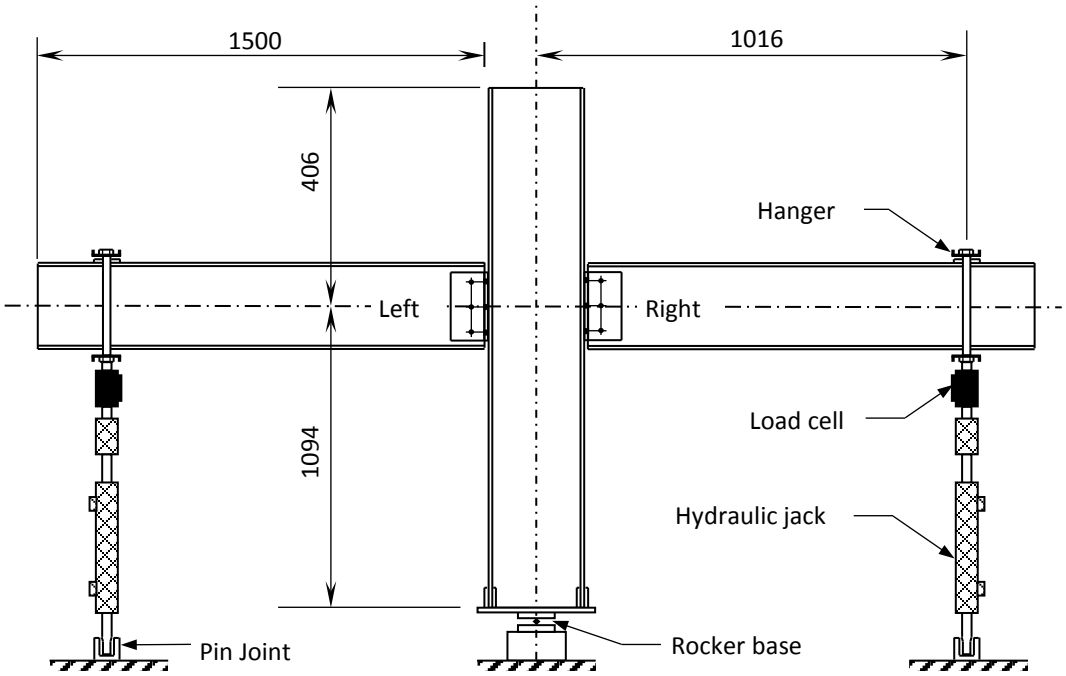


Fig. 1. Cruciform test configuration and loading arrangement (all dimensions are in mm).

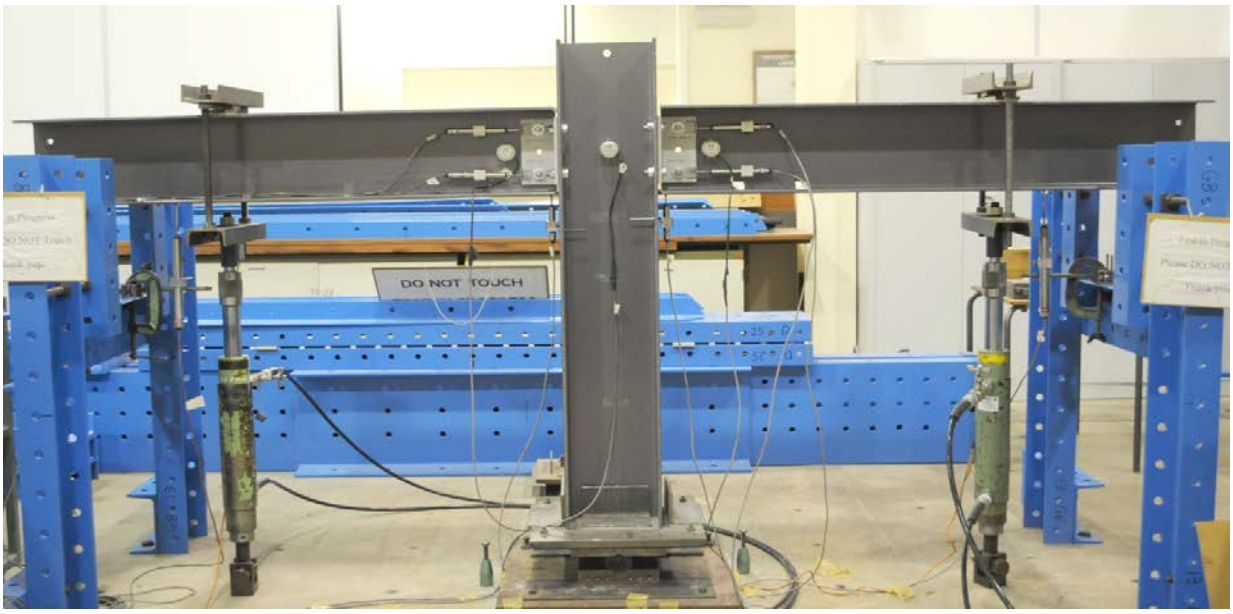


Fig. 2. General test arrangement for major-axis beam-to-column joint Wmj254_2M16_FC1-2.

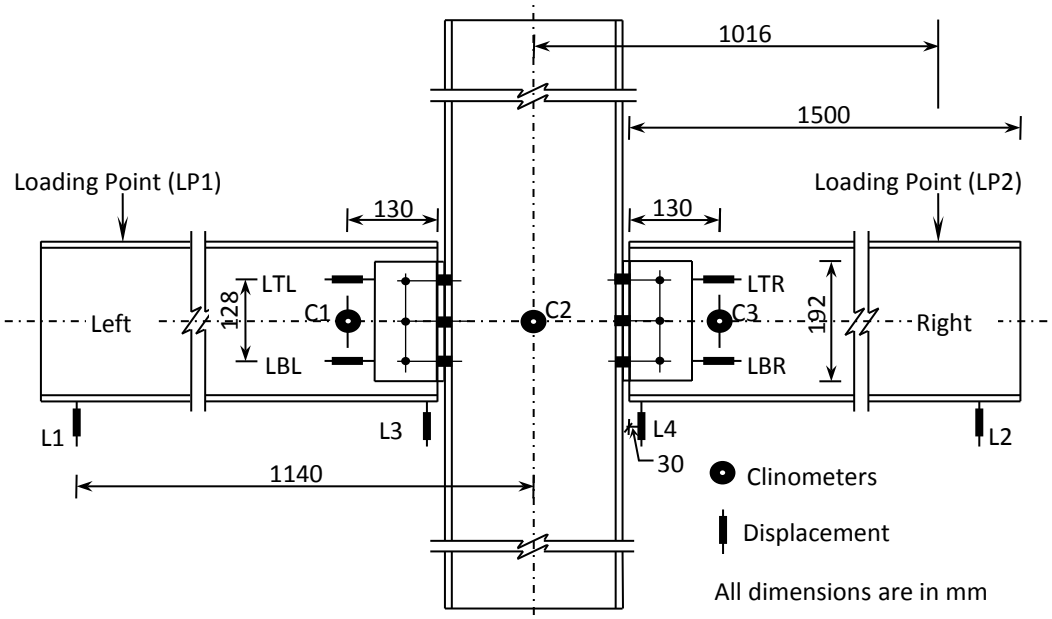


Fig. 3. Location of instrumentation in nominally pinned beam-to-column joint tests (all dimensions are in mm).

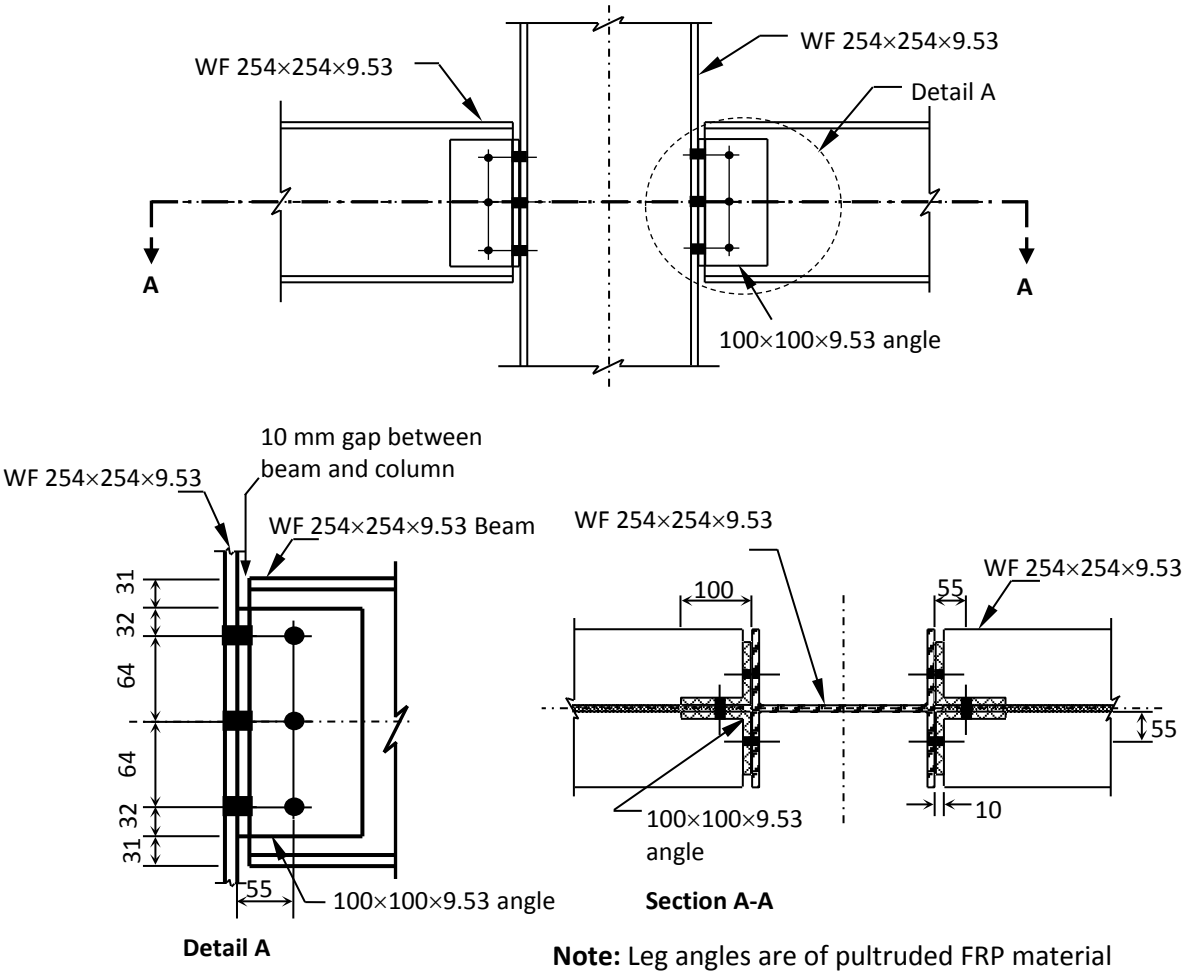


Fig. 4. Connection details for nominally pinned beam-to-column joint tests (all dimensions are in mm), adapted from [Fig. 1].

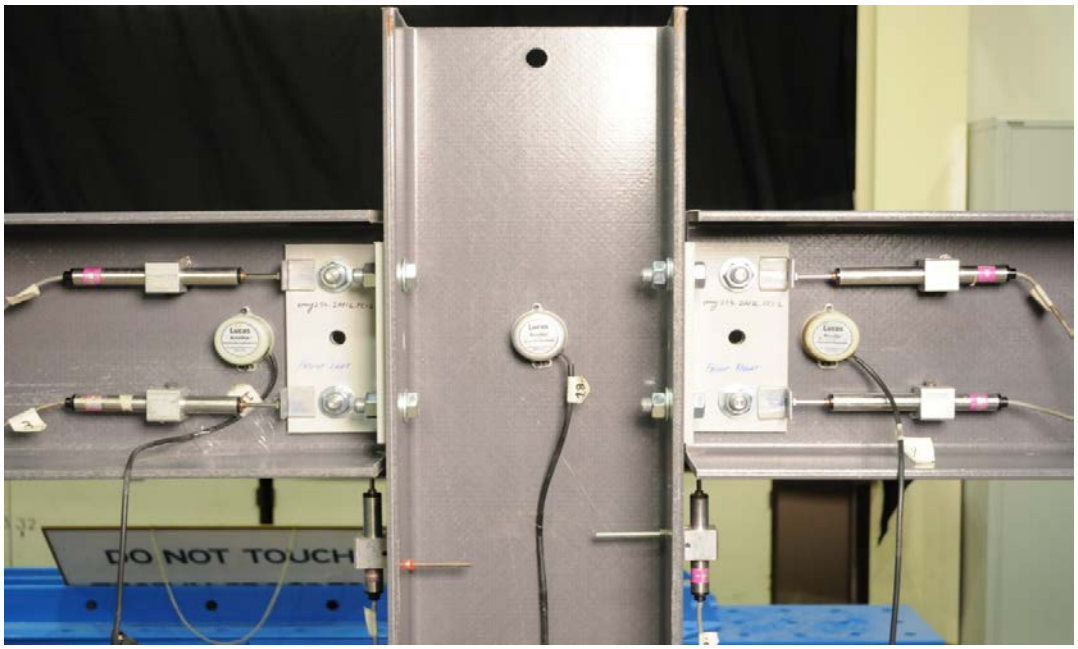


Fig. 5. Details of nominally pinned beam-to-column joint test Wmj254_2M16_FC1-2.

Test Ref: wmj254_2M16_FC1-2 Test date: 17th November 2011

Moment arm = 1.016 m

Load Incr	Centre rotation, C2 (CH18)	LEFT SIDE									
		Load Point, LP1 (CH 21)	Rotation, C1 (CH 17)	Moment =LP1 x moment arm	Joint rotation, (4)-(2)	Slip compensated joint rotation, (6)-(12)	End beam deflection L1, (CH11)	Slip top, LTL (CH1)	Slip bot, LBL (CH3)	Beam deflection near column end, L3 (CH13)	Rotation due to horizontal slip, arctan ((LBL-LTL)/L)
	mrad	kN	mrad	kN.m	mrad	mrad	mm	mm	mm	mm	mrad
1	2	3	4	5	6	7	8	9	10	11	12
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-1.26	0.20	-2.61	0.21	1.34	1.33	2.46	0.00	0.00	0.03	0.01
	-0.18	0.44	-3.60	0.45	3.42	3.21	3.43	-0.06	-0.03	0.05	0.21
	-0.86	0.64	-7.13	0.65	6.27	5.89	6.65	-0.08	-0.03	0.09	0.38
	-2.02	0.70	-10.31	0.71	8.30	7.65	9.46	-0.12	-0.03	0.10	0.65
	-0.64	0.03	-2.32	0.03	1.69	1.25	2.13	-0.11	-0.06	0.01	0.44
	-1.54	0.75	-10.37	0.76	8.83	8.10	9.47	-0.12	-0.03	0.11	0.73
	-0.46	0.90	-13.69	0.91	13.23	11.21	12.18	-0.28	-0.03	0.11	2.02
	-0.40	1.02	-15.62	1.04	15.22	13.08	13.86	-0.30	-0.03	0.14	2.14
	-0.47	0.98	-15.71	**1.00**	**15.24**	**13.12**	13.92	-0.30	-0.03	0.14	**2.12**
	0.22	1.15	-18.30	1.16	18.52	16.40	16.14	-0.34	-0.04	0.18	2.34
	0.22	1.12	-18.32	1.14	18.54	16.42	16.16	-0.35	-0.05	0.17	2.30
	1.04	1.30	-20.29	1.32	21.33	19.21	17.82	-0.37	-0.05	0.21	2.52
	-0.02	0.27	-9.17	0.27	9.15	7.03	8.01	-0.37	-0.06	0.02	2.45
	-0.05	0.28	-9.01	0.28	8.96	6.85	7.89	-0.37	-0.06	0.02	2.42
	-3.20	1.37	-26.53	1.39	23.33	21.22	23.57	-0.40	-0.04	0.23	2.83
	-3.29	1.28	-26.62	1.30	23.33	21.21	23.62	-0.41	-0.05	0.22	2.84
	-1.39	1.47	-28.11	1.49	26.73	24.61	24.72	-0.42	-0.04	0.27	2.91
	-1.13	1.51	-30.64	1.54	29.51	27.39	26.85	-0.43	-0.04	0.31	3.06
	-1.19	0.27	-13.75	0.28	12.56	10.44	11.98	-0.42	-0.07	0.06	2.80
	-1.04	0.29	-13.39	0.29	12.35	10.24	11.67	-0.43	-0.06	0.06	2.84
	-0.32	1.49	-30.01	1.51	29.69	27.57	26.23	-0.45	-0.04	0.31	3.23
	-0.37	1.39	-30.11	1.42	29.74	27.62	26.29	-0.46	-0.04	0.30	3.25
	-1.48	1.56	-34.91	1.59	33.43	31.31	30.51	-0.47	-0.02	0.35	3.46
	-1.98	1.44	-34.99	1.46	33.01	30.90	30.66	-0.47	-0.03	0.33	3.40
	-3.72	1.56	-38.62	1.58	34.90	32.78	33.89	-0.47	-0.03	0.36	3.45
	-5.55	1.39	-38.80	1.41	33.25	31.14	34.15	-0.47	-0.03	0.33	3.47
	-9.29	1.63	-45.80	1.66	36.51	34.39	40.37	-0.47	-0.03	0.38	3.51
	-10.53	1.72	-49.39	**1.75**	**38.86**	**36.74**	43.64	-0.48	-0.03	0.41	3.52
	-8.72	1.61	-52.97	1.64	44.25	42.13	46.52	-0.49	-0.01	0.49	3.74
	-7.65	1.49	-54.22	1.51	46.57	44.45	47.55	-0.50	-0.02	0.51	3.74
	-6.87	1.28	-54.72	1.30	47.85	45.73	47.80	-0.55	-0.07	0.52	3.82
	-5.41	0.18	-30.19	0.18	24.78	22.67	26.51	-0.51	-0.12	0.19	3.10
	-32.33	0.03	-49.23	0.03	16.90	14.78	44.75	-0.50	-0.15	0.08	2.75

Test Ref: wmj254_2M16_FC1-2 **Test date: 17th November 2011**

Note: L is vertical separation between two horizontal displacement transducers on the web cleat = 128 mm

Green: **indicates linear elastic joint properties**
Red: **shows joint properties at damage onset or when first crack appears in FRP cleats**
Blue: **indicates joint properties at maximum moment**

After damage onset (red values), it is assumed that steel bolt is bearing into FRP material.
Any slip rotation after damage onset is due to bearing and is not subtracted from joint rotation.

For Left side:	**Mi = 0.27 kNm**	**ϕi = 1.9 mrad**	**From Moment-rotation curve**

Test Ref: wmj254_2M16_FC1-2 Test date: 17th November 2011

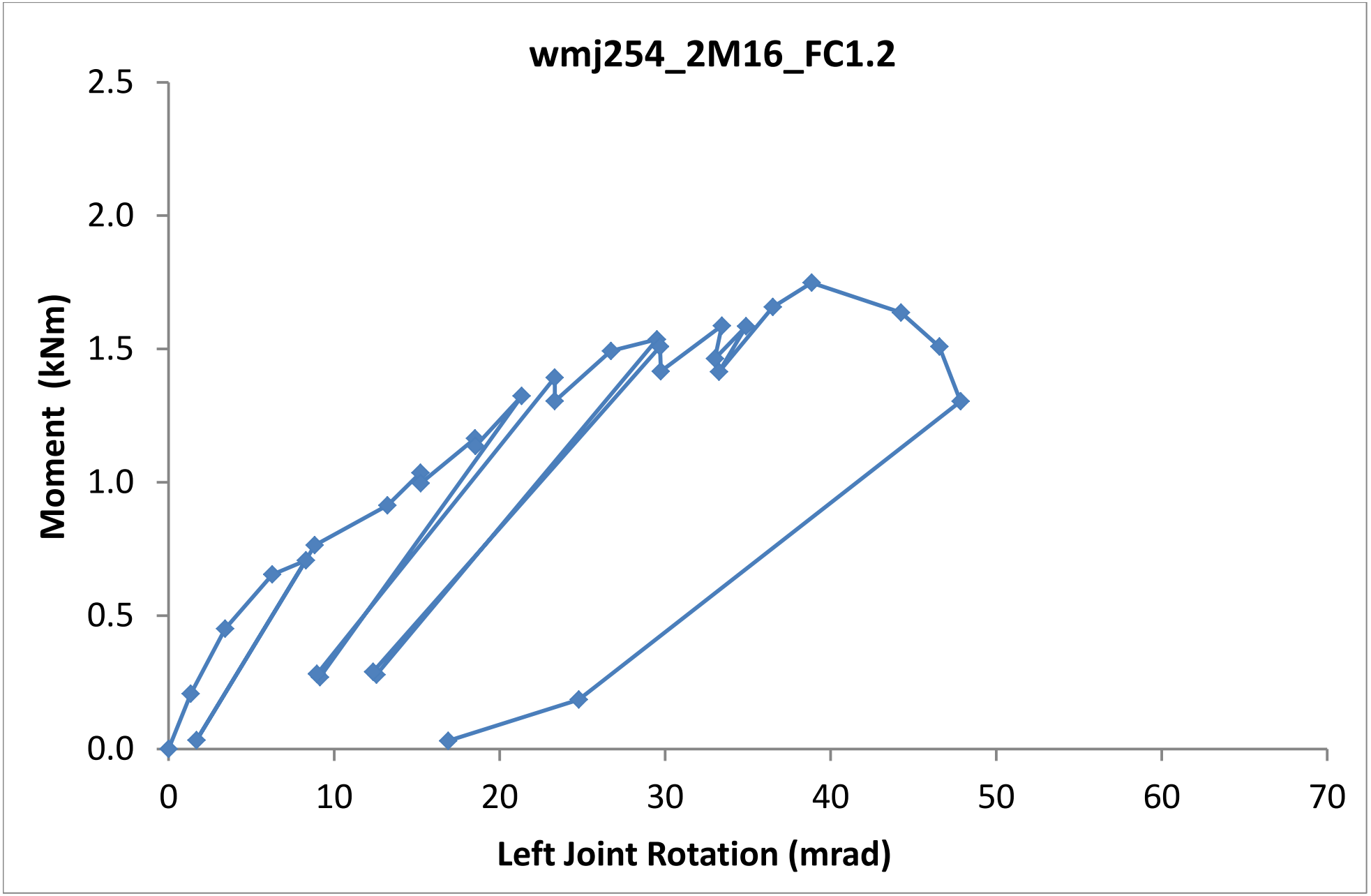
Moment arm = 1.016 m

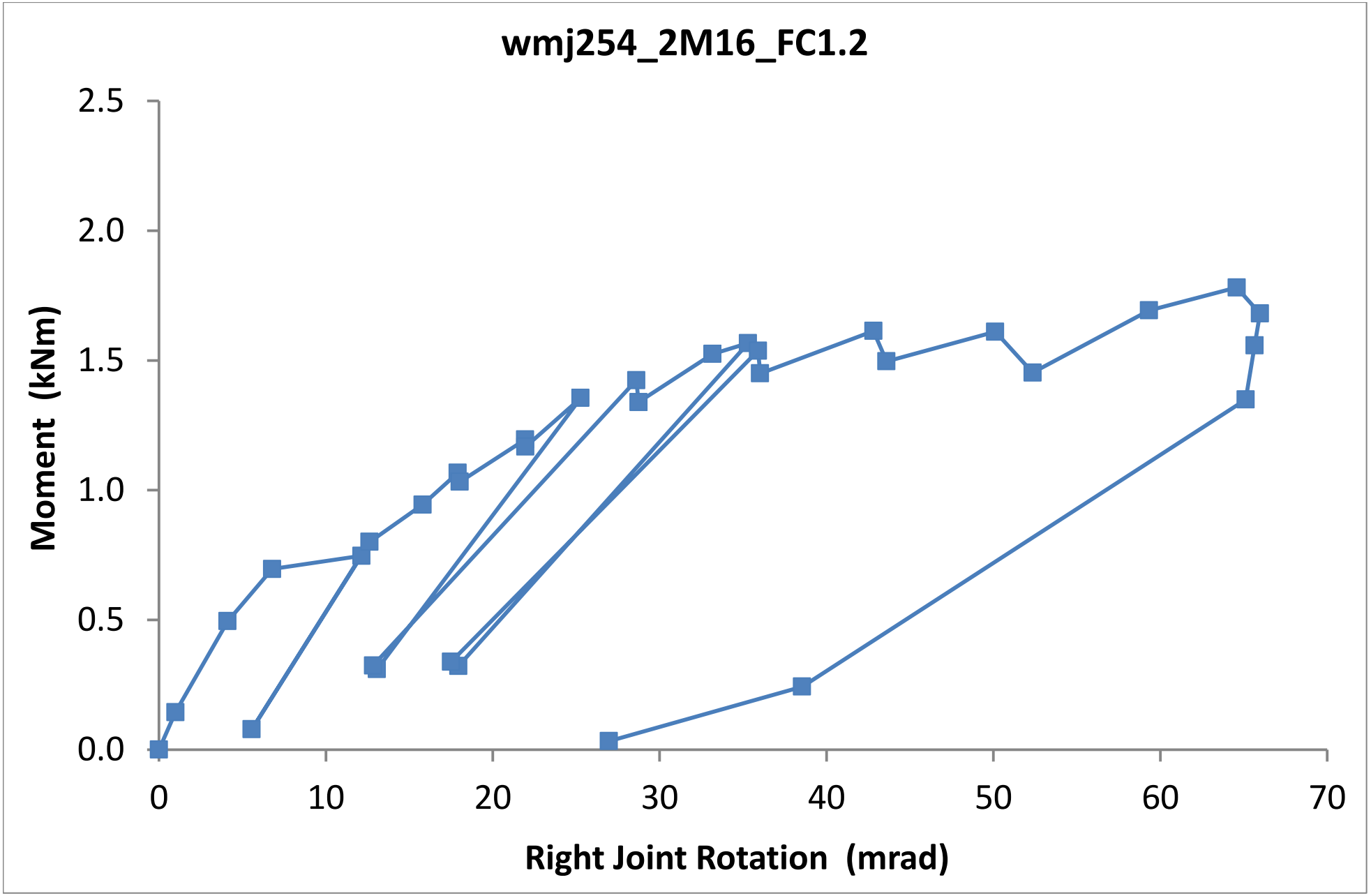
RIGHT SIDE

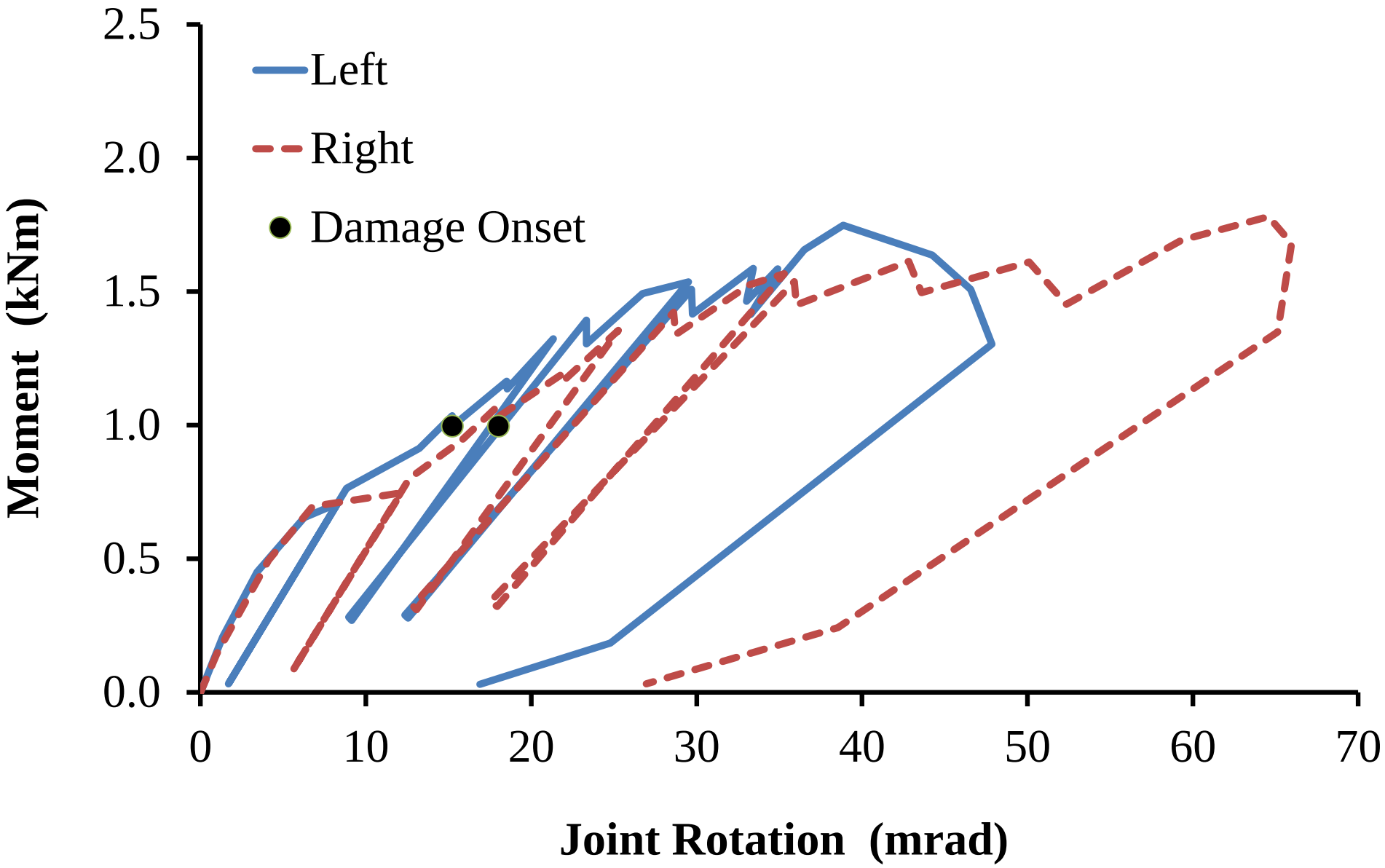
Load Point, LP2 (CH 22)	Rotation C3 (CH 19)	Moment =LP2 x moment arm	Joint rotation, (14)-(2)	Slip compensated joint rotation, (16)-(22)	End beam deflection L2, (CH9)	Slip top, LTR (CH5)	Slip bot, LBR (CH7)	Beam deflection near column end, L4 (CH15)	Rotation due to horizontal slip, arctan ((LBR-LTR)/L)
kN	mrad	kN.m	mrad	mrad	mm	mm	mm	mm	mrad
13	14	15	16	17	18	19	20	21	22
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.14	-0.27	0.14	0.99	0.98	-0.84	-0.01	0.00	0.00	0.02
0.49	3.94	0.49	4.12	4.02	3.52	-0.06	-0.05	0.04	0.09
0.69	5.92	0.70	6.78	6.49	5.12	-0.08	-0.04	0.06	0.29
0.74	10.12	0.75	12.13	9.17	8.30	-0.26	0.12	-0.01	2.97
0.08	4.92	0.08	5.56	2.69	3.90	-0.25	0.12	-0.08	2.87
0.79	11.09	0.80	12.63	9.59	9.20	-0.27	0.12	0.00	3.04
0.93	15.34	0.94	15.80	12.62	12.95	-0.28	0.13	0.02	3.18
1.05	17.50	1.07	17.90	14.57	14.77	-0.28	0.14	0.04	3.33
1.02	17.56	**1.03**	**18.03**	**14.70**	14.79	-0.29	0.14	0.04	**3.33**
1.18	22.17	1.19	21.95	18.62	18.76	-0.31	0.19	0.06	3.90
1.15	22.19	1.17	21.97	18.64	18.75	-0.32	0.18	0.06	3.91
1.33	26.31	1.36	25.27	21.94	22.37	-0.33	0.19	0.10	4.09
0.31	13.04	0.31	13.06	9.73	10.72	-0.34	0.19	-0.06	4.11
0.32	12.78	0.32	12.83	9.50	10.56	-0.34	0.18	-0.06	4.05
1.40	25.40	1.42	28.60	25.27	21.16	-0.37	0.21	0.13	4.50
1.32	25.45	1.34	28.74	25.41	21.17	-0.38	0.21	0.12	4.55
1.50	31.78	1.53	33.17	29.84	26.85	-0.40	0.22	0.18	4.84
1.54	34.17	1.57	35.30	31.97	28.89	-0.41	0.23	0.21	4.94
0.32	16.75	0.32	17.94	14.62	13.68	-0.40	0.20	-0.03	4.70
0.33	16.47	0.34	17.50	14.17	13.45	-0.40	0.20	-0.03	4.73
1.51	35.58	1.54	35.90	32.57	30.11	-0.42	0.22	0.21	5.02
1.43	35.66	1.45	36.03	32.70	30.12	-0.43	0.21	0.22	4.99
1.59	41.34	1.61	42.82	39.49	34.81	-0.44	0.22	0.31	5.14
1.47	41.62	1.50	43.60	40.27	34.89	-0.44	0.22	0.33	5.13
1.59	46.39	1.61	50.11	46.78	39.00	-0.44	0.22	0.42	5.10
1.43	46.81	1.45	52.36	49.03	39.20	-0.44	0.21	0.45	5.12
1.67	50.04	1.69	59.33	56.00	41.86	-0.44	0.21	0.55	5.12
1.75	54.05	**1.78**	**64.58**	**61.25**	45.27	-0.45	0.22	0.62	5.20
1.65	57.25	1.68	65.97	62.64	48.04	-0.46	0.22	0.66	5.30
1.53	58.01	1.56	65.66	62.33	48.72	-0.47	0.21	0.66	5.28
1.33	58.25	1.35	65.12	61.79	48.78	-0.51	0.16	0.65	5.17
0.24	33.13	0.24	38.54	35.21	26.72	-0.50	0.12	0.29	4.80
0.03	-5.37	0.03	26.96	23.63	-5.28	-0.48	0.10	0.14	4.55

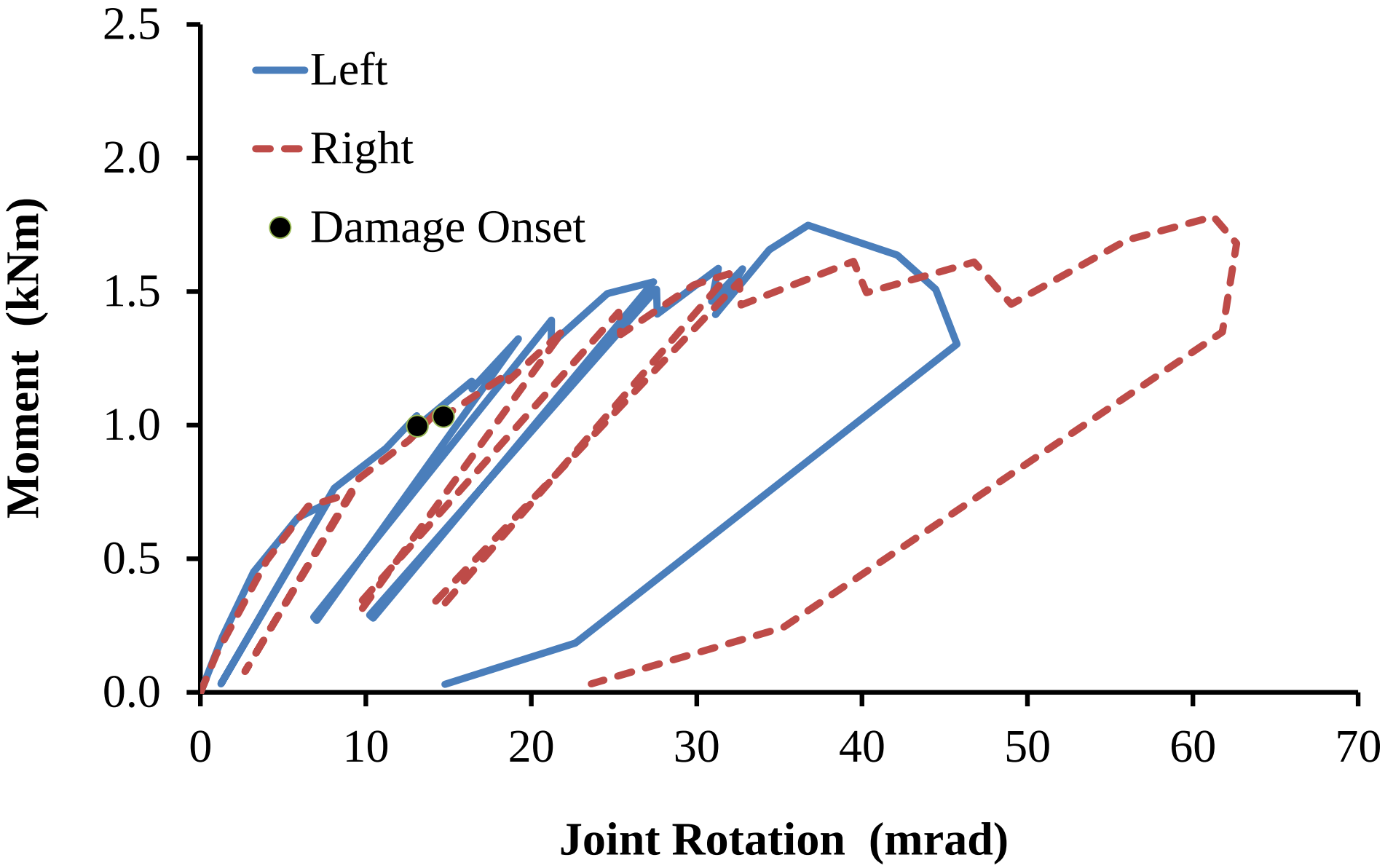
Test Ref: wmj254_2M16_FC1-2 **Test date: 17th November 2011**

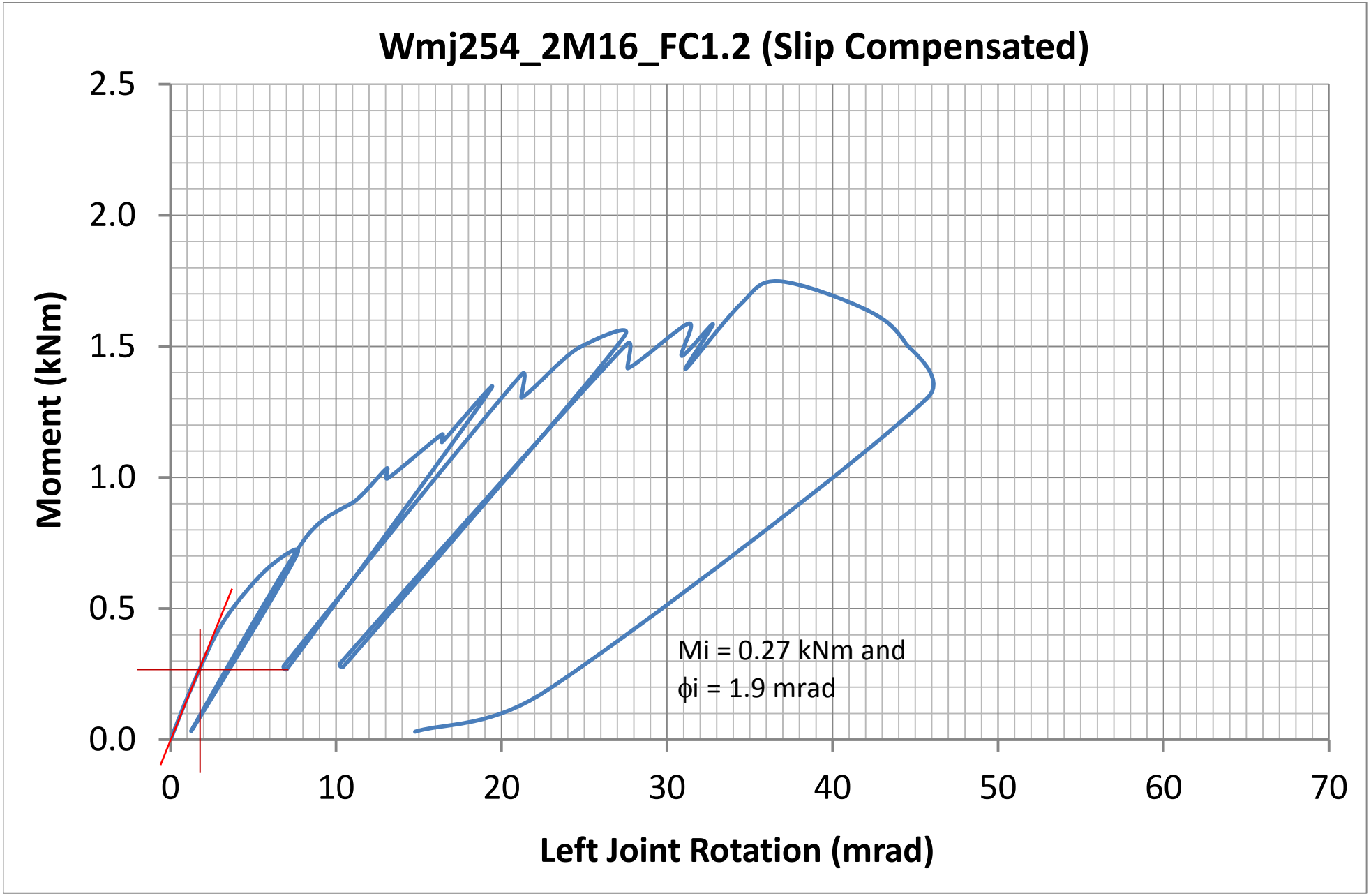
For Right side:	**Mi = 0.26 kNm**	**ϕi = 1.9 mrad**	**From Moment-rotation curve**

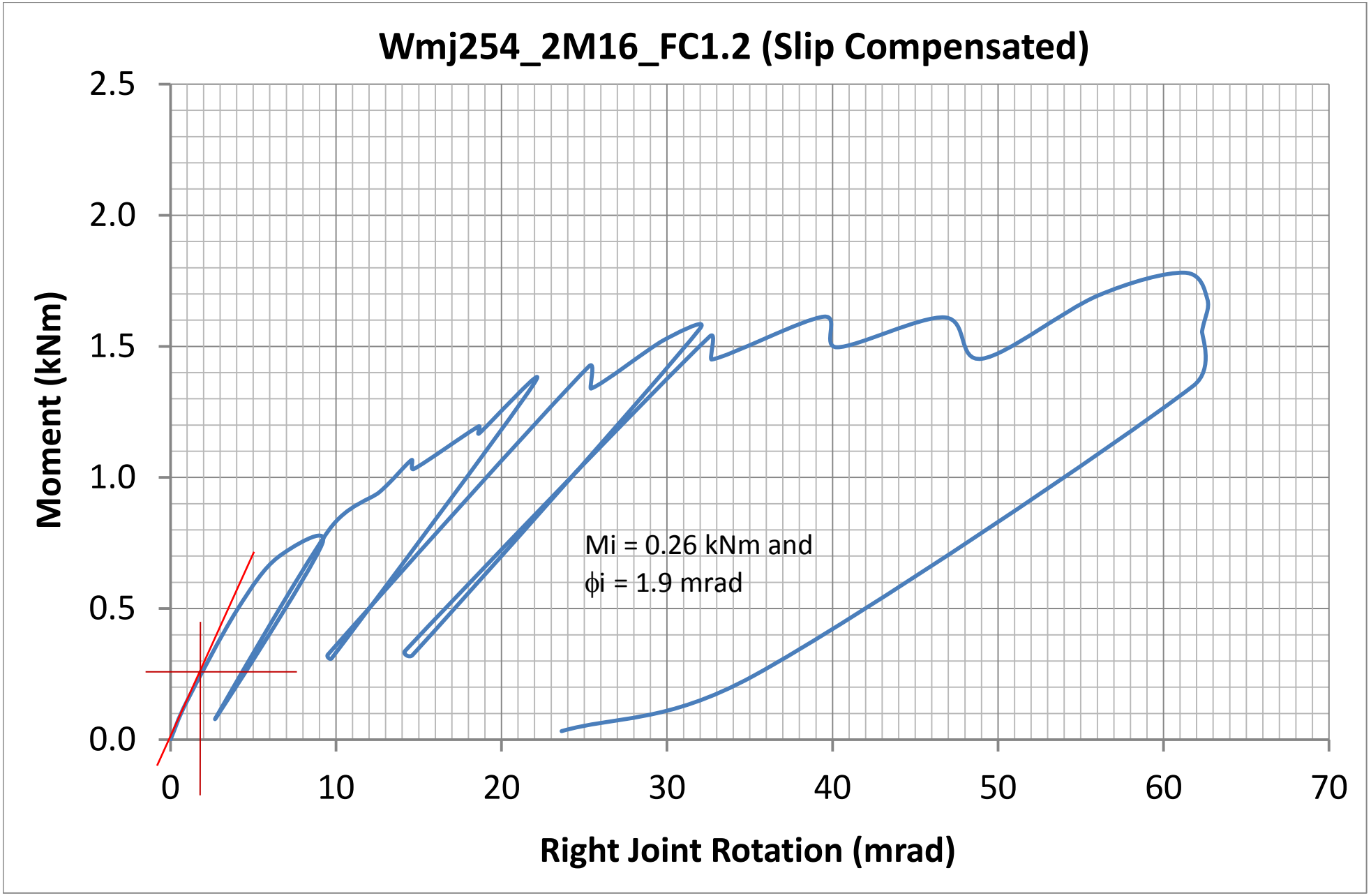

wmj254_2M16_FC1.2
Moment (kNm)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
Left Joint Rotation (mrad)


wmj254_2M16_FC1.2
Moment (kNm)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
Right Joint Rotation (mrad)


Left
Right
Damage Onset
Moment (kNm)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
Joint Rotation (mrad)


Left
Right
Damage Onset
Moment (kNm)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
Joint Rotation (mrad)


Wmj254_2M16_FC1.2 (Slip Compensated)
Moment (kNm)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
Left Joint Rotation (mrad)
Mi = 0.27 kNm and
ϕi = 1.9 mrad


Wmj254_2M16_FC1.2 (Slip Compensated)
Moment (kNm)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
Right Joint Rotation (mrad)
Mi = 0.26 kNm and
ϕi = 1.9 mrad