PANDROL

CEN TEST REPORT

65104-6

Testing to CEN Standards on a PANDROL Brand Rail Fastening Assembly, Type 22598 Incorporating PANDROL Brand Rail Clips, Type e2007AV for Dhaka Metro Depot, Bangladesh

EWR 8128

3 September 2019

No restriction

Partners in excellence

Revision History

Version	Date	Author	Comments
01	3/9/19	SDk	

Contents

Summary

Assembly Dynamic Stiffness (kN/mm)	150.27

Clamping Force (kN, ≤ 20% change)		
Pre RLT	Post RLT	Change (%)
20.68	20.71	0.16

Longitudinal Rail Restraint (7 kN minimum, ≤ 20% change)		
Pre RLT	Post RLT	Change (%)
12.43	12.13	2.40

Assembly Static Stiffness (kN/mm, ≤ 25% change)		
Pre RLT	Post RLT	Change (%)
141.94	174.83	23.17

Repeated Load Test (3 million cycles)	
Condition of components after test	Satisfactory

Electrical Resistance (kΩ, ≥ 5 kΩ)	9.99

Effects of Severe Environment (300 hours minimum)	
Results of Disassembly and Reassembly	Satisfactory

Torsional Resistance (kNm)	
Direction 1	0.73
Direction 2	1.36

Proof Load Test for Pull-Out Resistance	Pass

1. Introduction and Objectives

Testing has been carried out as follows by the Pandrol Fastening Systems Development Laboratory to verify the performance of a PANDROL Brand Rail Fastening Assembly, type 22598 incorporating PANDROL Brand Rail Clips, type e2007AV for application on Dhaka Metro Depot track, Bangladesh.

Test Location	Pandrol Fastening Systems Development Laboratory
Test Standard	BS EN 13481-2:2012+A1:2017, Category E
Standard Title	Fastening systems for concrete sleepers

CEN Test Regime		Standard
i	Assembly Dynamic Stiffness Test	BS EN 13146-9:2009+A1:2011
ii	Clamping Force Test Pre-Repeated Load	BS EN 13146-7:2019
iii	Longitudinal Rail Restraint Test Pre-Repeated Load	BS EN 13146-1:2019
iv	Assembly Static Stiffness Test Pre-Repeated Load	BS EN 13146-9:2009+A1:2011
v	Repeated Load Test	BS EN 13146-4:2012+A1:2014
vi	Assembly Static Stiffness Test Post-Repeated Load	BS EN 13146-9:2009+A1:2011
vii	Longitudinal Rail Restraint Test Post-Repeated Load	BS EN 13146-1:2019
viii	Clamping Force Test Post-Repeated Load	BS EN 13146-7:2019
ix	Effects of Severe Environment Test	BS EN 13146-6:2012
x	Electrical Resistance Test	BS EN 13146-5:2012
xi	Torsional Resistance Test	BS EN 13146-2:2012
xi	Proof Load Test for Pull-Out Resistance	BS EN 13146-10:2017

Component List	Part Number
Pandrol Brand Shoulder	7937
Pandrol Brand Rail Clip	e2007AV
Pandrol Brand Insulator	5720UV
Pandrol Brand Rail Pad	7031
Rail	60E1
Concrete Sleeper Sections	Pandrol Cast

1.1. Storage of Tested Components

Unless otherwise instructed the components will be discarded after a period of 28 days from the date of publication of this report.

2. Test Methods and Results

2.1. Assembly Dynamic Stiffness – BS EN 13146-9:2009+A1:2011

The assembly was clamped to a rigid horizontal baseplate. A cyclic vertical load between 1 kN and 76 kN was applied to the rail for 1,000 cycles at a frequency of 5 Hz.

The displacement of the rail at its four corners and the applied load were logged over 10 of the final 100 cycles. The maximum and minimum loads along with the displacements at both maximum and minimum load over the 10 cycles were determined and the dynamic stiffness was calculated from the mean results.

From BS EN 13481-2:2012+A1:2017 Table 3, the stiffness result determines the test loads and angles to be applied in the repeated load test (ref BS EN 13146-4:2012+A1:2014).

Figure 2.1.1: Assembly dynamic stiffness test arrangement

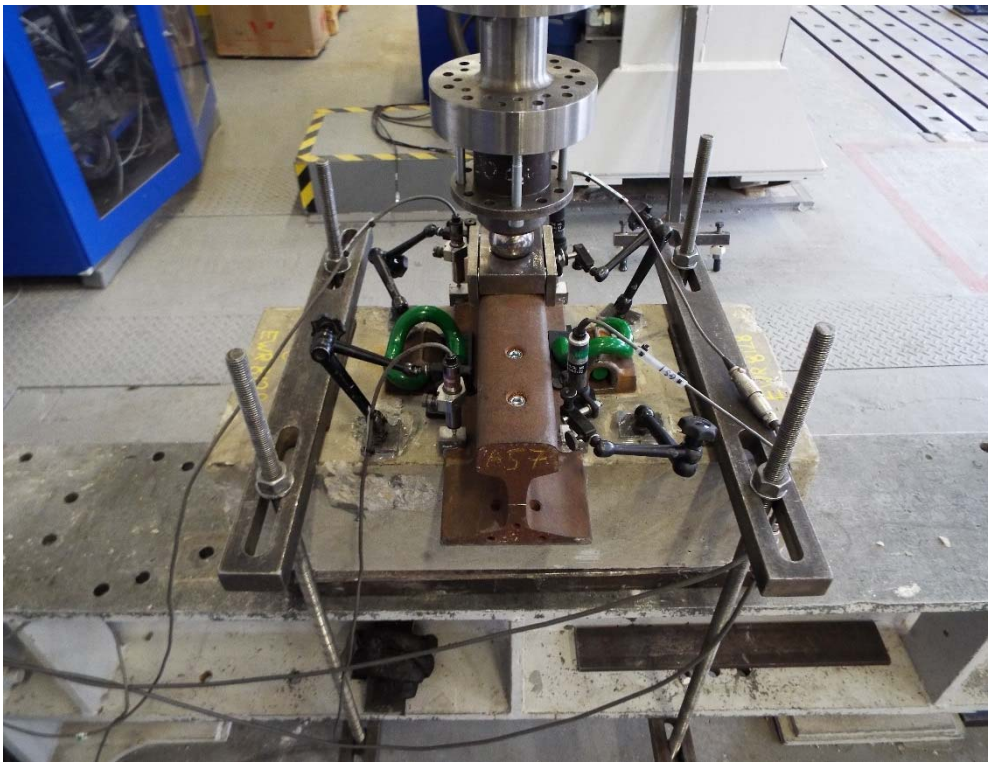


Table 2.1.2: Assembly dynamic stiffness test results

Dynamic Stiffness				
Test Temperature (°C)			24.9	
Test Frequency (Hz)			5	
Test No	Min Load (kN)	Min Deflection (mm)	Max Load (kN)	Max Deflection (mm)
1	1.02	0.43	75.98	0.93
2	1.00	0.43	76.03	0.93
3	0.98	0.43	75.99	0.93
4	1.00	0.43	76.03	0.93
5	1.00	0.43	76.00	0.93
6	1.01	0.43	76.06	0.93
7	1.02	0.43	76.05	0.93
8	1.02	0.43	76.04	0.93
9	1.01	0.43	75.98	0.93
10	1.02	0.43	75.99	0.93
Mean	1.01	0.43	76.01	0.93
Date of Test			26/07/2019	
Dynamic Stiffness Value (kN/mm)			150.27	

Assembly dynamic stiffness test results

Figure 2.1.3: Deflection graph

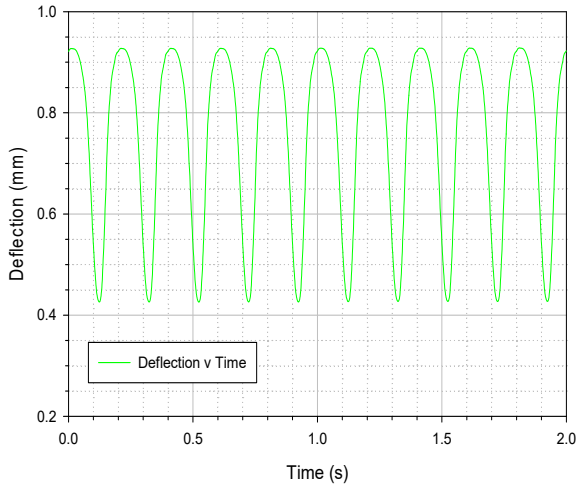
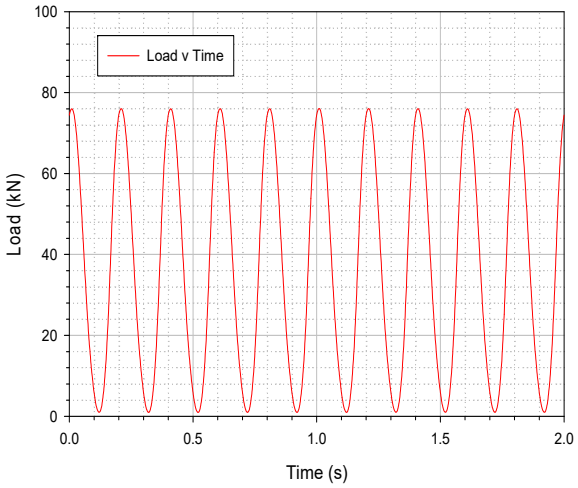


Figure 2.1.4: Load Graph



2.2. Clamping Force – BS EN 13146-7:2019

The repeated load test assembly was clamped to a rigid horizontal baseplate and displacement transducers were positioned at the four corners of the rail seat and zeroed. An increasing vertical tensile load at a rate of 10 kN/min was then applied to the railhead until the rail pad could just be removed. The load was then reduced until the average reading of the displacement transducers was zero, this is designated as load P_C. After removing the pad, the load was reduced to $0.9P_C$. The load was then increased to $1.1P_C$ or until the pad could be reinserted.

During the tests, recordings were made of load and displacement. A load displacement curve was plotted from each set of data and the clamping force was read off as the value of the load P_0 at d = 0 as the load was increased from $0.9P_C$ to $1.1P_C$. The procedure was carried out three times and the results were averaged.

The test procedure was carried out both before and after the repeated load test.

Figure 2.2.1: Clamping force test arrangement

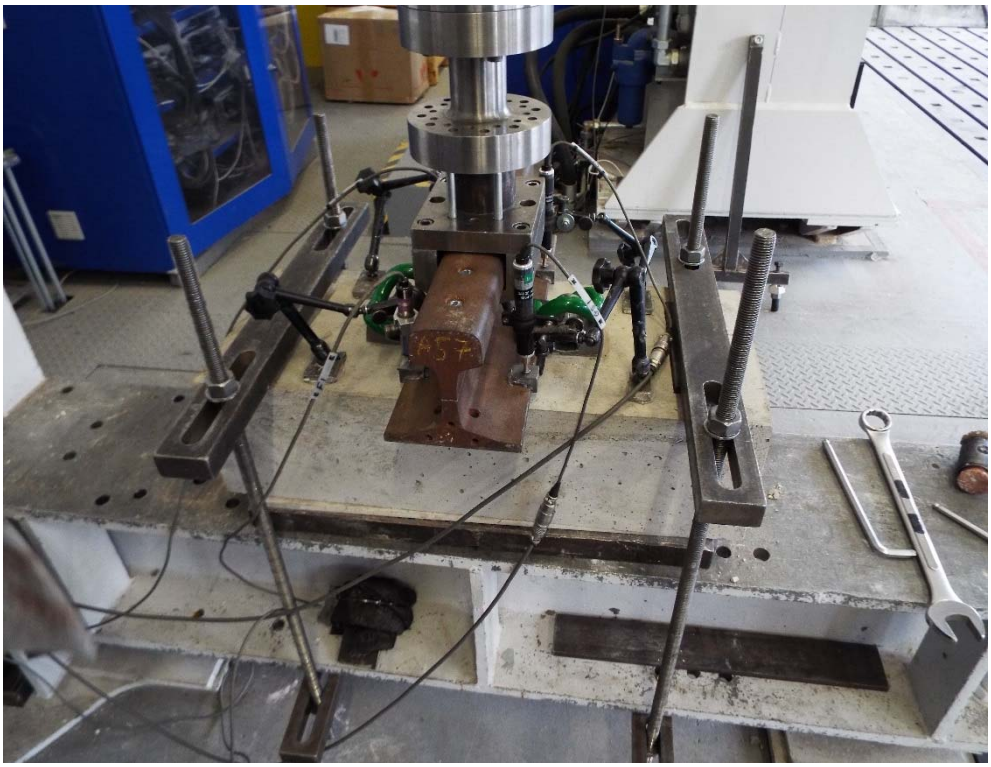


Table 2.2.2: Clamping force test results

Clamping Force						
Test Ref	Date of Test	Mean Clamping Force (kN)				
		1st loading	2nd loading	3rd loading	Mean	% Change
Pre-repeated load test	31/07/2019	20.47	20.75	20.81	20.68	0.16
Post-repeated load test	13/08/2019	19.75	21.13	21.25	20.71	
CEN Specification		20 % Maximum Change				

Clamping force test results

Figure 2.2.3: Pre-repeated load test

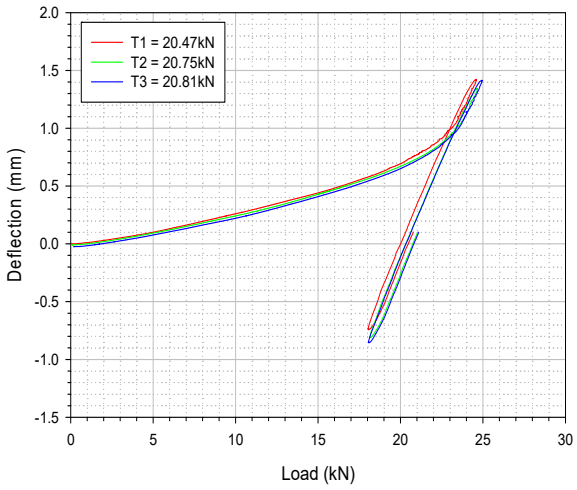
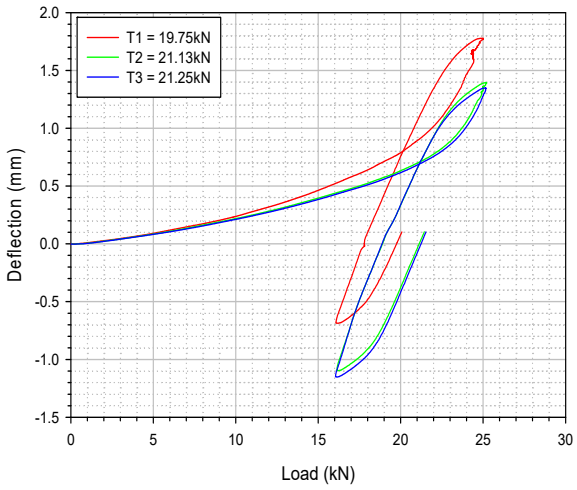


Figure 2.2.4: Post repeated load test



2.3. Longitudinal Rail Restraint – BS EN 13146-1:2019

The repeated load test assembly was clamped to a rigid horizontal baseplate and a tensile load at a rate of 10 kN/min was applied longitudinally to the rail foot. When the rail was observed to slip in the fastening assembly, the load was rapidly reduced to zero.

Both the load applied, and the longitudinal displacement of the rail were logged during the loading cycle and for a further two minutes after load removal.

This test was repeated a further three times with a minimum of 3 minutes between tests in the unloaded condition.

For each load cycle a load displacement curve was plotted and the maximum displacement (D1) and the residual displacement (D2) were determined. The initial elastic displacement (D3) was then calculated from the equation D1 - D2 = D3.

The longitudinal rail restraint was determined as the force required to produce the initial elastic displacement (D3).

The average longitudinal rail restraint was calculated from the final three loadings.

The test procedure was carried out both before and after the repeated load test.

Figure 2.3.1: Longitudinal rail restraint test arrangement

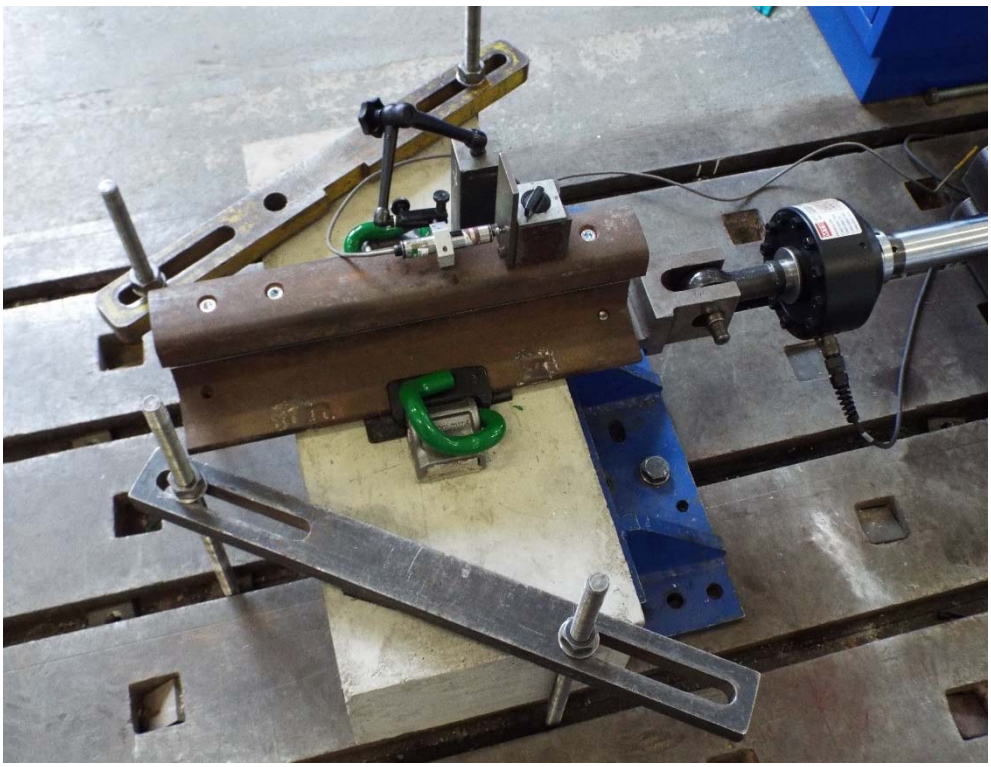


Table 2.3.2: Longitudinal rail restraint test results

Longitudinal Rail Restraint						
Test Ref	Date of Test	Mean Restraint Value (kN)				
		2nd loading	3rd loading	4th loading	Mean	% Change
Pre - dynamic test	31/07/2019	13.83	12.07	11.40	12.43	2.40
Post - dynamic test	13/08/2019	12.32	12.27	11.81	12.13	
CEN Specification					≥ 7 kN	20 % Max

Longitudinal rail restraint test results

Figure 2.3.3: Pre-repeated load test

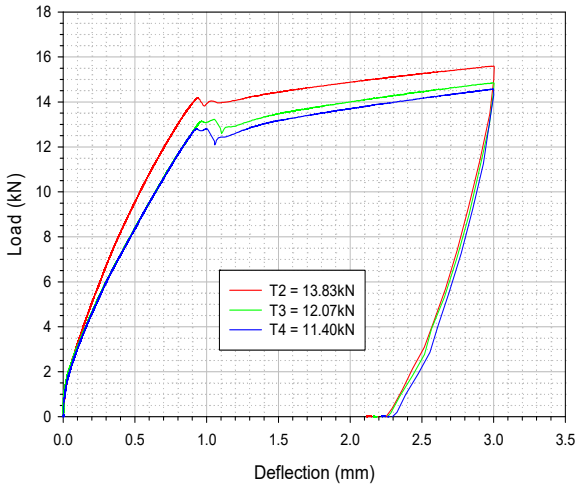
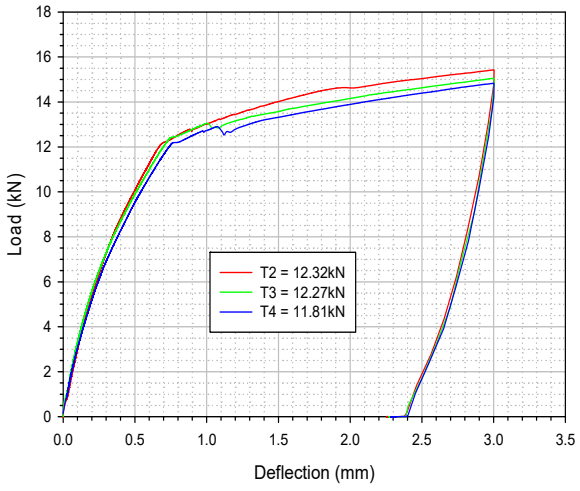


Figure 2.3.4: Post repeated load test



2.4. Assembly Static Stiffness – BS EN 13146-9:2009+A1:2011

The repeated load test assembly was clamped to a rigid horizontal baseplate and displacement transducers were positioned at the four corners of the rail seat. A vertical load of 95 kN was applied to the rail at a rate of 120 kN/min. The load was removed and then re-applied a further two times. During the third loading, both the applied load and the vertical displacement of the rail was recorded. The stiffness was then calculated between 1 kN and 76 kN.

The test procedure was carried out both before and after the repeated load test.

Figure 2.4.1: Assembly static stiffness test arrangement

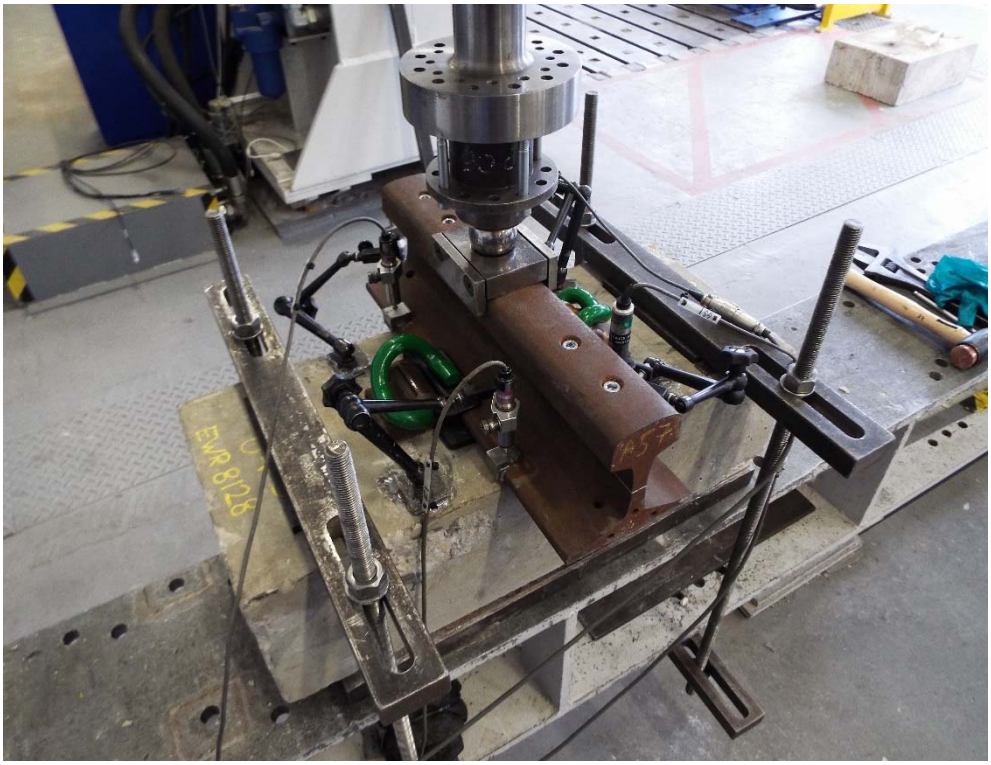


Figure 2.4.2: Assembly static stiffness test results

Static Stiffness											
Pre-Repeated Load						Post Repeated Load					
Date of Test	31/07/2019					Date of Test	13/08/2019				
Test Temp (°C)	21.7					Test Temp (°C)	21.9				
Test Load (kN)	Displacement (mm)					Test Load (kN)	Displacement (mm)				
	1	2	3	4	mean		1	2	3	4	mean
1.01	0.01	0.00	0.01	0.02	0.009	1.10	0.02	0.00	0.02	0.02	0.014
76.00	0.55	0.55	0.49	0.49	0.519	76.08	0.15	0.27	0.64	0.59	0.415
Stiffness (kN/mm)	141.94					Stiffness (kN/mm)	174.83				
Change (%)						23.17					
CEN Specification						25 % Max					

Assembly static stiffness test results

Figure 2.4.3: Pre-repeated load test

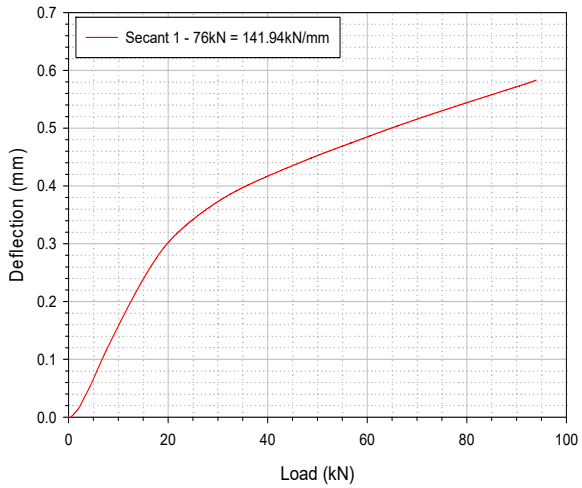
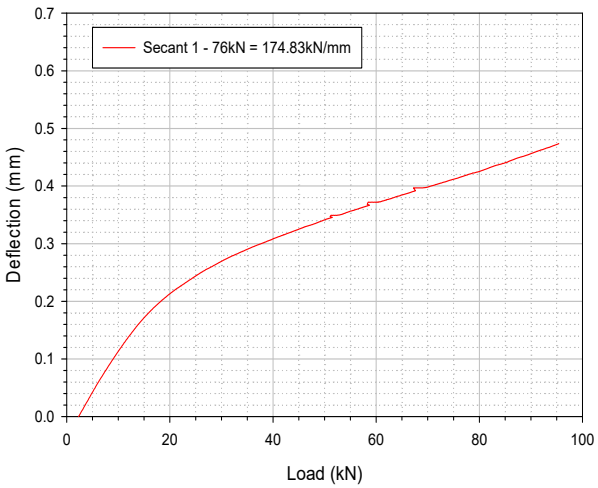


Figure 2.4.4: Post repeated load test



2.5. Repeated Load – BS EN 13146-4:2012+A1:2014

The repeated load test assembly with a section of rail modified such that the load could be applied along a line 75 mm below the gauge corner was clamped to a frame inclined at 40° beneath a hydraulic cylinder. A vertical load of 100 kN was applied to the rail. The load was cycled 10 times at a rate of 100 kN/min.

During the last 3 cycles, the maximum static displacements of the rail relative to the test block were measured.

A cyclic vertical load between 5 kN and 100 kN was then applied to the rail for 3m cycles at a frequency of 4 Hz. The dynamic displacements were measured during the first 1,000 cycles and at the end of the test.

On completion of 3m cycles, a vertical load of 100 kN was again applied to the rail and the maximum static displacements of the rail relative to the test block were again measured.

The mean residual static deflections and mean dynamic deflections were then calculated.

Following the repeated load test, the rail fastening components were inspected for wear or deformation. Photographs of the components are shown in Figures A.1 to A.6, Appendix A.

Figure 2.5.1: Repeated load test arrangement

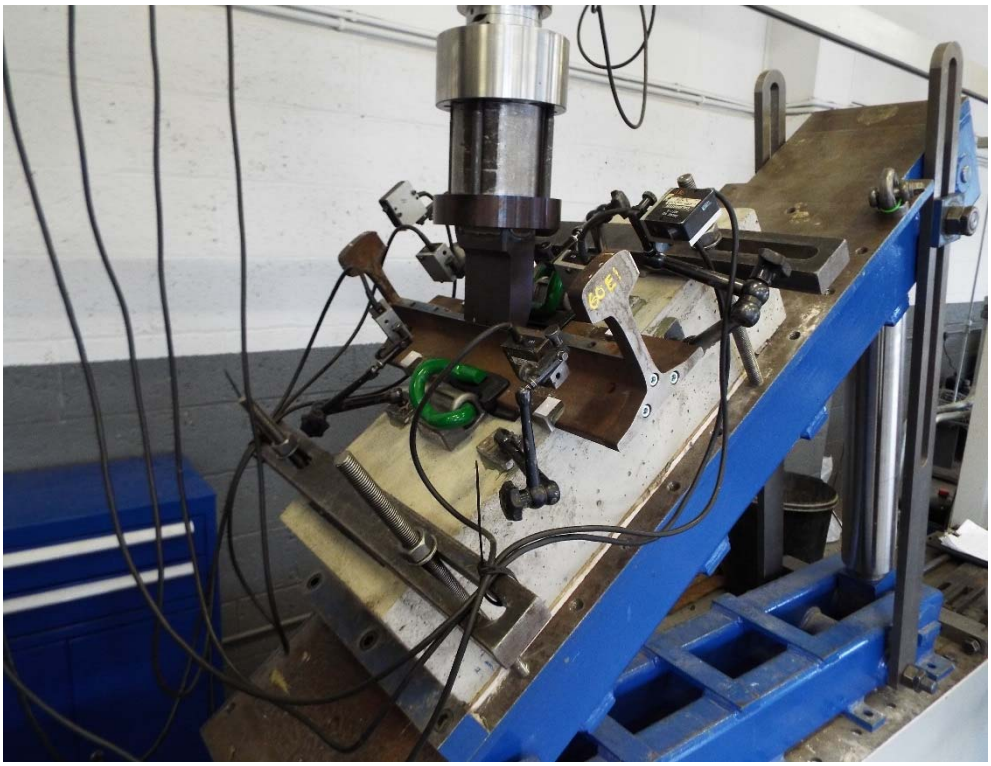
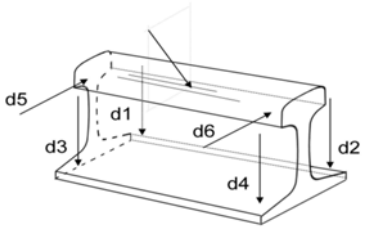


Table 2.5.2: Displacement measuring points and measurements

Repeated Load		
Test load kN	Min	Max
	5	100
Angle Degrees		40
X =		75
Freq Hz		4
Loadcell S/no		2141/11
Transducer S/no		4077/1,3,4,5,6,7
Date started		01/08/2019
Date finished		10/08/2019



Cycles	Displacement mm											
	Fieldside				Gaugeside				Railhead			
	1		2		3		4		5		6	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Static displacement before		0.66		1.10		-0.15		0.29		1.27		0.10
1000 cycles dyn	0.34	0.71	0.66	1.07	-0.24	-0.18	0.06	0.20	0.70	1.45	0.31	-0.32
Final 1000 cycles dyn	0.68	0.94	0.94	1.29	-0.26	-0.20	0.03	0.18	1.85	2.43	-1.18	-1.99
Static 3 million		0.96		1.30		-0.18		0.20		2.45		-2.11
Displacement @ zero load		0.44		0.71		-0.23		-0.23		1.53		-0.86
Mean static residual displacement		0.30		0.20		-0.04		-0.09		1.18		-2.21
		0.25				-0.06				-0.51		
				0.10								
Mean dynamic displacement after 1000 cycles		0.37		0.41		0.05		0.14		0.75		-0.63
		0.39				0.10				0.06		
				0.24								
Mean dynamic displacement last 1000 cycles		0.26		0.35		0.05		0.14		0.58		-0.80
		0.31				0.10				-0.11		
				0.20								
Instrument Polarity	Rail movement away from the instrument is displayed as positive (+)											
	Rail movement towards the instrument is displayed as negative (-)											

2.6. Effects of Severe Environmental Conditions – BS EN 13146-6:2012

The assembly was subject to the environmental conditions for a period of 313 hours. After this time the assembly was removed from the corrosion chamber, dismantled, assessed and re-assembled.

The assembly was dismantled and rebuilt without difficulty using installation tool AE22663 and extraction tool AE22939.

Photographs of the assembly components are shown in Figures A.7 to A.14, Appendix A.

2.7. Electrical Resistance – BS EN 13146-5:2012

An electrical test was carried out on one sleeper section. The first stage of testing is a wash down and no results are recorded for this stage.

The average of the results of the following three tests constitutes the electrical resistance of the sleeper assembly.

For each test, an AC voltage was applied between the rail heads and water was sprayed on to the sleeper surface for 2 minutes.

The current flowing was measured during spraying and for a minimum period of 10 minutes after spraying had ceased. The maximum current value (minimum resistance), was recorded. The resistance of the assembly was then calculated.

Figure 2.7.1: Electrical resistance test arrangement

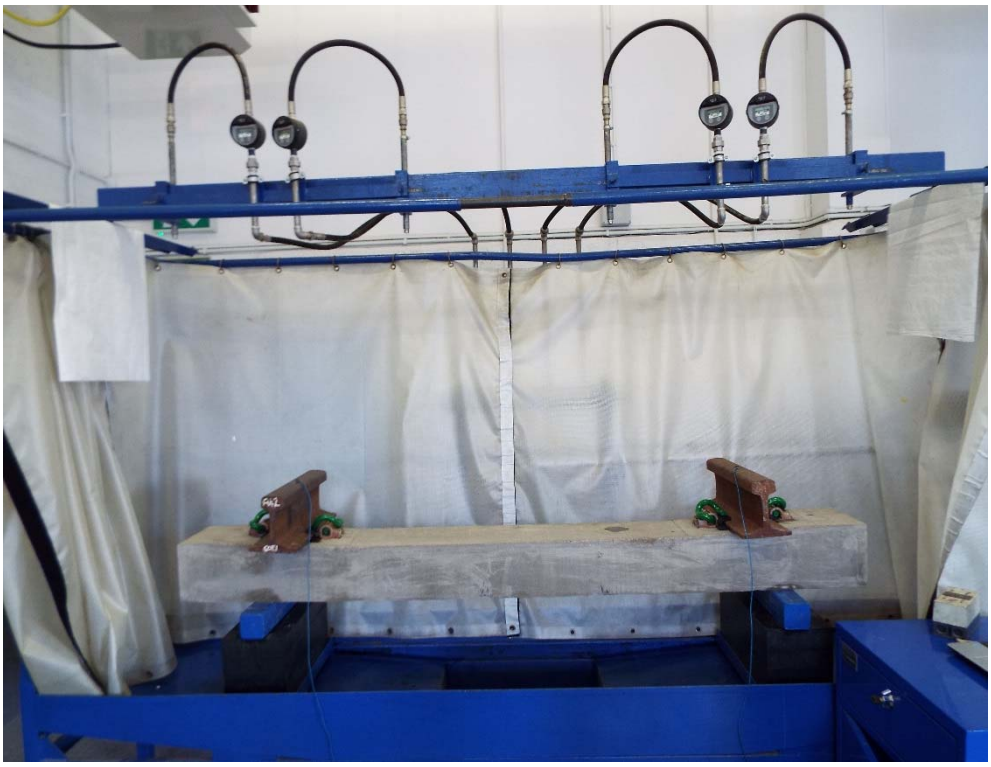
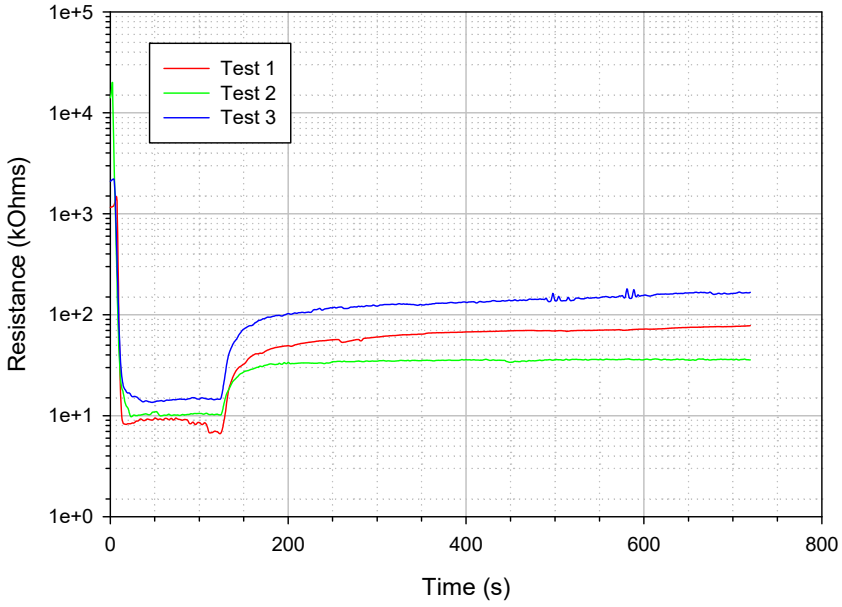


Table 2.7.2: Electrical resistance test results

Electrical Resistance			
	Test 1	Test 2	Test 3
Date of Test	13/08/2019	23/08/2019	30/08/2019
Air Temp (°C)	20.80	22.70	22.30
Water Temp (°C)	18.60	19.40	19.40
Water Conductivity (mS/m)	52.40	52.20	54.10
Maximum Current (mA)	4.532	3.070	2.207
Voltage (v)	30.10	29.98	29.92
Resistance (kΩ)	6.642	9.765	13.557
Average Electrical Resistance		9.988	
CEN Specification		5 kΩ Minimum	

Figure 2.7.3: Electrical resistance test results



2.8. Torsional Resistance – BS EN 13146-2:2012

The sleeper section was restrained on a horizontal baseplate and a load was applied to the edge of the rail foot, normal to the rail at a point 300 mm from the centreline of the assembly, at a rate of 2 kN/min to push the rail foot until diagonal contact was established with both sidepost insulators.

The load was then applied at the same position on the opposite side of the rail until the angular displacement of the rail reached a minimum of 1.5°. The load was then removed and, after a minimum of 3 minutes, re-applied to the opposite side of rail until the angular displacement of the rail had again reached a minimum of 1.5°.

During the loading cycles both load and angular displacement were continually logged and a plot of moment of load against angular displacement was generated.

The torsional resistance was determined as the moment required to cause an angular displacement of 1°.

Figure 2.8.1: Torsional resistance test arrangement

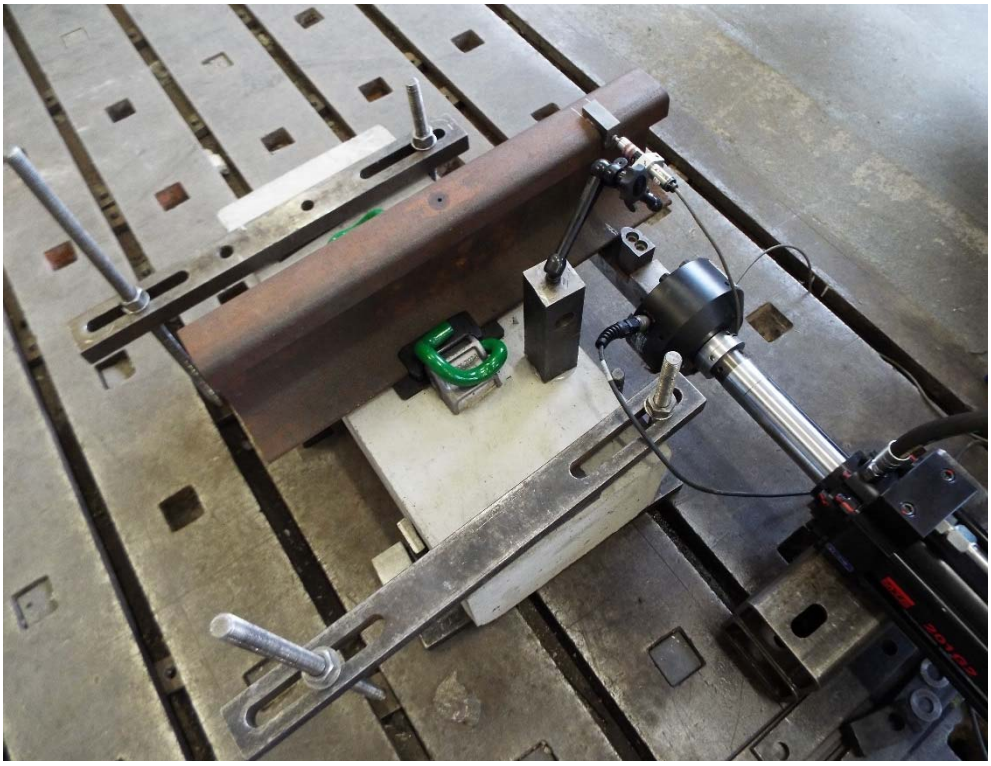
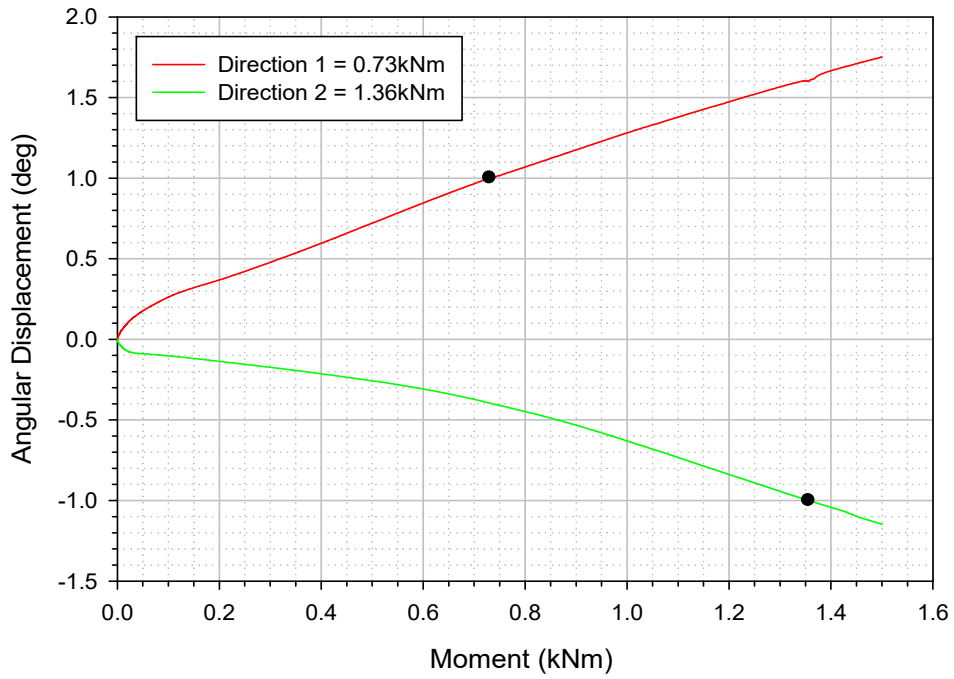


Table 2.8.2: Torsional resistance results

Torsional Resistance (kNm)	
Direction 1	0.73
Direction 2	1.36

Figure 2.8.3: Torsional resistance graph



2.9. Proof Load for Pull-Out Resistance – BS EN 13146-10:2017

A vertical load test for cast-in components was carried out on three blocks.

Each block was fastened to a steel base using restraints, positioned 100 mm to each side of the shoulder to be tested.

A vertical load of 60 kN was applied to the shoulder at a rate of 60 kN/min and maintained for a period of 3 minutes.

The load was then removed, and the shoulder and surrounding concrete visually examined.

No damage had occurred to the shoulders or the blocks.

Figure 2.9.1: Vertical load test arrangement

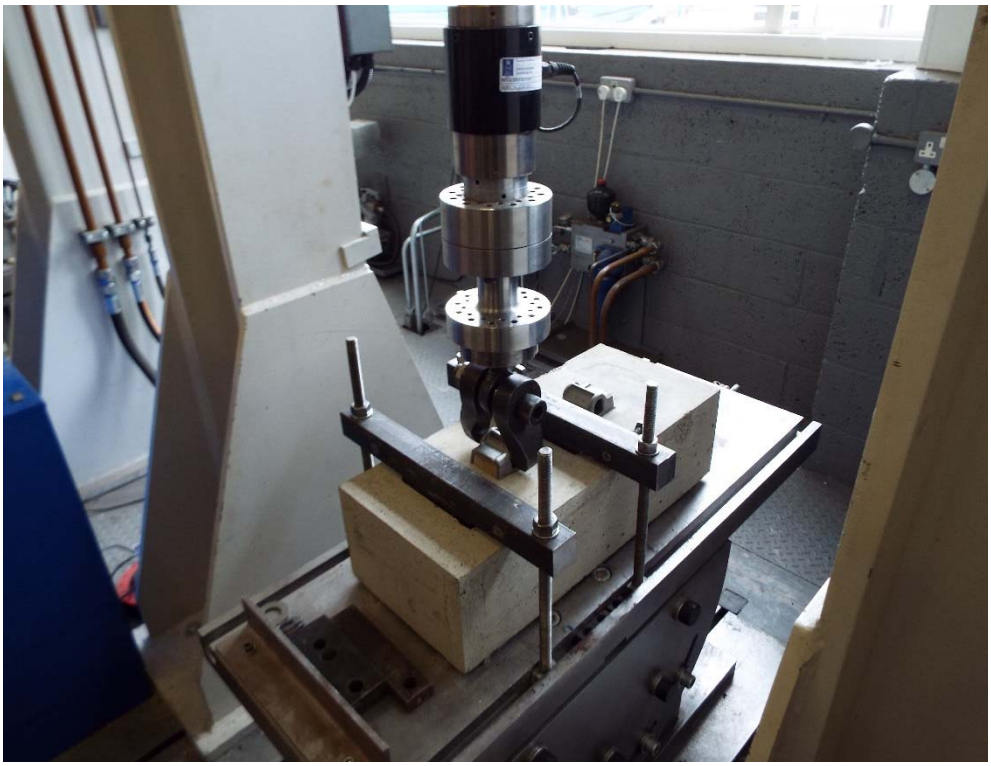


Figure 2.9.2: Vertical load test results, block B1

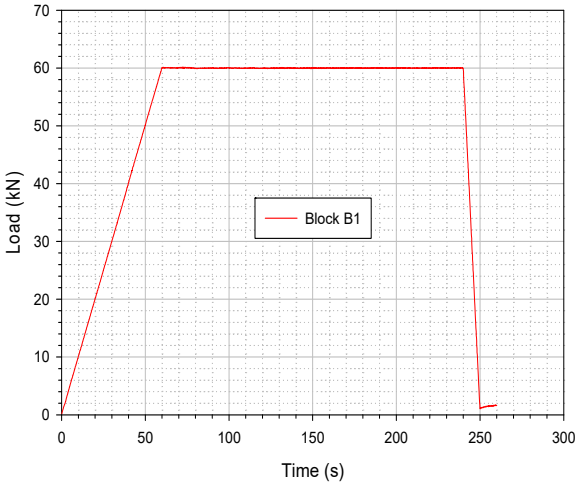


Figure 2.9.3: Vertical load test results, block B2

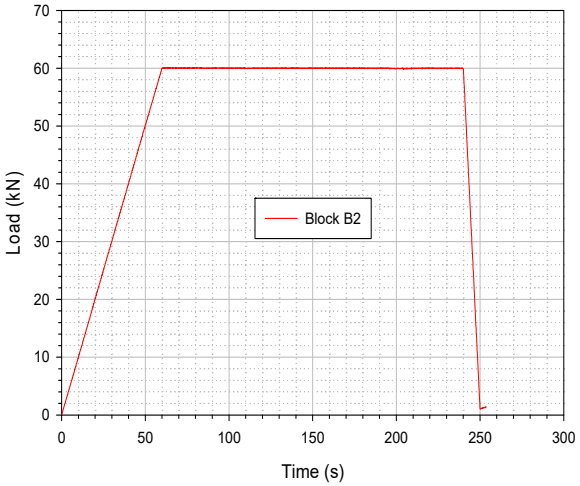
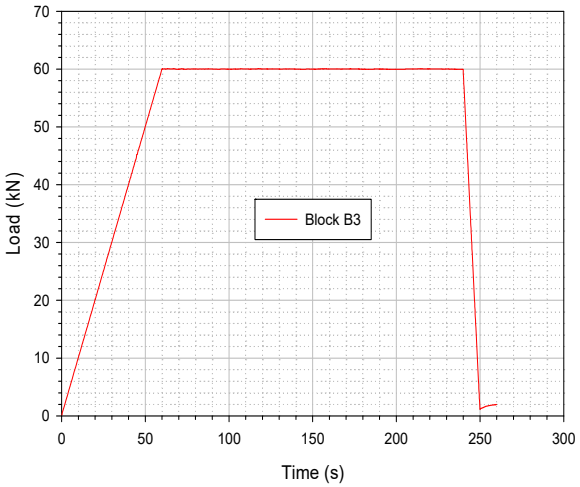


Figure 2.9.4: Vertical load test results, block B3



3. Discussion

The PANDROL Brand Rail Assembly, type 22598 incorporating PANDROL Rail Clips, type e2007AV performed well during all of the testing described.

The assembly was compliant with the CEN performance requirements for clamping force, longitudinal rail restraint, stiffness, electrical resistance, pull-out resistance, severe environmental conditions and repeated load.

Following testing all the components were inspected and found to be in good condition.

4. Conclusion

The assembly fully satisfied the requirements of BS EN 13481-2:2012+A1:2017 ‘Fastening systems for concrete sleepers’ for a Category E application.

For tests on concrete sleepers, note that compliance with category E implies compliance with categories A-D.

5. Appendix A – Post Test Photographs

Figure A1: Rail pad upper surface following repeated load test

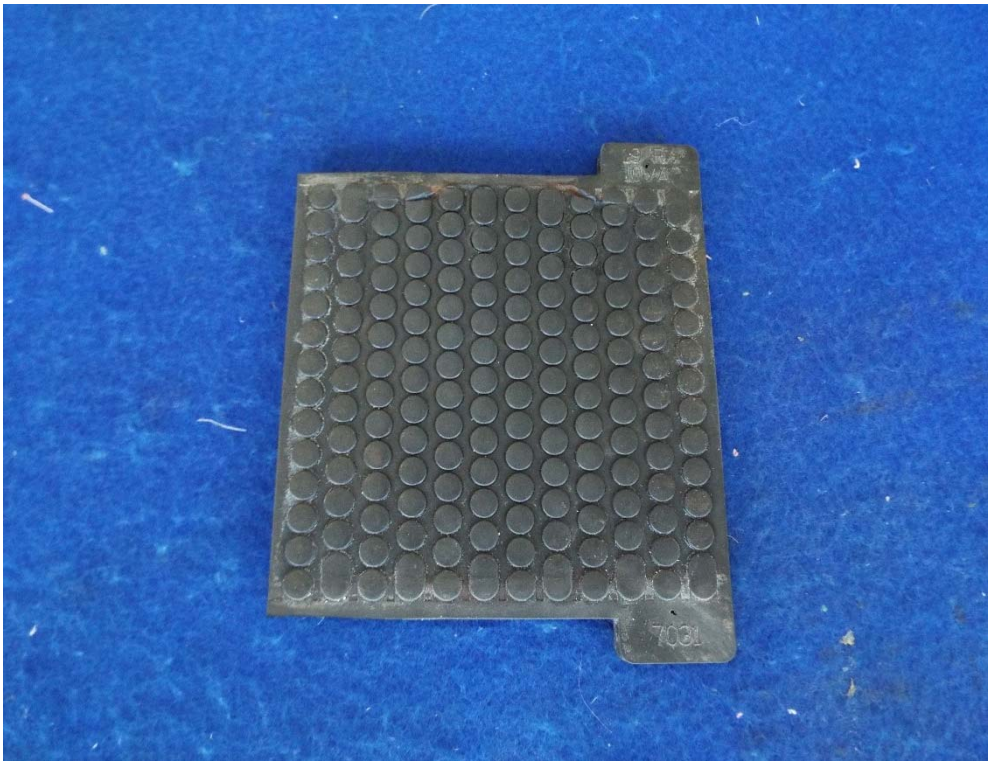


Figure A2: Rail pad lower surface following repeated load test

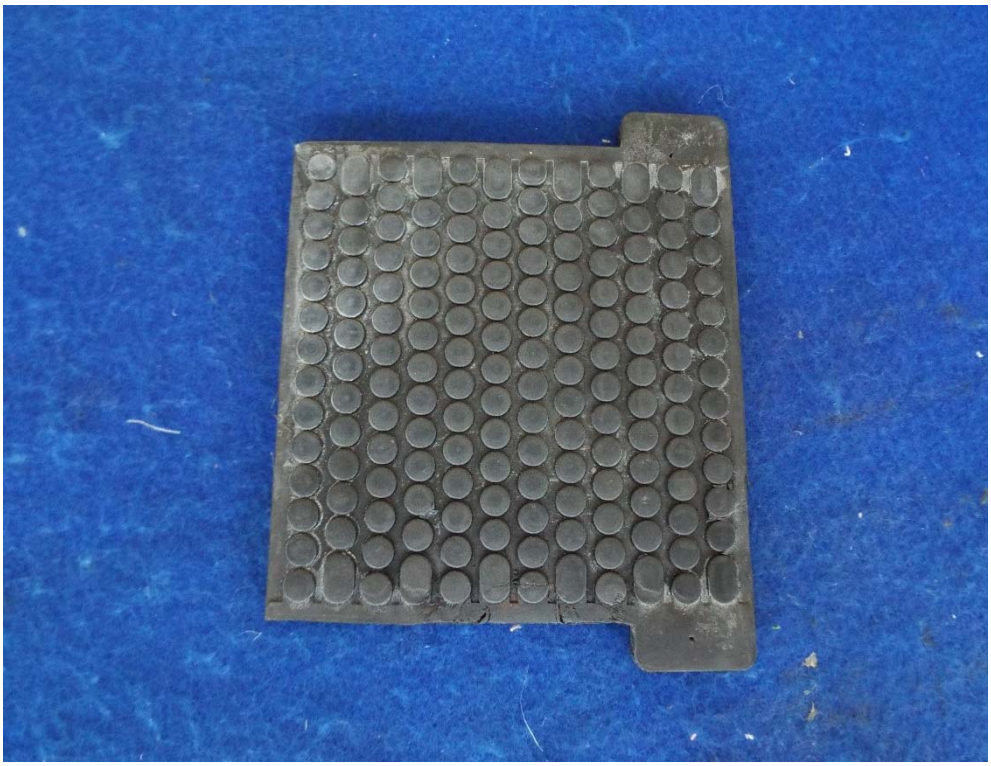


Figure A3: Insulators upper surface following repeated load test

Figure A4: Insulators lower surface following repeated load test

Figure A5: Rail clips upper surface following repeated load test

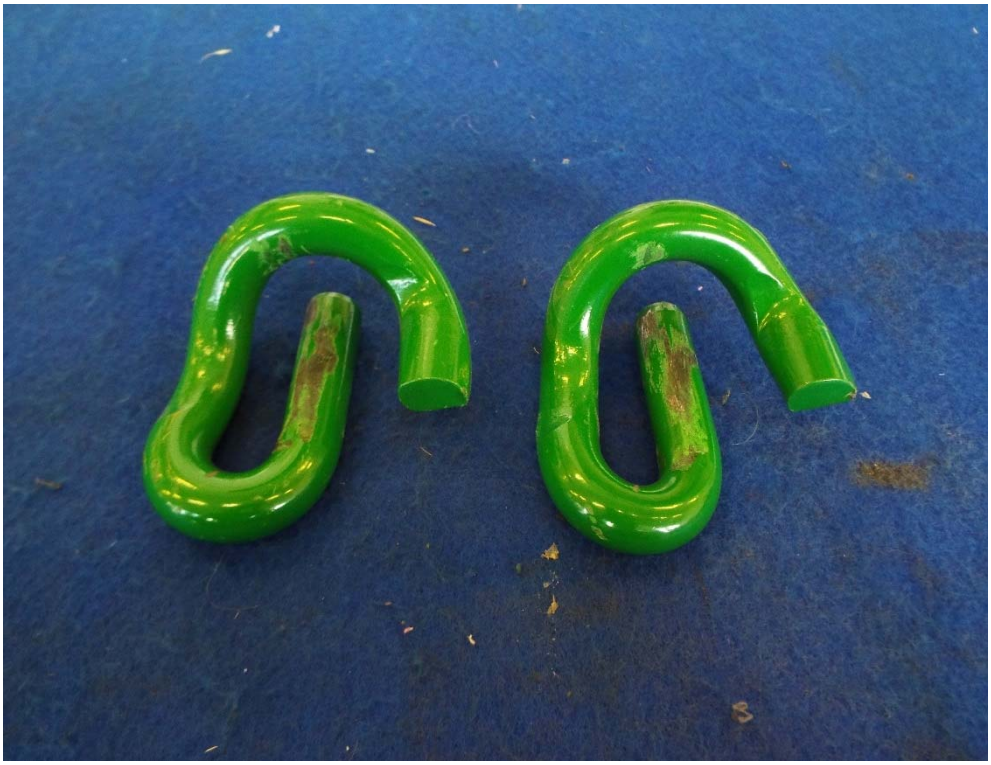


Figure A6: Rail clips lower surface following repeated load test

Figure A7: Assembly prior to effects of severe environmental conditions test

Figure A8: Assembly following effects of severe environmental conditions test

Figure A9: Rail pad upper surface following effects of severe environmental conditions test

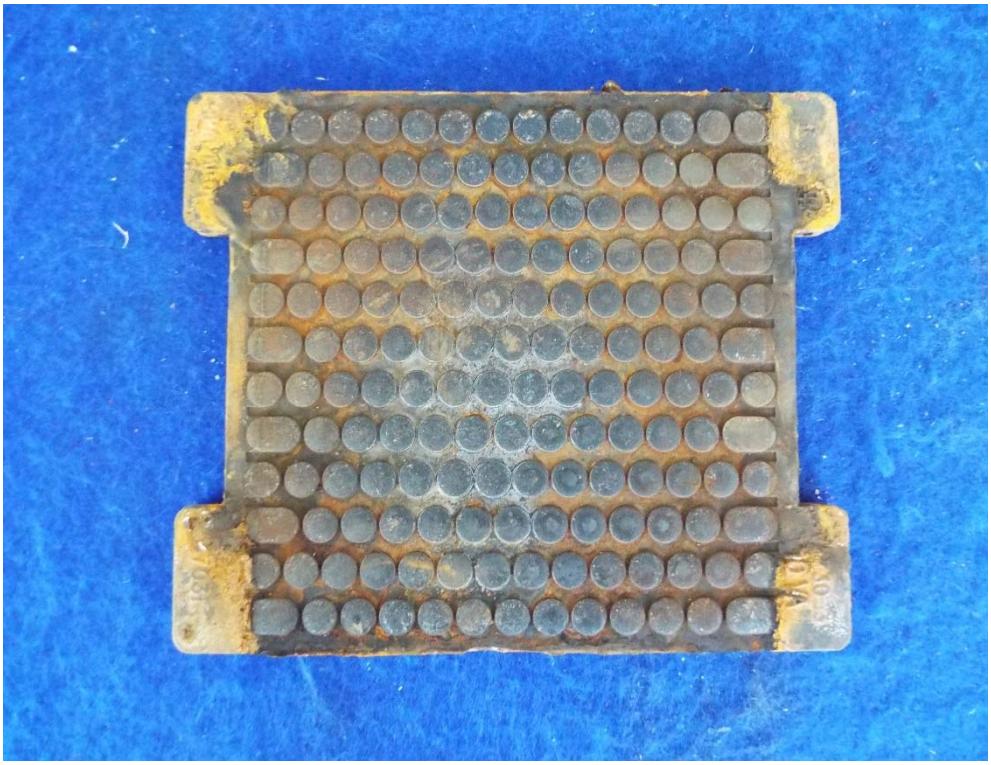


Figure A10: Rail pad lower surface following effects of severe environmental conditions test

Figure A11: Insulators upper surface following effects of severe environmental conditions test

Figure A12: Insulators lower surface following effects of severe environmental conditions test

Figure A13: Rail clips upper surface following effects of severe environmental conditions test

Figure A14: Rail clips lower surface following effects of severe environmental conditions test

6. Appendix B- SGS Report

SGS United Kingdom Ltd
Station Road, Oldbury,
West Midlands, B69 4LN

INSPECTION REPORT

Inspection report no. 313921 {Amalgamated} Rev 02
Report submission date. 23rd September 2019

Project:		**Supplier:**	**Pandrol UK Ltd**
Project Ref.	Dhaka Metro	Details:	Witness tests
P.O. Ref. No:		Job No:	EWR 8128
Client:	Pandrol UK Ltd	**Sub-Supplier:**	
Country	United Kingdom		
Client Reference No.			
Equipment / Material	Depot Assembly - 22598	Place of inspection	Pandrol UK Ltd
PO at Supplier		Contact person:	Rhys Major
		Address:	Gateford Road Worksop S81 7AX

Inspection Dates:26th; 31st July; 1st; 12th; 13th; 14th; 23rd and 30th August 2019

Inspection Result:	☒ Satisfactory ☐ conditionally accepted * ☐ Non-conformant * ☐ rejected* ☐ aborted inspection *	**NCR/Punch list issued:** ☒ No ☐ Yes* (* see report detail)
Inspection Conclusion	Witness Tests Nos 1–11 [as detailed in report] have been completed and considered satisfactory.	

Inspector: P. Bygate	Signature P Bygate	Date:	23rd September 2019
Approved: D. Bishop	Signature David Bishop	Date:	23rd September 2019

SGS United Kingdom Ltd
Station Road, Oldbury,
West Midlands, B69 4LN

INSPECTION REPORT

Inspection report no. 313921 {Amalgamated} Rev 02
Report submission date. 23rd September 2019

Present at inspections

Nathan Briggs [Pandrol Test Lab] {26th; 31st July & 1st; 12th~14th; 23rd and 30th August}
Peter Bygate [SGS UK] {all dates}
Antony Brown [Pandrol Test Lab] {31st July and 1st; 12th~14th August}
Steve Ducker [Pandrol Test Lab] {12th~14th August}
Steve Dudley [Pandrol Test Lab] {12th~14th August}
Jamie Pogson [Pandrol Test Lab] {12th~14th August}

Material / equipment subject to inspection

Depot Assembly - 22598

Scope of inspection

Witness Test Nos 1 – 11 and additional Torsional Resistance Test for the type 22598 Assembly, in accordance with the relevant sections of EN Standard 13146 & EN 13481 for a category "E" Assembly, as detailed in Report below,

Applicable documents

Title	*Document No*	*Rev No.*	*Attached to Inspection instruction*	*Obtained at place of inspection*	*Document Used by inspector*
Schedule of Work	-	01	☐	☒	☒
GA Drawing	22598	A1	☐	☒	☒
EN Standard	EN 13146	-	☐	☒	☒
	EN 13481	-	☐	☒	☒

Instruments used and calibration status

26th July 2019

- 100kN Universal Actuator ref.2141 / 9 - s/n 122423A
- Strain Gauge Transducers s/nos. 4064 – 13/ 27/ 32 /33 /14
- Inclinometer ref. 4080 / 5

31st July and 1st August 2019
Instrumentation used on 26th July as well as:-

- 150kN Universal Actuator ref. 2141 / 8B - s/n 10551822C
- 100 kN Universal Actuator ref. 2141 /12 - s/n 122425A
- 250kN [B]Universal Actuator ref.2141 / 11 - s/n 10597807B
- 6 Laser Transducers s/no's 4077 - 1, 3, 4, 5, 6, 7

12th ~14th August 2019
Instrumentation stated above as well as

- Stopwatch ref. 4059 / 17
- Conductivity Meter ref. 4059 / 20
- HBM Spider 8 Data Logger ref. 5003/8 [s/n FO6437}
- 4 Flow Meters ref. 4061 - / 2 / 3 / 4 / 5

23rd and 30th August

- Stopwatch ref. 4059/17
- Conductivity Meter ref. 4059/20
- HBM Spider 8 Data Logger ref. 5003/8 [s/n FO6437]
- 4 Flow Meters ref. 4061 - / 2 / 3 / 4 / 5

All above instrumentation was in current calibration status and copies of calibration certificates will accompany the final report.

Inspection conducted

26th July 2019

Depot Assembly – 22598
[This assembly is to be tested to the requirements of EN13481 - 2:2012+A1:2017 Category "E" assembly as follows.]

Test no.1 - Dynamic Stiffness [EN13146-9 + A1: 2011]

Tested on 100kN load Test Rig ref.2141/9 used with 4 Strain Gauge Transducers ref. 4064 - /13 /27 /32 /33.

. Test witnessed at loading of 1 – 76kN over 1000 cycles with Final results confirmed as acceptable to the required standard and countersigned as witnessed.

Test no. 10 - Severe Environmental Conditions [EN13146-6: 2012]

The commencement of this test was witnessed and the scheduled completion of salt solution mist Spray was set for 300 hours. [hour reading at start of test recorded at 191.10 hours. [see photograph]

31st July and 1st August

Test no. 2 - Determination of Clamping Force – Pre-test [EN13146-7: 2019]

Tested on 100kN load Test Rig ref. 2141/9 used with 4 Strain Gauge Transducers ref. 4064 - /13 /27 /32 /33.

Test witnessed with Interim results confirmed as acceptable to the required standard and countersigned as witnessed.
[Assembly Rail Pad "locating ears" removed to facilitate removal of pad at Clamp Test loading]

Test no.3 - Determination of Longitudinal Rail Restraint – Pre-test [EN13146-1:2019]

Tested on 100kN load Test Rig ref.2141/12 used with Strain Gauge Transducer ref. 4064/14

Test witnessed with Interim results confirmed as acceptable to the required standard and countersigned as witnessed.

Test no.4 - Vertical Stiffness – Pre-test [EN13146-9+A1:2011]

Tested on 100kN load Test Rig ref. 2141/9 used with 4 Strain Gauge Transducers ref. 4064 - /13 /27 /32 /33

Test witnessed with Interim results confirmed as acceptable to the required standard and countersigned as witnessed.

Test no.5 - Repeated Loading Cycle (@ 4Hz) [EN13146-4:2012+A1:2014]

Tested on 250 kN load Test Rig(B) ref. 2141/11 used with 6 Laser Transducers ref. 4077 - /1 /3 /4 /5 /6 /7.
Load angle checked with Inclinometer ref. 4080/5.
Test load of100kN to be applied at "X" point dimension of 75 mm [Cat E requirement]
Commencement of test on 1/08/19 witnessed and Test Rig set for 3,000,000 cycles.
[see photograph for reading at time of inspection]

Test no. 10 - Severe Environmental Conditions [EN13146-6: 2012]

The commencement of this test was witnessed and the scheduled completion of salt solution mist Spray was set for 300 hours. [hour reading at start of test recorded at 191.10 hours. [see photograph]

. Interim hour reading on 1/08/19 was recorded at 338.25 hours for an interim test hours duration of 147.15 hours and continuing.

Test no. 11 - Vertical Load Test for Cast-in Components [EN13146-10: 2017]

Tested on150kN load Test Rig ref. 2141/8 (B) with 2 Slabs [Nos. 1 & 2] used for 2 individual tests at Vertical loading of 60kN (duration 3 minutes).
Both tests were witnessed and were considered acceptable with no visible evidence of fracture or surface hairline cracking.

12th ~ 14th August

Test no.5 - Repeated Loading Cycle (@ 4Hz) [EN13146-4:2012+A1:2014]

Test completed on 250 kN load Test Rig(B) ref. 2141/11 used with 6 Laser Transducers ref. 4077 - /1/3/4/5/6/7.
Load angle checked with Inclinometer ref. 4080/5.
Test load of100kN to be applied at "X" point dimension of 75 mm [Cat E requirement]
Test completed with Test Rig recorded at 3,000,014 cycles.
[see photograph for reading at time of inspection]

Test no. 8 - Determination of Clamping Force – Post-test [EN13146-7: 2019]

Tested on 100kN load Test Rig ref. 2141/9 used with 4 Strain Gauge Transducers ref. 4064 - /13/27/32/33

Test witnessed with Final results confirmed as acceptable to the required standard and countersigned as witnessed.

Test no.7 - Determination of Longitudinal Rail Restraint – Post-test [EN13146-1:2019]

Tested on 100kN load Test Rig ref.2141/12 used with Strain Gauge Transducer ref. 4064/14

Test witnessed with Final results confirmed as acceptable to the required standard and countersigned as witnessed.

Test no.6 - Vertical Stiffness – Post-test [EN13146-9+A1:2011]

Tested on 250kN load Test Rig ref. 2141/11 used with 4 Strain Gauge Transducers ref. 4064 - /36 /37 /38 /39

Test witnessed with Final results confirmed as acceptable to the required standard and countersigned as witnessed.

Test No.9 - Determination of Electrical Resistance [EN13146-5:2012]

Tested on Slab with spray booth arrangement details in accordance with the relevant requirements of EN 13146 [3.6mm dia nozzles / 120^0 cone / 6 – 8 l/min flow]
Preliminary 2-minute Washdown test and no.1 Electrical Resistance Test were witnessed with initial test result confirmed as acceptable to the required standard.
[Check nos. 2 & 3 to be completed]

Test no. 10 - Severe Environmental Conditions [EN13146-6: 2012]

Test schedule of 300 hours completed and verified by test records at 313 hours. [see photograph]
The complete assembly was successfully dismantled and subsequently re-assembled manually with the use of Hand Lever only.
This test was then considered complete and acceptable

Test no. 11 - vertical Load Test for Cast-in Components [EN13146-10: 2017]

Tested on 150kN load Test Rig ref. 2141/8 (B) with Slabs used for 3 individual cast-in component tests.
All 3 tests were witnessed and were considered acceptable with no visible evidence of fracture or surface hairline cracking.
Load Test graphs countersigned as witnessed.

Extra - Torsion Resistance Test [EN13146-2:2012]

Tested on 100kN load Test Rig ref. 2141/12, used with Strain Gauge Transducer ref. 4064/14.
Test witnessed at loading rate of 2kN per min. for maximum of 9mm deflection.
This test is detailed for information purpose only.
The Angular Displacement / Moment kNm] graph was countersigned as witnessed.

23rd and 30th August 2019

Test No.9 - Determination of Electrical Resistance [EN13146-5:2012]

Tested on Slab with 60E1 Rail section and spray booth arrangement details in accordance with the relevant requirements of EN 13146 [3.6mm dia nozzles / 120^0 cone / 6 – 8 l/min flow]
Preliminary 2-minute Washdown test and the no.1 Electrical Resistance Test check had been completed and witnessed on 13/08/2019 with initial test result confirmed as acceptable to the required standard.

The no.2 Electrical Resistance Test check had been completed and witnessed on 23/08/2019 with the interim test result confirmed as acceptable to the required standard.

The no.3 Electrical Resistance Test check has been completed and witnessed on 30/08/2019 with the final test results confirmed as acceptable to the required standard.

Documentation Review

Calibration Certificates for all instrumentation detailed above were reviewed and considered acceptable and in current calibration status.

The Final Test Results and Resistance / Time Record were countersigned as witnessed. [copies attached.

Non-conformances

- None

Further operations

- None

Attachments

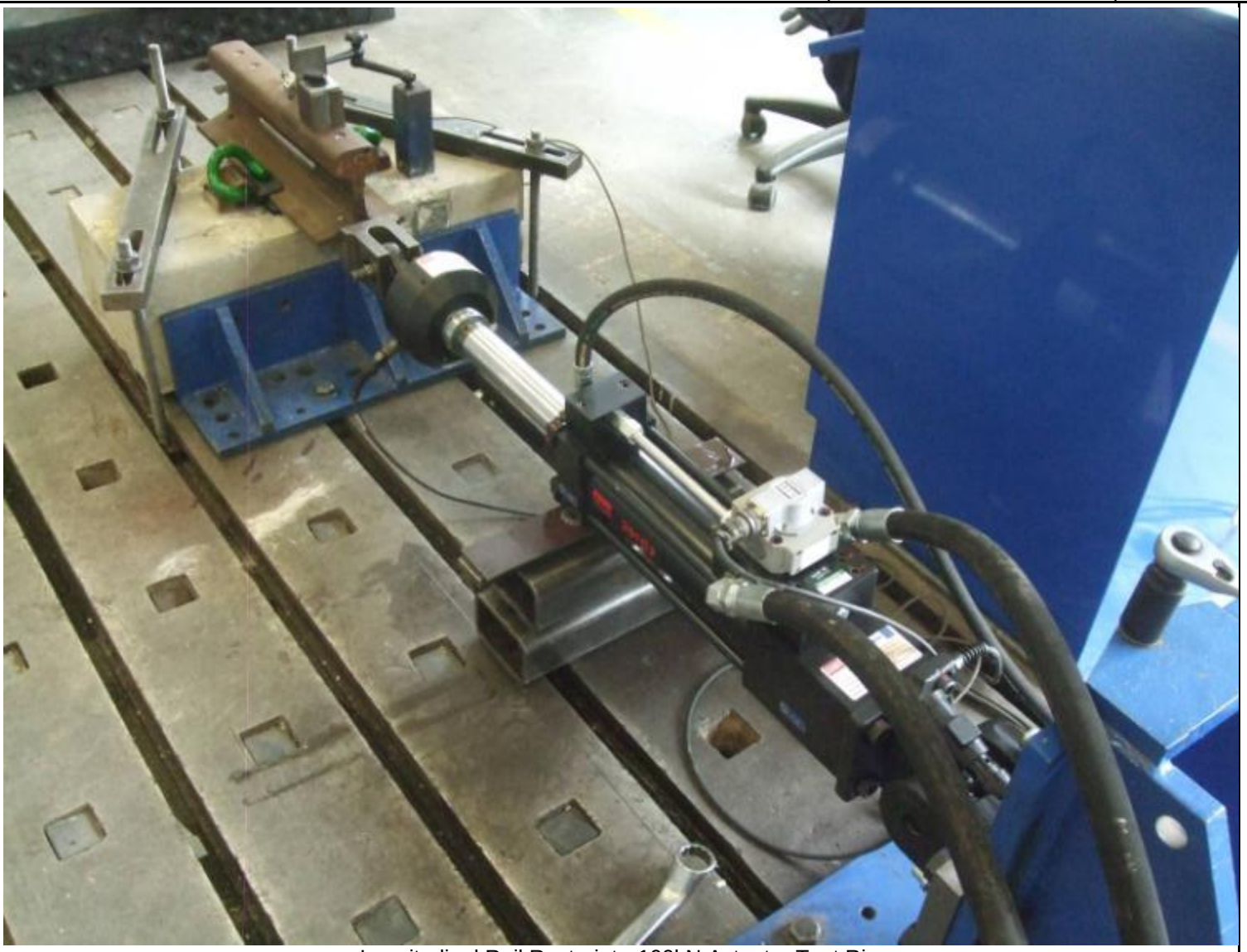
- Test reports and Calibration certificates

Photographs

26th July 2019 inspection

Dynamic Stiffness - 100kN Actuator Test Rig & Transducer Arrangement

Clamping Force - 100kN Actuator Test Rig & Transducer Arrangement



Longitudinal Rail Restraint - 100kN Actuator Test Rig

Longitudinal Rail Restraint – Transducer arrangement

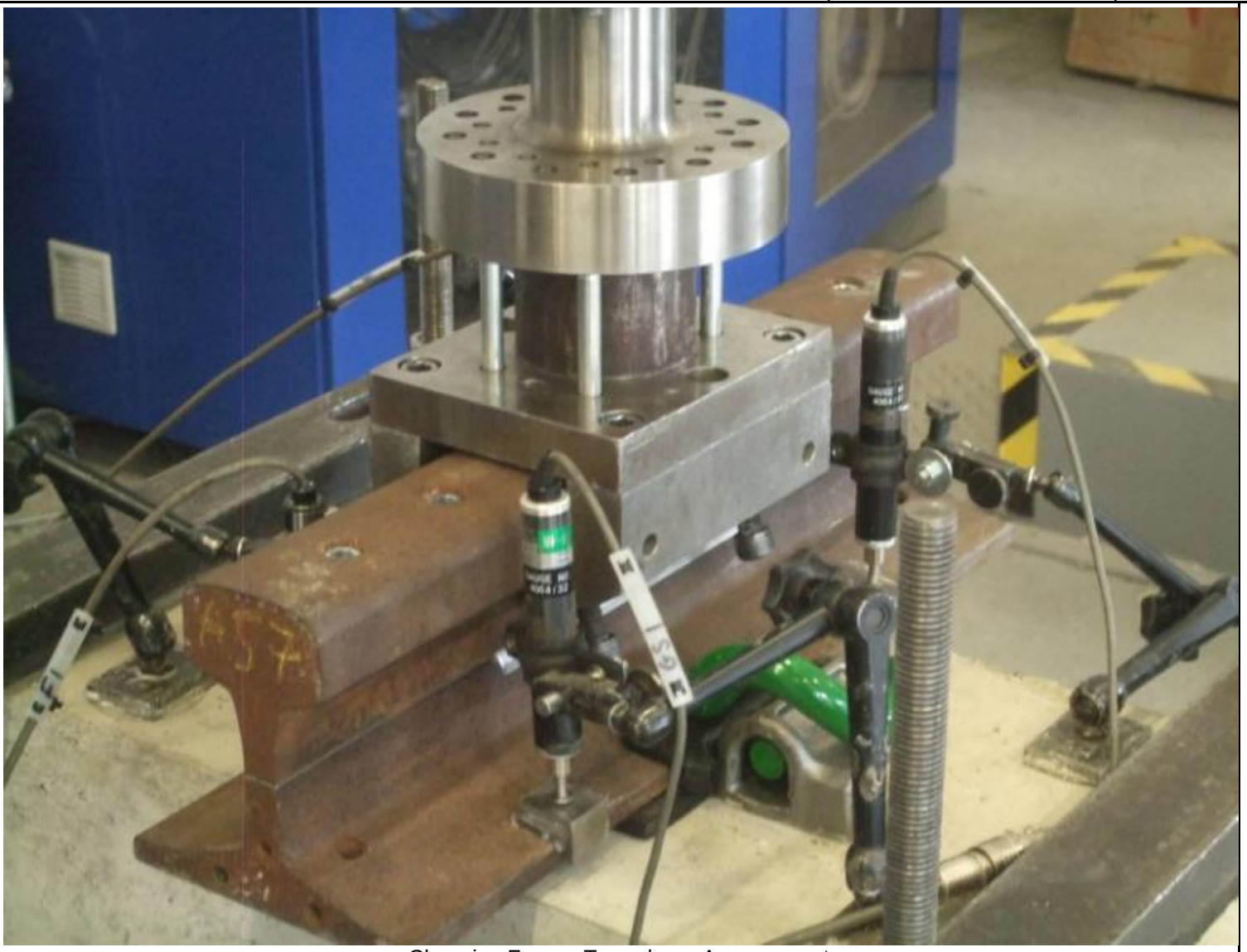
Vertical Stiffness - 100kN Actuator Test Rig & Transducer Arrangement

Severe Environmental Conditions - Test sample

Severe Environmental Conditions - Salt Spray Cabinet

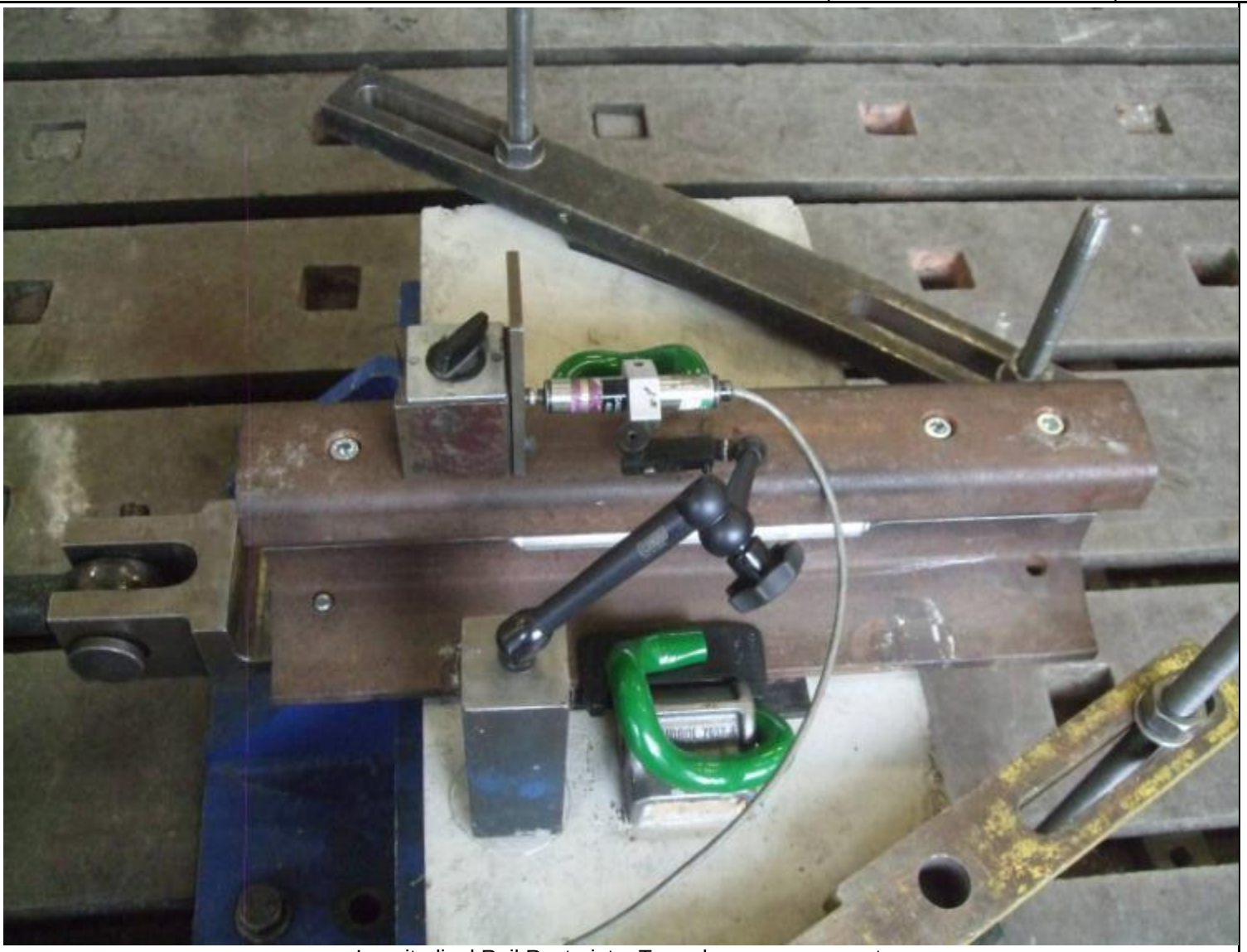
Severe Environmental Conditions Test started - Set for 300 hours
[initial hour meter reading at start of test]

Clamping Force - 100kN Actuator Test Rig & Transducer Arrangement



Clamping Force - Transducer Arrangement

Longitudinal Rail Restraint - 100kN Actuator Test Rig

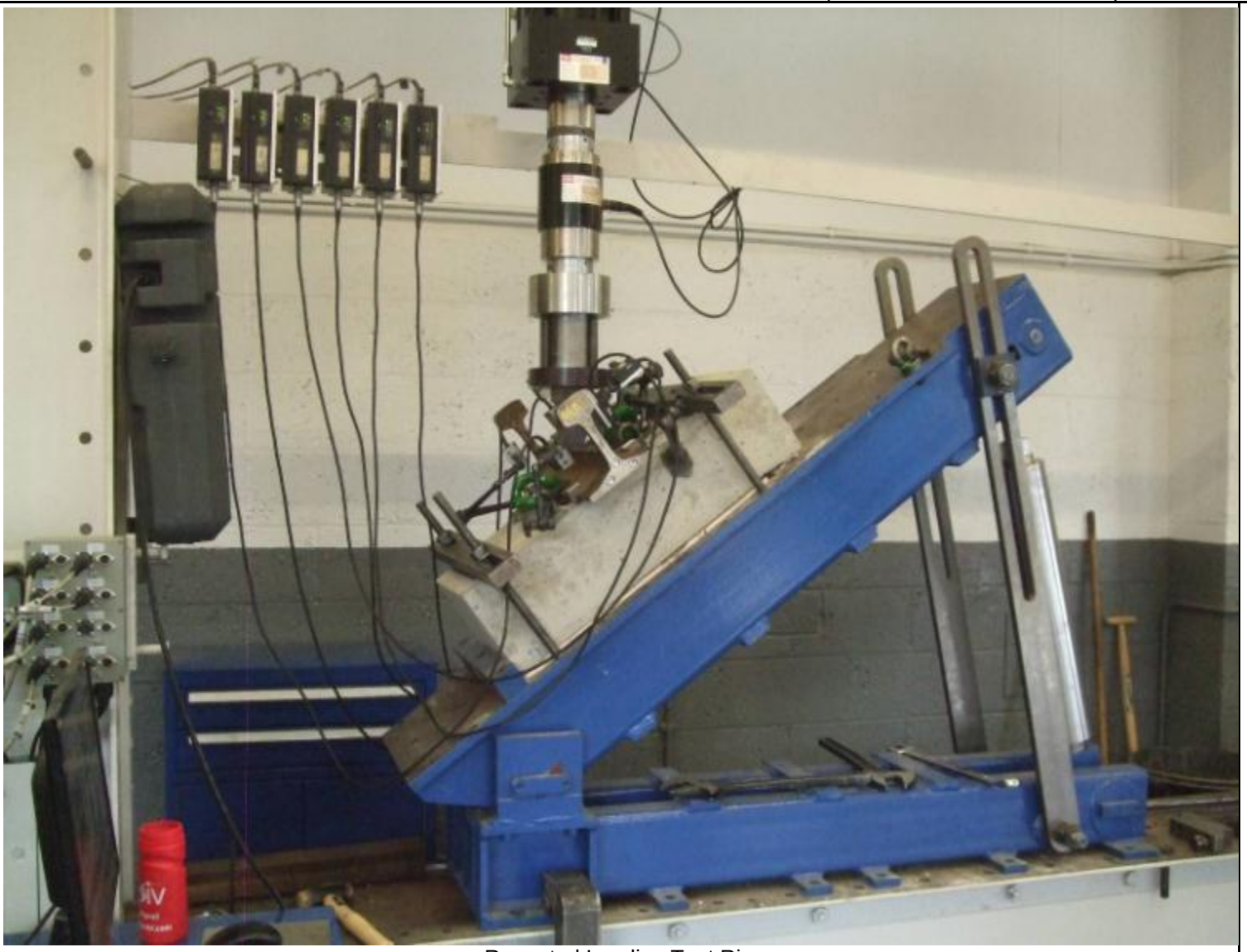


Longitudinal Rail Restraint – Transducer arrangement

Vertical Stiffness - 100kN Actuator Test Rig & Transducer Arrangement

Vertical Stiffness - Transducer Arrangement

Severe Environmental Conditions - Interim hour meter reading



Repeated Loading Test Rig

Repeated Loading Test – Laser Arrangement

Repeated Loading - Started

Repeated Loading - Interim Reading

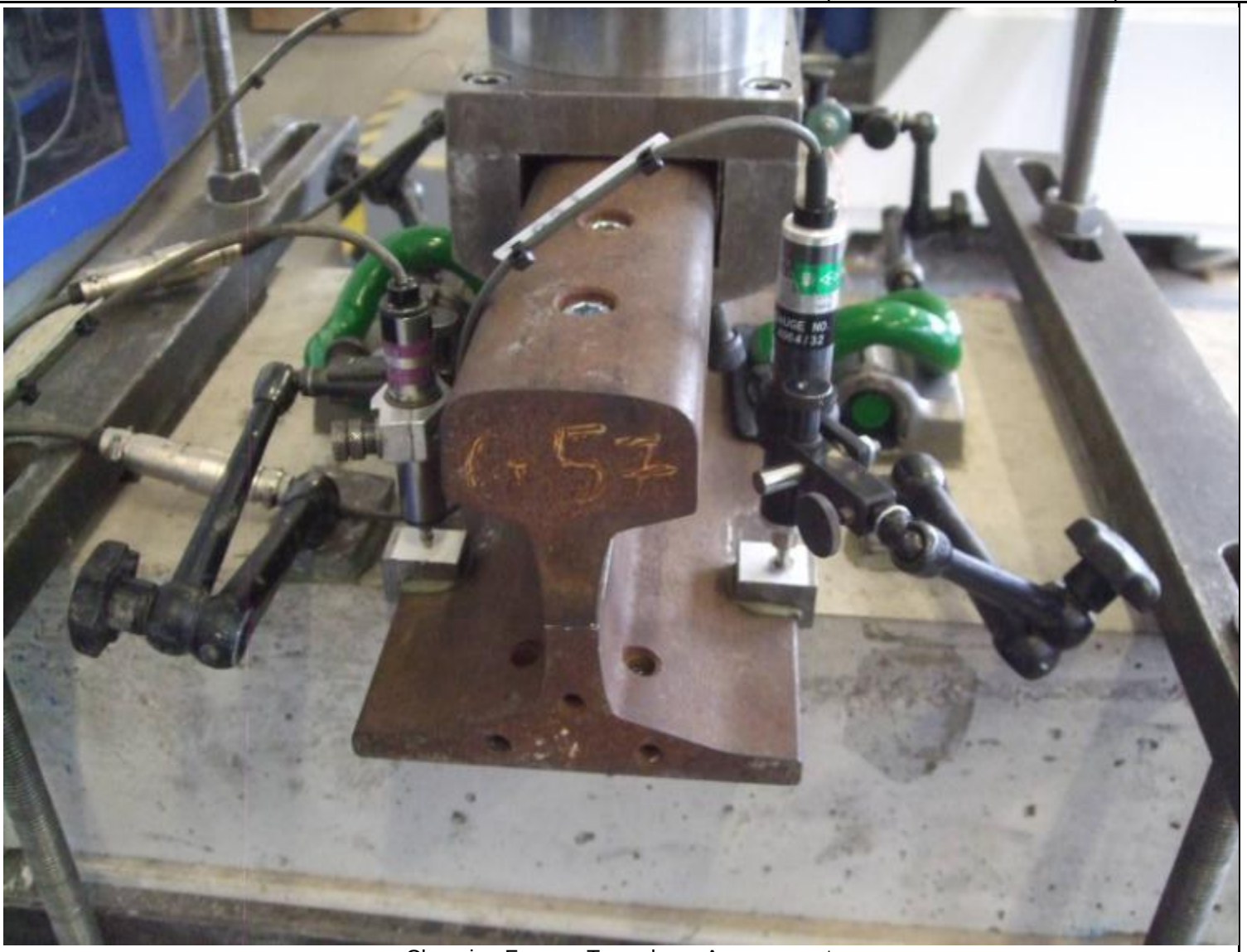
Vertical Load Test Rig – Cast-in Component

Vertical Load – Cast-in Components

Vertical Load – Slab No. 1 Cast-in Component Surface Post test

Vertical Load – Slab No. 2 Cast-in Component Surface Post test

Clamping Force - 100kN Actuator Test Rig & Transducer Arrangement

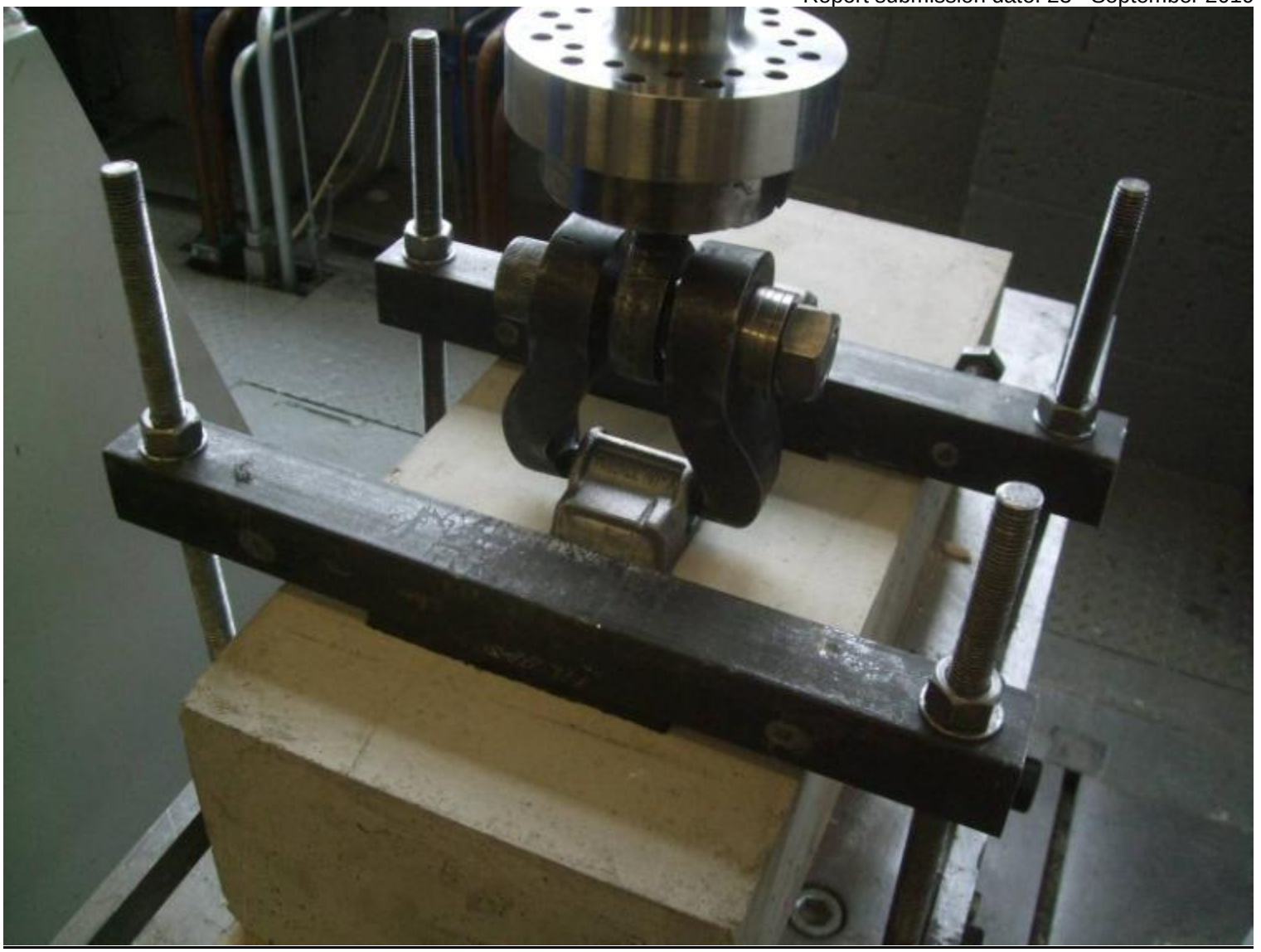


Clamping Force - Transducer Arrangement

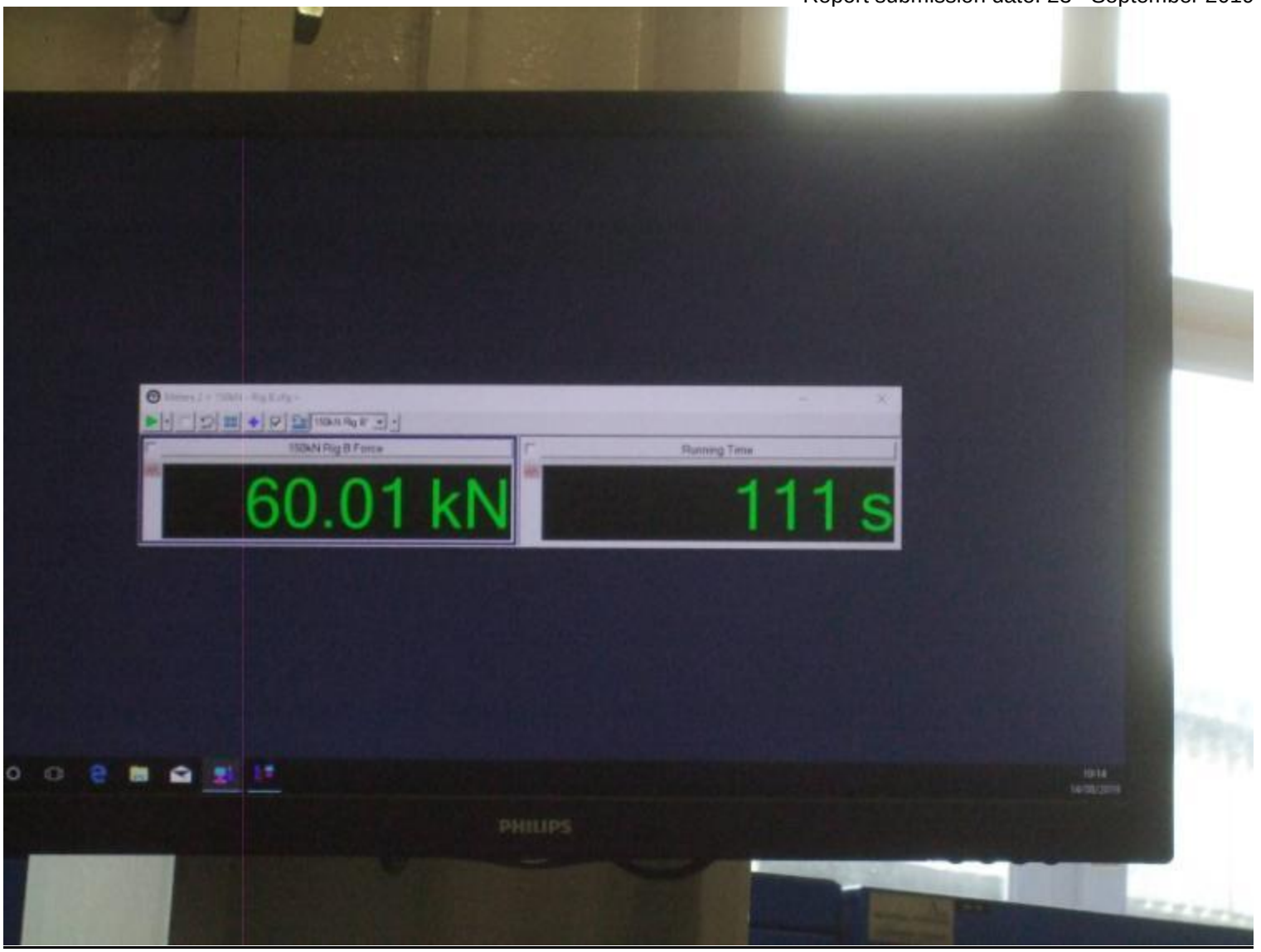
Longitudinal Rail Restraint - 100kN Actuator Test Rig & Transducer arrangement

Vertical Stiffness - 100kN Actuator Test Rig & Transducer Arrangement

Repeated Loading – Final Cycle Reading



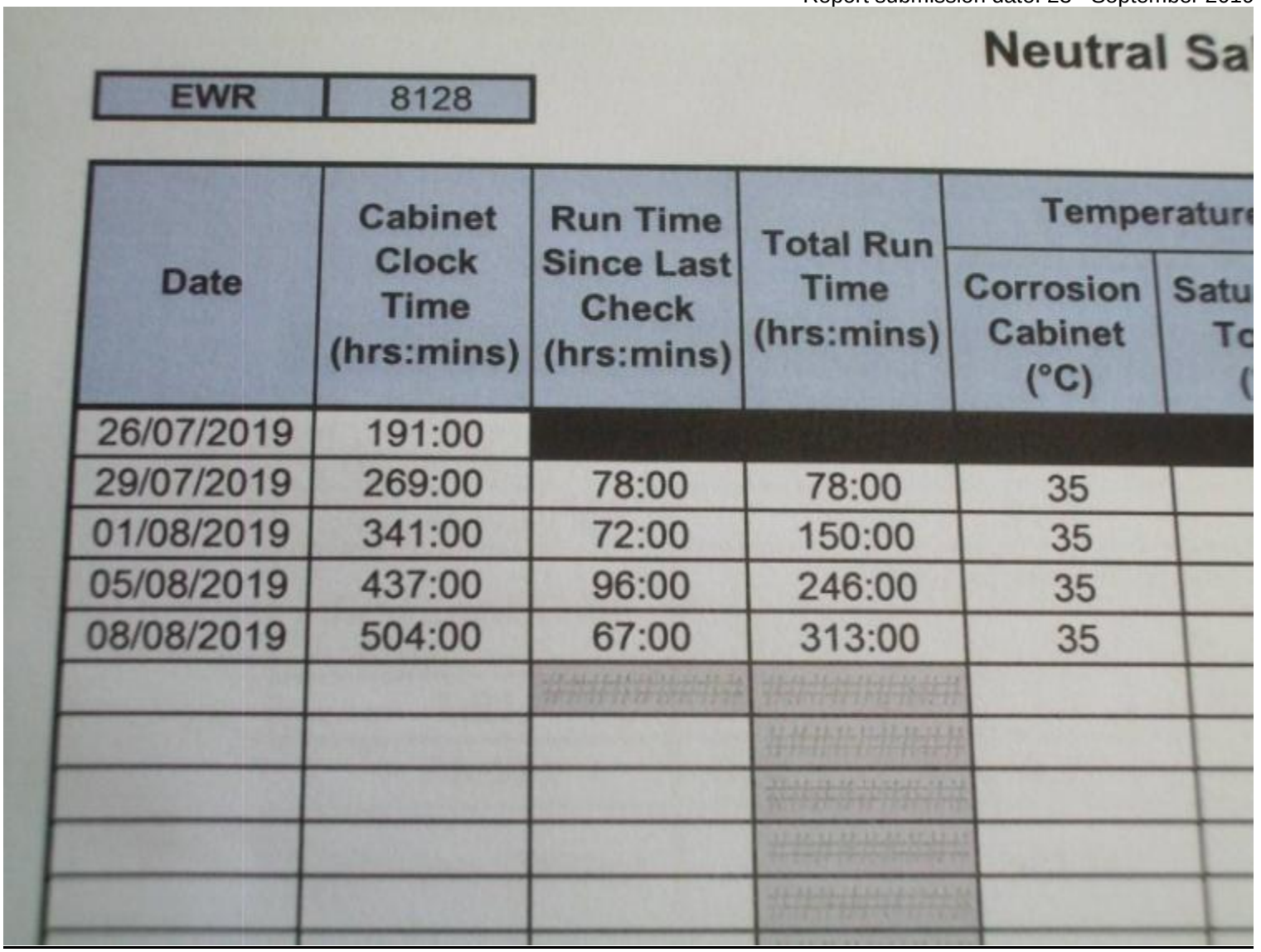
Vertical Load Test Rig – Cast-in Component



Vertical Load Test – Cast-in Components

Vertical Load Test - Cast-in Component Surface after Test

Severe Environmental Conditions - Test sample after 313 hours Immersion



Neutral Sa

EWR	8128

Date	Cabinet Clock Time (hrs:mins)	Run Time Since Last Check (hrs:mins)	Total Run Time (hrs:mins)	Temperature	
				Corrosion Cabinet (°C)	Satu To (
26/07/2019	191:00				
29/07/2019	269:00	78:00	78:00	35	
01/08/2019	341:00	72:00	150:00	35	
05/08/2019	437:00	96:00	246:00	35	
08/08/2019	504:00	67:00	313:00	35	

Severe Environmental Conditions - Test Log

Severe Environmental Conditions - Manual dismantle

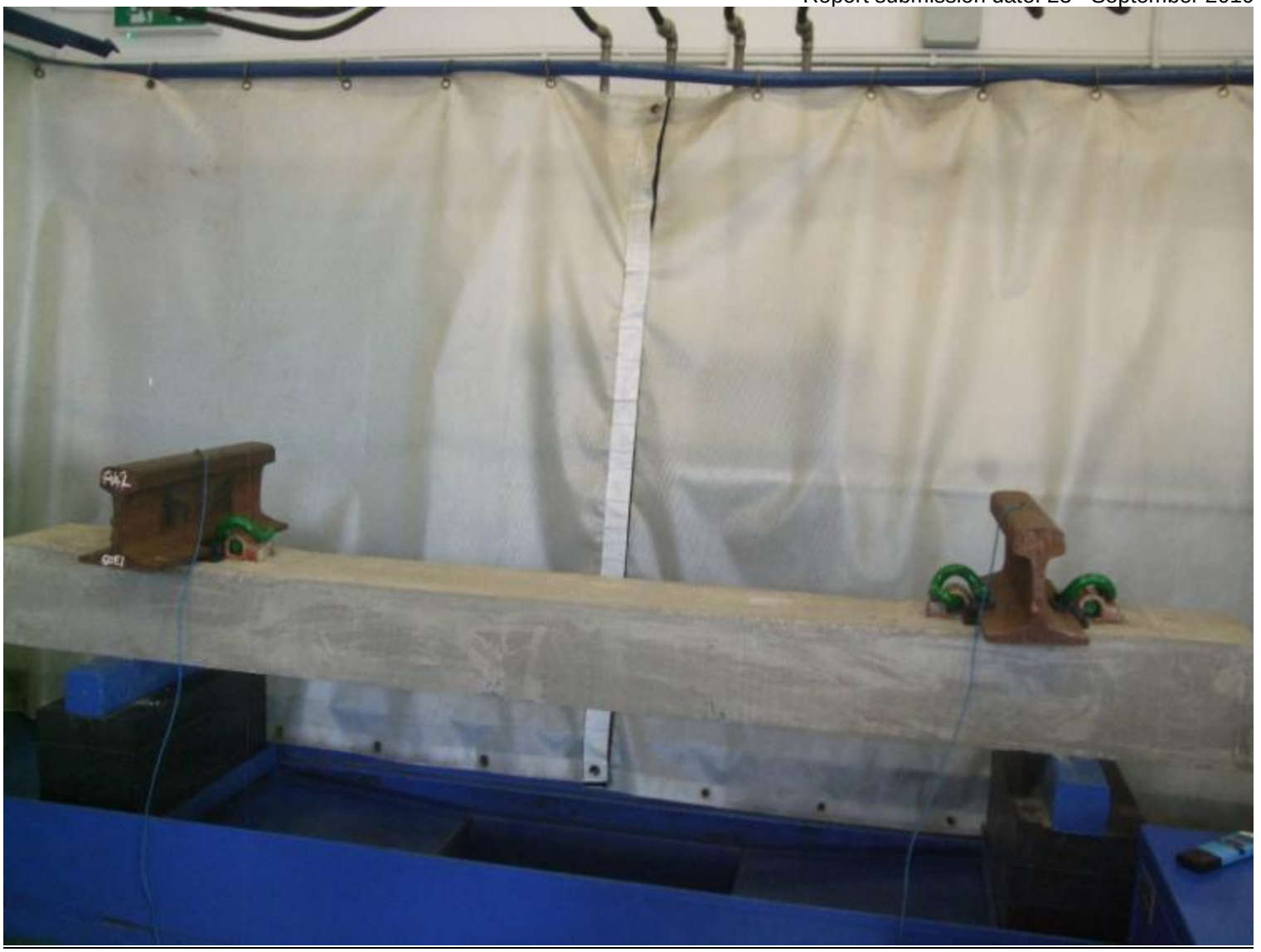
Severe Environmental Conditions - Components after dismantle

Severe Environmental Conditions - Slab after Dismantle

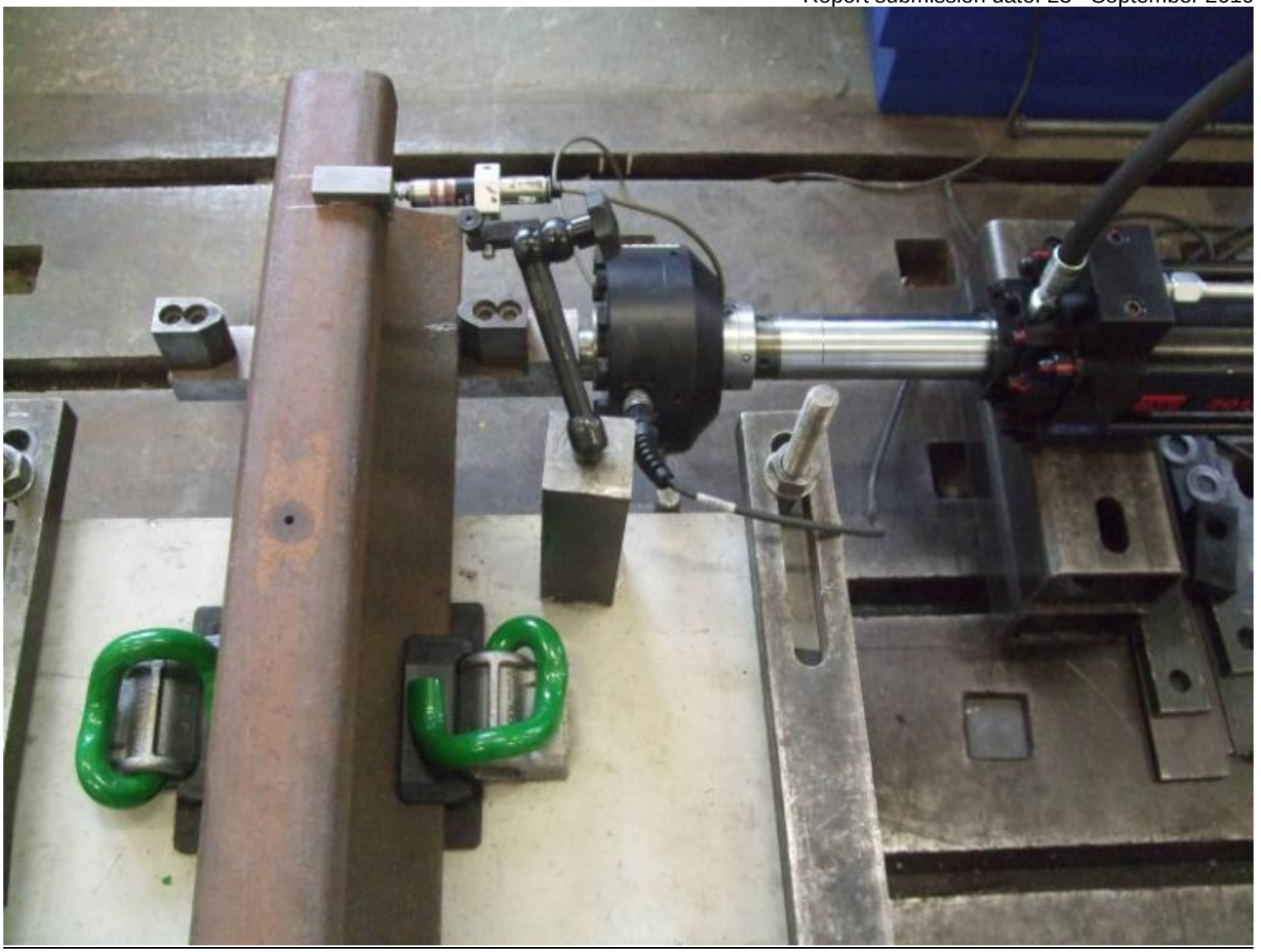
Severe Environmental Conditions - Manual Re – Assembly

Electrical Resistance Test Slab

Electrical Resistance Test Sample

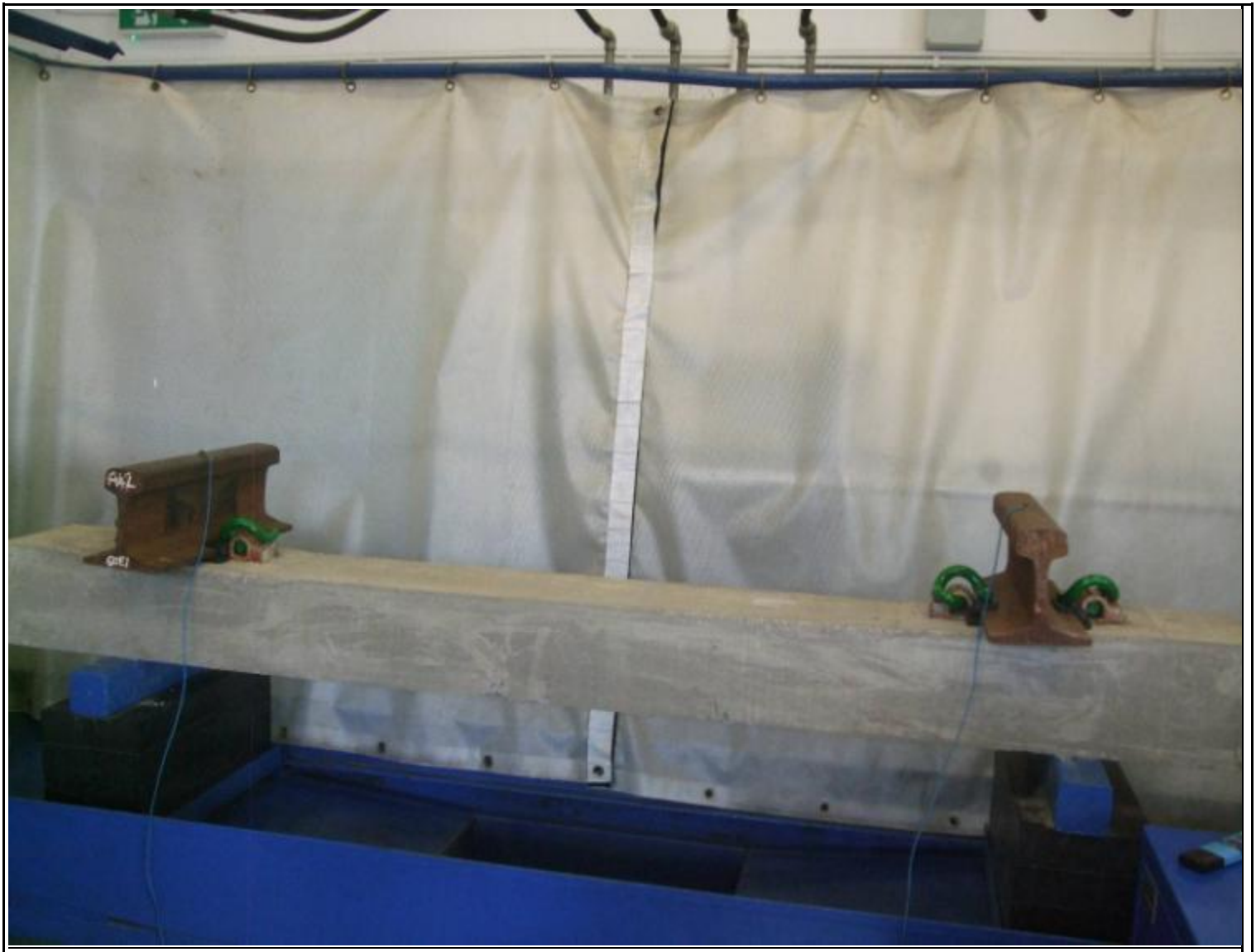


Electrical Resistance Test - Test Spray Booth



Torsional Resistance Test Rig

23rd and 30th August



Electrical Resistance Test - Test Spray Booth

Electrical Resistance Test Sample & Electrical Connection

Timesheet

Time:	inspection(hours):	26/07 7½ hrs 31/07 6 hrs 01/08 8 hrs 12/08 6 hrs 13/08 6 hrs 14/08 5¾ hrs 23/08 1¾ hrs 30/08 3 hrs	
	reporting(hours):	26/07 1¾ hrs 01/08 2 hrs 14/08 2½ hrs 30/08 2 hrs	
	travel(hours):	26/07 2¼ hrs 31/07 2 hrs 01/08 2¼ hrs 12/08 2 hrs 13/08 2 hrs 14/08 2¼ hrs 23/08 2 hrs 30/08 2 hrs	
	distance(miles):	68 x 8	
	Arrival time	26/07 08.40am 31/07 08.30am 01/08 08.20am 12/08 08.45am 13/08 08.45am 14/08 09.00am 23/08 08.45am 30/08 08.45am	
	Departure time)	26/07 04.10pm 31/07 02.30pm 01/08 02.20pm 12/08 2.45pm 13/08 2.45pm 14/08 2.45pm 23/08 10.30am 30/08 11.45am	

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