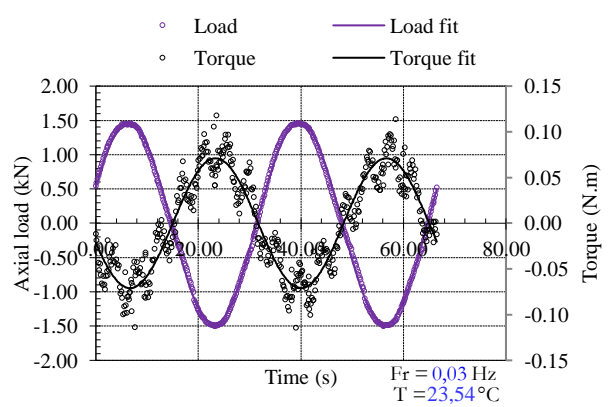
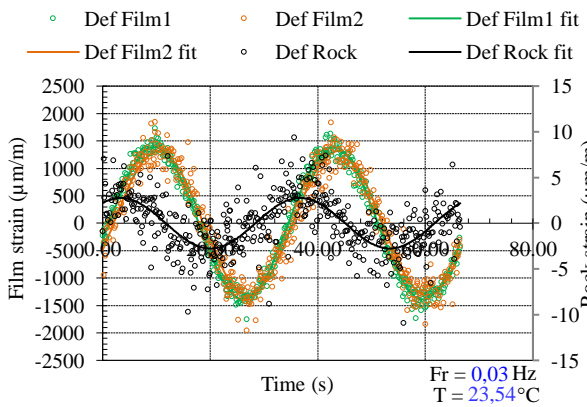
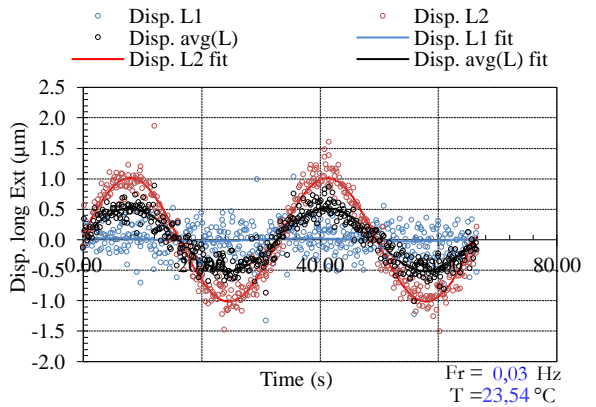
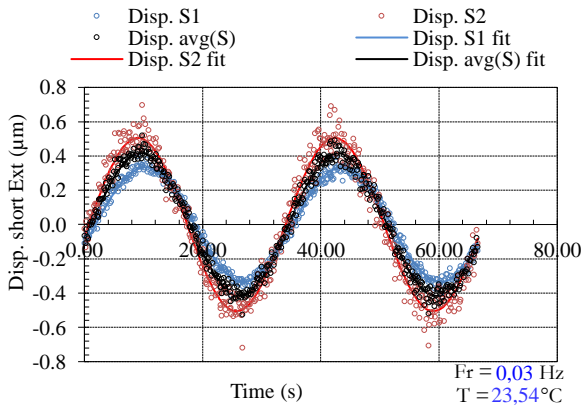
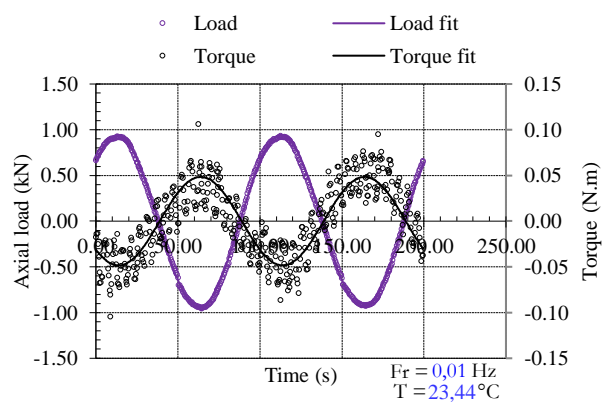
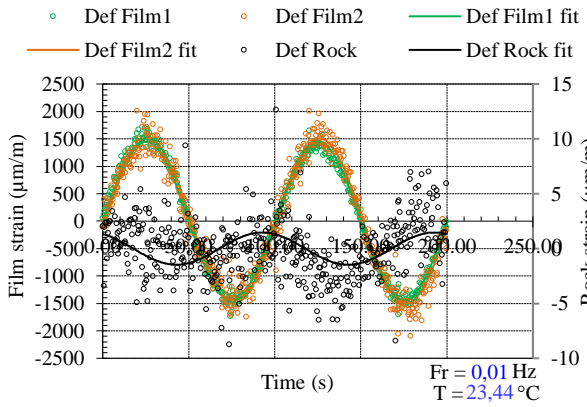
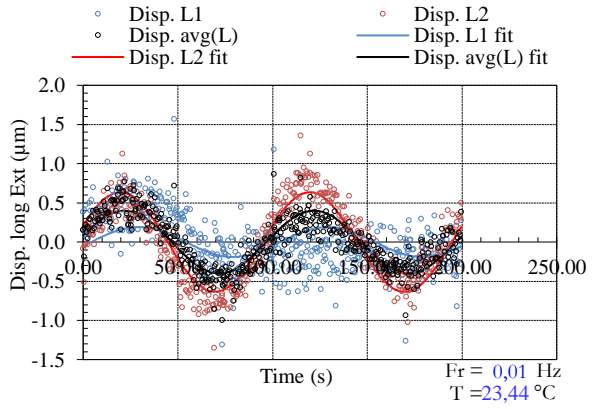
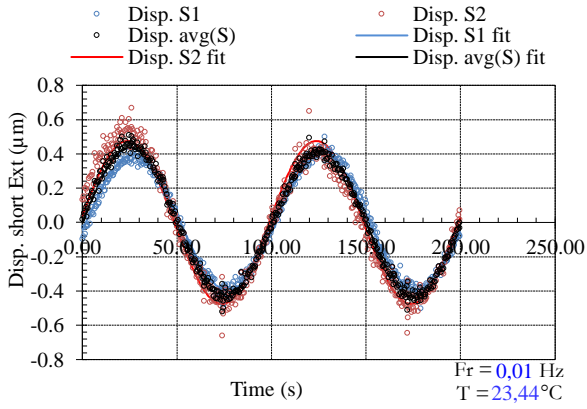
Temperature (°C) 23,4

Frequency (Hz)	0,01	0,03	0,1	0,3	1	3
Disp. amplitude (µm)	Small Ext1	0,38	0,34	0,20	0,14	0,12
	Small Ext2	0,49	0,50	0,35	0,26	0,22
	Avg. Small Ext	0,43	0,42	0,27	0,20	0,17
	<b>Long Ext1(failed)</b>	<b>39,12</b>	<b>0,02</b>	<b>0,02</b>	<b>0,02</b>	<b>0,02</b>
	Long Ext2	0,61	1,01	0,85	0,72	0,67
	<b>Avg. Long Ext</b>	<b>19,78</b>	<b>0,51</b>	<b>0,43</b>	<b>0,36</b>	<b>0,34</b>
	In 1cm length of 50GPa rock cylinder (calculated)	0,04	0,06	0,06	0,05	0,05
Phase angle (°)	Small Ext1	50,3	41,9	25,4	14,5	8,0
	Small Ext2	39,6	29,0	21,5	15,2	10,8
	Avg. Small Ext	44,3	34,1	22,9	14,9	9,8
	Long Ext1	71,3	6,5	315,5	2,0	235,7
	Long Ext2	23,6	16,1	10,1	8,0	6,0
	Avg. Long Ext	57,7	15,8	9,4	7,2	6,4



### 3 Thin film thermomechanical tests

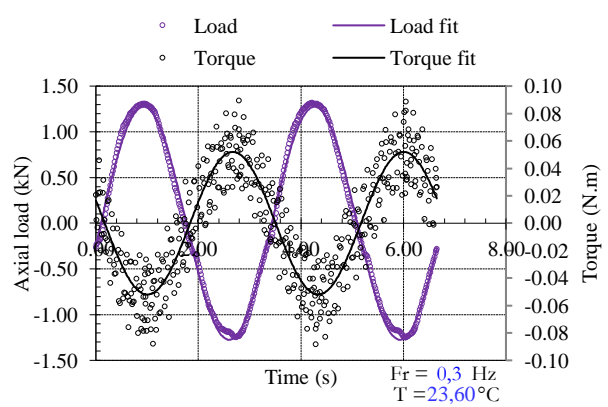
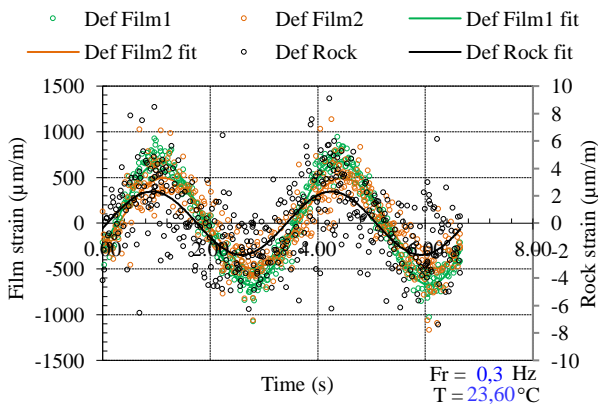
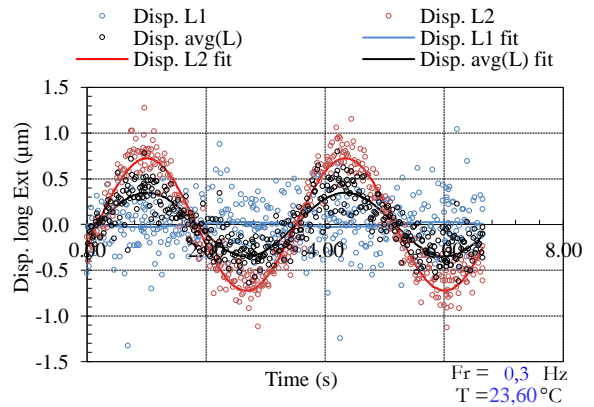
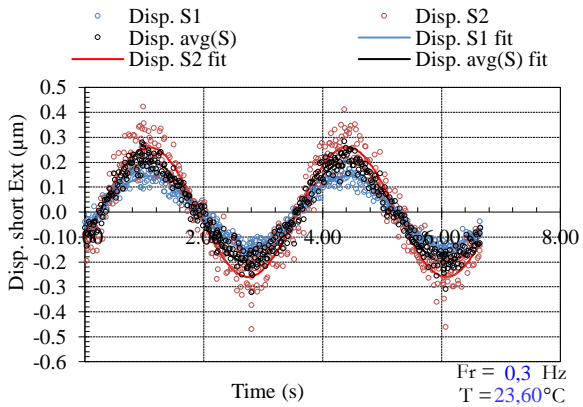
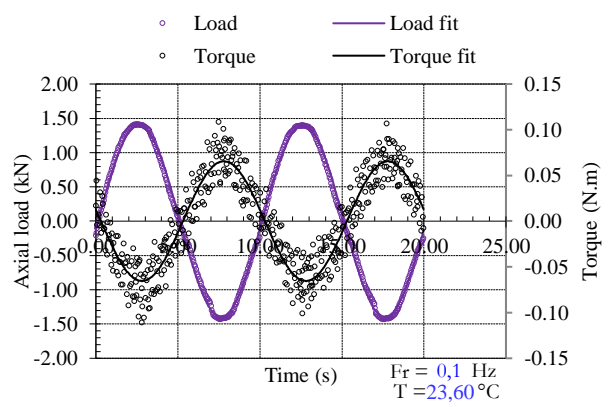
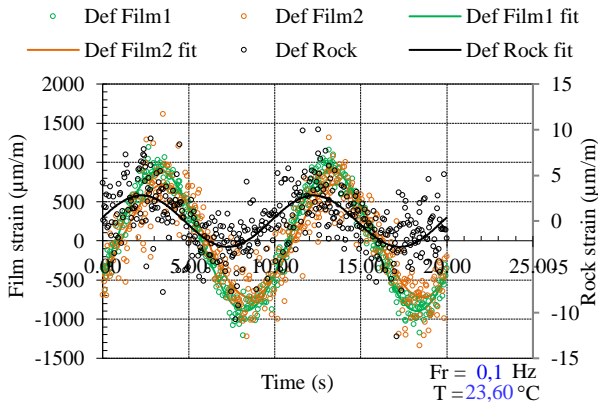
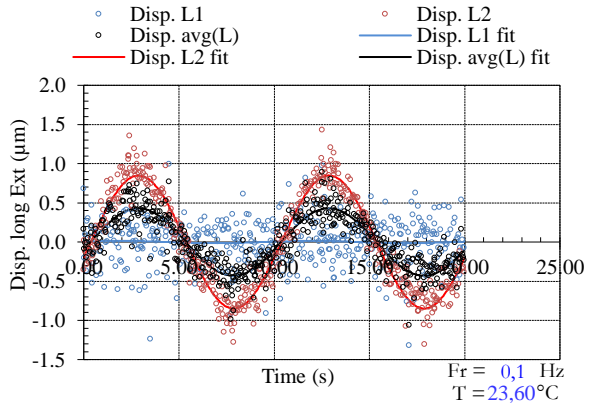
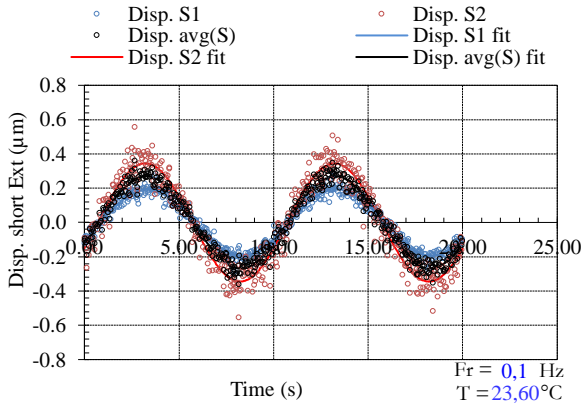
#### 3.1 Complex modulus



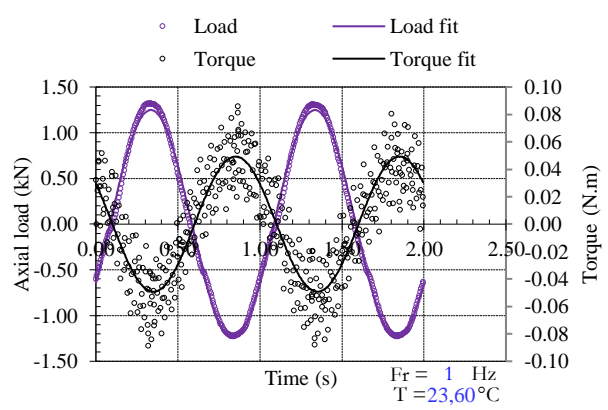
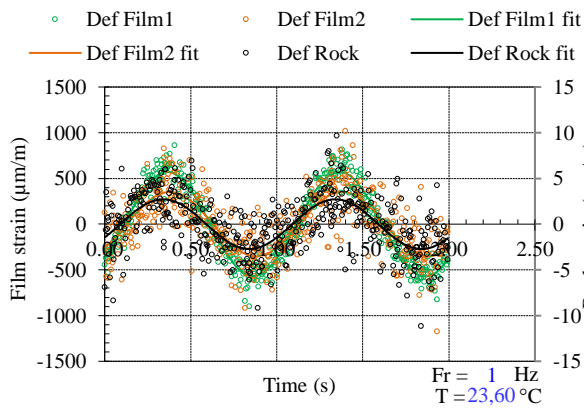
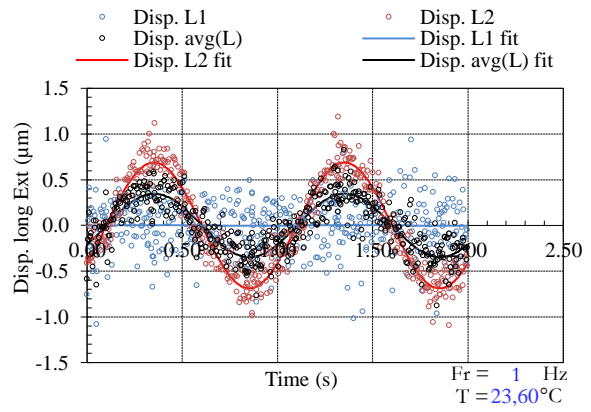
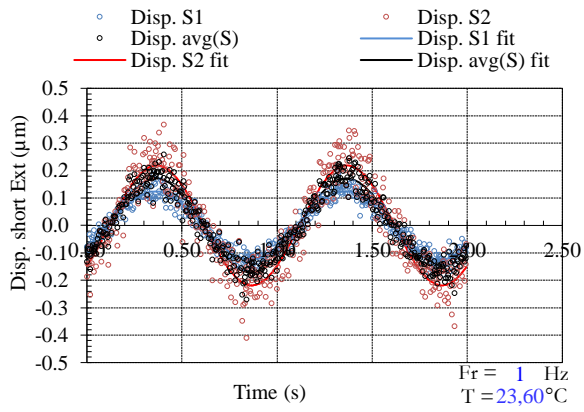


### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests 3.1 Complex modulus

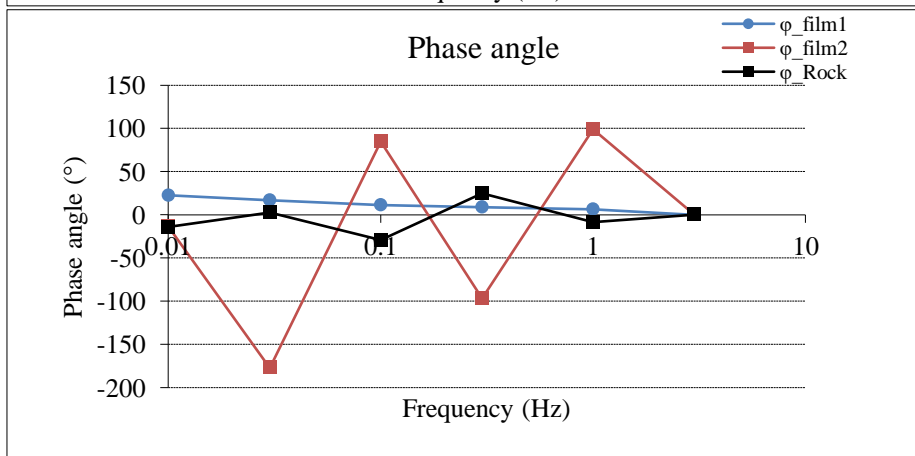
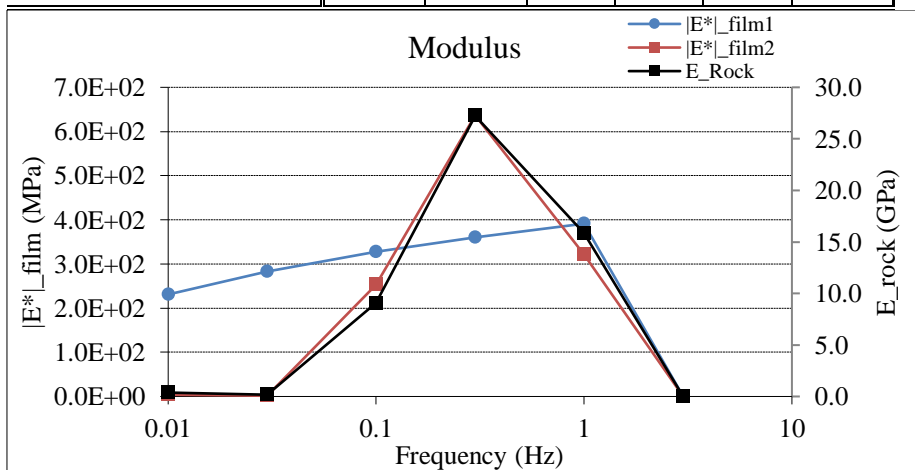


### 3 Thin film thermomechanical tests 3.1 Complex modulus

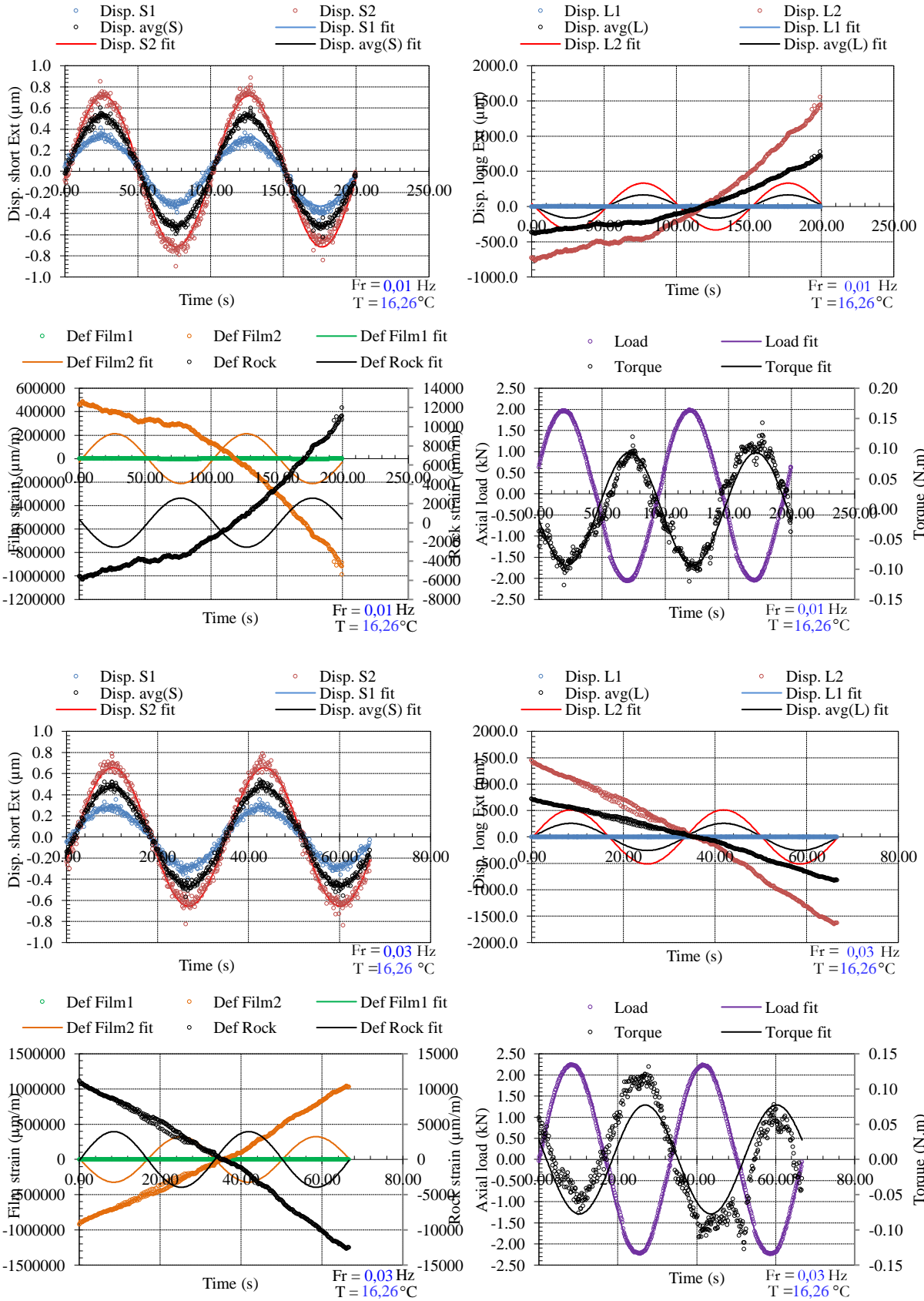
**B\_CO\_300\_LD\_sp1**

Temperature (°C) 16,2

Frequency (Hz)	0,01	0,03	0,1	0,3	1	3
Disp. amplitude (µm)	Small Ext1	0,33	0,29	0,27	0,23	0,20
	Small Ext2	0,72	0,65	0,64	0,60	0,57
	Avg. Small Ext	0,52	0,47	0,46	0,41	0,38
	Long Ext1	1,40	1,51	1,86	1,95	2,22
	Long Ext2 (failed)	209,89	416,87	9,35	1,88	3,43
	Avg. Long Ext	104,47	209,18	5,26	1,81	2,72
	In 1cm length of 50GPa rock cylinder (calculated)	0,08	0,09	0,10	0,10	0,10
Phase angle (°)	Small Ext1	19,9	13,2	7,0	4,2	1,8
	Small Ext2	24,0	18,2	13,6	10,3	8,4
	Avg. Small Ext	22,7	16,7	11,6	8,6	6,7
	Long Ext1	12,4	9,8	8,5	7,2	7,9
	Long Ext2	345,9	2,8	30,0	45,8	341,6
	Avg. Long Ext	345,5	2,8	32,0	20,8	353,7

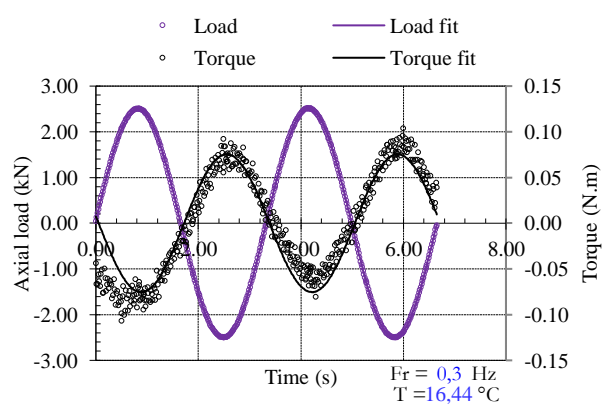
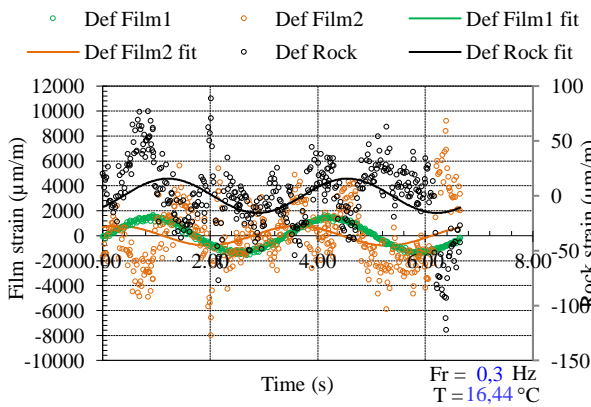
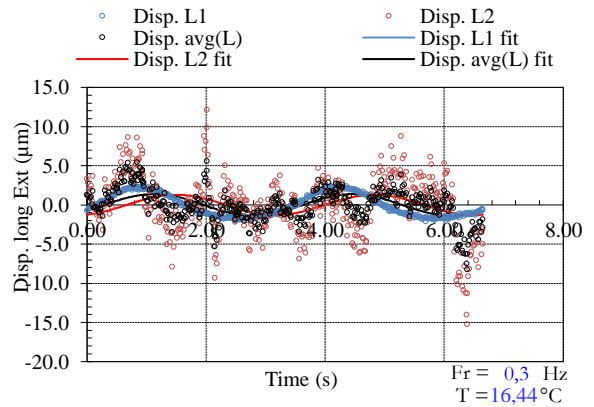
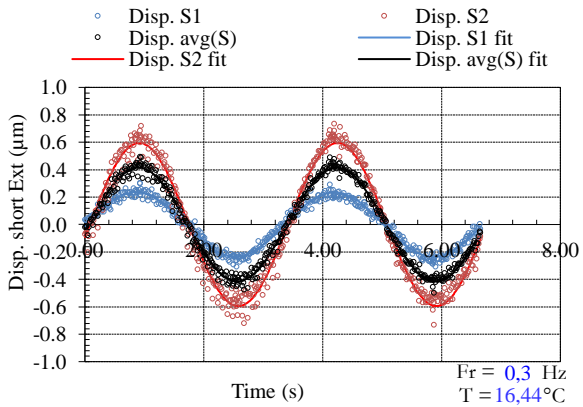
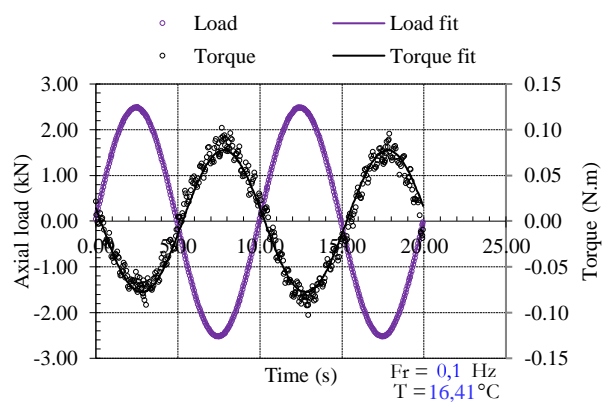
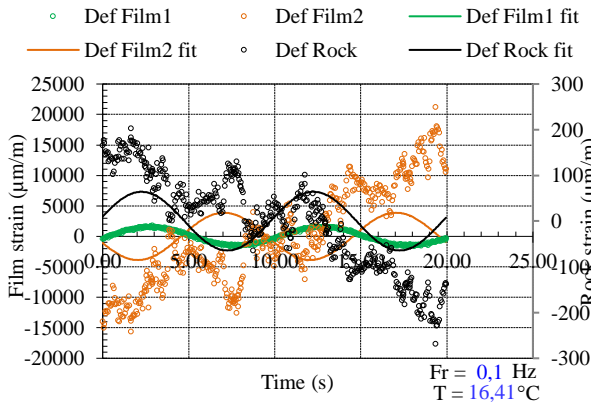
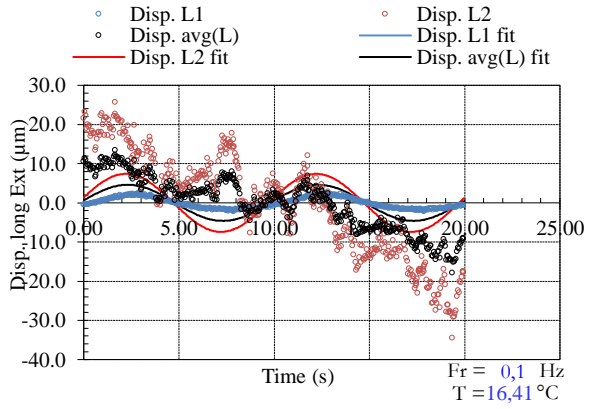
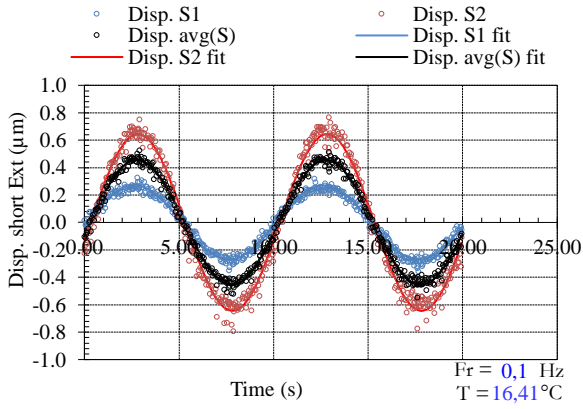


### 3 Thin film thermomechanical tests 3.1 Complex modulus

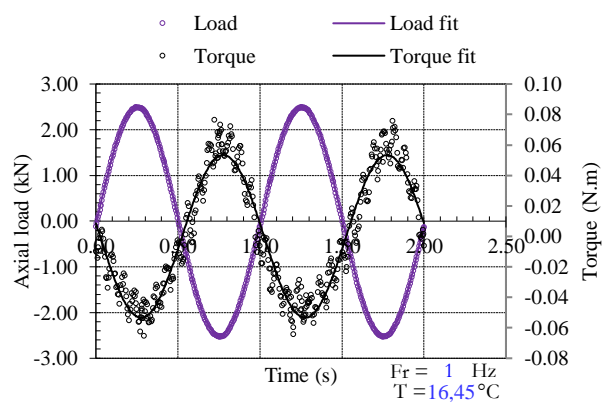
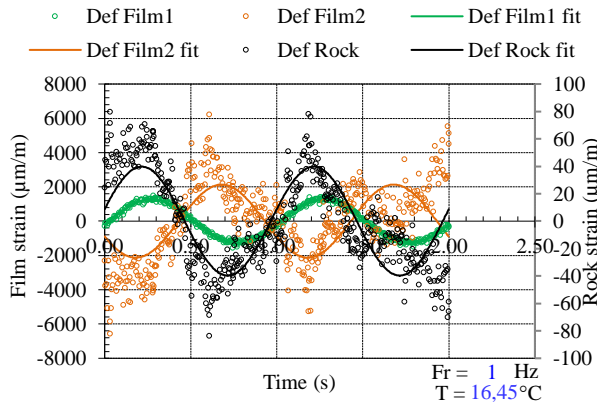
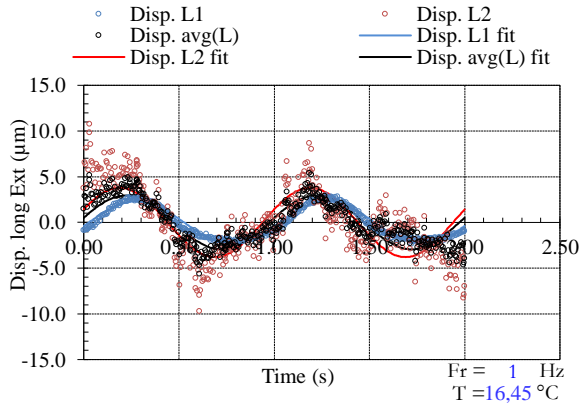
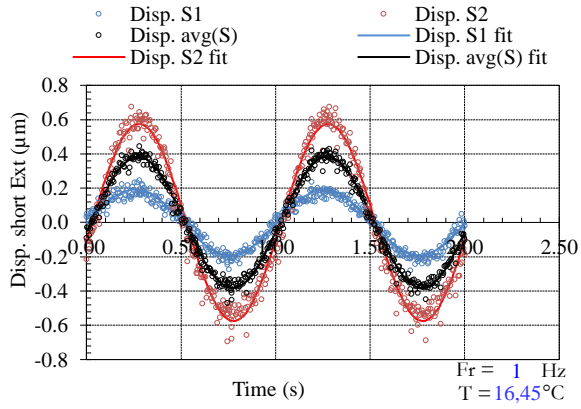


### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus

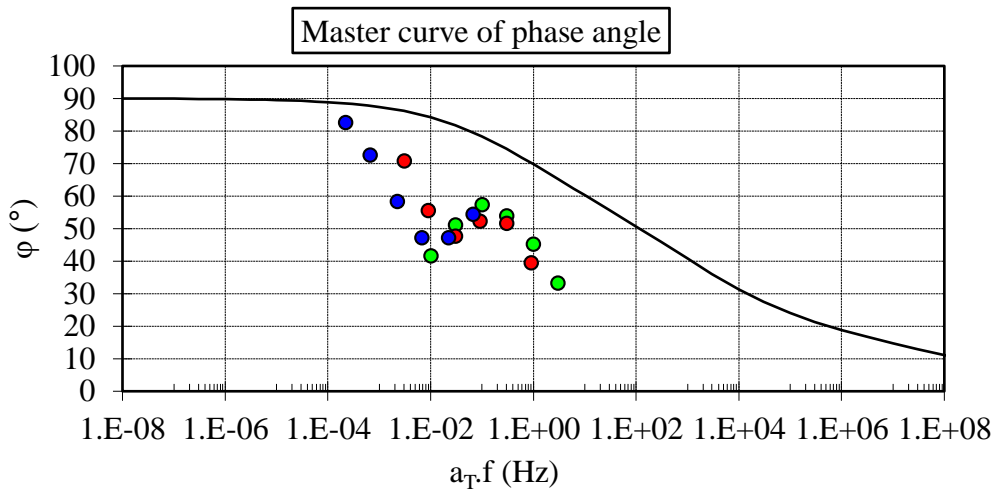
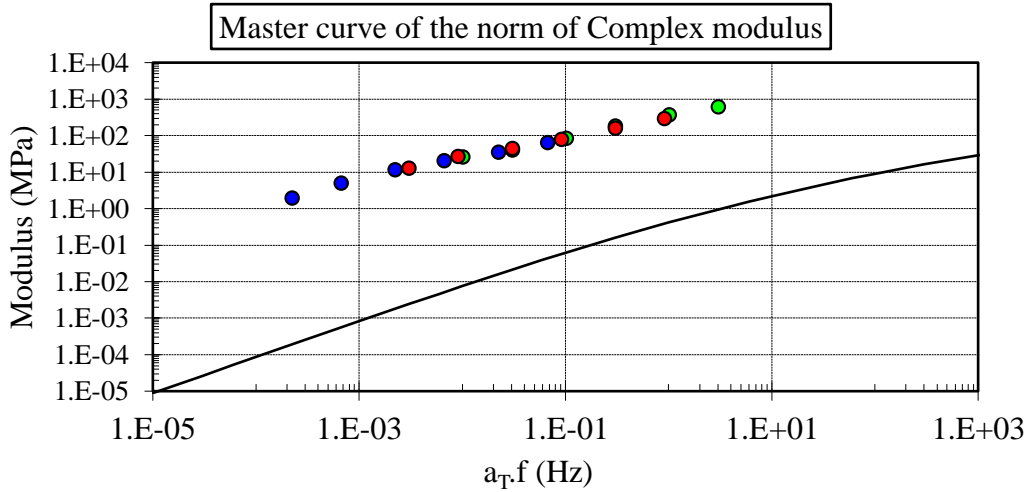
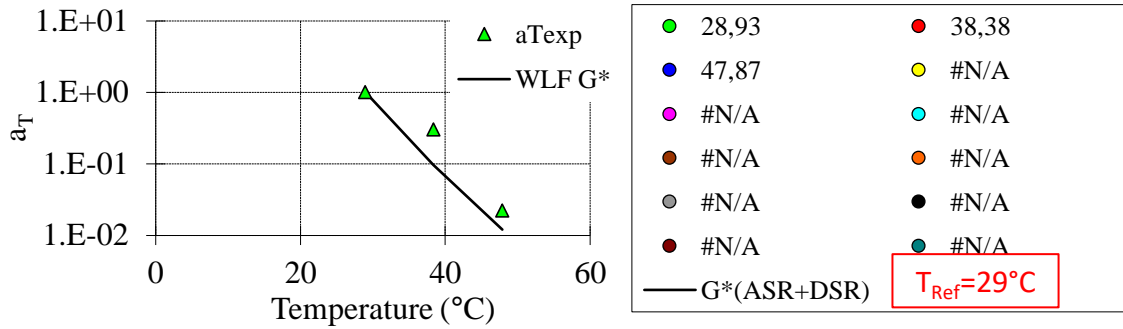
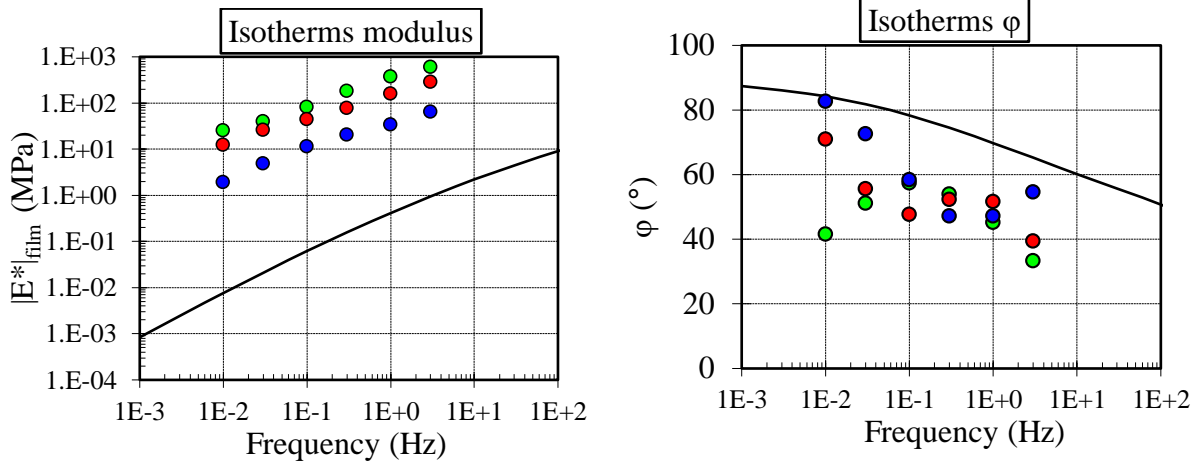


### 3 Thin film thermomechanical tests 3.1 Complex modulus

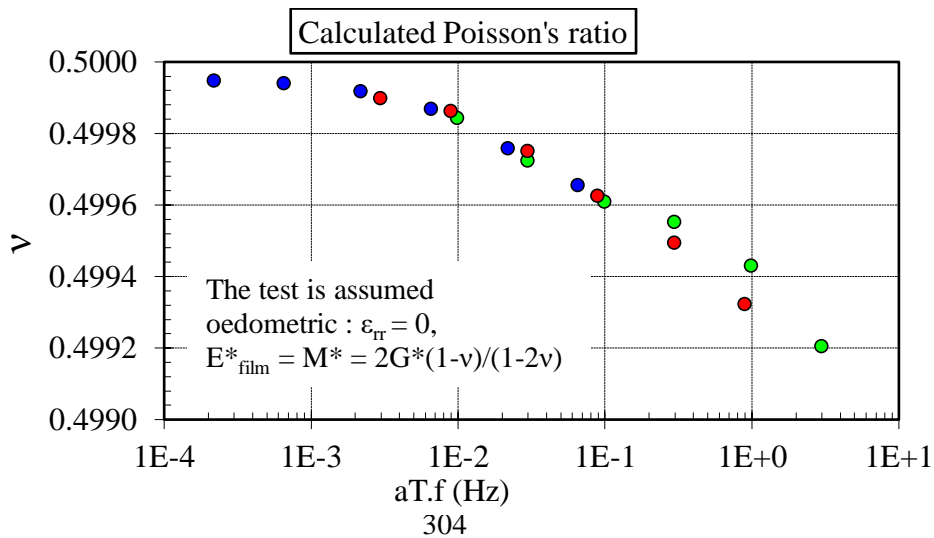
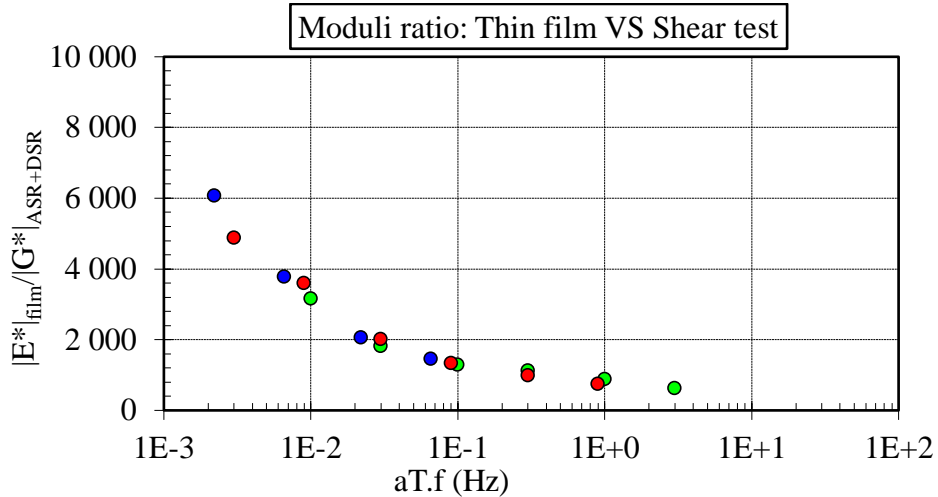
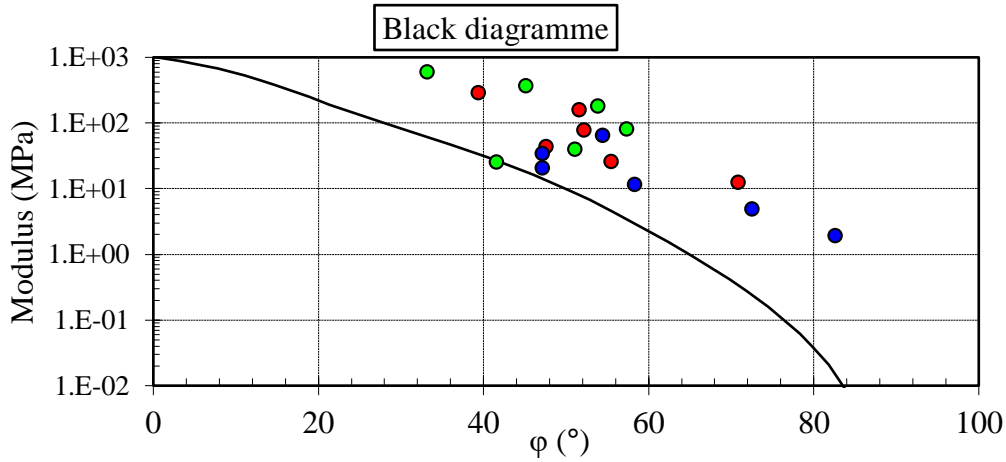
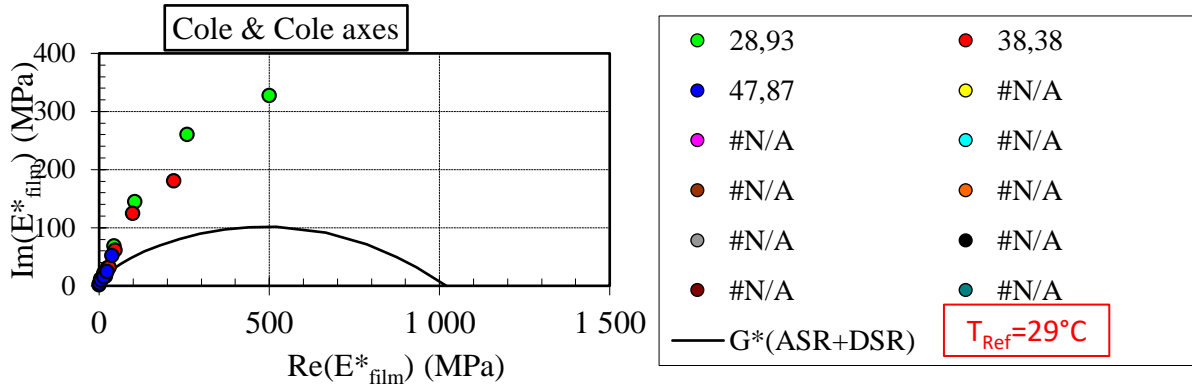


3 Thin film thermomechanical tests  
3.1 Complex modulus

3.1.2.B\_CO\_300\_LD\_sp2



### 3 Thin film thermomechanical tests 3.1 Complex modulus



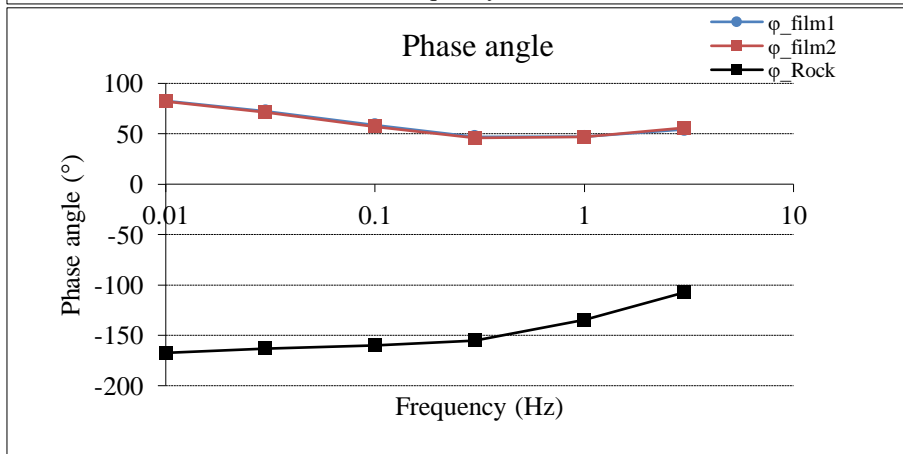
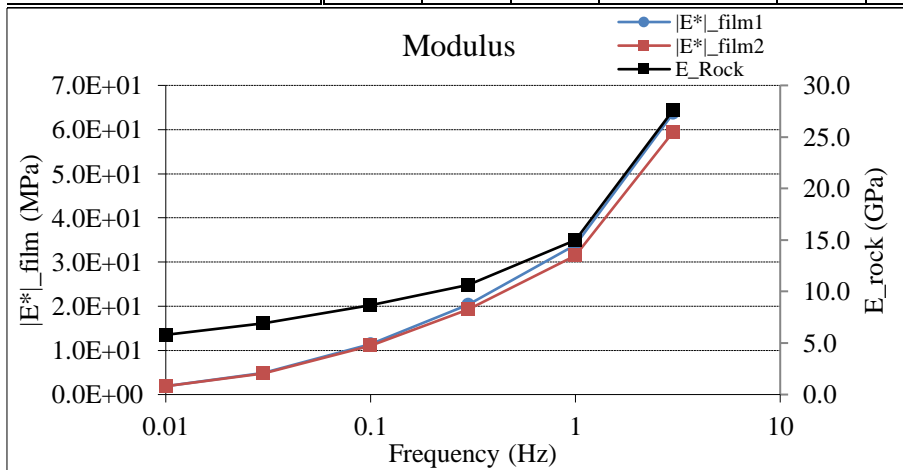


### 3 Thin film thermomechanical tests 3.1 Complex modulus

**B\_CO\_300\_LD\_sp2**

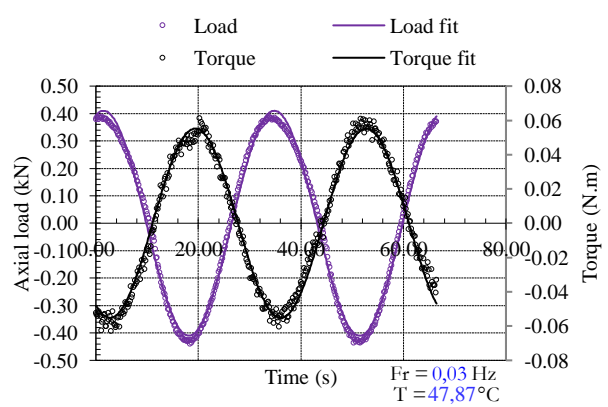
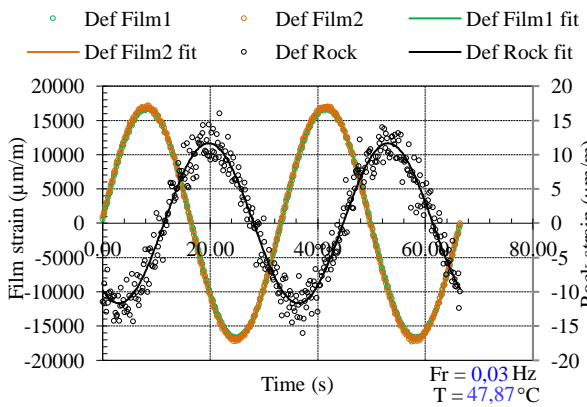
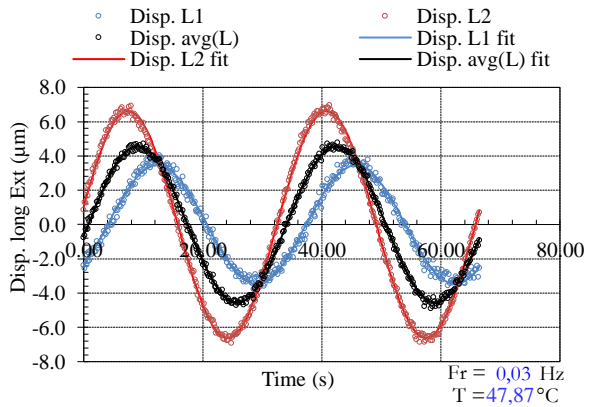
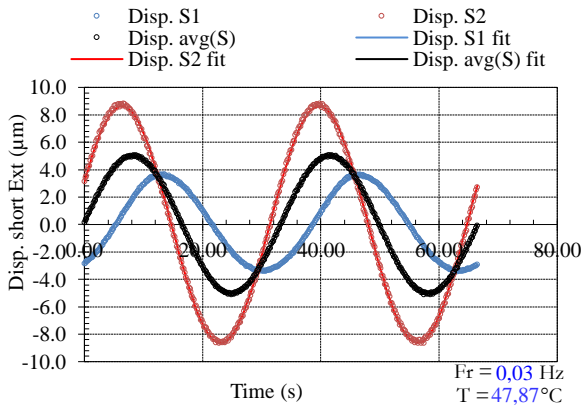
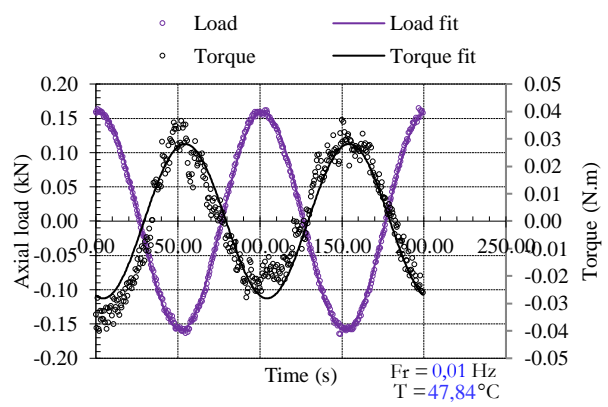
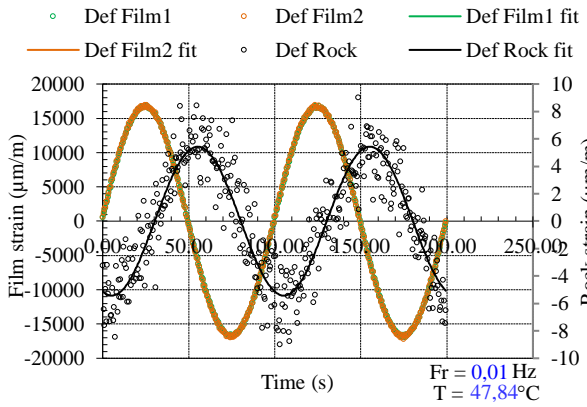
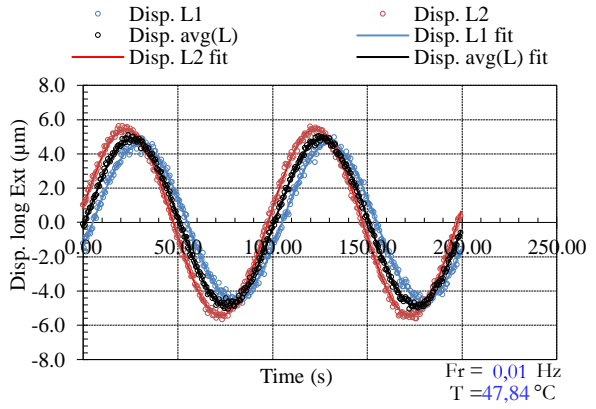
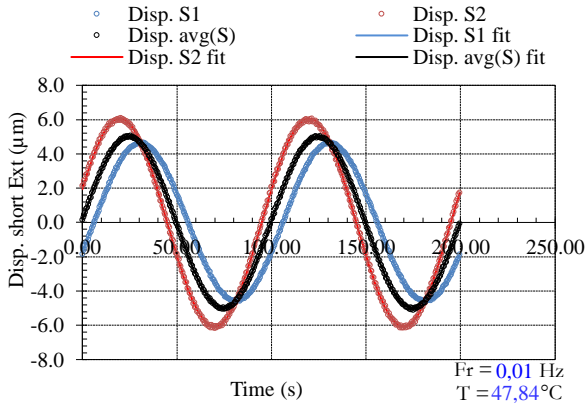
Temperature (°C) 47,8

Frequency (Hz)	0,01	0,03	0,1	0,3	1	3	
Disp. amplitude (µm)	Small Ext1	4,60	3,50	1,03	0,61	0,33	0,17
	Small Ext2	6,07	8,62	6,47	6,48	4,32	2,57
	Avg. Small Ext	5,01	5,03	3,02	2,96	2,00	1,22
	Long Ext1	4,58	3,45	0,80	0,08	0,24	0,37
	Long Ext2	5,44	6,61	4,33	3,37	1,51	0,84
	Avg. Long Ext	4,88	4,56	2,28	1,67	0,80	0,56
	In 1cm length of 50GPa rock cylinder (calculated)	0,01	0,02	0,02	0,04	0,05	0,05
Phase angle (°)	Small Ext1	105,8	129,0	168,6	202,7	227,2	276,7
	Small Ext2	65,3	52,8	49,8	45,0	47,2	57,1
	Avg. Small Ext	82,6	72,6	58,3	47,2	47,2	54,5
	Long Ext1	102,0	117,8	143,7	183,5	345,1	355,2
	Long Ext2	75,3	64,8	65,2	66,2	58,5	44,4
	Avg. Long Ext	87,5	82,4	75,1	67,4	50,2	29,8



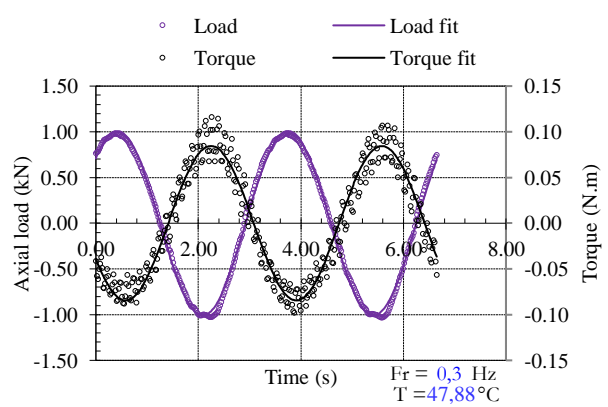
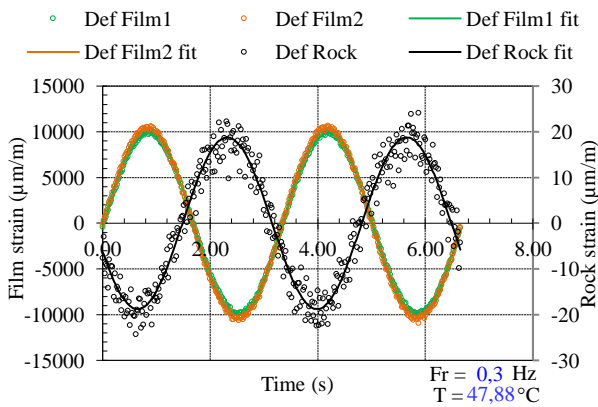
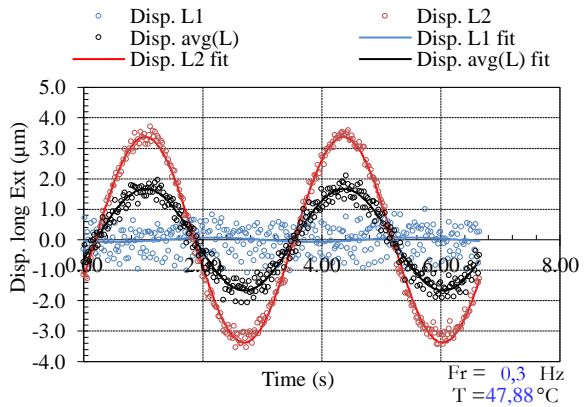
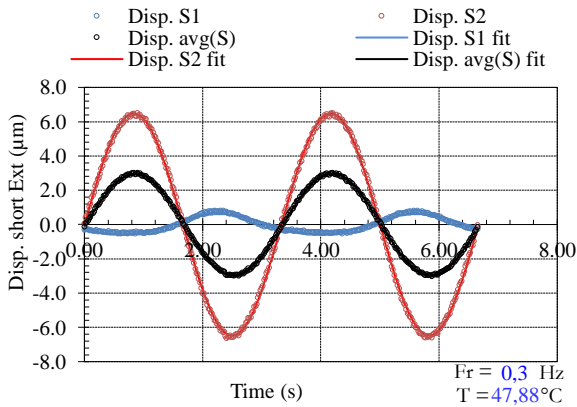
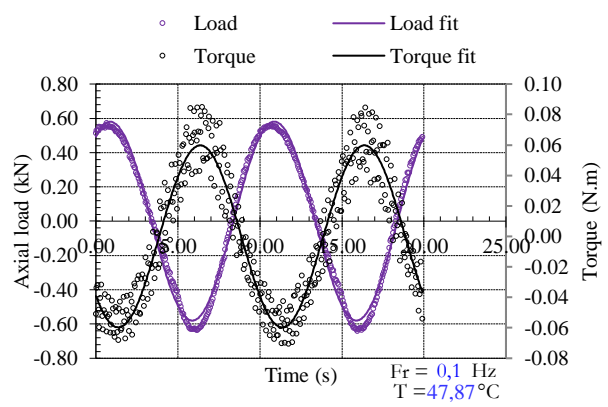
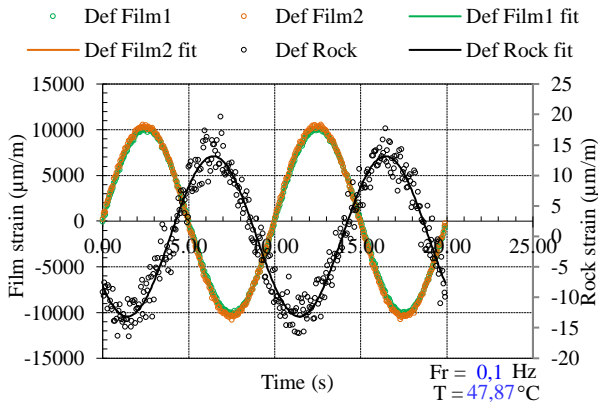
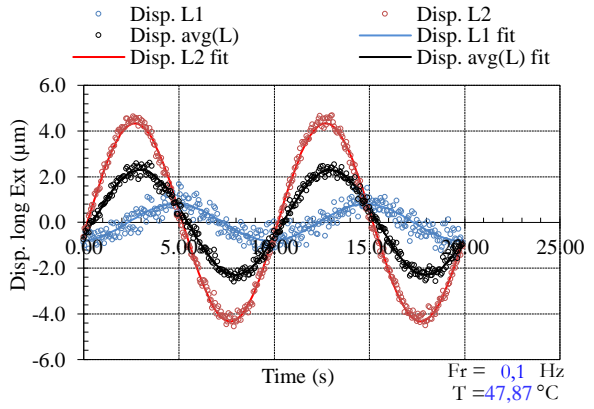
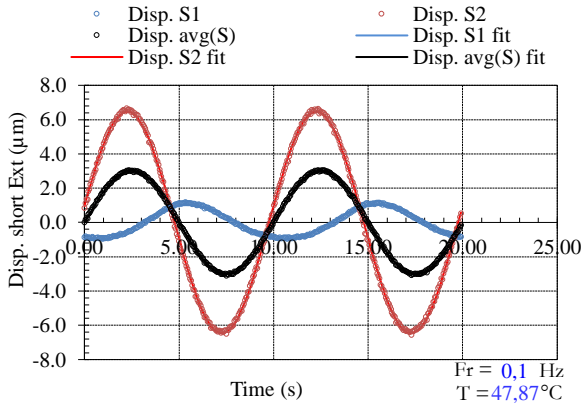
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



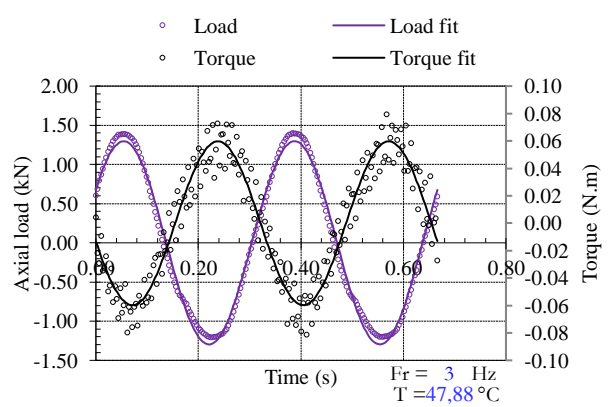
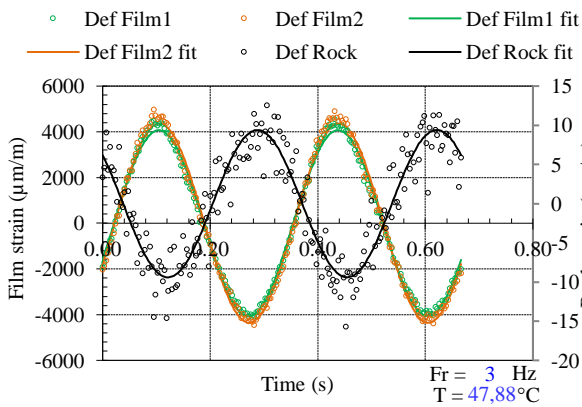
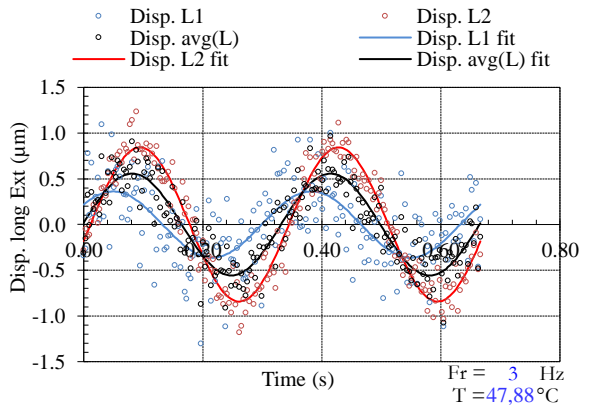
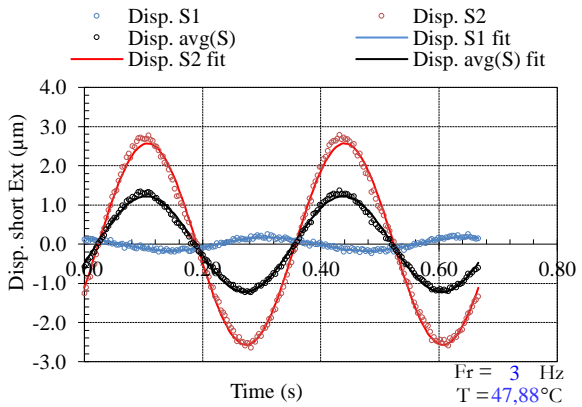
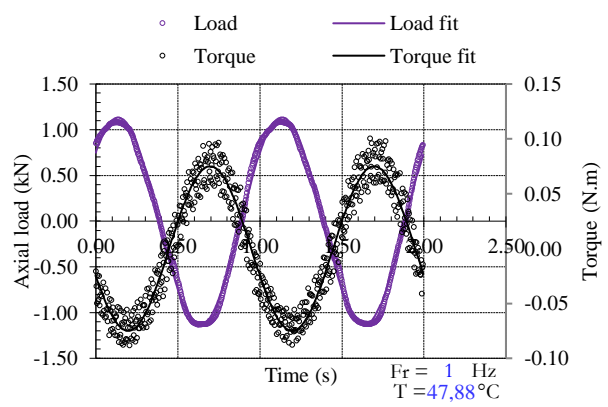
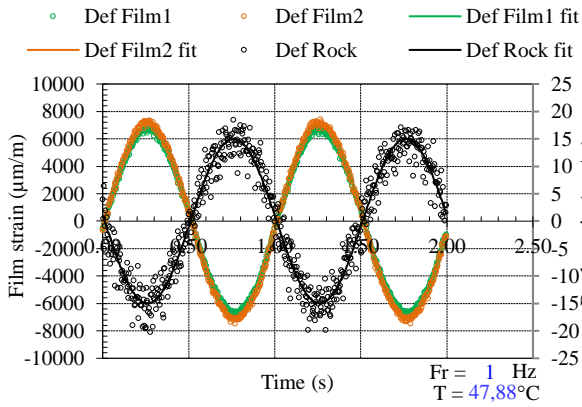
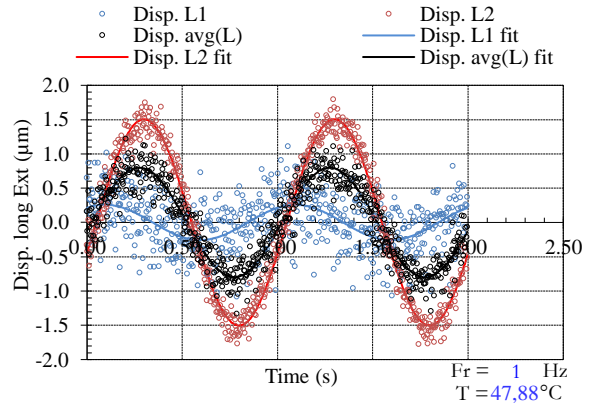
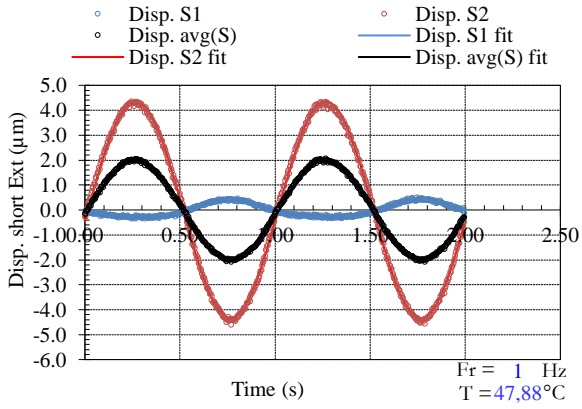
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus

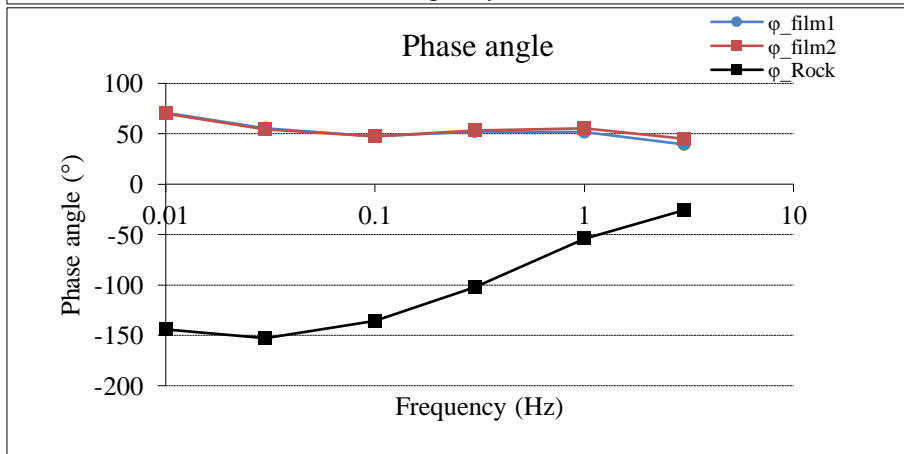
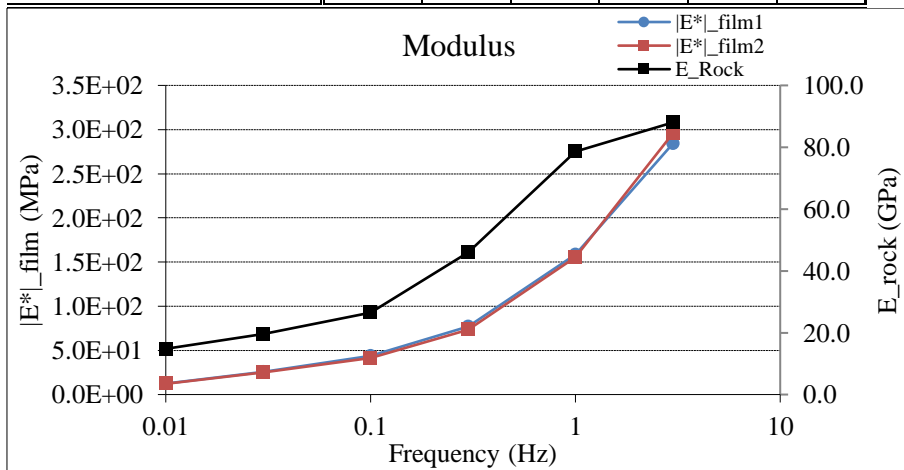


### 3 Thin film thermomechanical tests 3.1 Complex modulus

**B\_CO\_300\_LD\_sp2**

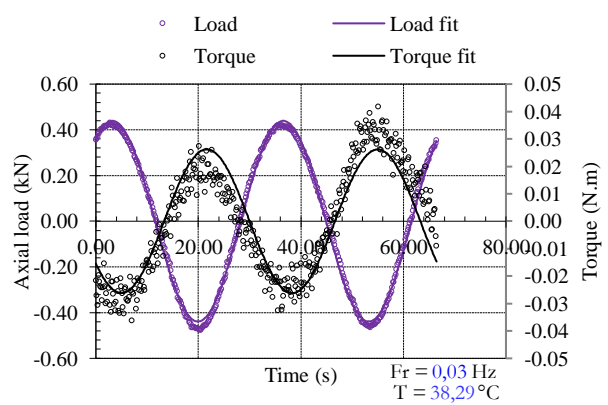
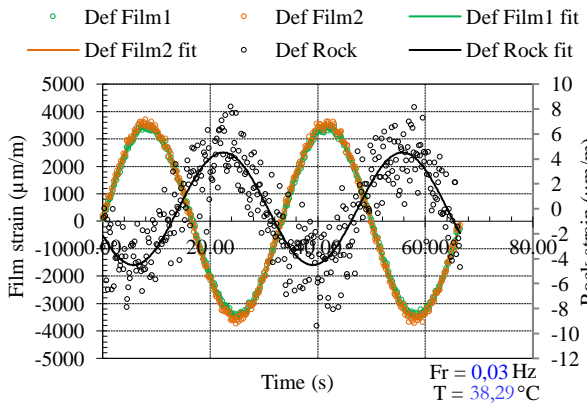
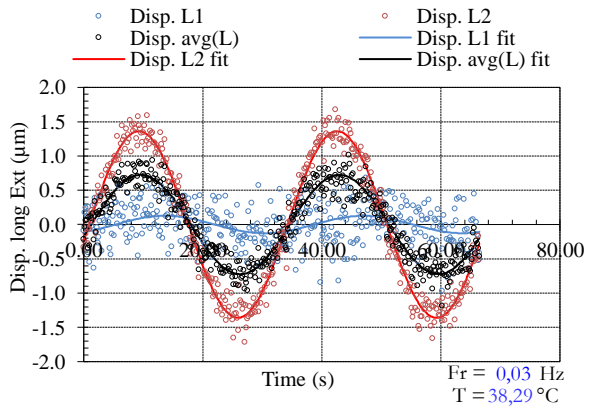
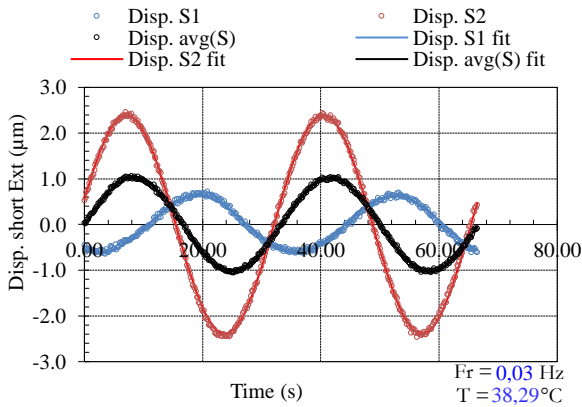
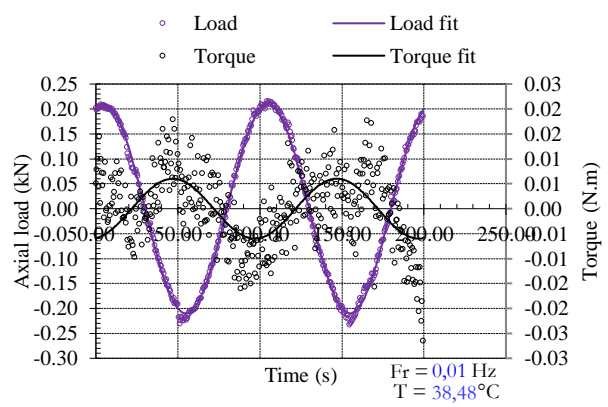
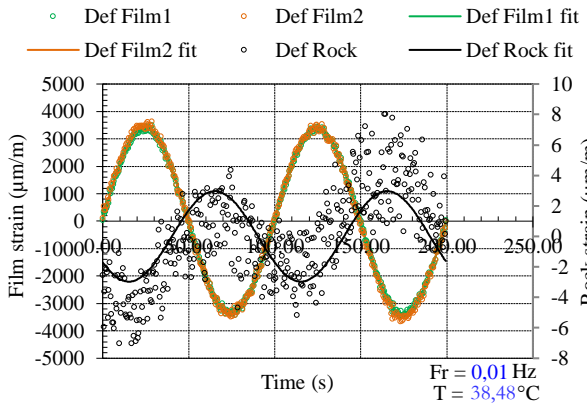
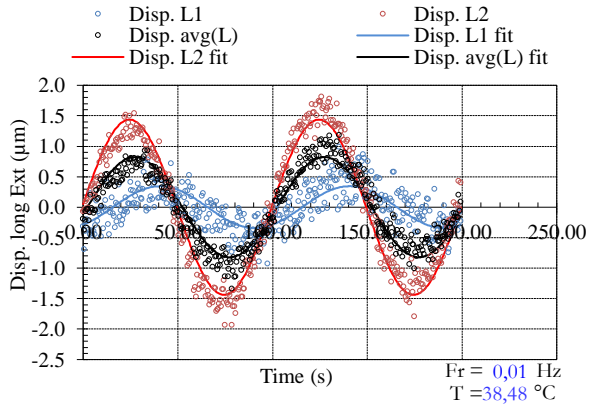
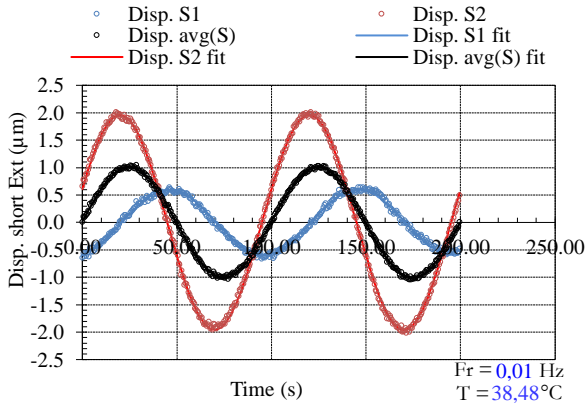
Temperature (°C) 38,5

Frequency (Hz)	0,01	0,03	0,1	0,3	1	3	
Disp. amplitude (µm)	Small Ext1	0,59	0,63	0,80	0,79	0,64	0,33
	Small Ext2	1,96	2,39	2,73	2,68	2,33	1,21
	Avg. Small Ext	1,01	1,02	1,00	0,94	0,87	0,53
	Long Ext1	0,34	0,14	0,11	0,31	0,67	0,74
	Long Ext2	1,45	1,35	1,06	0,96	1,12	0,95
	Avg. Long Ext	0,83	0,73	0,56	0,59	0,87	0,84
	In 1cm length of 50GPa rock cylinder (calculated)	0,01	0,02	0,03	0,05	0,09	0,10
Phase angle (°)	Small Ext1	147,0	171,1	201,6	227,7	257,0	291,4
	Small Ext2	53,9	41,8	40,3	50,9	58,4	54,7
	Avg. Small Ext	70,9	55,5	47,6	52,2	51,6	39,4
	Long Ext1	125,5	106,2	355,5	357,3	1,6	0,5
	Long Ext2	70,1	65,7	54,8	45,5	31,6	16,6
	Avg. Long Ext	79,8	69,1	50,2	34,3	20,4	9,5



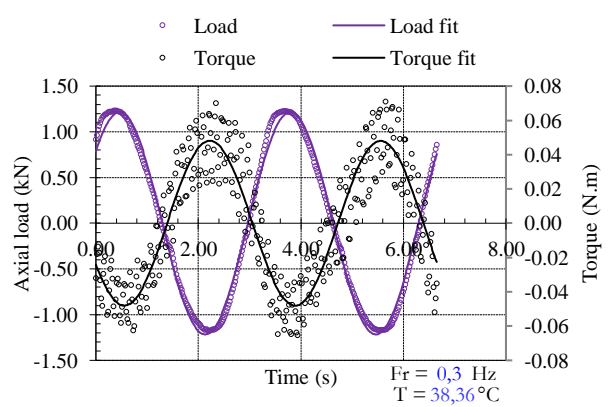
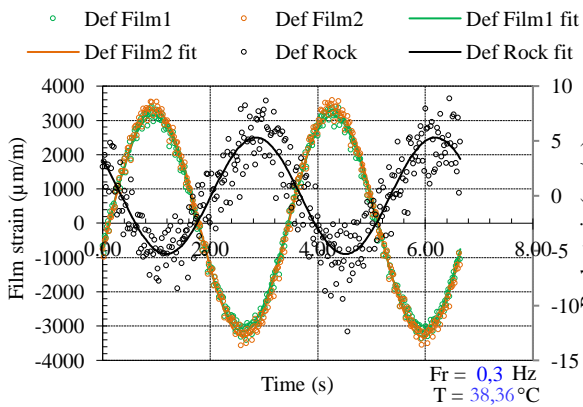
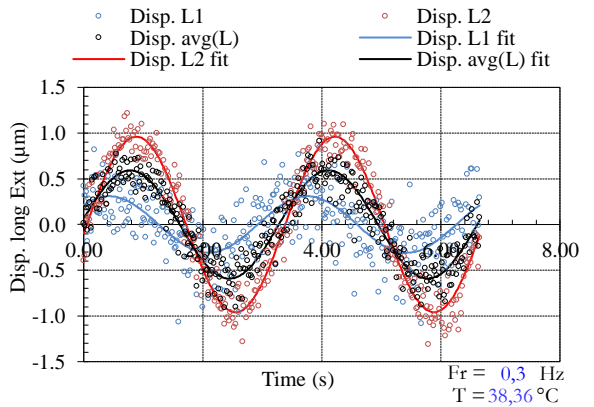
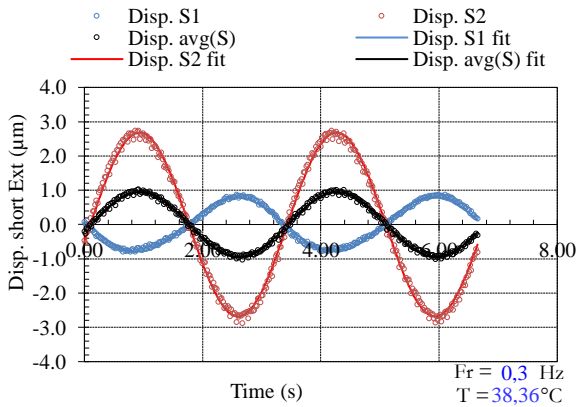
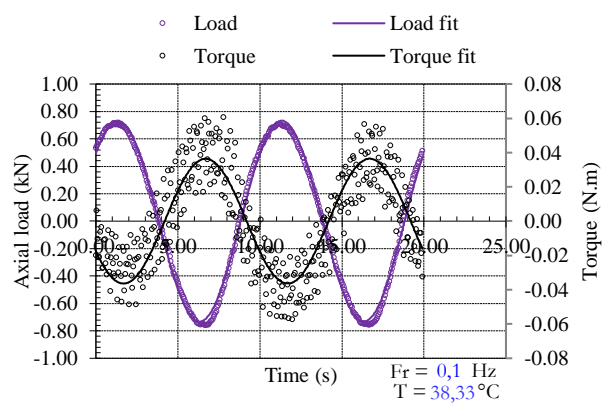
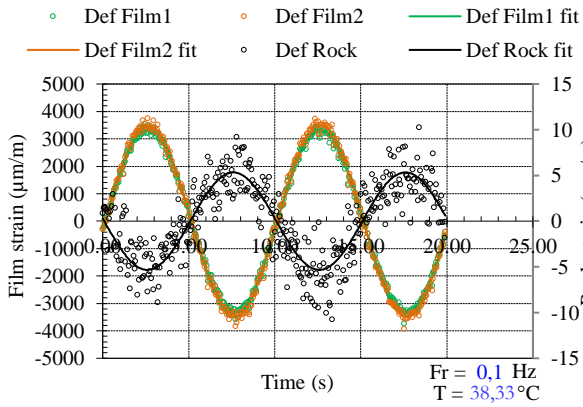
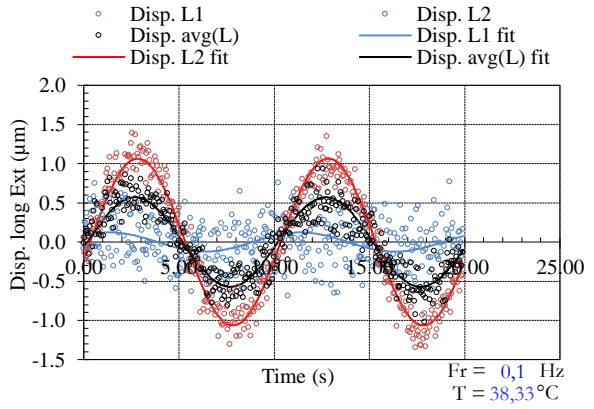
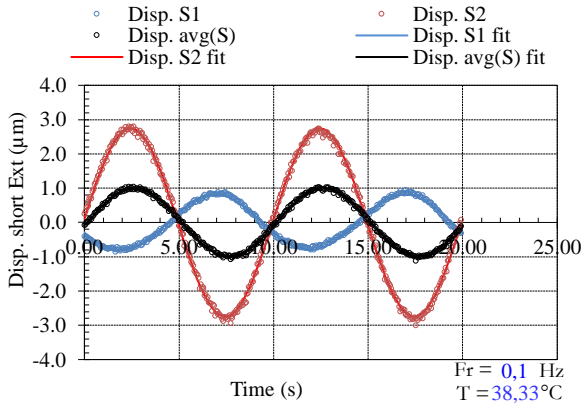
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



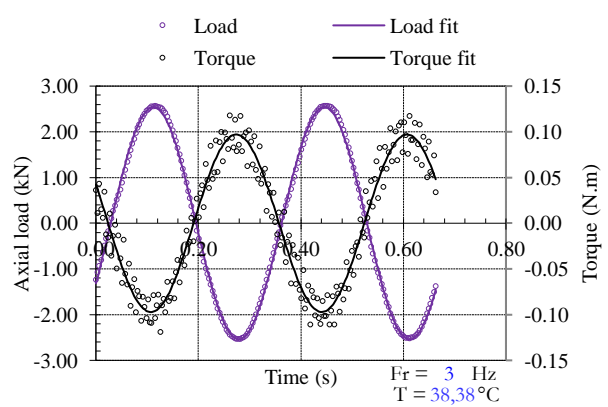
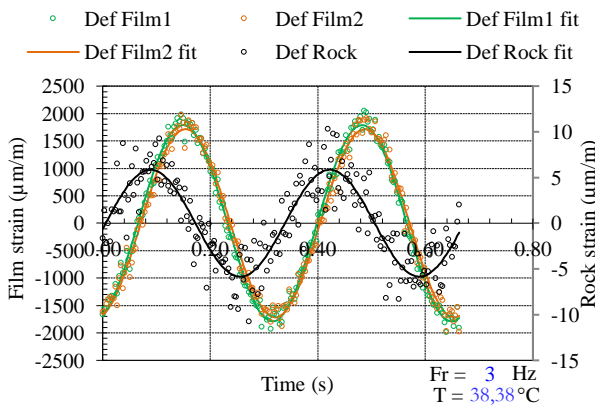
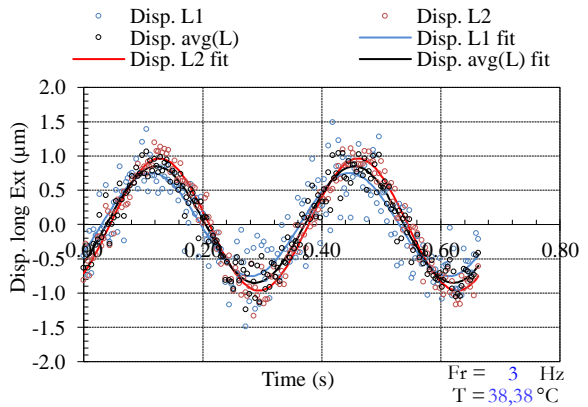
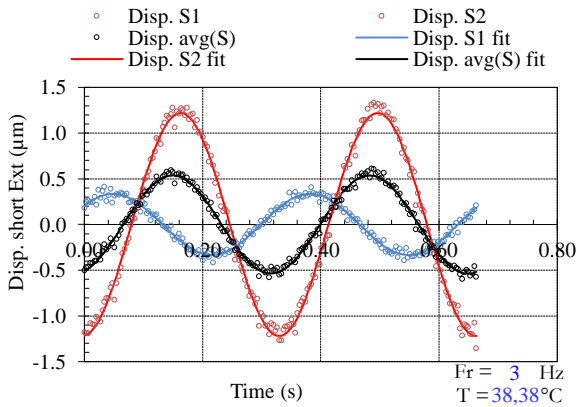
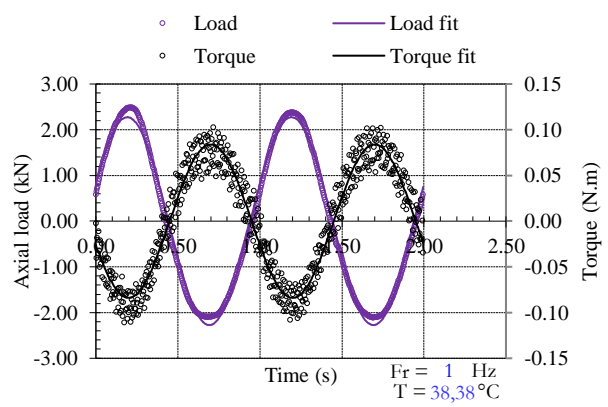
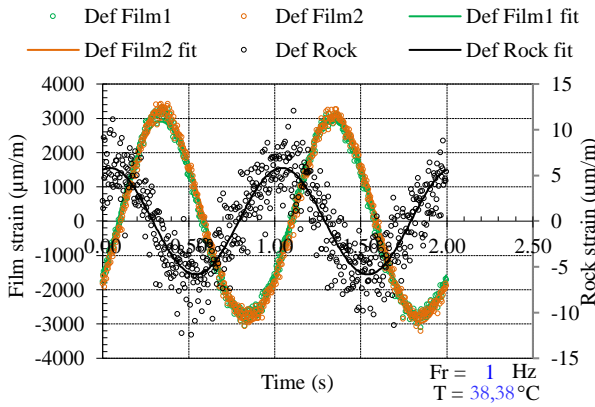
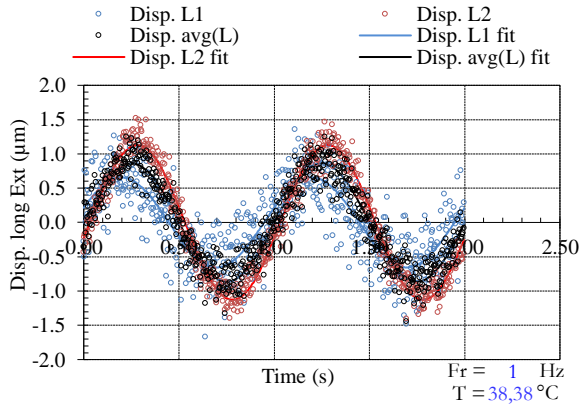
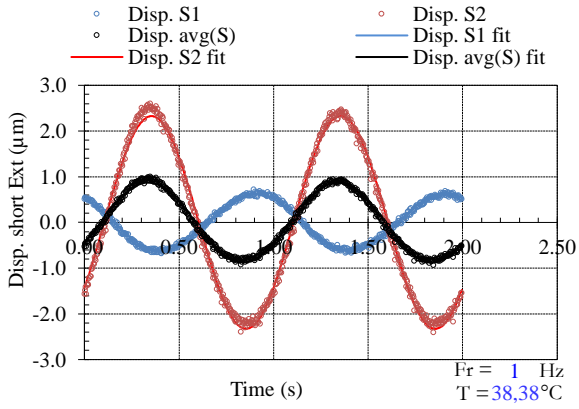
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



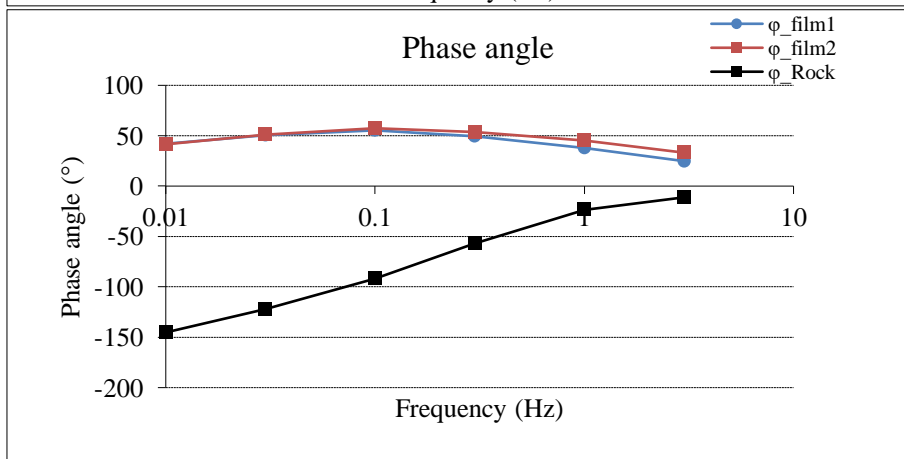
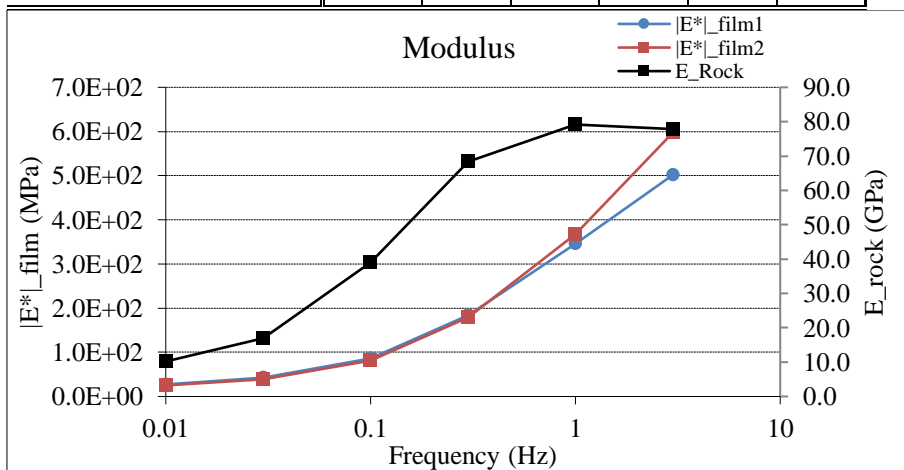


### 3 Thin film thermomechanical tests 3.1 Complex modulus

**B\_CO\_300\_LD\_sp2**

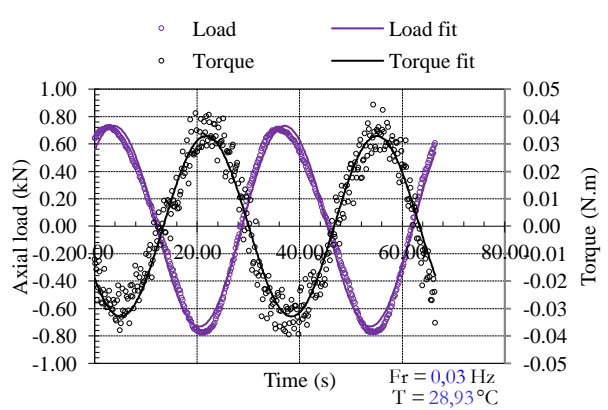
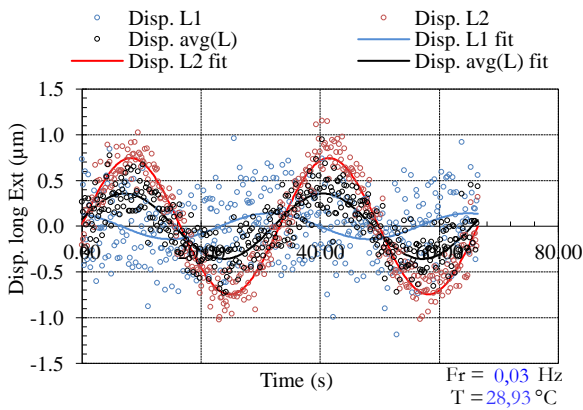
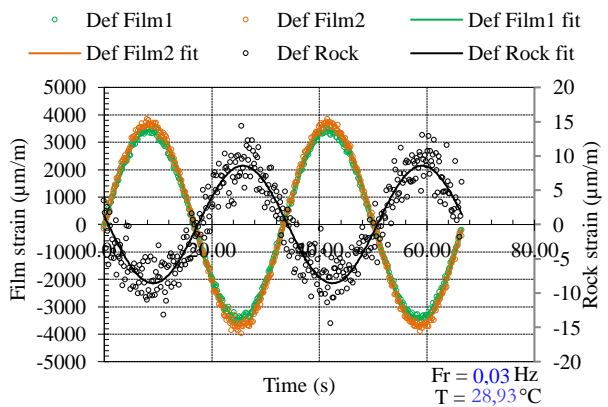
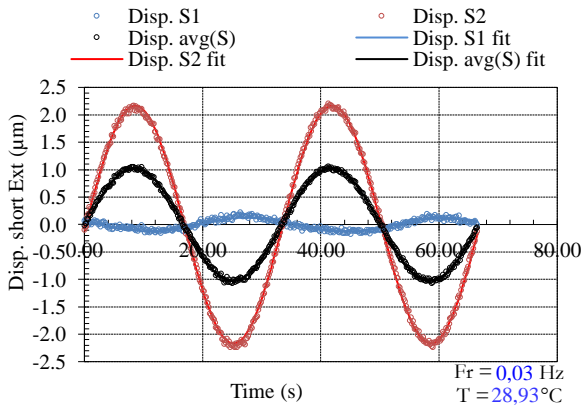
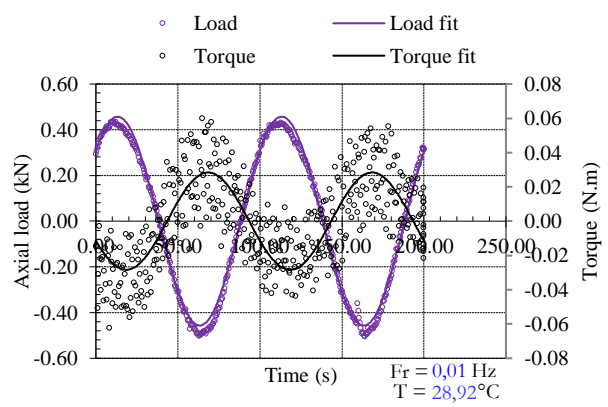
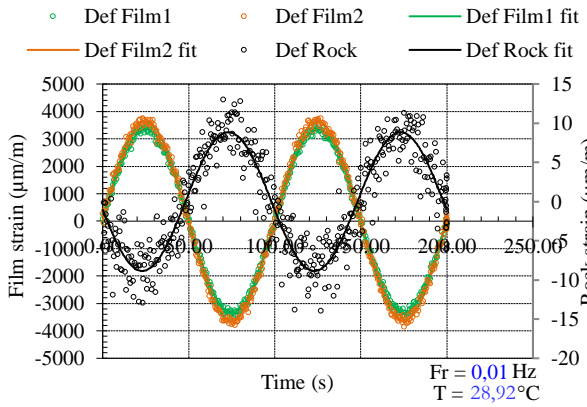
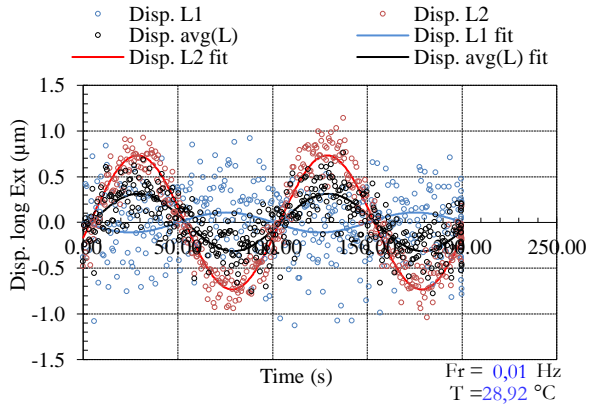
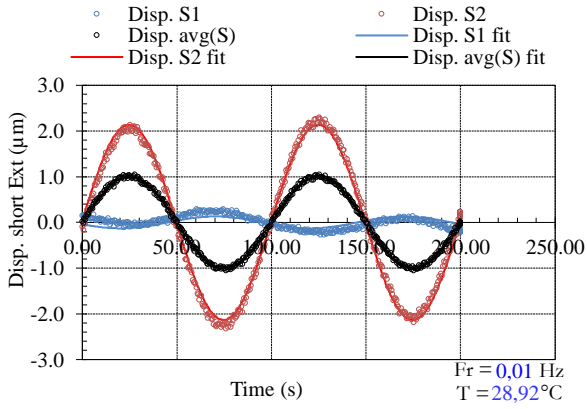
Temperature (°C) 28,9

Frequency (Hz)	0,01	0,03	0,1	0,3	1	3	
Disp. amplitude (µm)	Small Ext1	0,12	0,13	0,14	0,12	0,14	0,09
	Small Ext2	2,13	2,17	2,01	0,77	0,46	0,18
	Avg. Small Ext	1,01	1,03	1,00	0,41	0,28	0,13
	Long Ext1	0,12	0,15	0,42	0,37	0,49	0,32
	Long Ext2	0,73	0,74	0,88	0,52	0,56	0,36
	Avg. Long Ext	0,31	0,36	0,60	0,43	0,52	0,34
	In 1cm length of 50GPa rock cylinder (calculated)	0,02	0,03	0,06	0,05	0,06	0,04
Phase angle (°)	Small Ext1	204,7	257,9	323,1	347,6	0,6	3,1
	Small Ext2	41,2	52,1	59,4	57,2	47,9	34,8
	Avg. Small Ext	42,2	50,6	55,3	49,2	37,6	24,8
	Long Ext1	215,7	302,2	349,3	353,3	358,6	358,8
	Long Ext2	55,8	47,6	38,5	19,2	9,3	4,6
	Avg. Long Ext	59,6	35,8	23,2	8,6	4,4	1,9



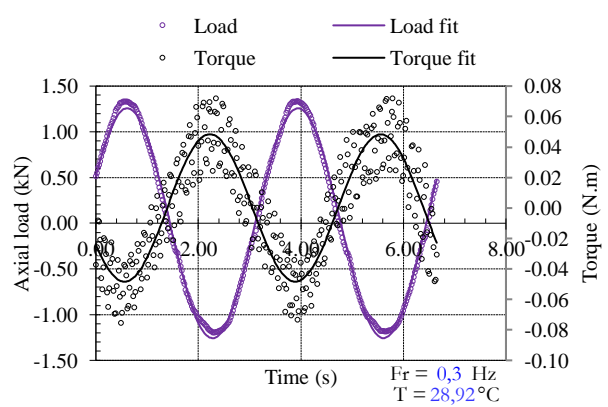
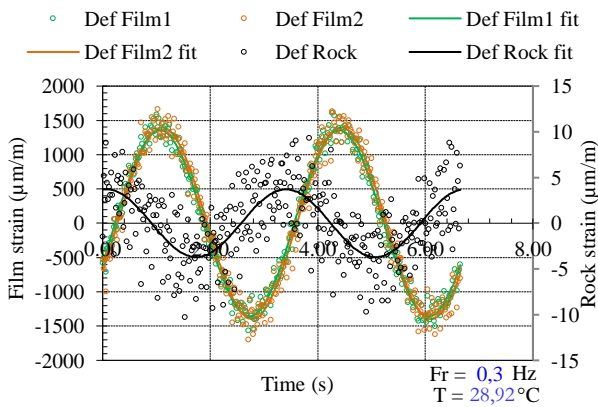
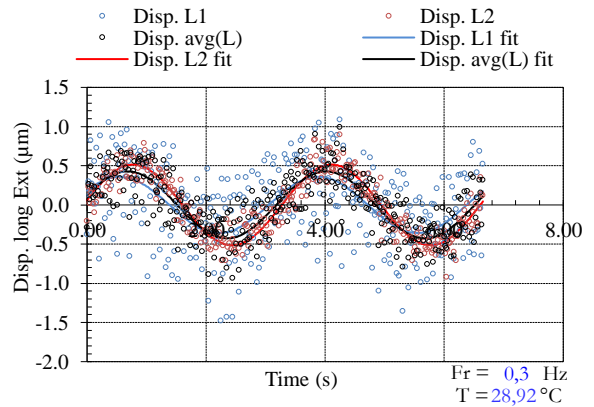
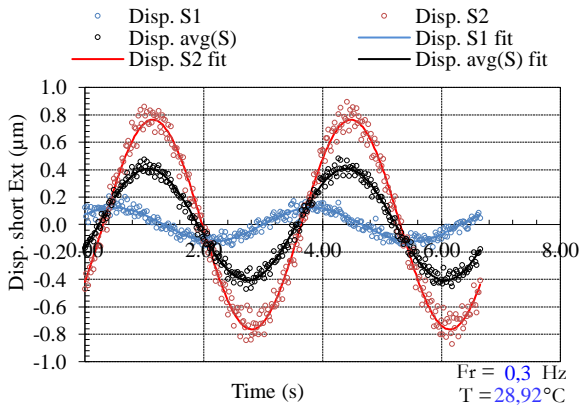
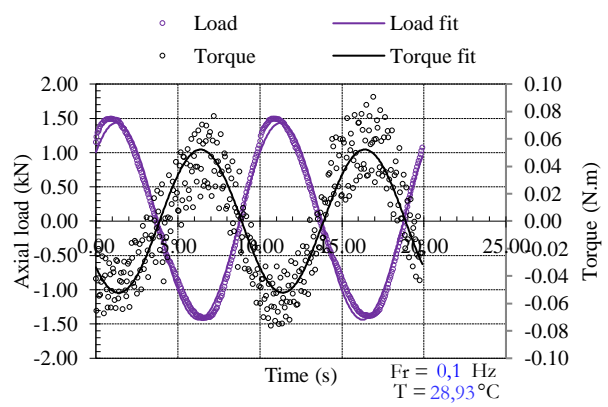
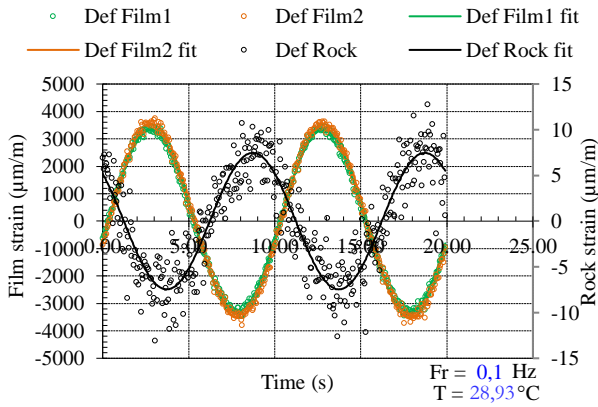
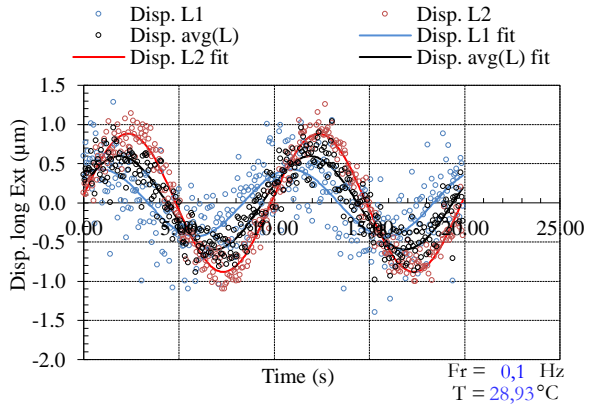
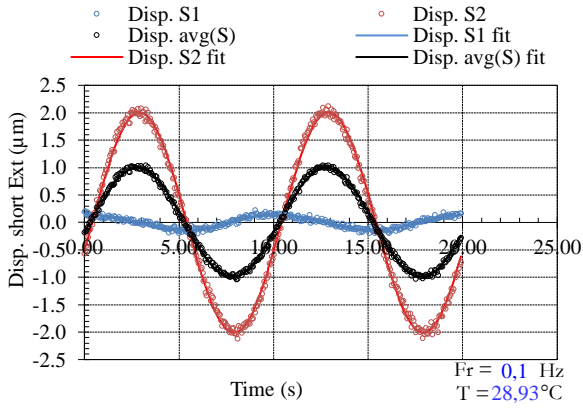
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



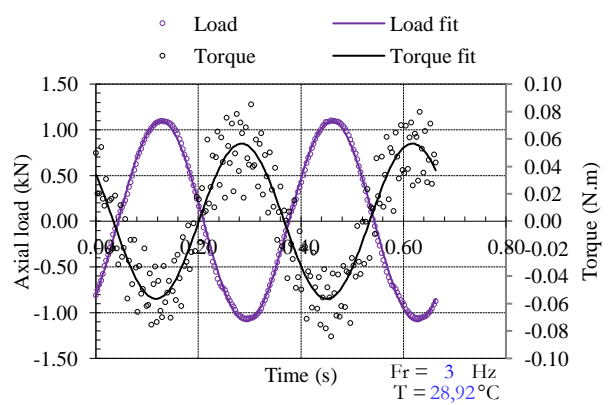
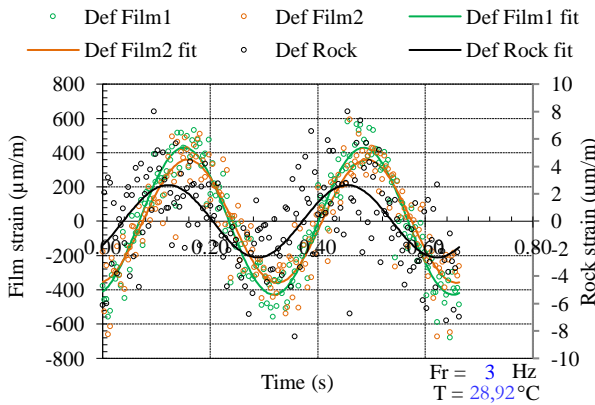
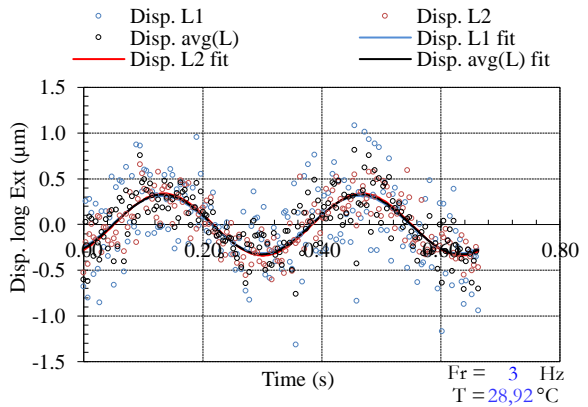
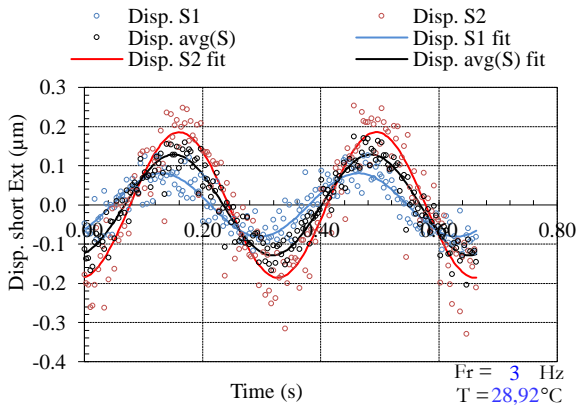
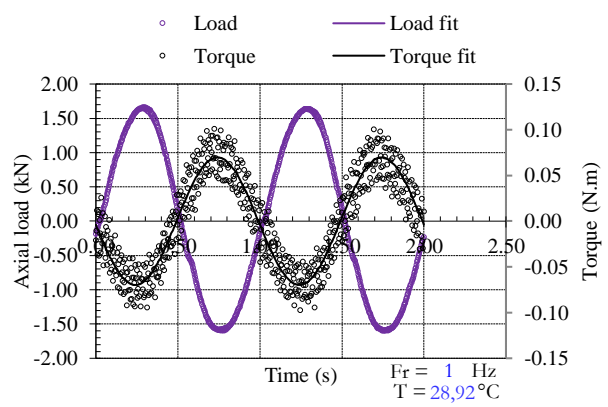
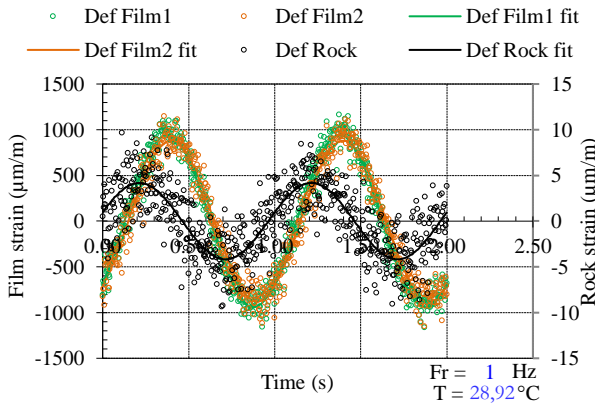
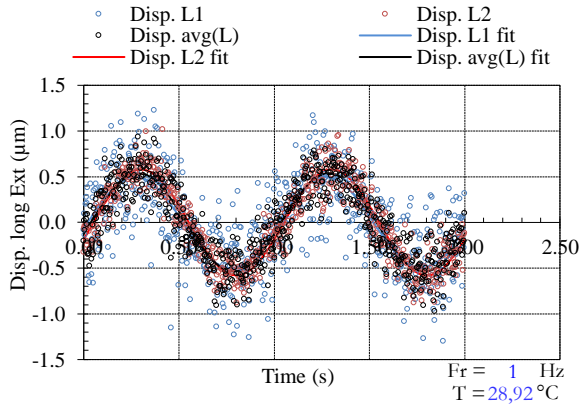
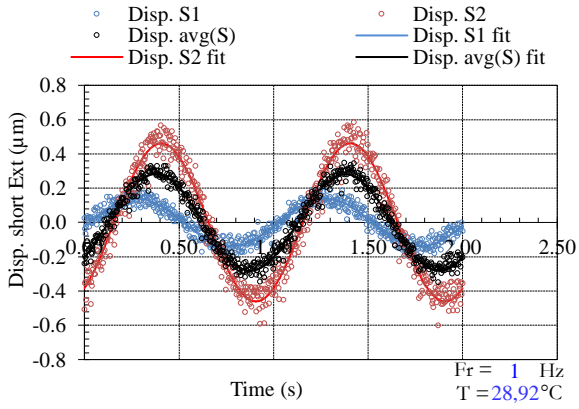
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



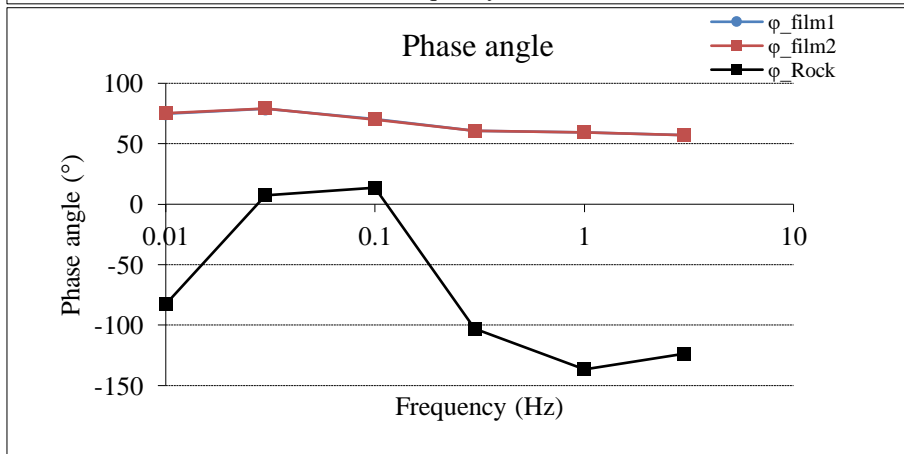
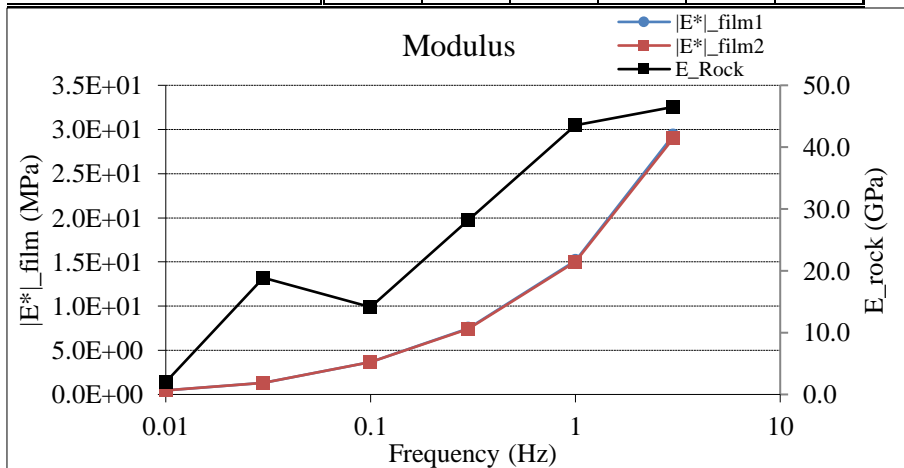
### 3 Thin film thermomechanical tests 3.1 Complex modulus

3.1.3.B\_CO\_300\_SD\_sp1

**B\_CO\_300\_SD\_sp1**

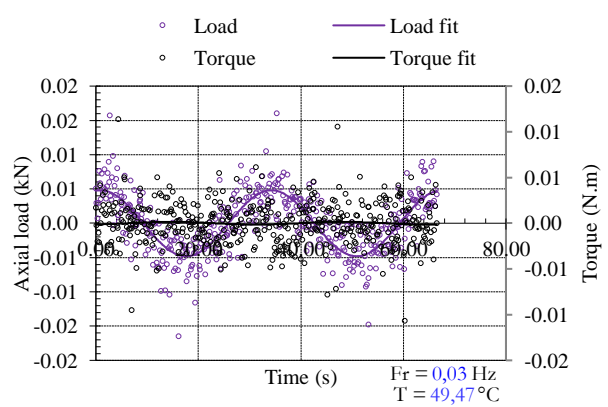
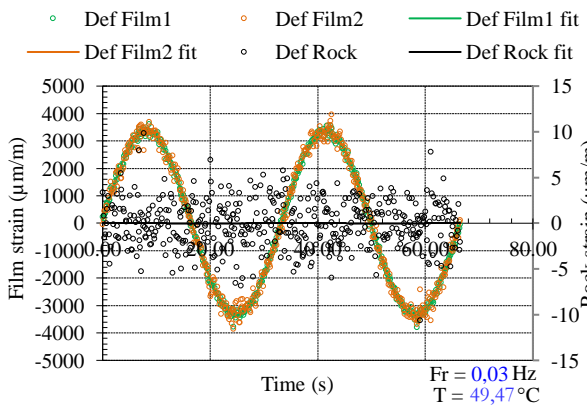
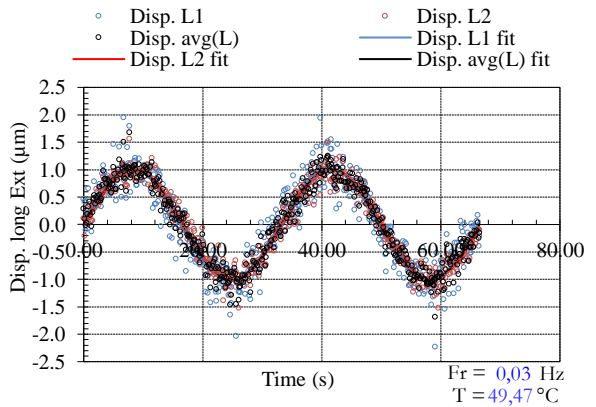
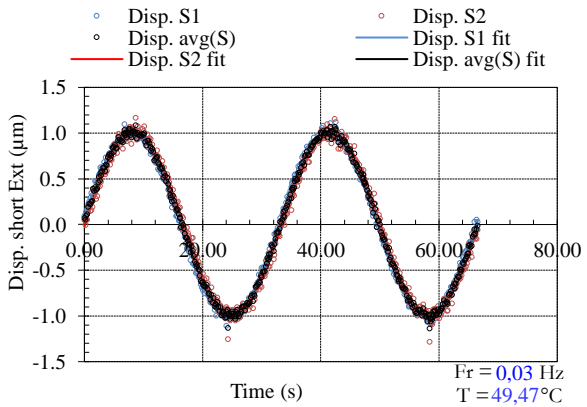
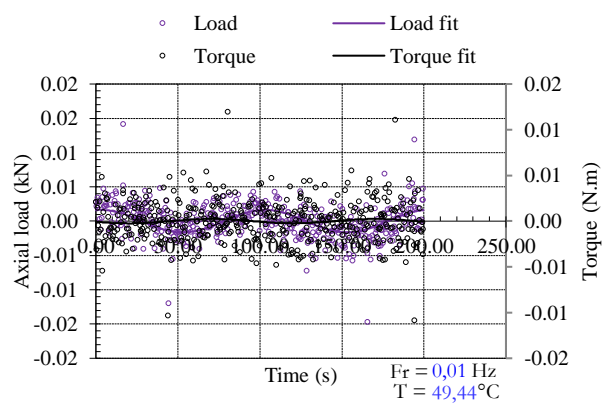
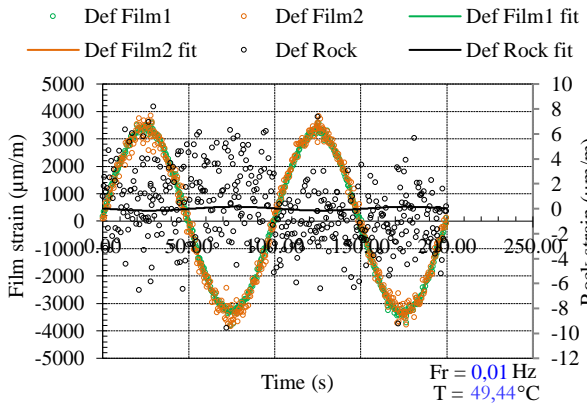
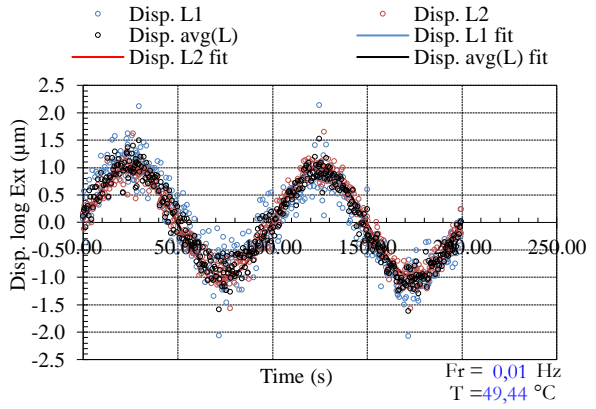
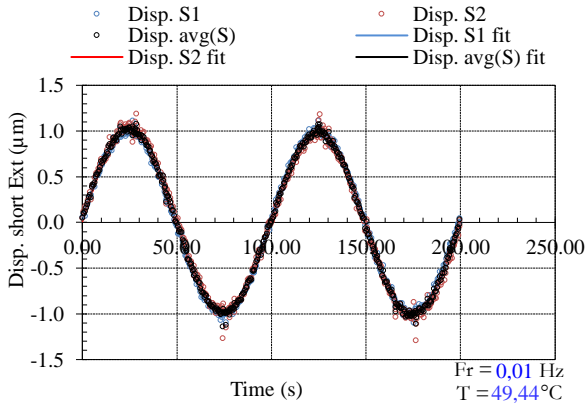
Temperature (°C) 49,4

Frequency (Hz)	0,01	0,03	0,1	0,3	1	3	
Disp. amplitude (µm)	Small Ext1	1,00	1,01	1,06	1,20	1,52	2,13
	Small Ext2	1,01	1,00	0,96	0,89	0,77	0,75
	Avg. Small Ext	1,00	1,00	1,00	1,00	1,01	1,06
	Long Ext1	1,00	1,03	1,08	1,20	1,54	2,19
	Long Ext2	0,98	0,99	0,95	0,87	0,78	0,83
	Avg. Long Ext	0,99	1,01	1,00	0,99	0,99	1,03
	In 1cm length of 50GPa rock cylinder (calculated)	0,00	0,00	0,00	0,00	0,00	0,00
Phase angle (°)	Small Ext1	74,1	76,0	62,5	47,2	40,5	37,0
	Small Ext2	75,9	82,0	78,8	79,2	99,5	137,2
	Avg. Small Ext	75,0	79,0	70,2	60,8	59,5	57,2
	Long Ext1	73,9	75,0	62,4	46,5	38,6	34,8
	Long Ext2	75,6	82,3	80,0	81,3	105,2	145,1
	Avg. Long Ext	74,8	78,6	70,7	61,1	59,8	57,1



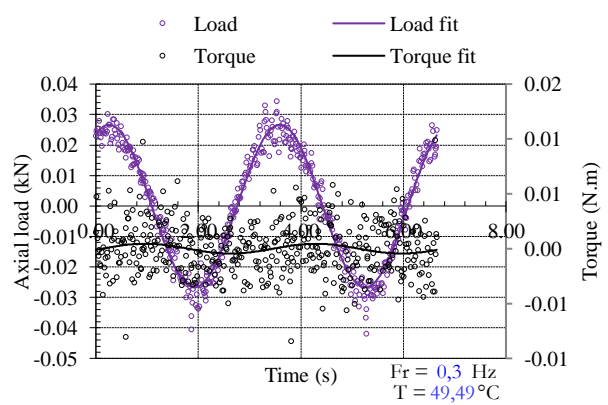
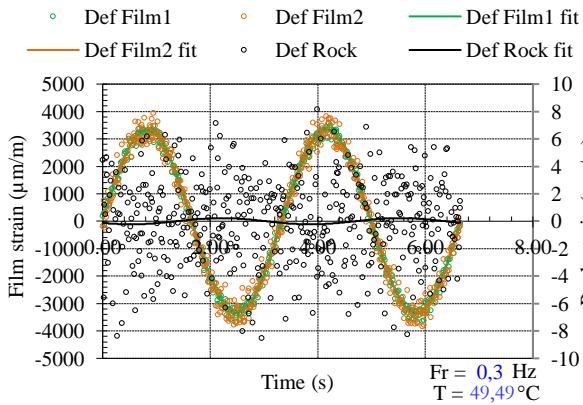
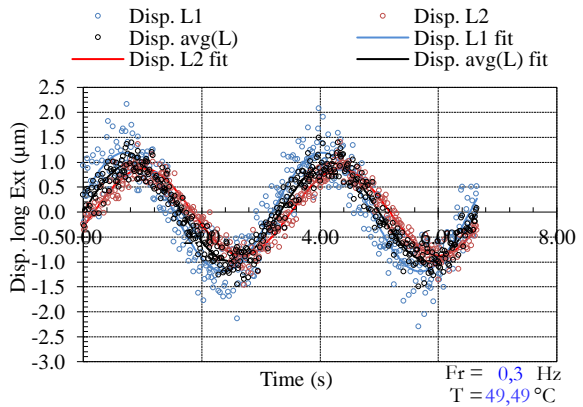
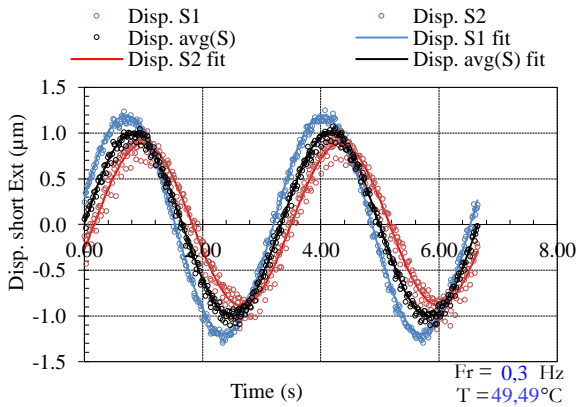
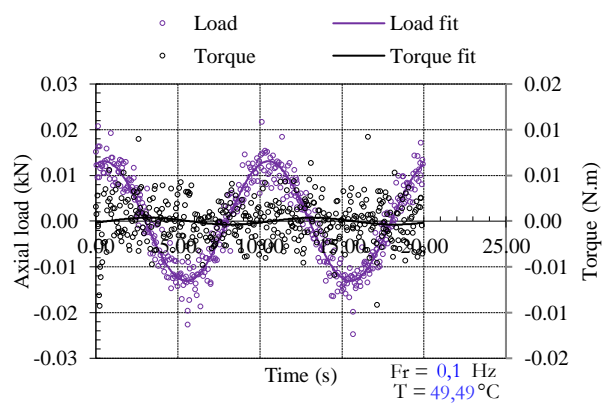
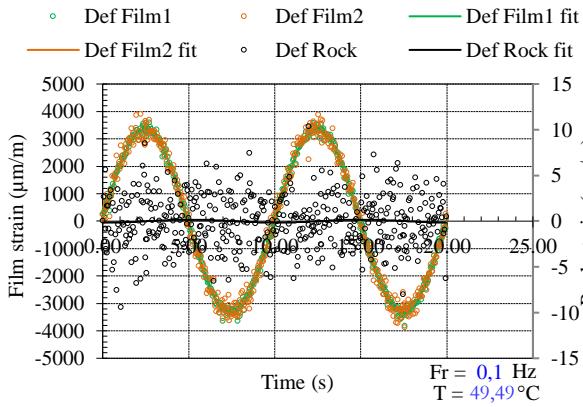
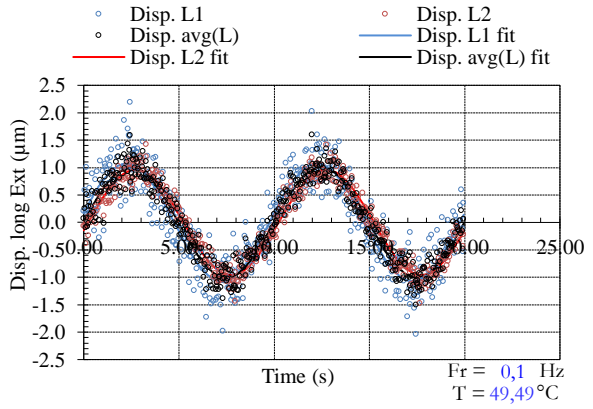
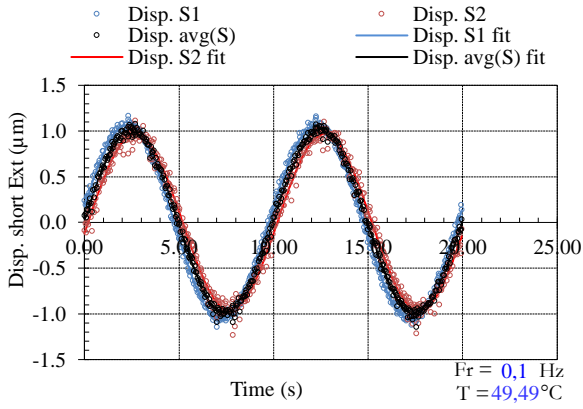
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



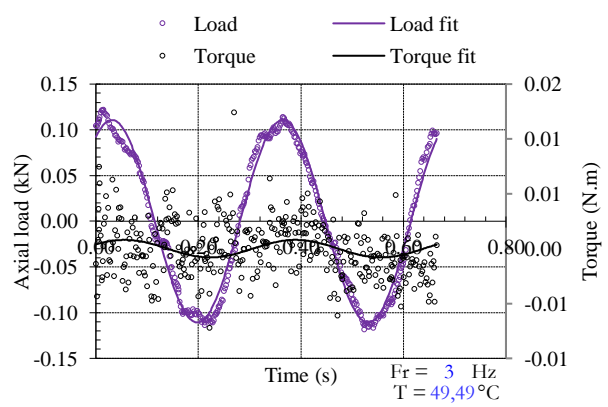
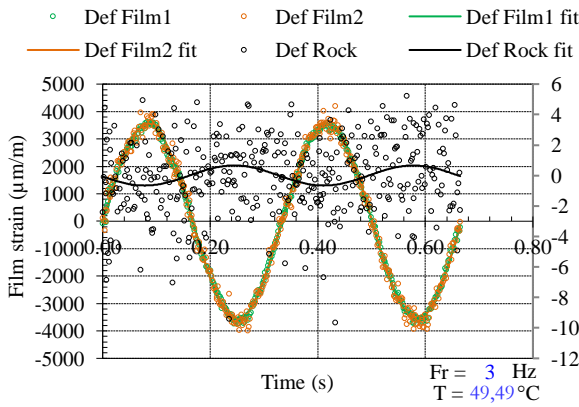
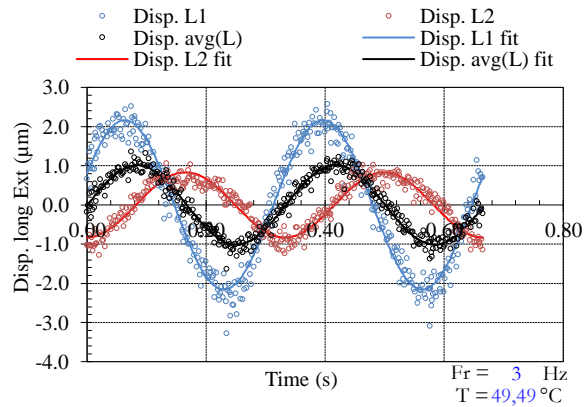
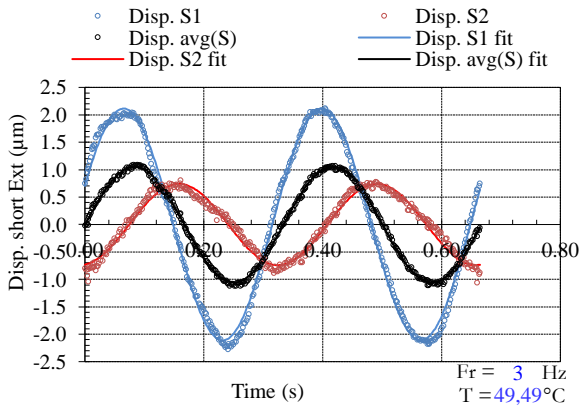
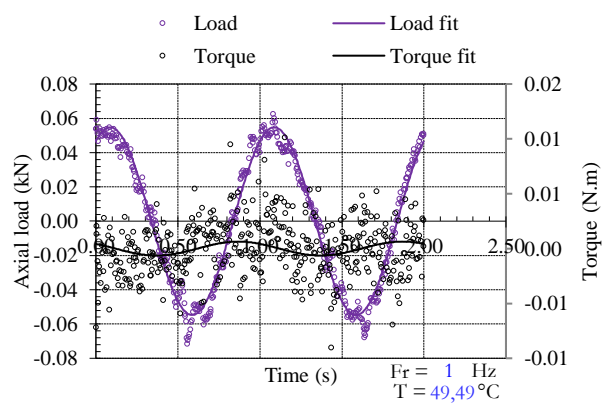
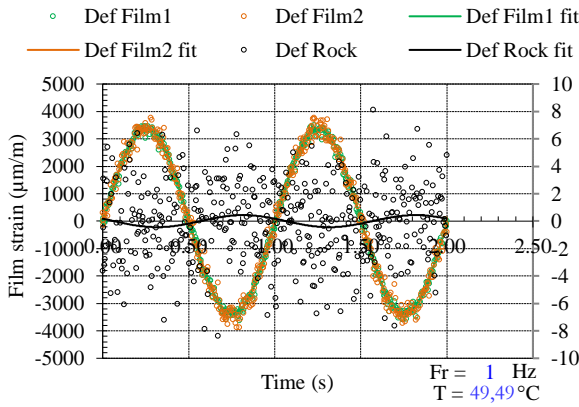
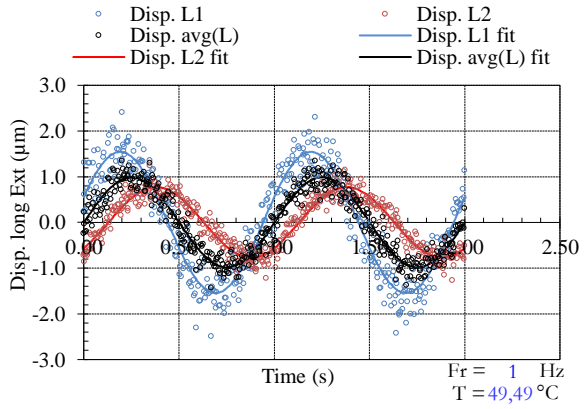
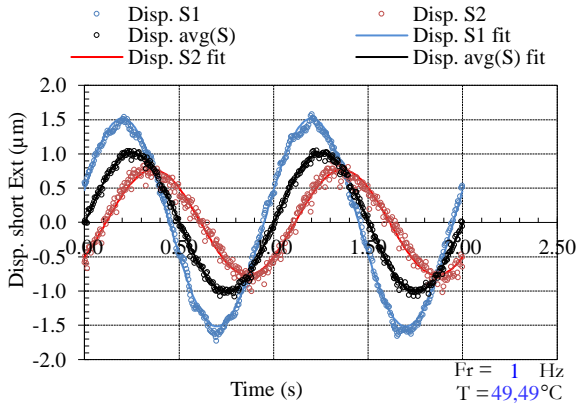
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



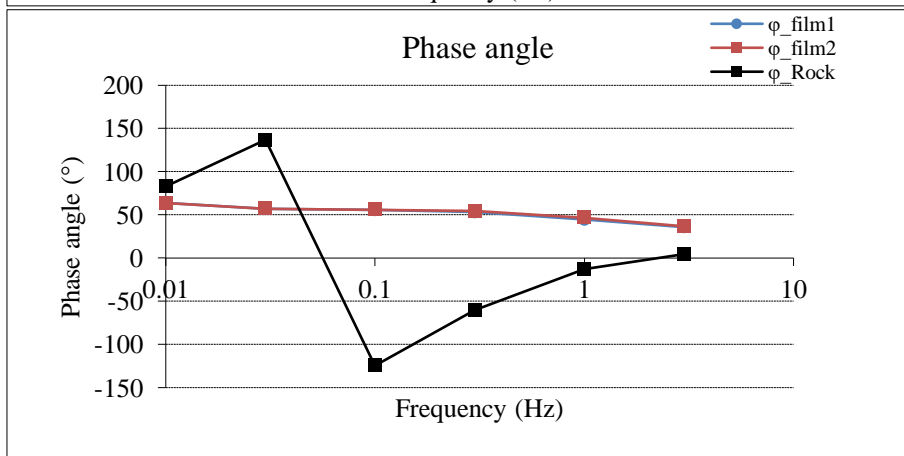
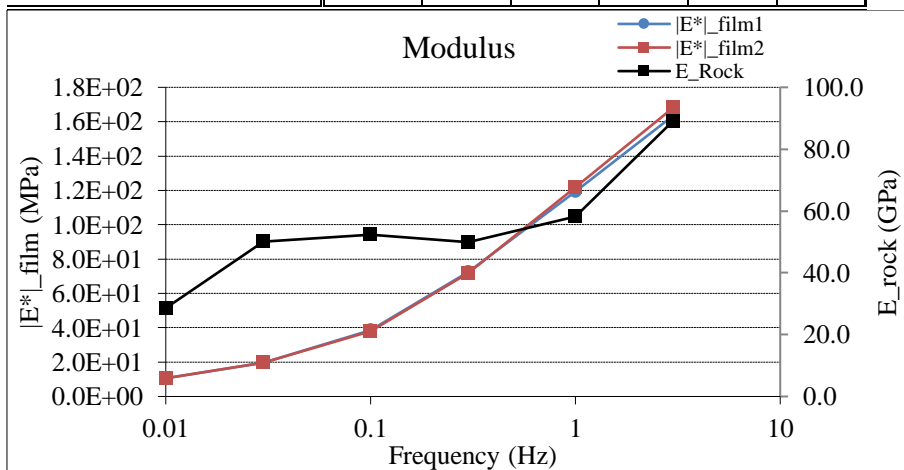


### 3 Thin film thermomechanical tests 3.1 Complex modulus

**B\_CO\_300\_SD\_sp1**

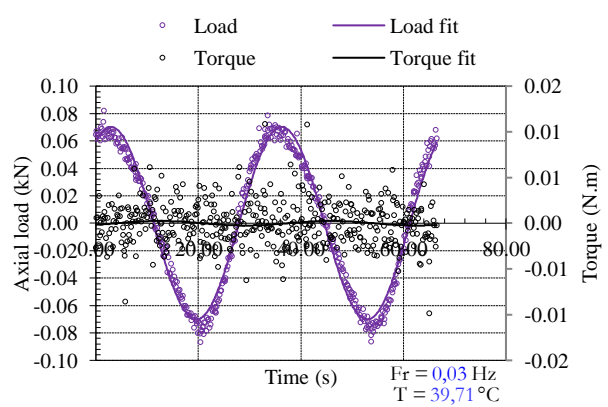
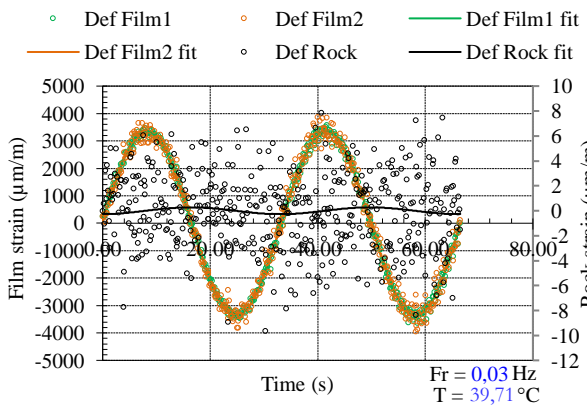
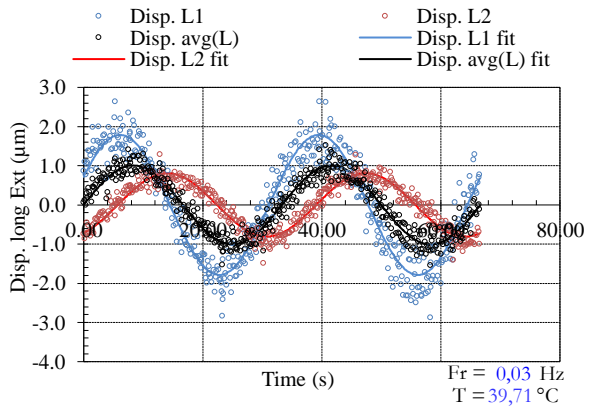
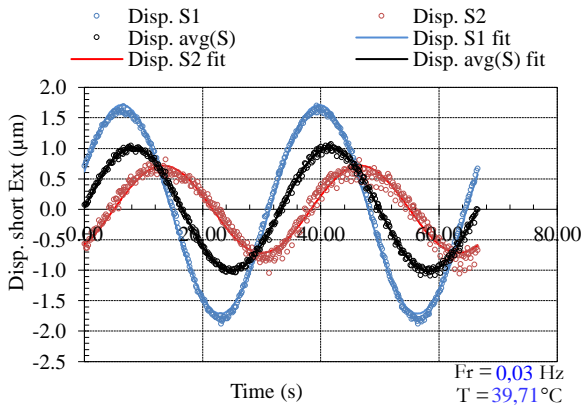
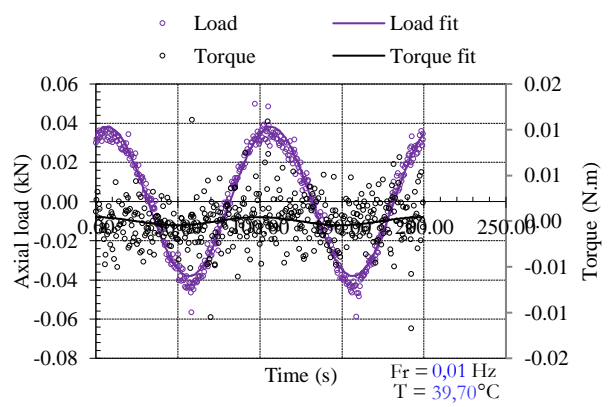
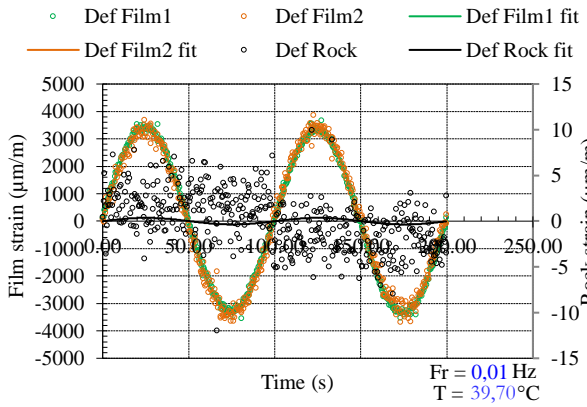
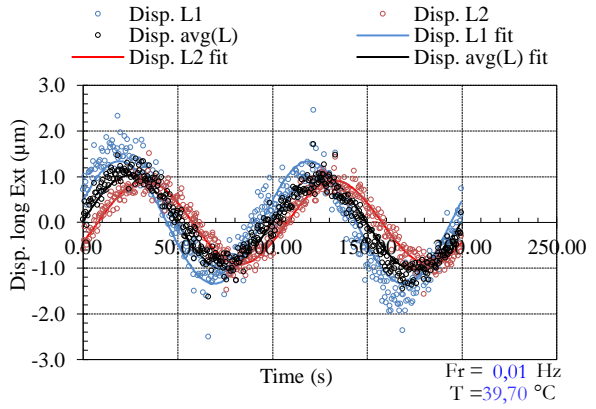
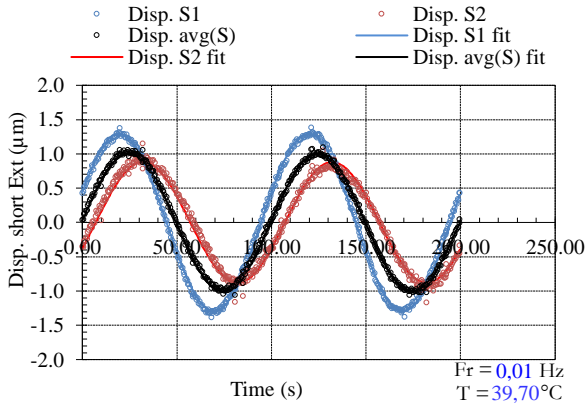
Temperature (°C) 39,7

Frequency (Hz)		0,01	0,03	0,1	0,3	1	3
Disp. amplitude (µm)	Small Ext1	1,29	1,71	2,28	2,71	3,02	3,21
	Small Ext2	0,88	0,71	0,63	0,75	1,00	1,09
	Avg. Small Ext	1,00	1,01	1,01	1,00	1,01	1,07
	Long Ext1	1,33	1,78	2,50	3,06	3,31	3,39
	Long Ext2	0,91	0,81	0,93	1,14	1,18	1,14
	Avg. Long Ext	1,02	1,01	0,97	0,98	1,07	1,15
	In 1cm length of 50GPa rock cylinder (calculated)	0,00	0,00	0,01	0,01	0,02	0,02
Phase angle (°)	Small Ext1	45,5	37,2	40,6	46,7	45,0	40,3
	Small Ext2	91,1	112,5	162,9	88,8	225,6	229,2
	Avg. Small Ext	63,8	57,3	55,9	53,3	44,7	35,8
	Long Ext1	44,4	34,8	36,5	43,3	43,1	39,8
	Long Ext2	93,7	119,8	172,3	212,2	228,0	232,8
	Avg. Long Ext	64,1	58,3	55,9	49,7	40,3	33,4



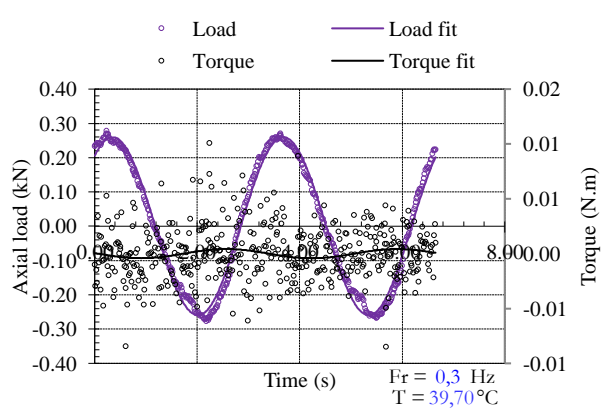
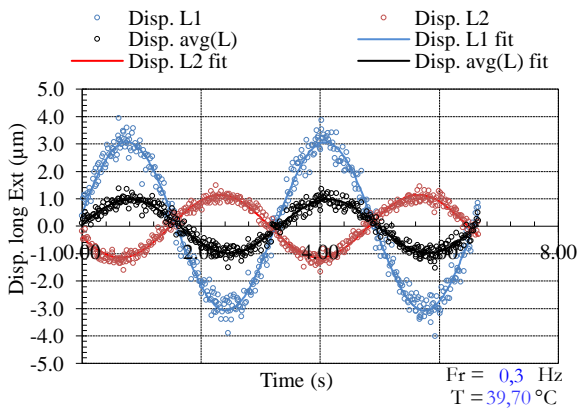
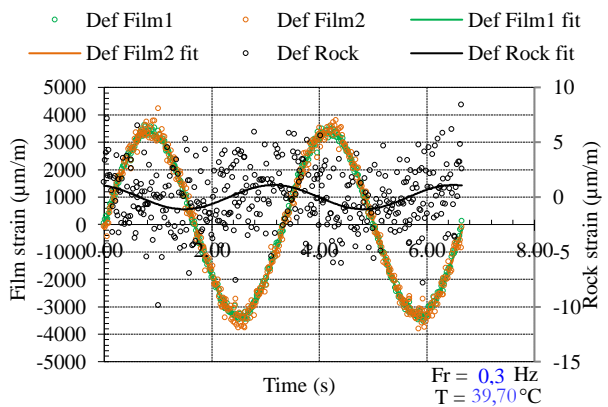
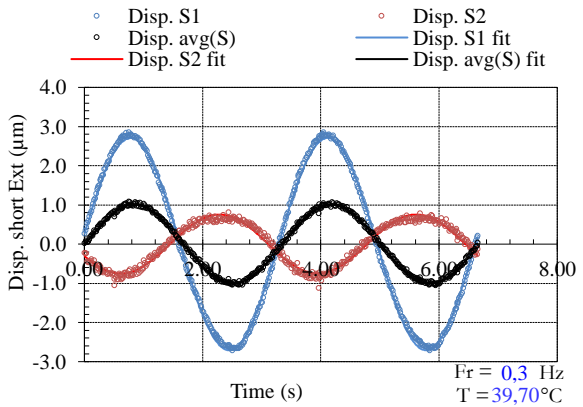
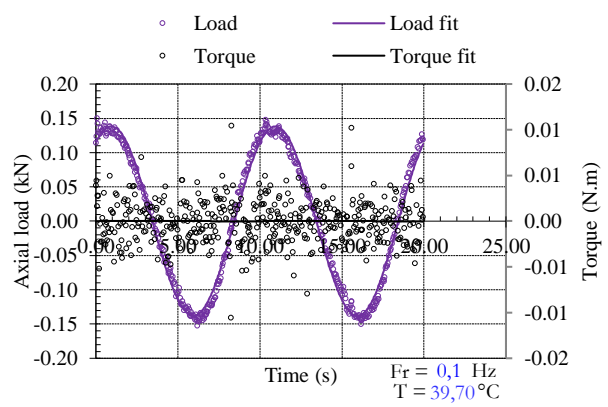
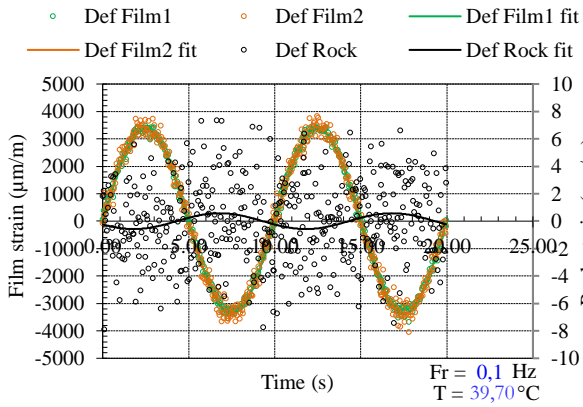
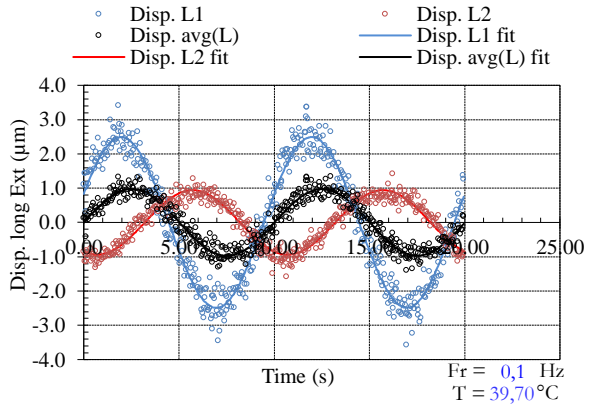
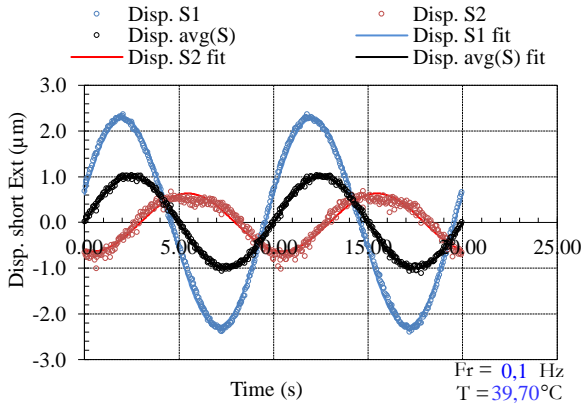
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



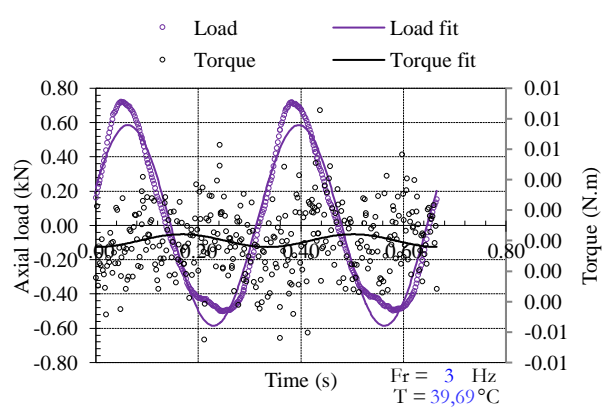
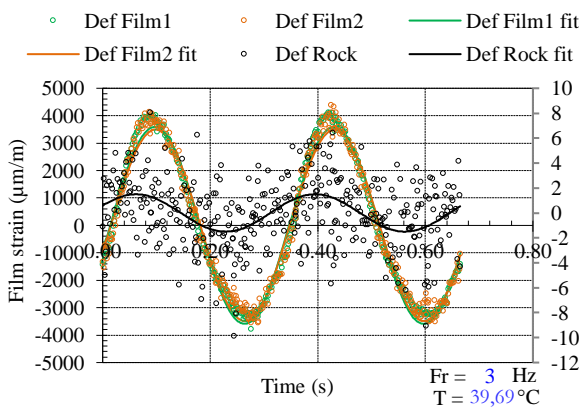
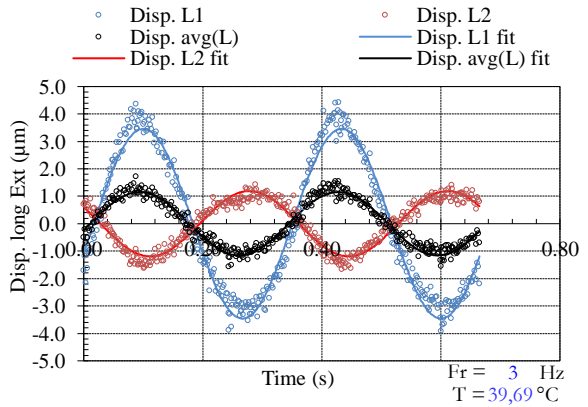
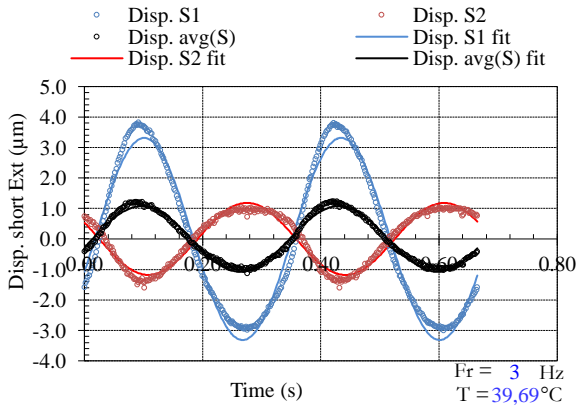
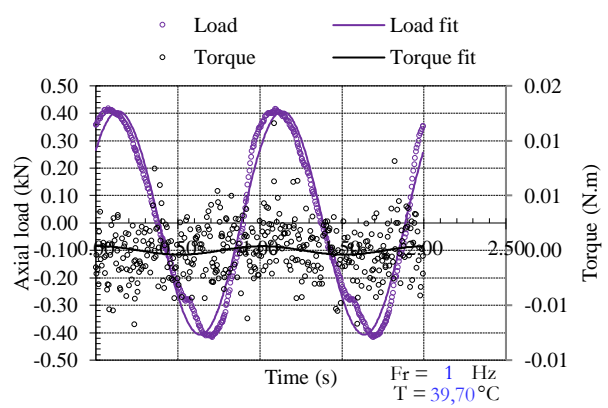
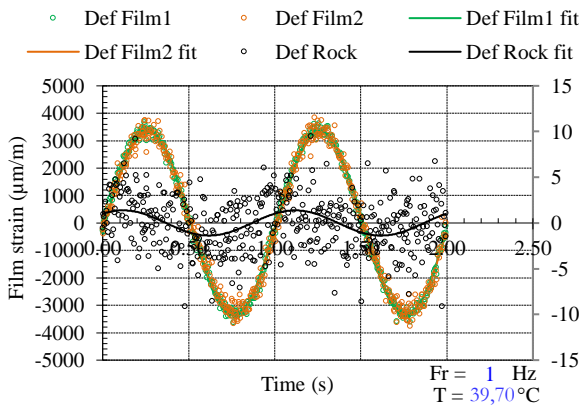
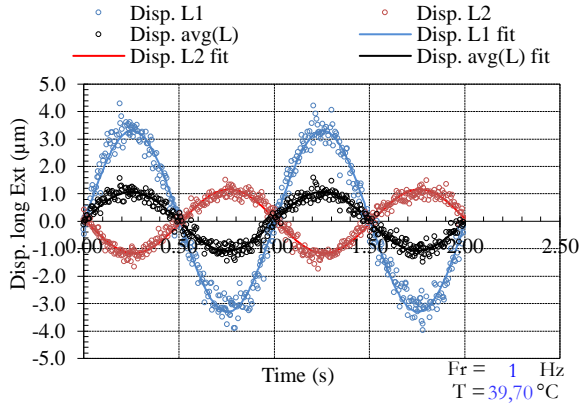
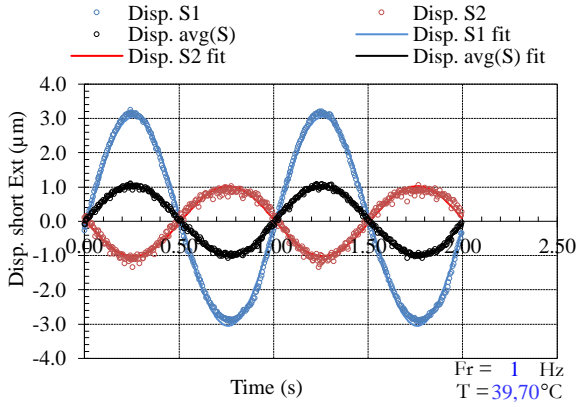
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus

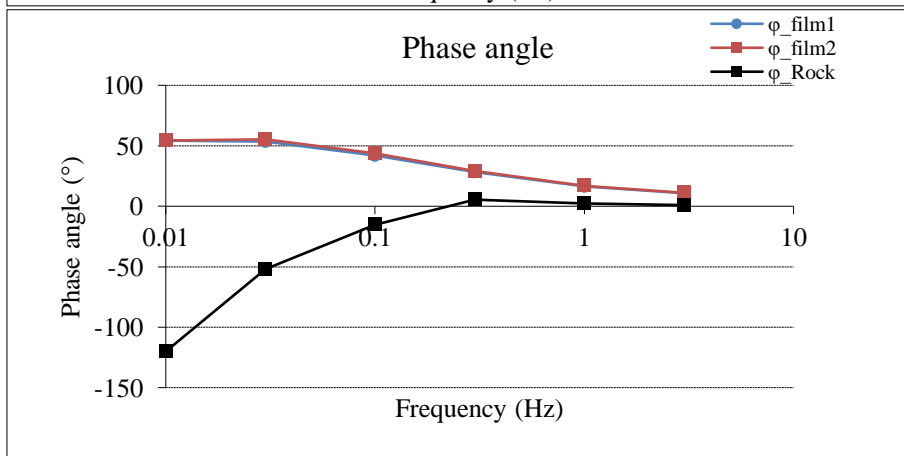
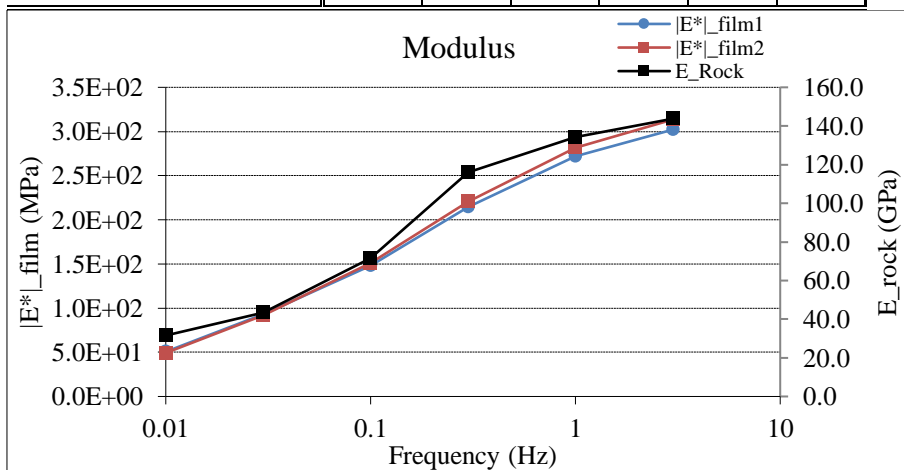


### 3 Thin film thermomechanical tests 3.1 Complex modulus

**B\_CO\_300\_SD\_sp1**

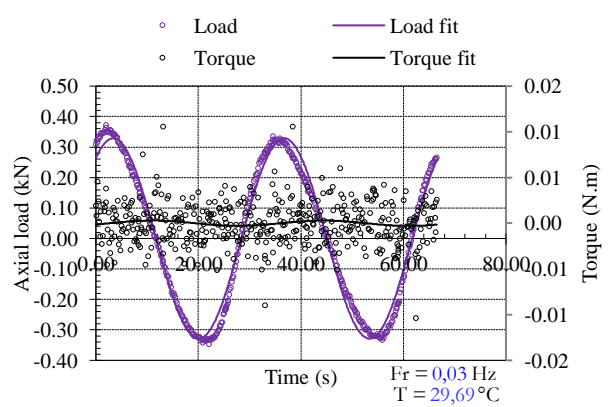
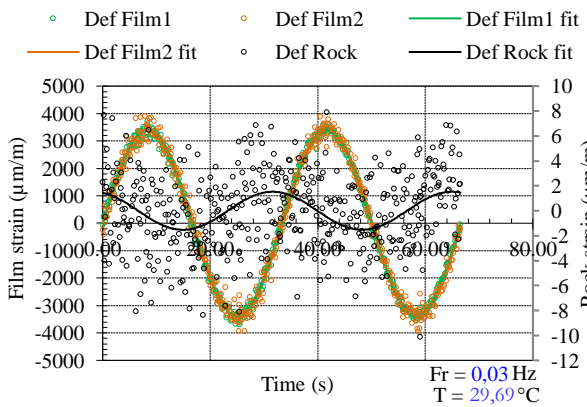
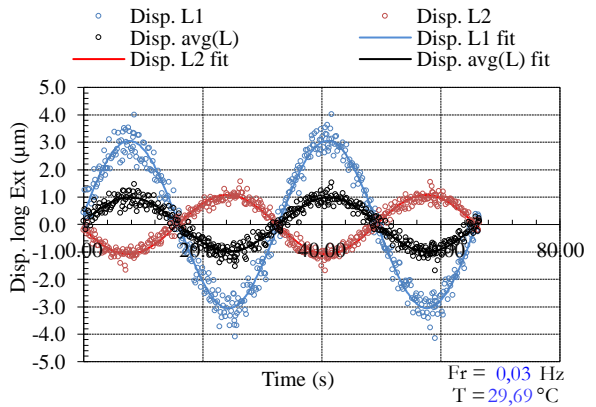
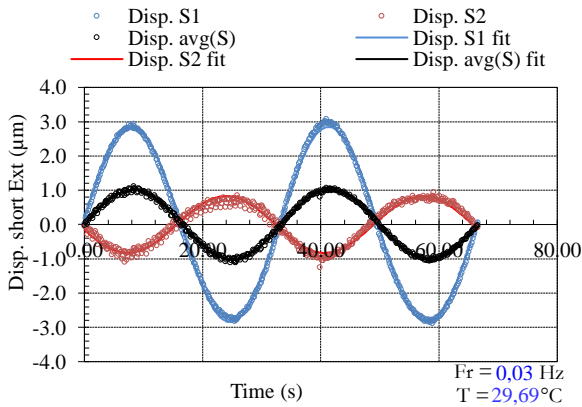
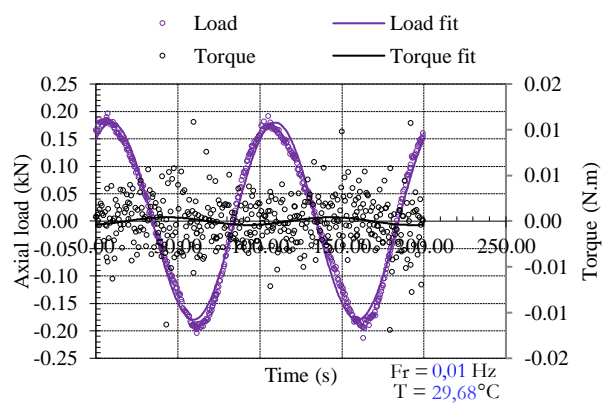
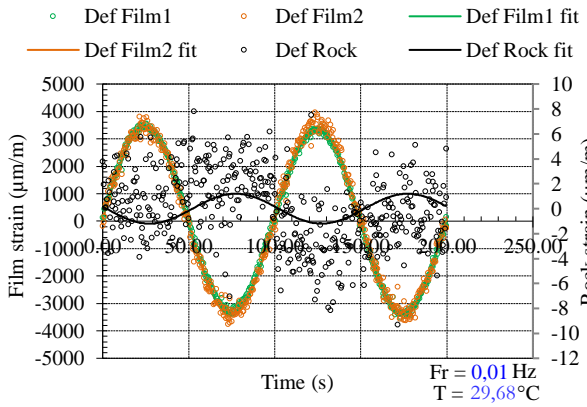
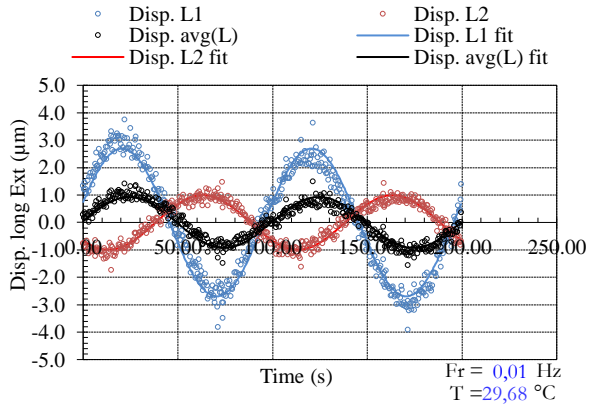
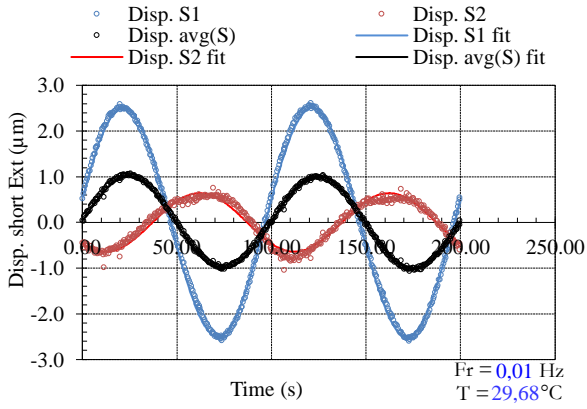
Temperature (°C) 29,7

Frequency (Hz)		0,01	0,03	0,1	0,3	1	3
Disp. amplitude (µm)	Small Ext1	2,50	2,81	2,88	2,55	2,28	2,07
	Small Ext2	0,62	0,79	0,91	0,71	0,49	0,38
	Avg. Small Ext	1,00	1,01	0,99	0,94	0,91	0,86
	Long Ext1	2,71	3,04	3,24	2,86	2,47	2,21
	Long Ext2	1,01	1,06	1,18	0,91	0,56	0,38
	Avg. Long Ext	0,93	0,99	1,05	1,01	0,99	0,94
	In 1cm length of 50GPa rock cylinder (calculated)	0,01	0,01	0,02	0,03	0,04	0,04
Phase angle (°)	Small Ext1	44,3	50,7	44,9	34,4	21,7	15,1
	Small Ext2	190,3	223,9	231,3	230,2	221,9	215,2
	Avg. Small Ext	54,3	53,3	42,0	28,5	16,3	10,8
	Long Ext1	40,1	46,9	43,4	35,3	22,5	15,5
	Long Ext2	194,0	225,4	233,8	235,0	229,5	224,5
	Avg. Long Ext	53,8	47,7	37,6	26,7	15,1	9,9



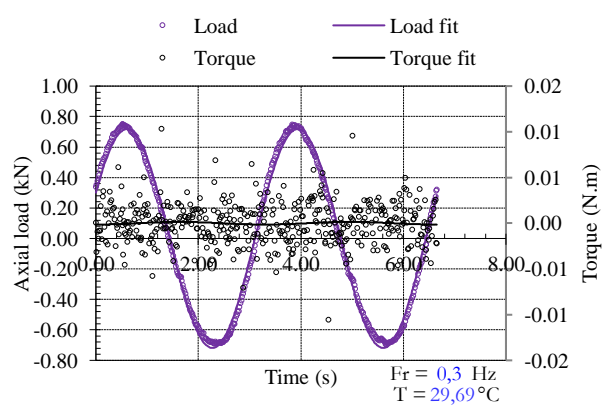
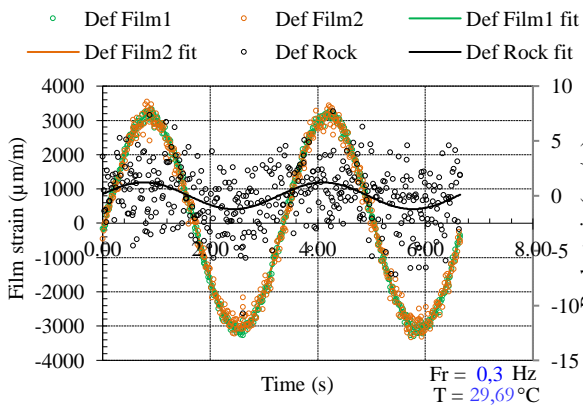
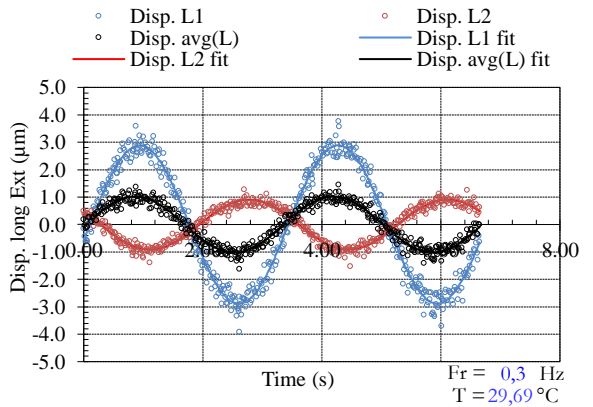
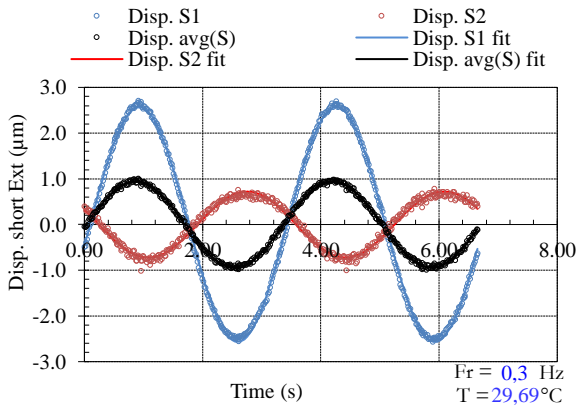
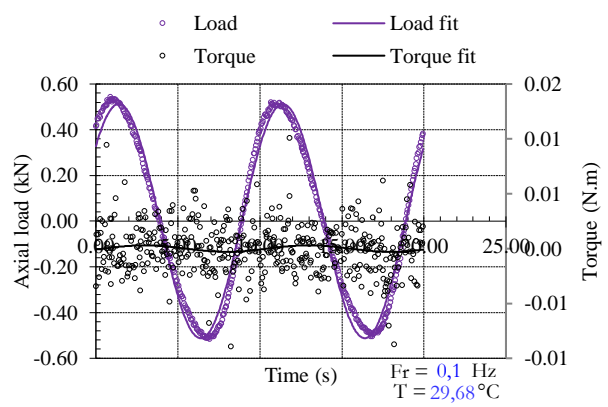
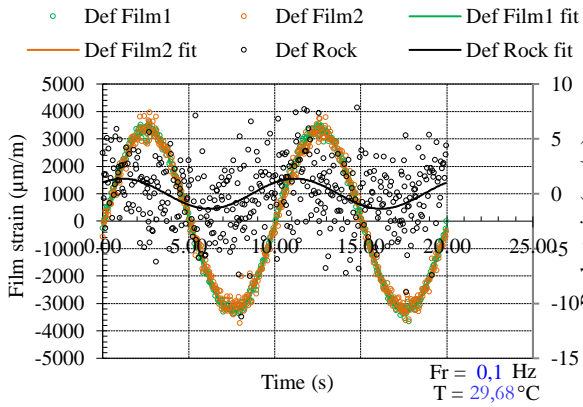
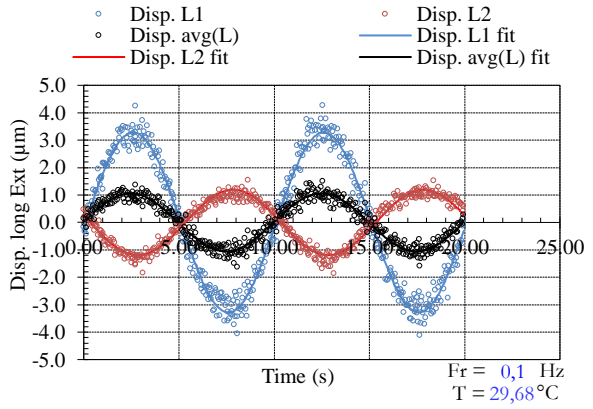
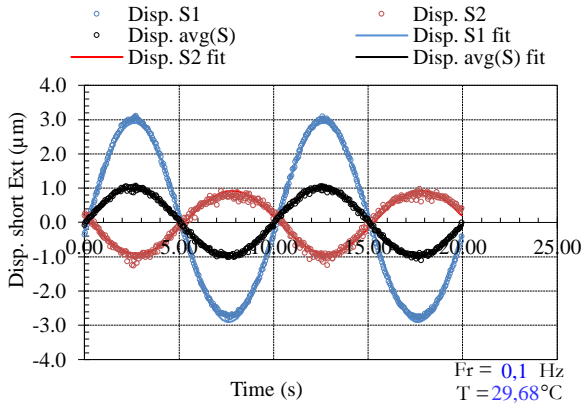
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



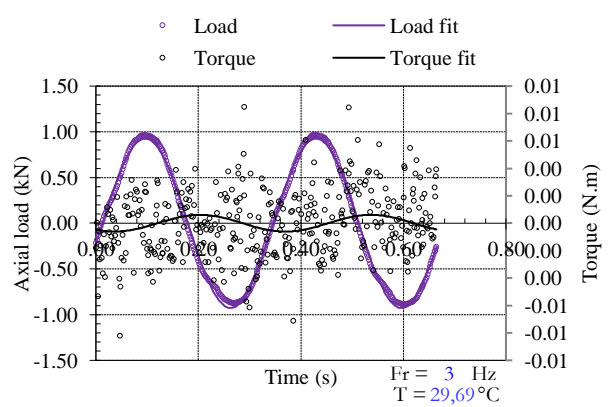
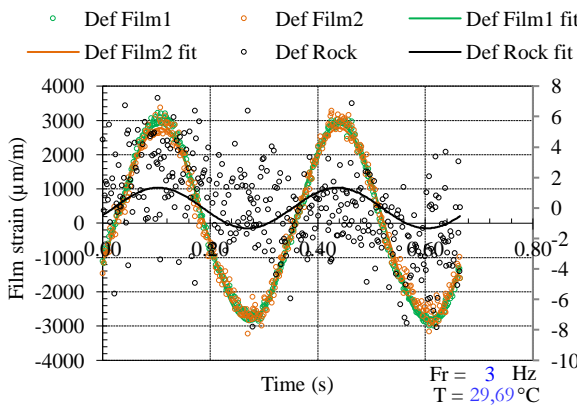
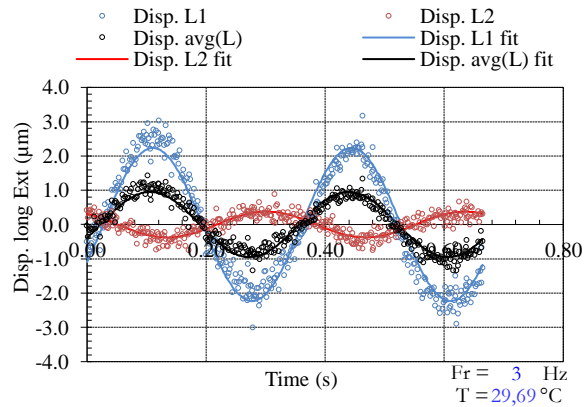
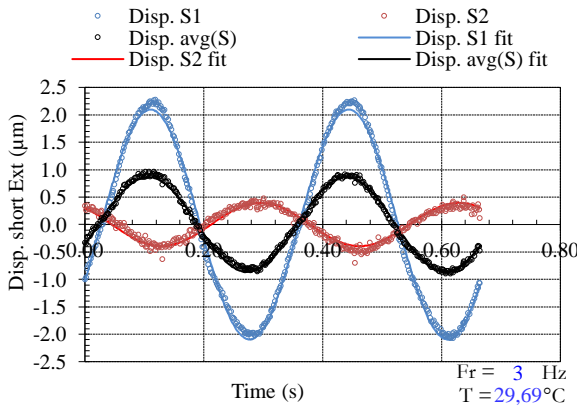
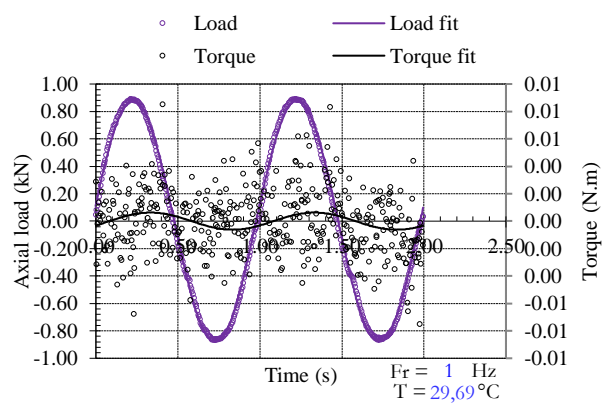
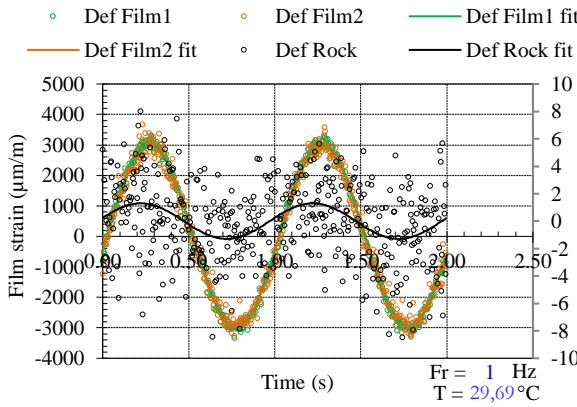
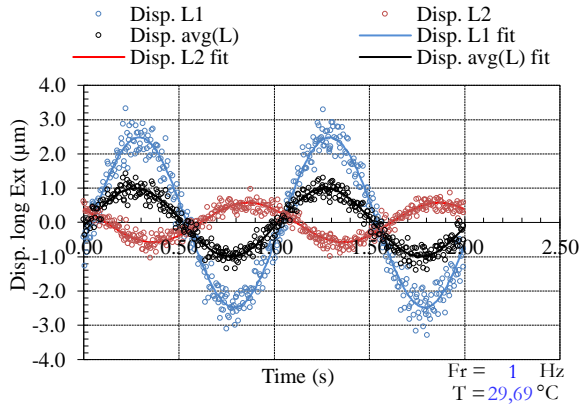
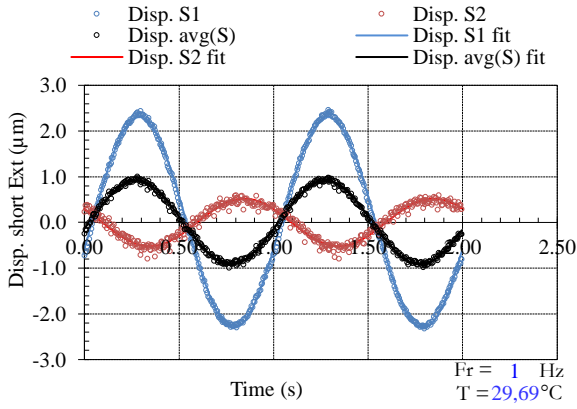
### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus



### 3 Thin film thermomechanical tests

#### 3.1 Complex modulus





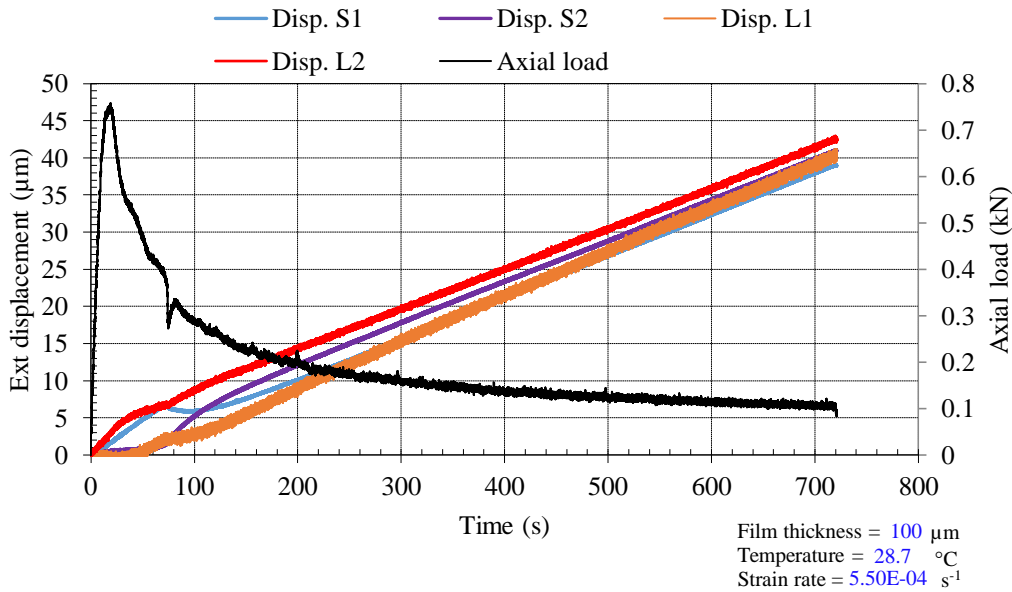
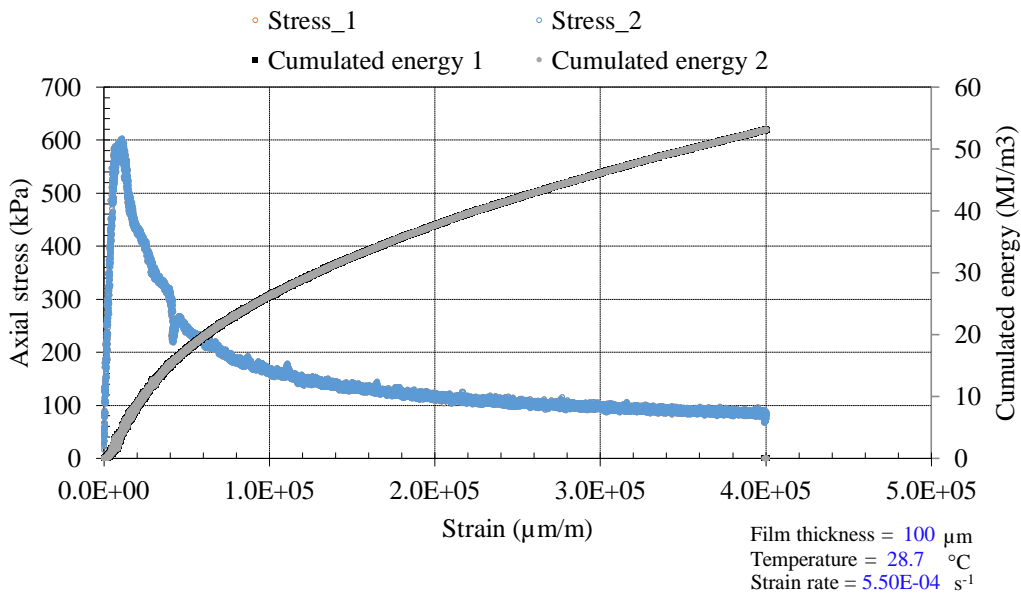
### 3 Thin film thermomechanical tests 3.2 Stripping tests

#### 3.2. Stripping tests

Thin film specimen	Thickness (μm)	Temperature (°C)	Strain rate (s <sup>-1</sup> )	Tensile strength (kPa)	Failure type
B_CO_100_SD_sp1	100	28.7	5.50E-04	603	Cohesive
B_CO_300_SD_sp1	300*	29.7	2.80E-03	906	Adhesive
B_CO_300_SD_sp2	300	29.7	2.80E-03	319	Cohesive
B_CO_300_SD_sp3	300	29.7	2.80E-03	230	Cohesive

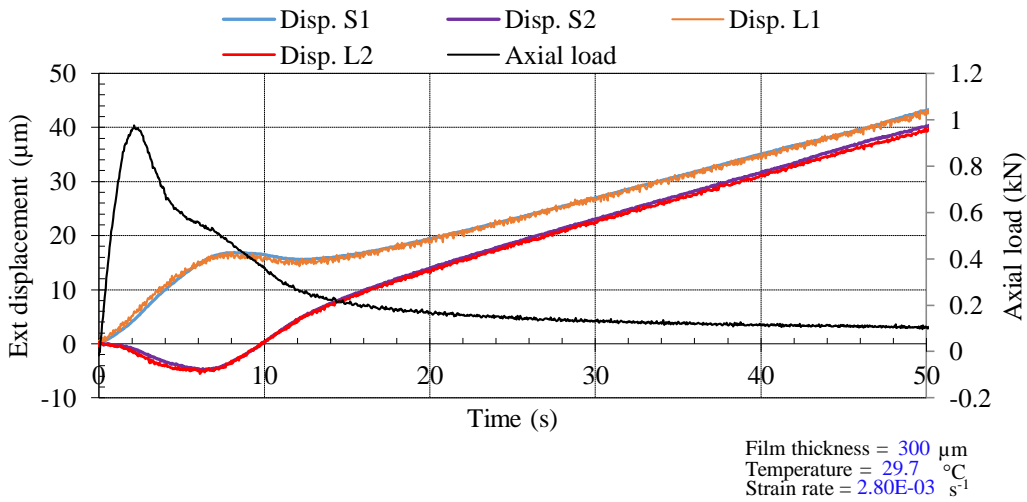
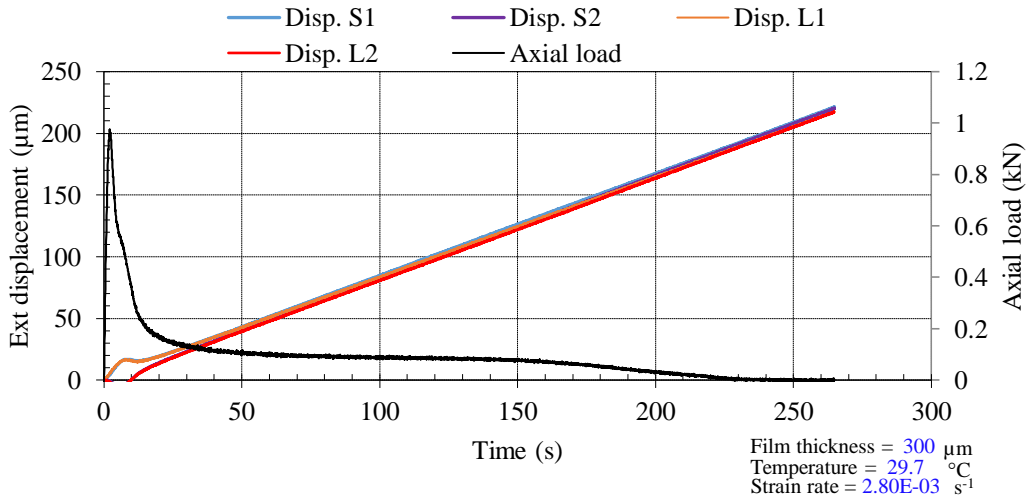
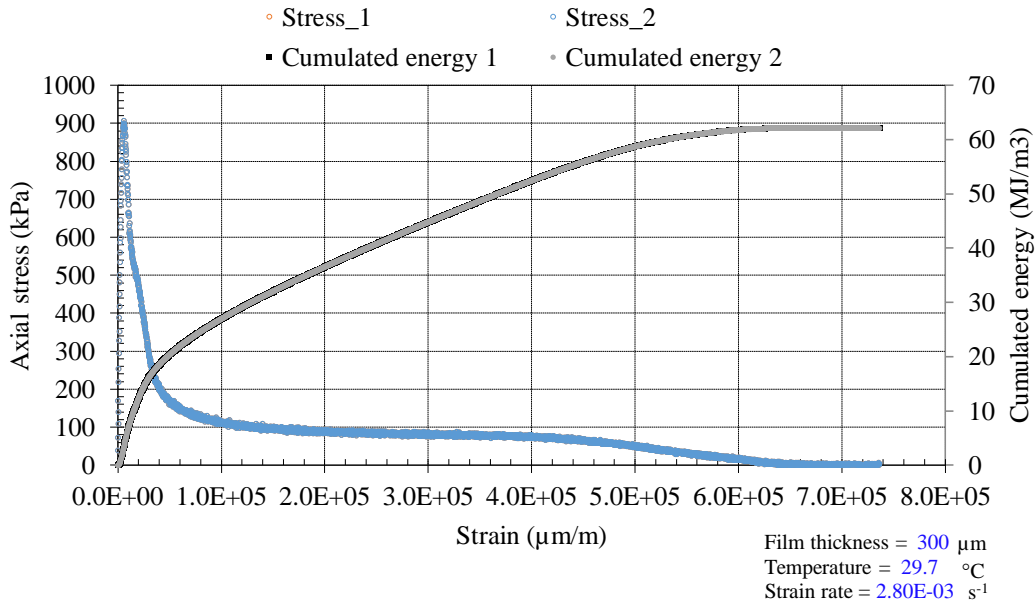
\* Accidental compression before stripping, not recorded

#### 3.2.1.B\_CO\_100\_SD\_sp1



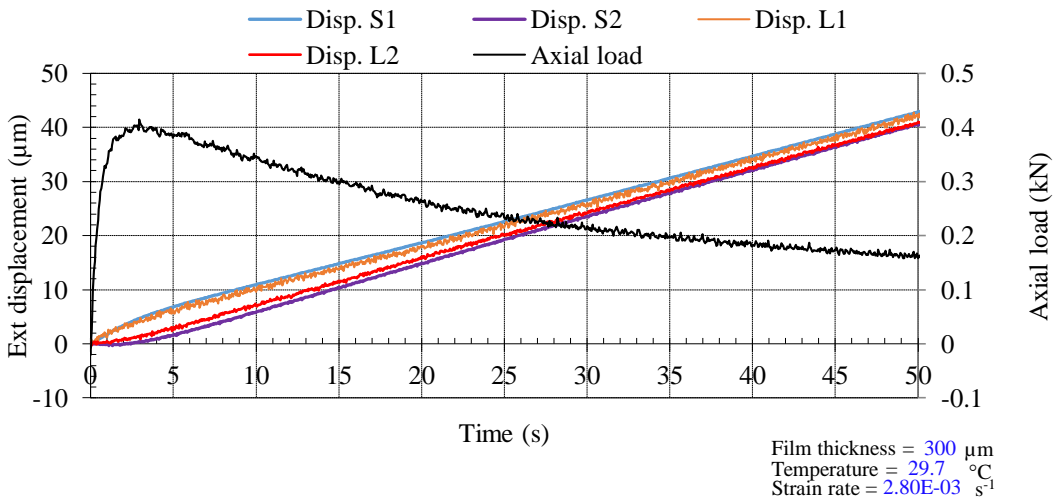
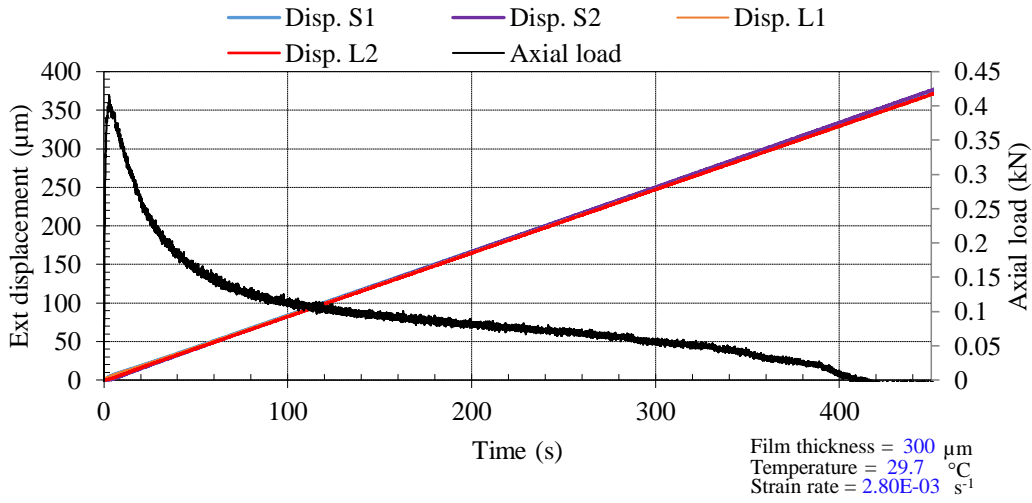
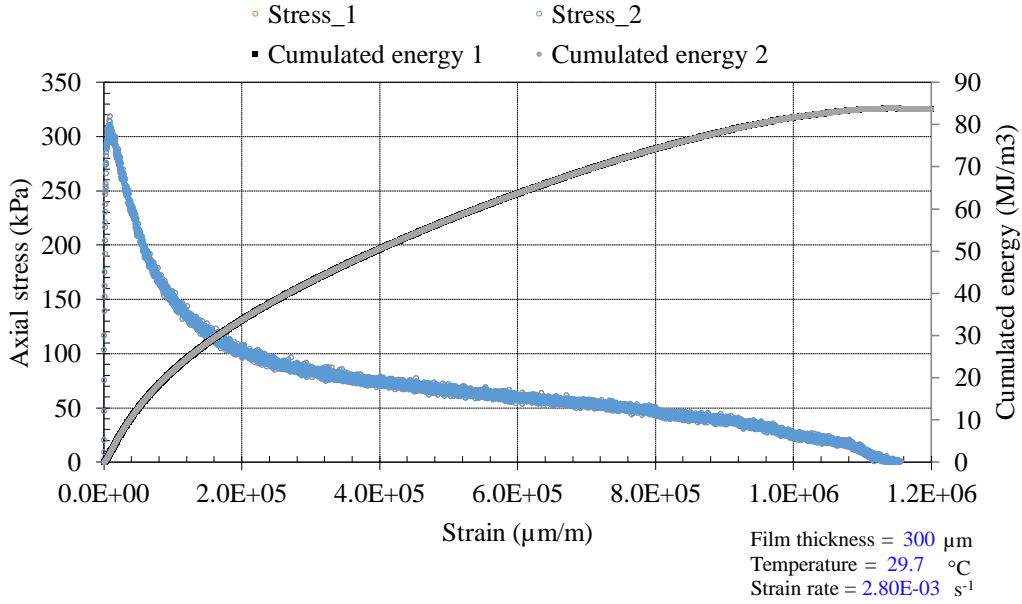
#### 3.2.2.B\_CO\_300\_SD\_sp1

### 3 Thin film thermomechanical tests 3.2 Stripping tests



3.2.3.B\_CO\_300\_SD\_sp2

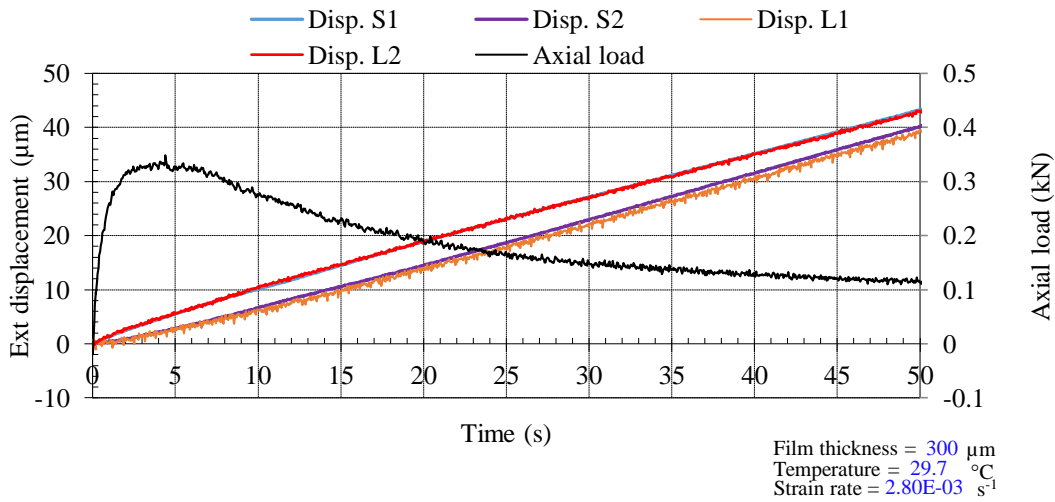
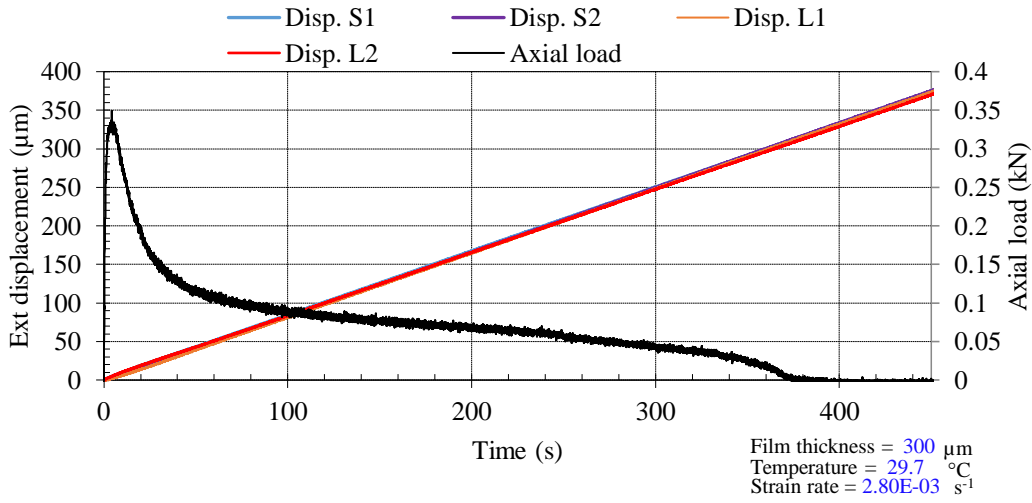
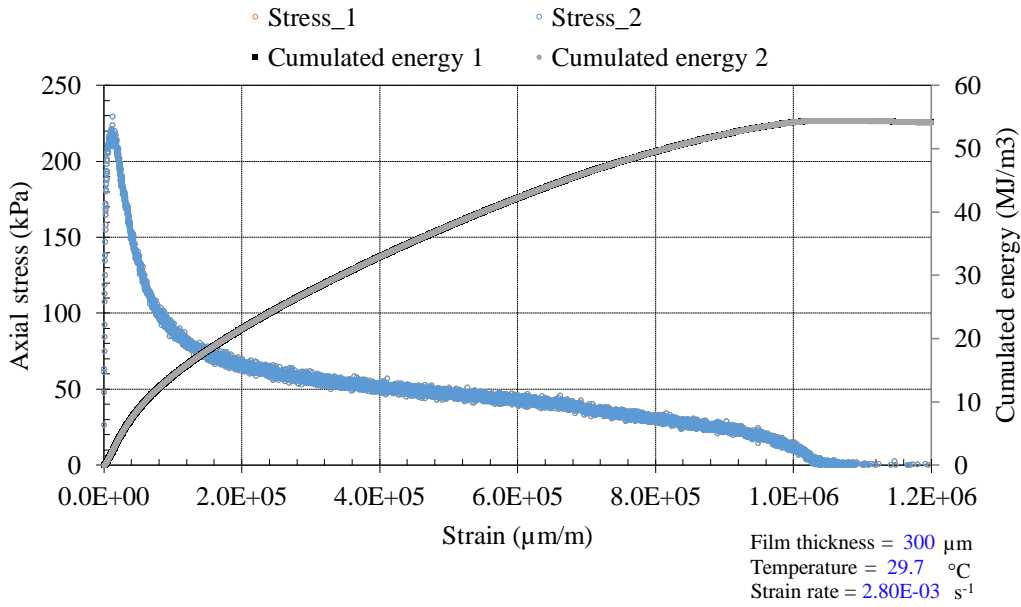
### 3 Thin film thermomechanical tests 3.2 Stripping tests



3.2.4.B\_CO\_300\_SD\_sp3

### 3 Thin film thermomechanical tests

#### 3.2 Stripping tests



## 4 Simulation of the thin film test using FEM

4.1 Stress and strain homogeneity verification  
Imposed conditions: 1) at the top of specimen  $\sigma_{zz}=110kPa$ , 2) no radial displacement at the top and the bottom of the specimen, 3) no lateral pressure on the specimen side  $\sigma_{rr}=0$ .

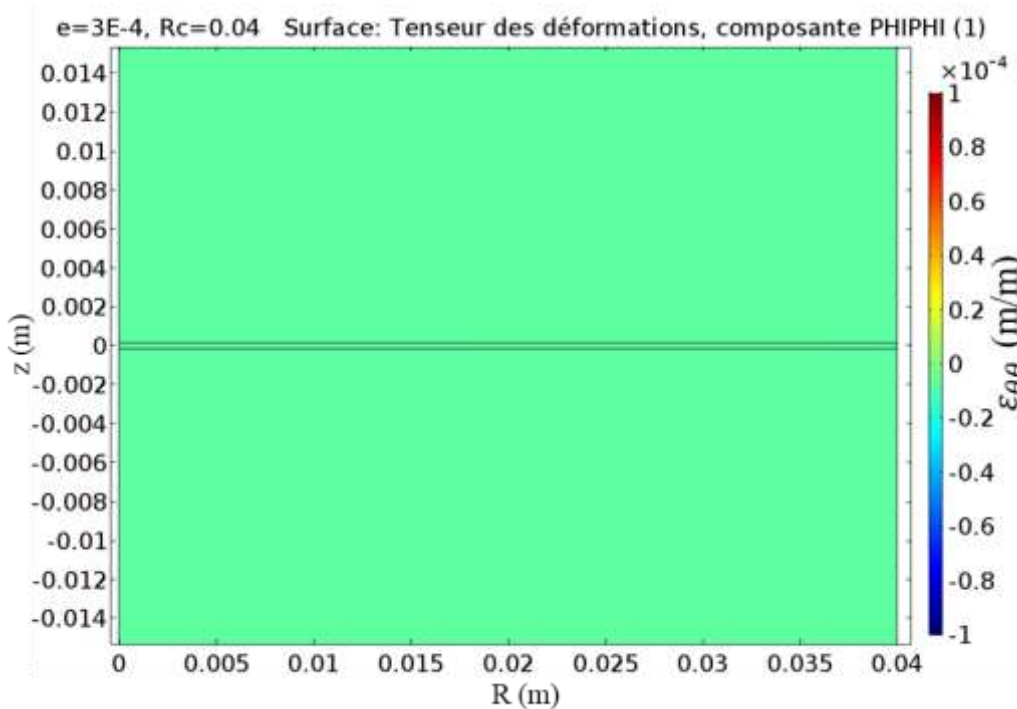
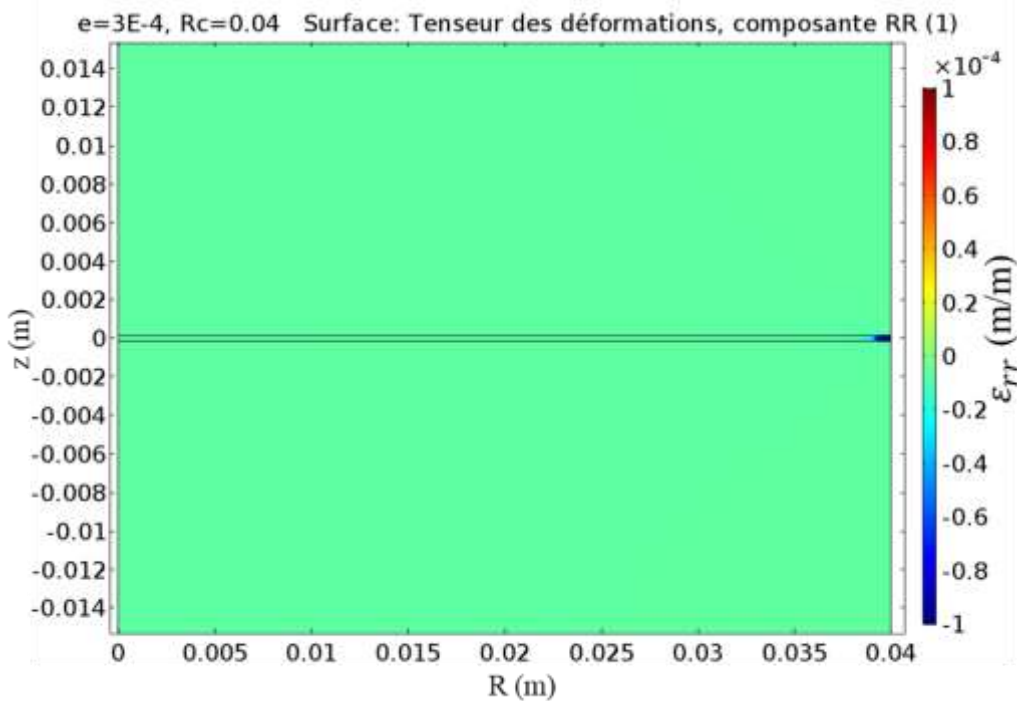
### 4. Simulation of the thin film test using FEM

#### 4.1. Stress and strain homogeneity verification

4.1.1. Stress and strain distribution for  $D=80mm$ ,  $e=300\mu m$ ,  $G_b=45MPa$ ,  $\nu_b=0.35$

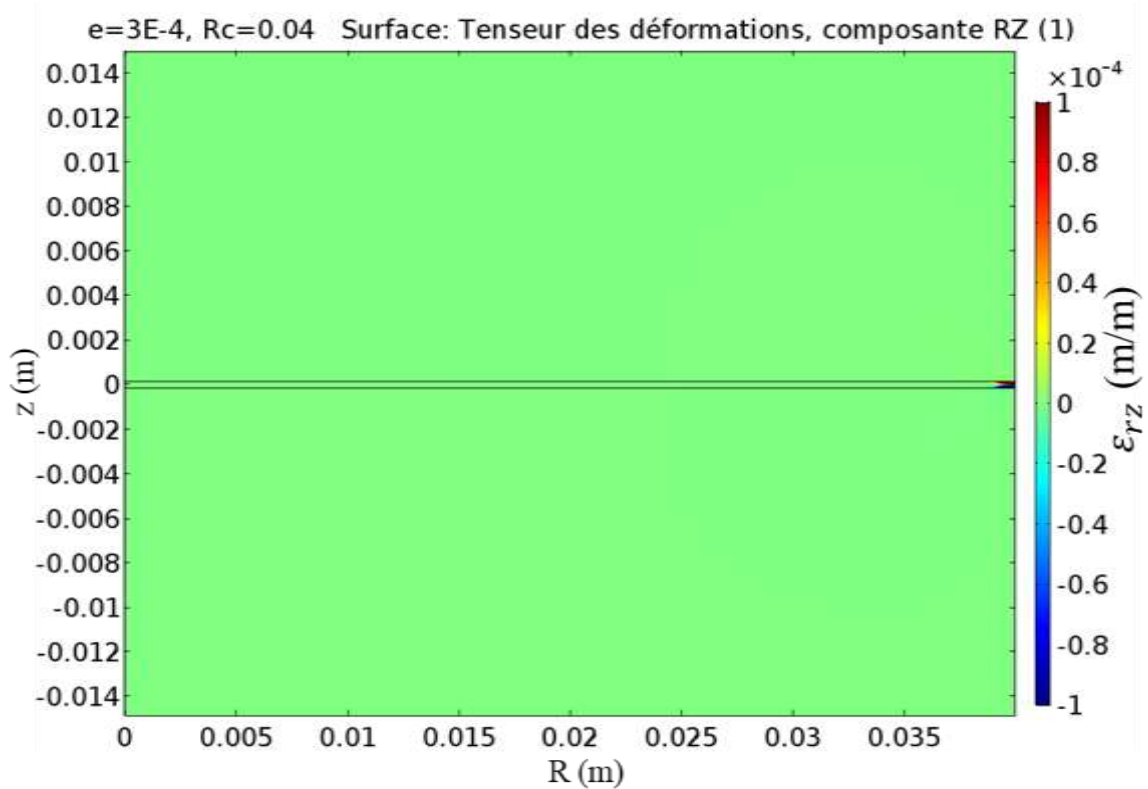
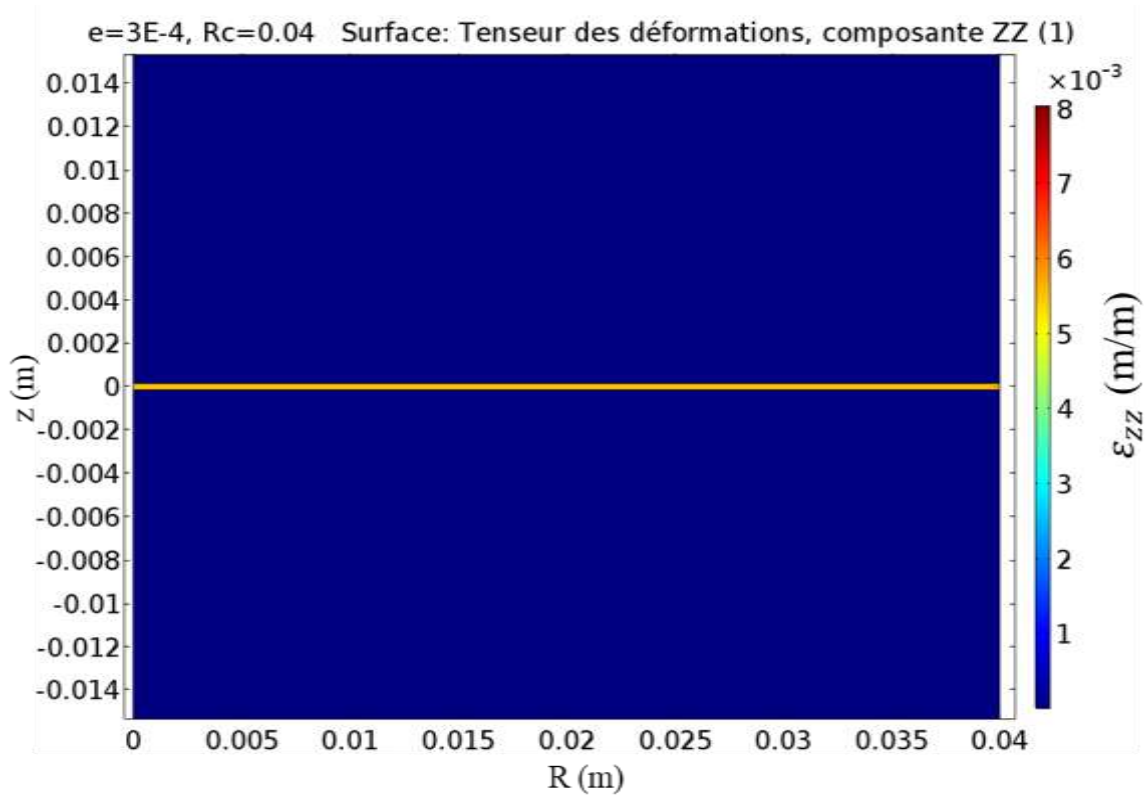
Imposed conditions: 1) at the top of specimen  $\sigma_{zz} = 110kPa$ , 2) no radial displacement at the top and the bottom of the specimen, 3) no lateral pressure on the specimen side  $\sigma_{rr} = 0$ .

Rock  $E=50GPa$ ,  $\nu=0.3$



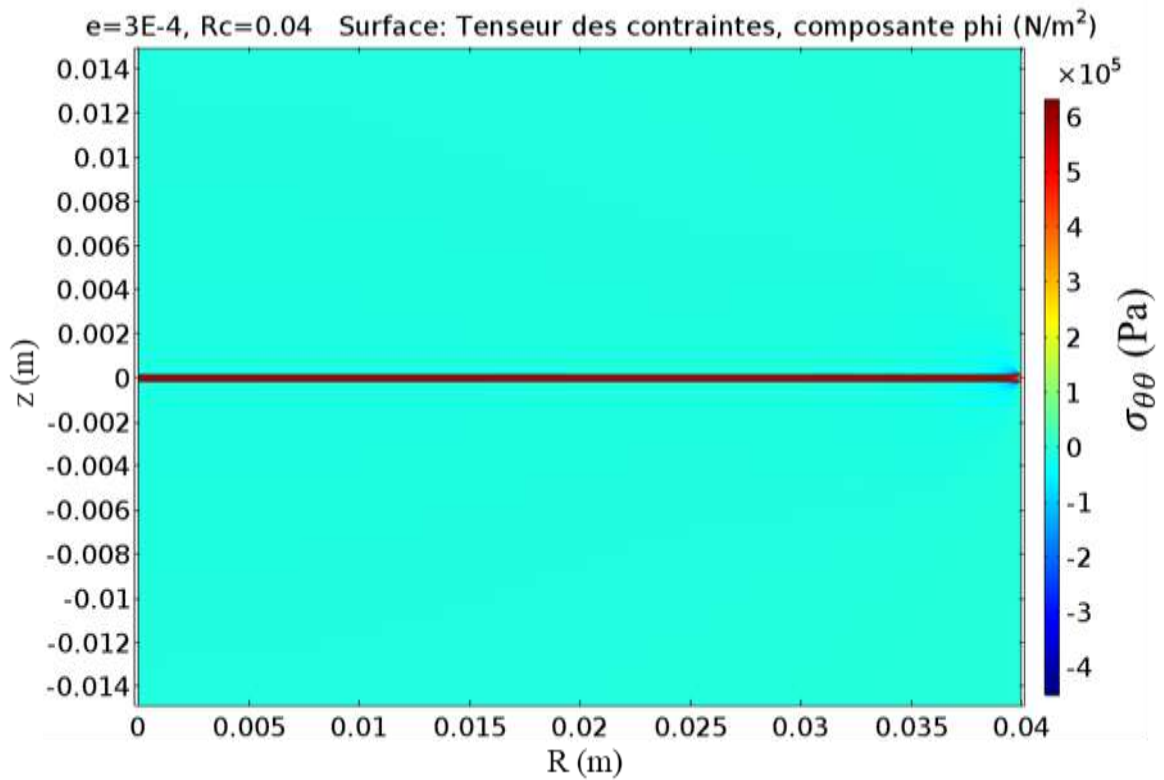
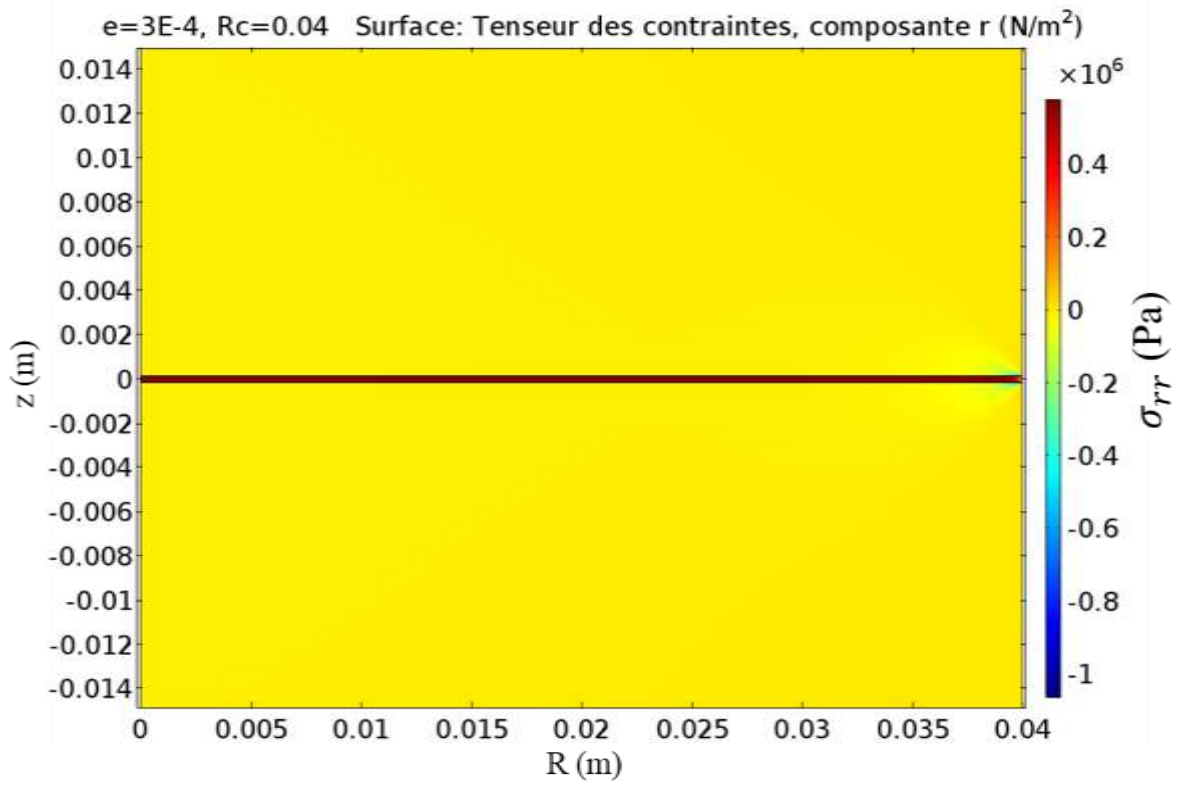
## 4 Simulation of the thin film test using FEM

### 4.1 Stress and strain homogeneity verification



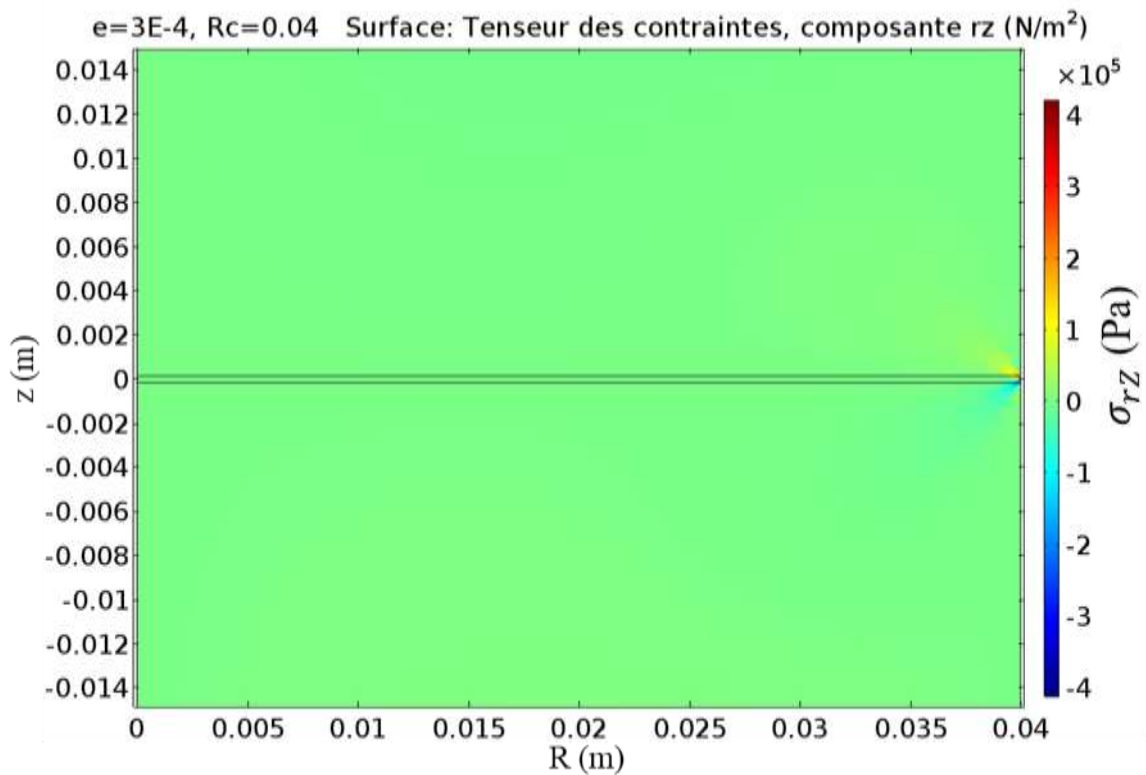
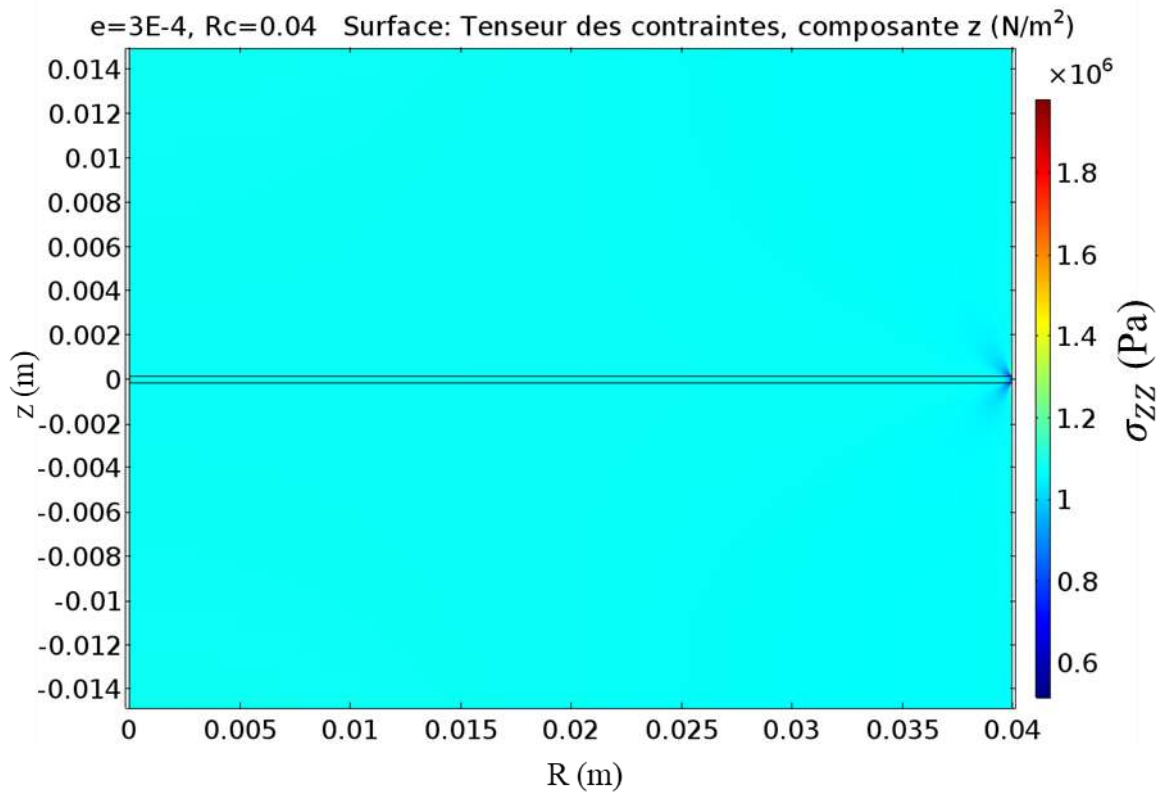
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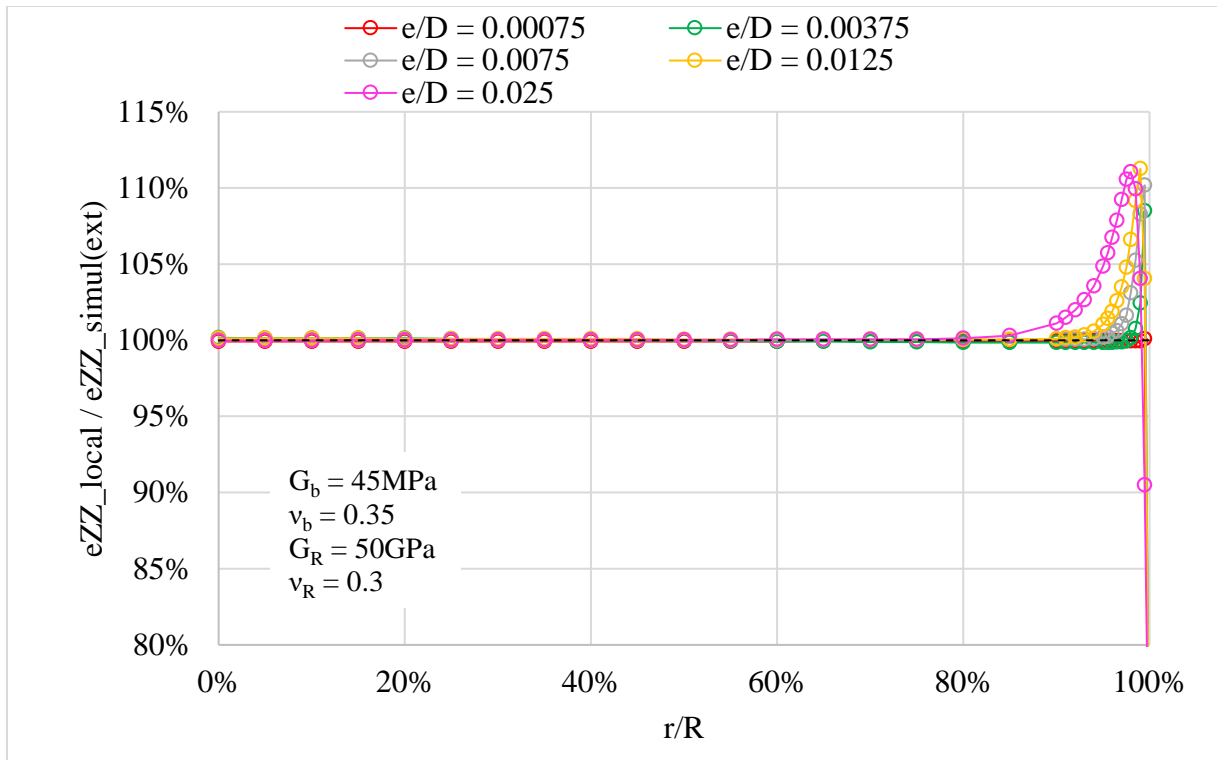




## 4 Simulation of the thin film test using FEM

### 4.1 Stress and strain homogeneity verification

#### 4.1.2. Comparison of axial strain with simulated extensometer VS local values



#### 4 Simulation of the thin film test using FEM

4.2 Influence of aspect ratio, G and Poisson's ratio on simulated modulus  
Imposed conditions: 1) at the top of specimen  $\sigma_{zz}=100kPa$ , 2) no radial displacement at the top and the bottom of the specimen, 3) no lateral pressure on the specimen side  $\sigma_{rr}=0$ .

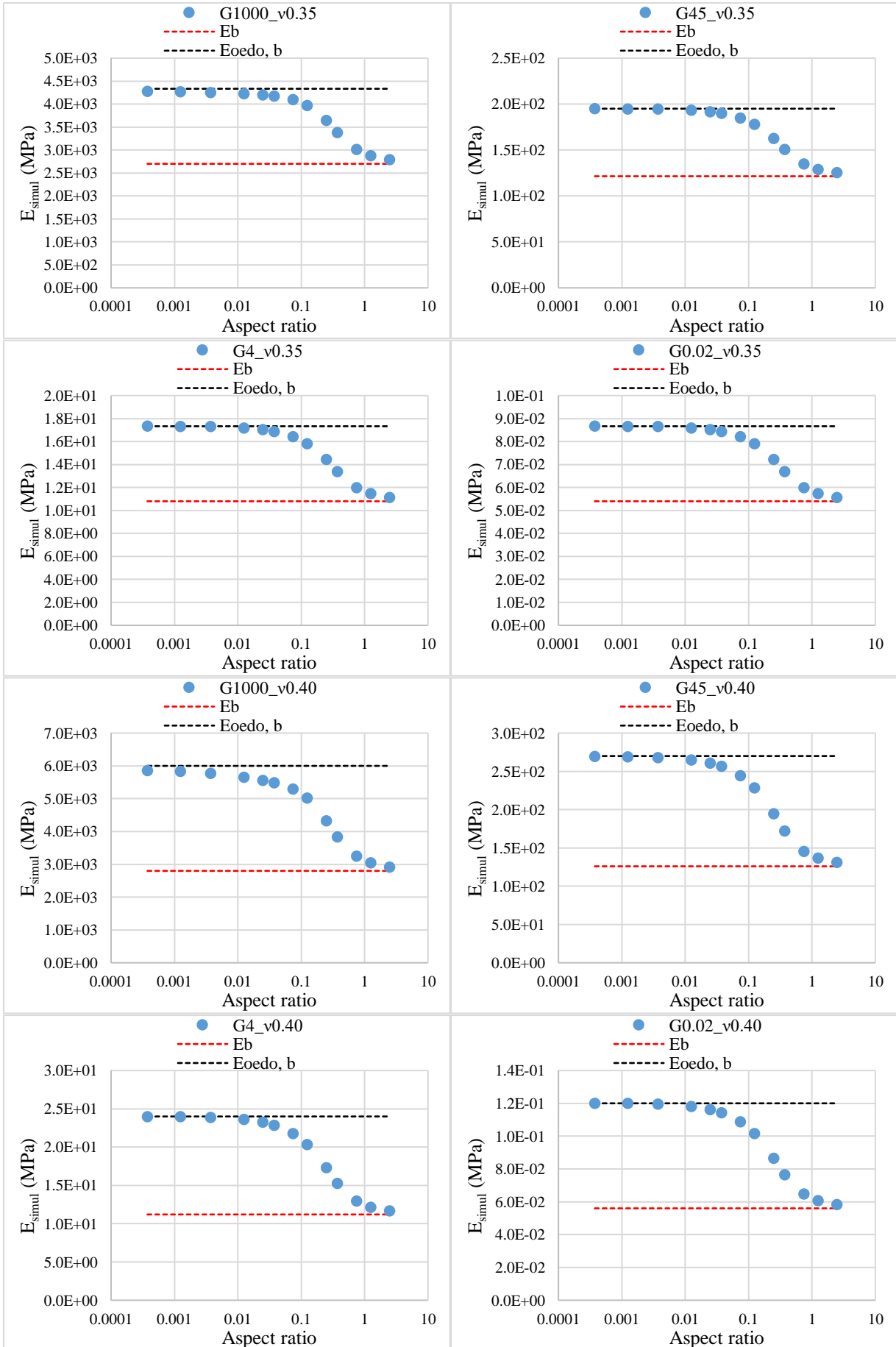
##### 4.2. Influence of aspect ratio, G and Poisson's ratio on simulated modulus

Imposed conditions: 1) at the top of specimen  $\sigma_{zz} = 100kPa$ , 2) no radial displacement at the top and the bottom of the specimen, 3) no lateral pressure on the specimen side  $\sigma_{rr} = 0$ .

Rock  $E=50GPa$ ,  $\nu=0.3$

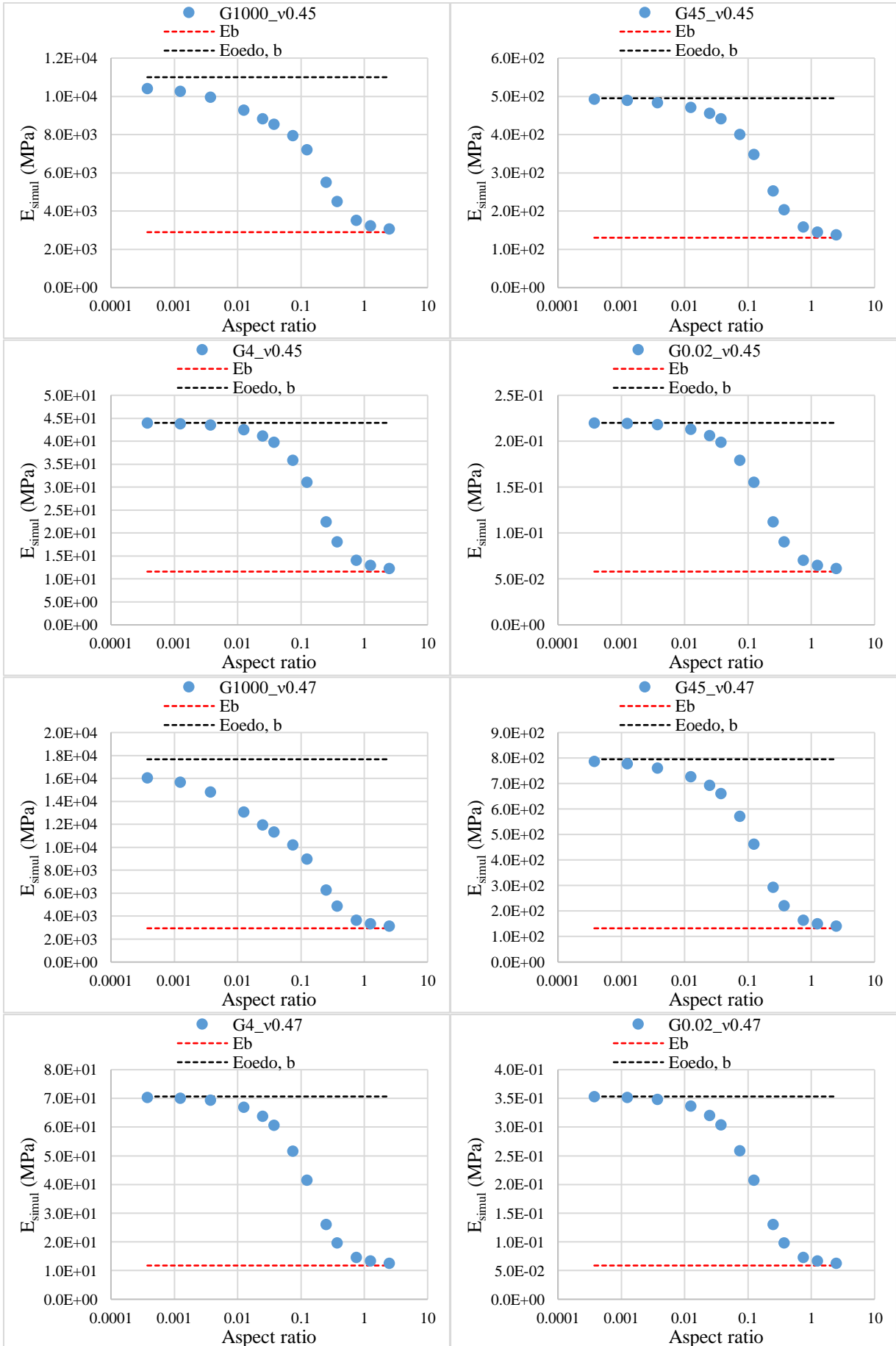
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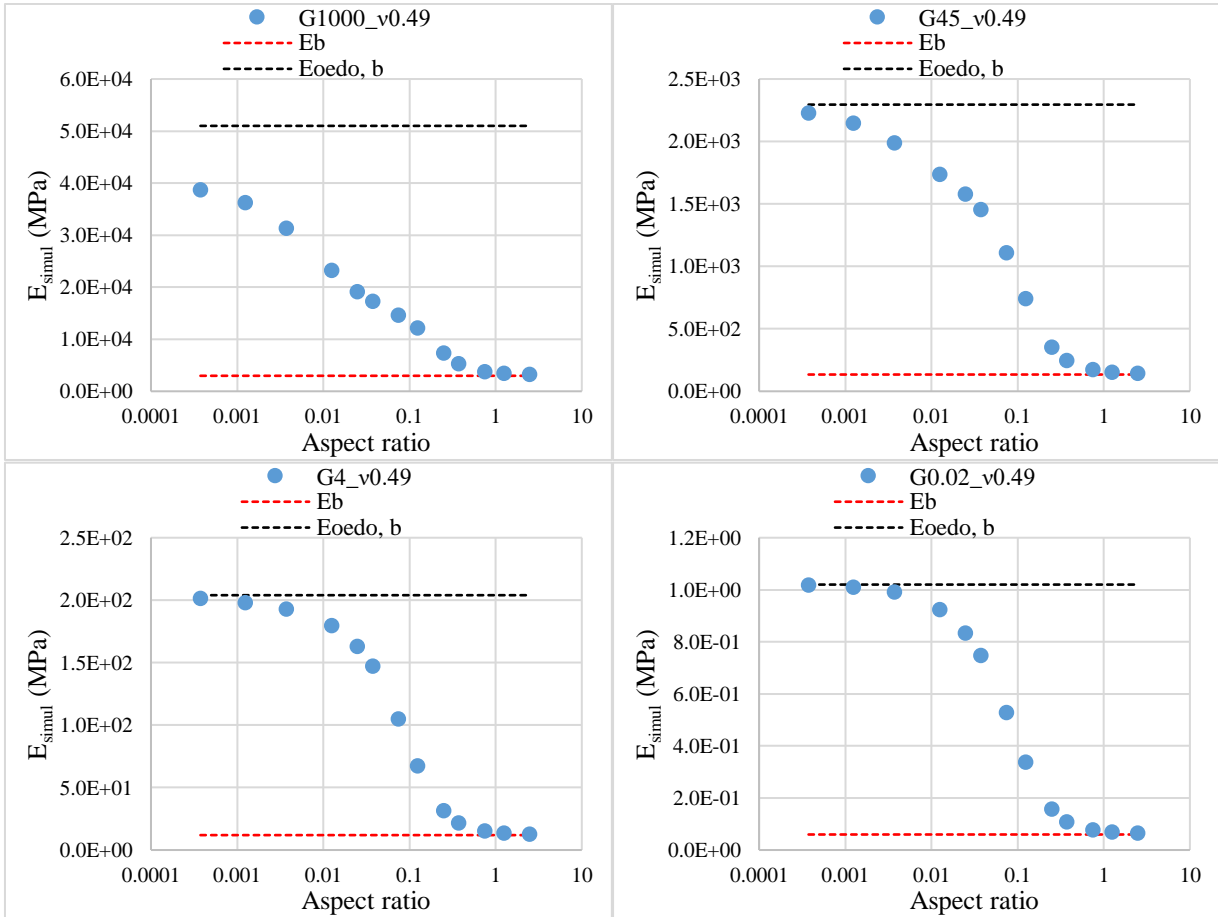
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