

COMPFIRE

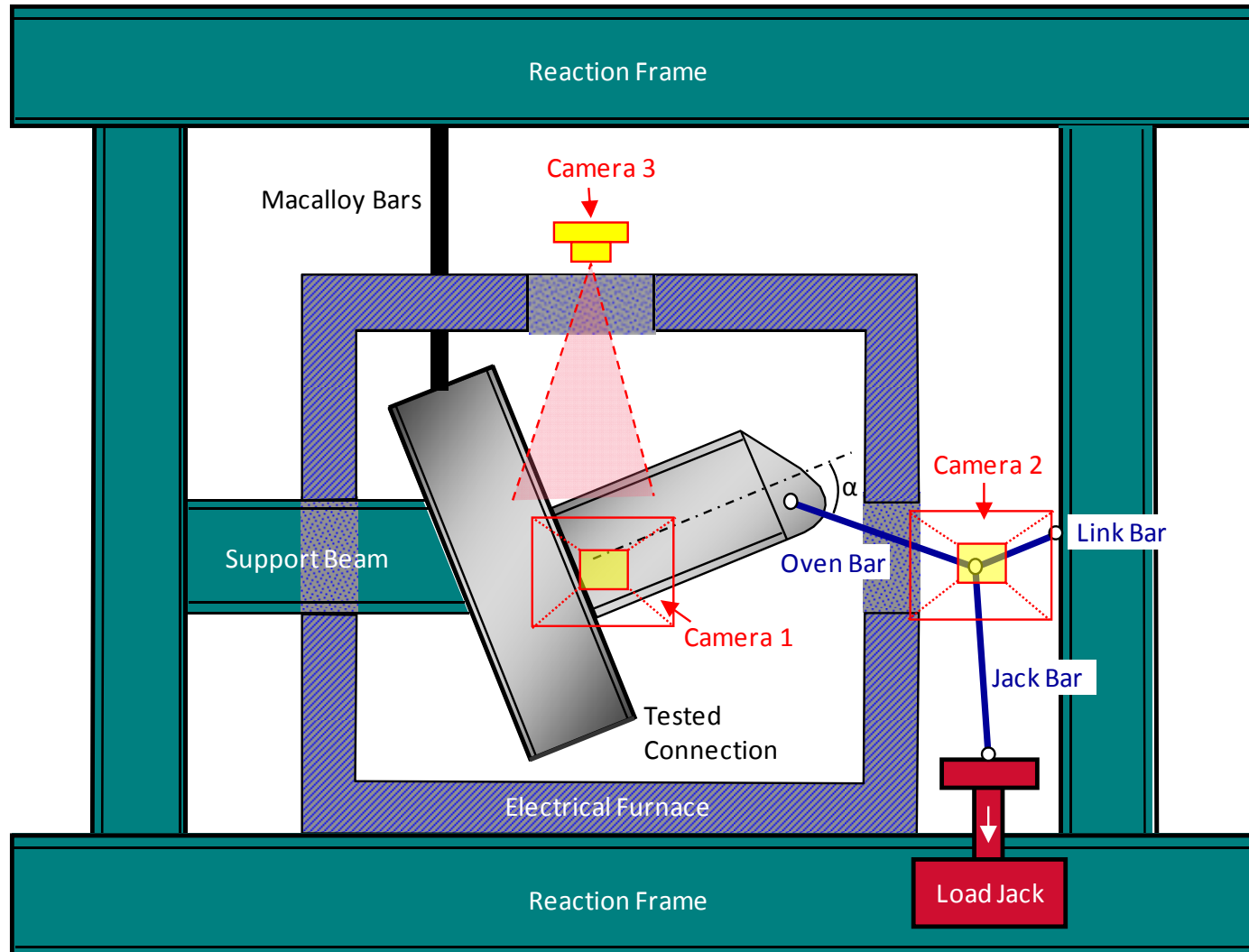
PE-EP_650_55_10-09-2010

10 September 2010 Flush Endplate Connection to Partially-Encased Column Test Result

RFSR-CT-2009-0021

Design of joints to composite columns for improved fire robustness

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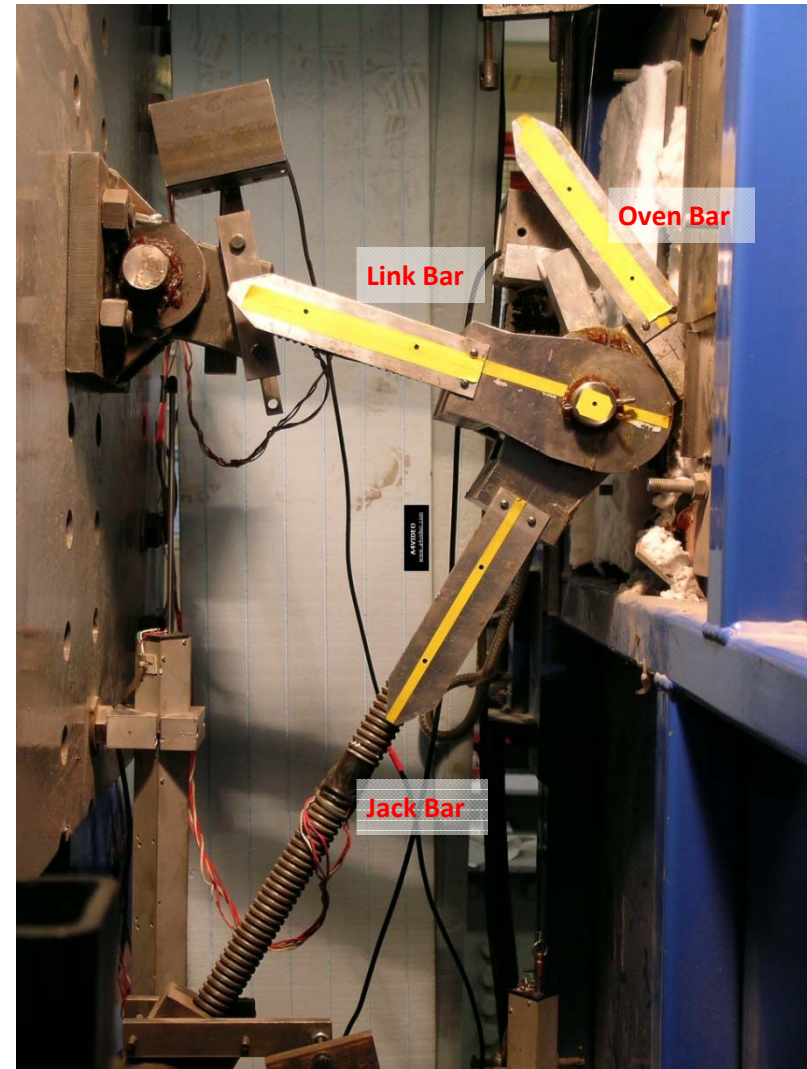
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View of Camera 1



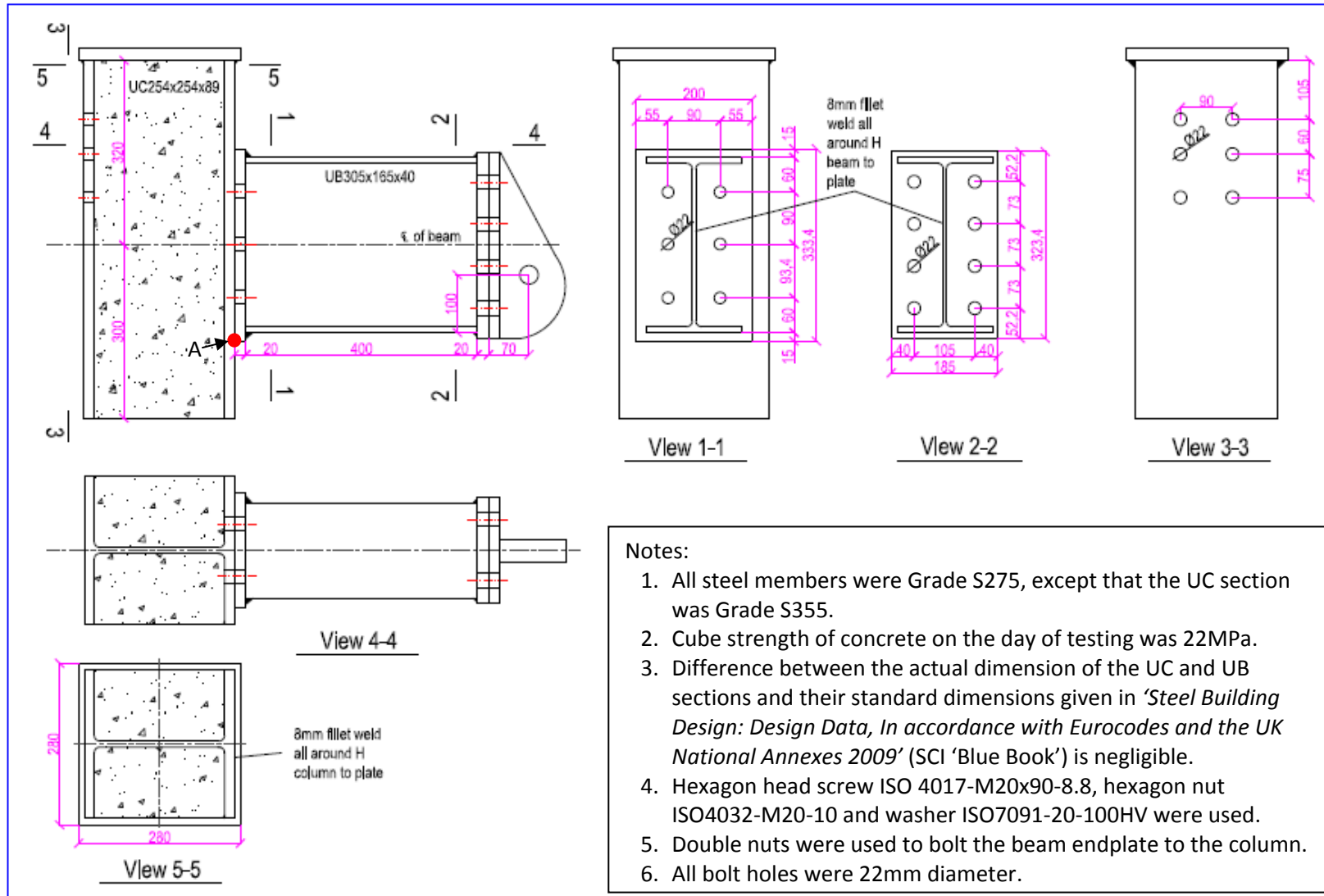
View of Camera 2

*Camera 3 was not necessary in this test.

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Nominal Temperature: 650°C

Time	Temperature*	Jack Displacement	Load Angle	Beam Rotation	Column Rotation	Connection Rotation	Oven Bar Force	Tension	Shear	Moment**
(minute)	Average (°C)	(mm)	α (°)	(°)	(°)	(°)	(kN)	(kN)	(kN)	(kNm)
0	650.99	0.00	58.86	0.00	0.00	0.00	-8.95	-4.63	-7.66	-4.44
1	651.27	1.25	58.84	0.07	0.06	0.01	-4.08	-2.11	-3.49	-2.02
2	651.47	2.78	58.75	0.10	0.10	0.00	-1.61	-0.83	-1.37	-0.80
3	651.69	4.42	58.75	0.18	0.14	0.04	-1.24	-0.64	-1.06	-0.62
4	651.90	5.76	58.76	0.19	0.15	0.04	-0.53	-0.28	-0.45	-0.26
5	652.07	7.14	58.71	0.19	0.14	0.05	0.91	0.48	0.78	0.45
6	652.20	8.91	58.65	0.22	0.17	0.05	2.95	1.54	2.52	1.46
7	651.97	10.50	58.63	0.29	0.18	0.10	4.38	2.28	3.74	2.17
8	651.57	12.04	58.57	0.32	0.19	0.13	6.05	3.16	5.16	3.00
9	651.38	13.48	58.50	0.38	0.20	0.18	7.95	4.15	6.78	3.93
10	651.47	14.96	58.47	0.45	0.23	0.22	9.25	4.84	7.88	4.58
11	651.58	16.28	58.44	0.48	0.24	0.24	10.65	5.58	9.08	5.27
12	651.73	17.43	58.38	0.51	0.26	0.25	12.35	6.47	10.51	6.11
13	651.81	18.86	58.34	0.56	0.28	0.28	14.77	7.76	12.57	7.31
14	651.93	20.40	58.29	0.62	0.29	0.33	17.65	9.28	15.01	8.72
15	652.04	21.84	58.21	0.68	0.33	0.35	20.21	10.64	17.17	9.98
16	652.27	24.52	58.13	0.74	0.37	0.38	22.41	11.83	19.03	11.06
17	652.44	26.06	58.09	0.79	0.38	0.40	25.29	13.37	21.47	12.49
18	652.62	27.46	58.03	0.86	0.42	0.43	27.90	14.78	23.67	13.77
19	652.87	29.05	57.94	0.91	0.45	0.46	30.37	16.12	25.74	14.98
20	653.01	30.63	57.82	1.00	0.48	0.52	32.69	17.41	27.67	16.11
21	653.22	32.14	57.78	1.09	0.51	0.57	34.85	18.58	29.48	17.17

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22	653.74	33.77	57.61	1.16	0.54	0.62	36.80	19.71	31.08	18.12
23	654.01	35.40	57.57	1.27	0.57	0.70	38.61	20.70	32.59	19.00
24	654.29	36.81	57.47	1.34	0.59	0.75	40.28	21.66	33.96	19.81
25	654.41	38.46	57.33	1.43	0.60	0.83	41.77	22.55	35.16	20.53
26	654.52	40.03	57.22	1.53	0.63	0.91	43.12	23.34	36.25	21.17
27	654.76	41.60	57.09	1.61	0.65	0.96	44.23	24.03	37.13	21.70
28	654.95	43.24	56.99	1.73	0.67	1.06	45.23	24.64	37.93	22.18
29	655.22	44.72	56.89	1.82	0.68	1.14	45.99	25.12	38.52	22.54
30	655.51	46.28	56.79	1.92	0.70	1.22	46.56	25.50	38.96	22.80
31	655.66	47.93	56.69	2.02	0.72	1.30	47.29	25.97	39.52	23.14
32	655.80	49.57	56.57	2.14	0.72	1.42	47.93	26.41	40.00	23.44
33	655.97	51.13	56.46	2.26	0.74	1.52	48.46	26.77	40.39	23.68
34	656.16	52.75	56.34	2.38	0.76	1.61	48.87	27.09	40.67	23.86
35	656.29	54.41	56.18	2.49	0.77	1.72	49.18	27.38	40.86	23.99
36	656.45	56.22	56.08	2.63	0.78	1.85	49.29	27.51	40.90	24.02
37	656.61	57.64	55.99	2.74	0.78	1.96	49.39	27.63	40.94	24.05
38	656.71	59.25	55.86	2.86	0.79	2.08	49.36	27.70	40.85	24.02
39	656.96	60.83	55.75	2.99	0.79	2.20	49.22	27.70	40.68	23.93
40	657.10	62.37	55.67	3.12	0.80	2.31	49.12	27.71	40.57	23.87
41	657.21	64.06	55.55	3.24	0.81	2.44	48.88	27.66	40.31	23.74
42	657.41	65.66	55.43	3.38	0.81	2.56	48.63	27.60	40.04	23.59
43	657.12	67.12	55.36	3.53	0.82	2.71	48.35	27.48	39.78	23.45
44	656.58	68.90	55.17	3.65	0.82	2.83	47.96	27.39	39.37	23.23
45	656.28	70.22	55.07	3.81	0.82	2.99	47.67	27.30	39.08	23.07
46	656.20	71.83	54.95	3.95	0.81	3.14	47.22	27.12	38.65	22.83
47	656.25	73.29	54.80	4.09	0.81	3.28	46.74	26.94	38.19	22.57
48	656.30	74.87	54.75	4.24	0.80	3.44	46.10	26.61	37.65	22.26

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49	656.36	76.39	54.47	4.39	0.81	3.58	45.58	26.49	37.09	21.96
50	656.30	77.99	54.27	4.53	0.81	3.72	44.89	26.21	36.44	21.60
51	656.32	79.64	54.18	4.67	0.81	3.87	44.22	25.88	35.86	21.26
52	656.39	81.45	54.01	4.83	0.80	4.04	43.44	25.53	35.15	20.86
53	656.37	82.99	53.86	4.98	0.81	4.17	42.58	25.11	34.39	20.43
54	656.15	84.55	53.73	5.13	0.80	4.33	41.68	24.65	33.60	19.97
55	655.56	86.10	53.63	5.28	0.81	4.47	40.70	24.13	32.77	19.49
56	655.07	87.72	53.38	5.46	0.79	4.67	39.67	23.67	31.84	18.96
57	654.78	89.19	53.30	5.62	0.79	4.82	38.27	22.88	30.68	18.28
58	654.67	90.83	53.09	5.78	0.78	5.00	36.86	22.14	29.48	17.58
59	654.67	92.24	52.94	5.93	0.77	5.17	35.53	21.41	28.35	16.92
60	654.73	93.84	52.86	6.09	0.76	5.33	34.02	20.54	27.12	16.19
61	654.70	95.37	52.63	6.27	0.75	5.52	31.74	19.26	25.22	15.08
62	654.67	96.98	52.46	6.44	0.74	5.70	26.51	16.15	21.02	12.58
63	654.62	98.60	52.15	6.66	0.71	5.95	22.43	13.76	17.71	10.61
64	654.62	100.08	52.12	6.87	0.68	6.19	20.88	12.82	16.48	9.88
65	654.64	101.78	51.90	7.02	0.67	6.35	19.84	12.24	15.61	9.37
66	654.60	103.29	51.70	7.20	0.66	6.54	19.06	11.81	14.96	8.99
67	654.69	104.95	51.53	7.37	0.65	6.73	18.17	11.30	14.23	8.55
68	654.71	106.59	51.07	7.55	0.65	6.89	17.39	10.93	13.53	8.16
69	654.84	108.11	51.21	7.72	0.64	7.08	16.09	10.08	12.54	7.55
70	654.91	109.69	50.59	7.89	0.65	7.24	15.03	9.54	11.61	7.02
71	654.90	111.32	50.39	8.07	0.63	7.44	14.14	9.02	10.89	6.59
72	654.99	112.86	50.21	8.26	0.62	7.64	13.60	8.70	10.45	6.33
73	655.07	114.68	50.04	8.44	0.61	7.83	13.23	8.50	10.14	6.15
74	655.14	116.25	49.86	8.61	0.61	8.00	12.96	8.35	9.90	6.01
75	655.18	117.90	49.72	8.78	0.61	8.17	12.70	8.21	9.69	5.88

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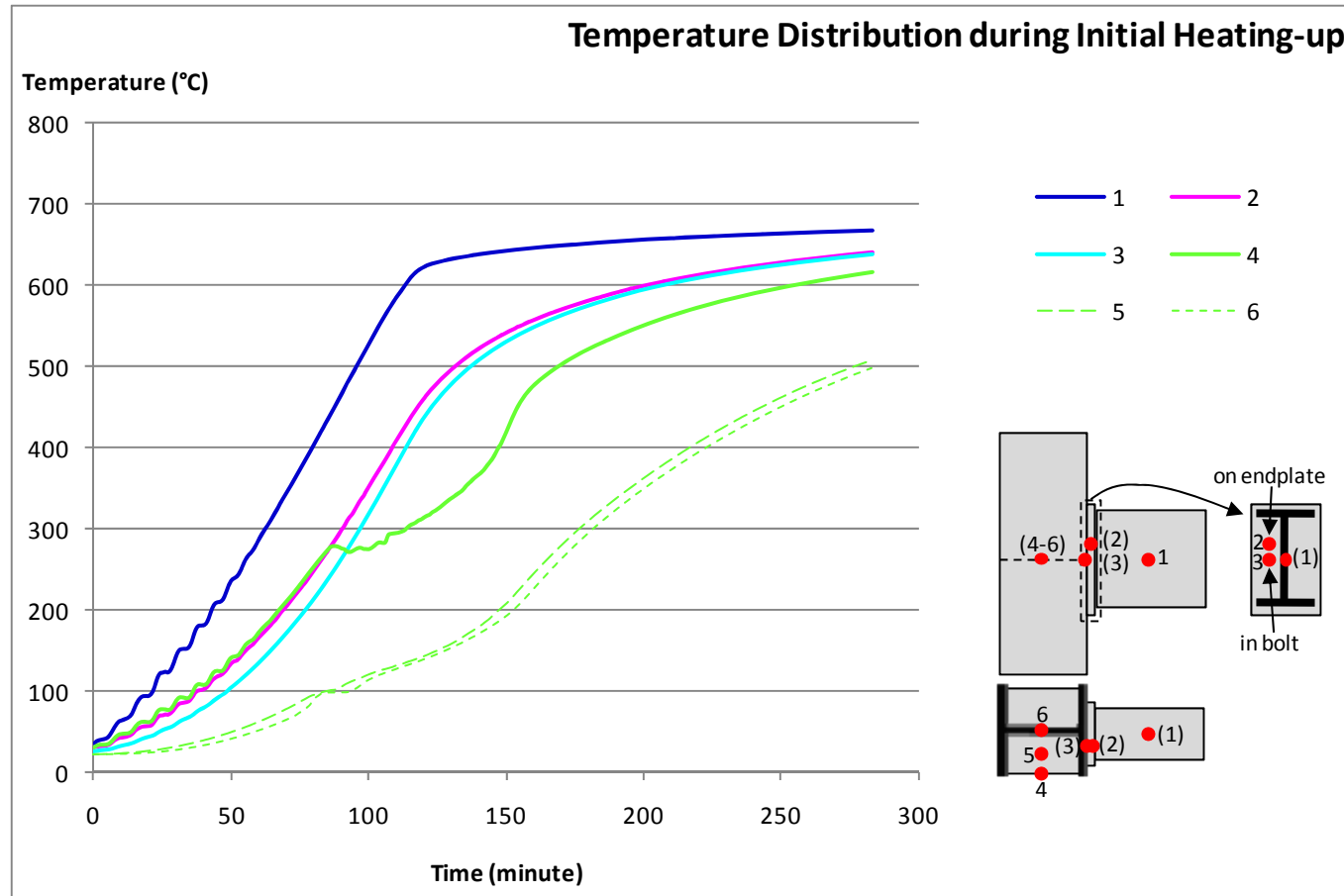
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76	655.22	119.54	49.69	8.97	0.61	8.36	12.49	8.08	9.52	5.79
77	655.30	121.28	49.94	9.15	0.60	8.55	12.20	7.85	9.34	5.66
78	655.31	122.84	49.72	9.33	0.58	8.75	11.91	7.70	9.08	5.52
79	655.07	124.50	49.50	9.51	0.57	8.93	11.59	7.53	8.82	5.36
80	654.45	125.98	49.33	9.69	0.58	9.11	11.31	7.37	8.58	5.22
81	653.86	127.52	49.32	9.84	0.56	9.27	11.08	7.22	8.40	5.12
82	653.58	129.12	49.04	10.03	0.57	9.46	10.83	7.10	8.18	4.99
83	653.54	130.67	48.84	10.21	0.56	9.65	10.56	6.95	7.95	4.85
84	653.47	132.45	48.72	10.41	0.56	9.85	10.31	6.80	7.75	4.73
85	653.44	134.00	48.49	10.56	0.54	10.02	9.66	6.41	7.24	4.43
86	653.32	135.68	48.13	10.77	0.54	10.23	8.18	5.46	6.09	3.73
87	653.31	137.26	48.13	10.97	0.53	10.44	7.72	5.15	5.75	3.52
88	653.27	139.10	47.81	11.16	0.53	10.62	7.61	5.11	5.64	3.46
89	653.25	140.51	47.70	11.34	0.53	10.80	7.49	5.04	5.54	3.41
90	653.26	142.06	47.48	11.54	0.54	11.00	7.43	5.02	5.48	3.37
91	653.18	143.45	47.31	11.71	0.53	11.18	7.40	5.01	5.44	3.35
92	653.18	145.38	47.12	11.90	0.53	11.37	7.31	4.97	5.36	3.30
93	653.18	146.92	46.94	12.09	0.52	11.57	7.23	4.94	5.28	3.26

* Average temperature of the beam web, endplate and bolt

** Moment about Point A on the specimen drawing



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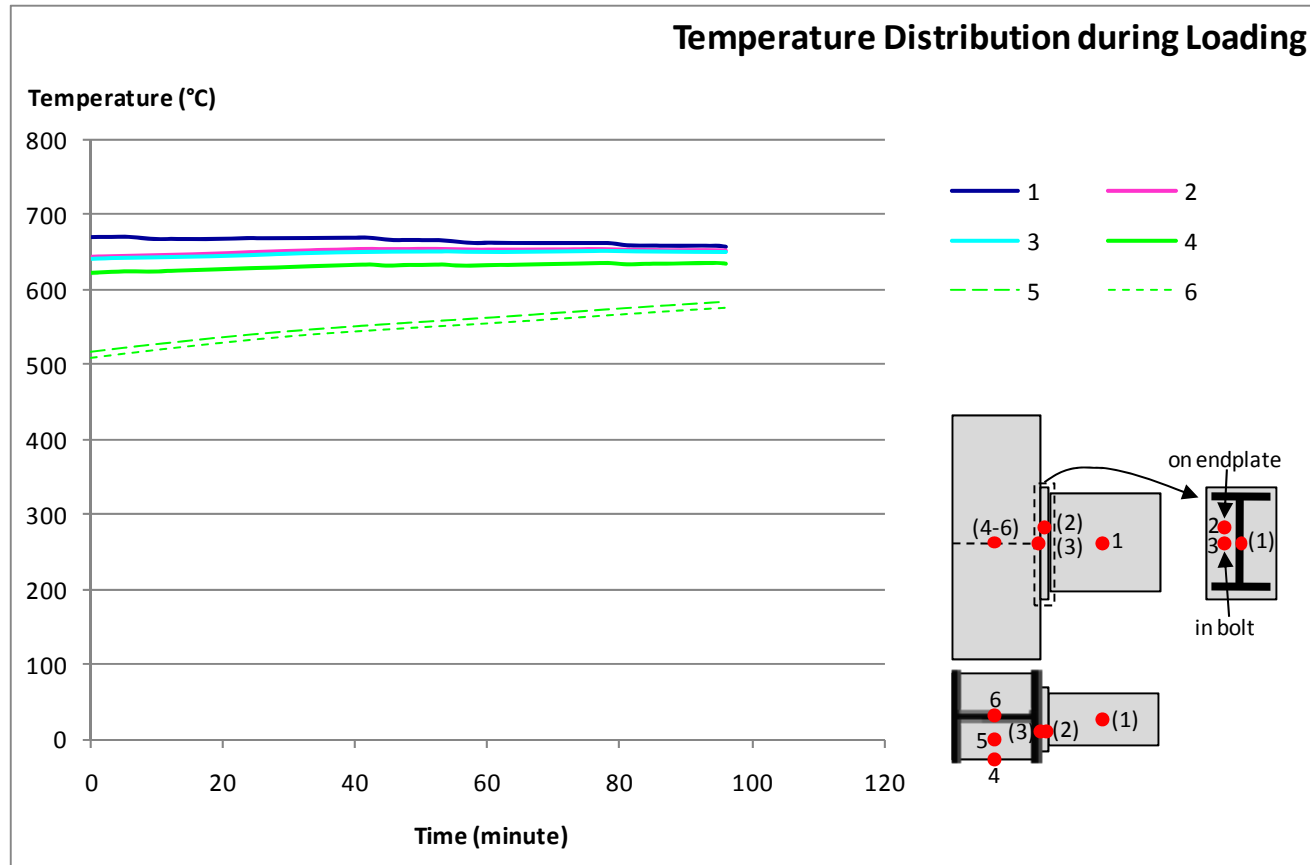
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Design of joints to composite columns for improved fire robustness

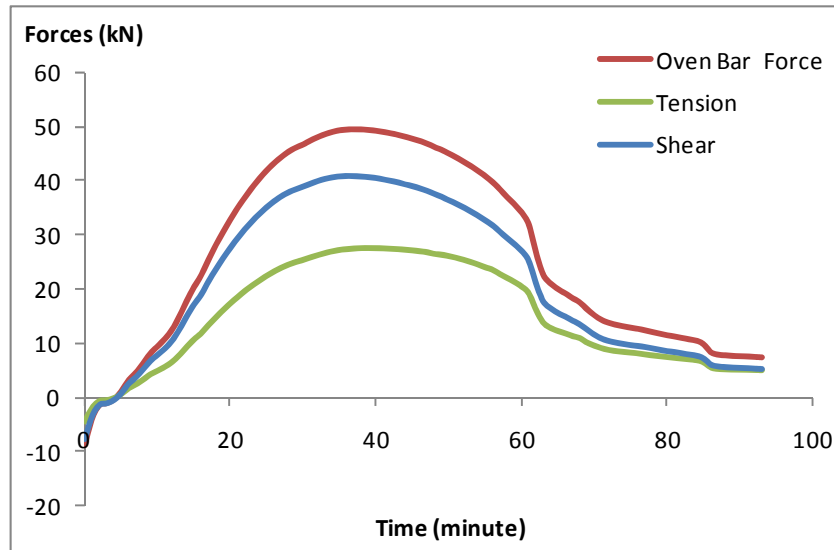
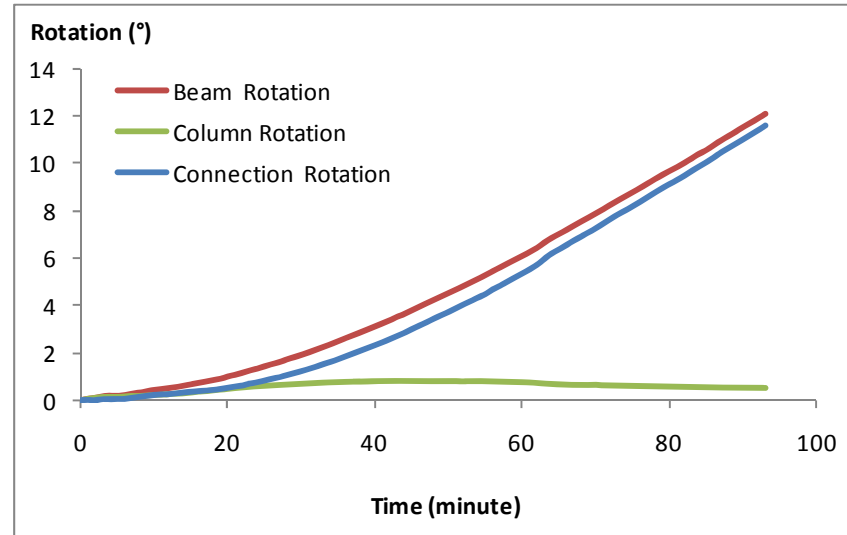
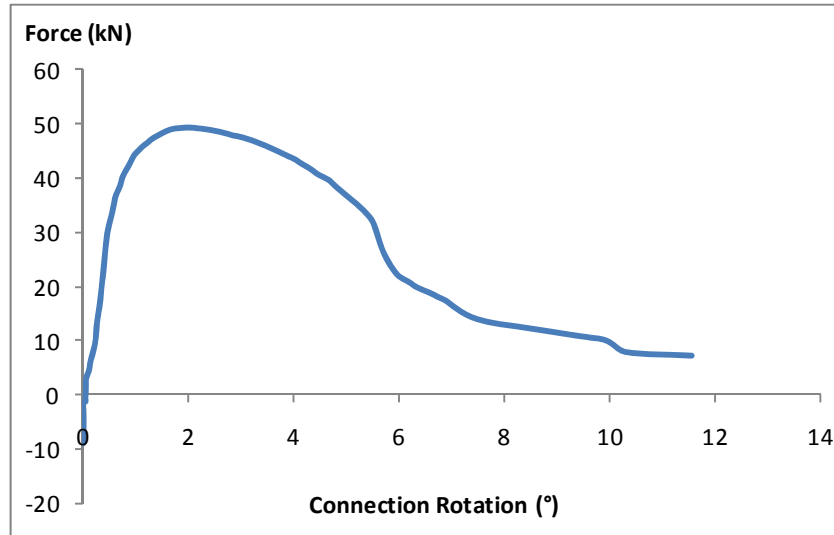
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Photographs after Test



Failure mode: tensile failure of the bolts