



Project:	TWF Rebar Tie Testing
Title:	Preliminary Tests Series 1
Client:	Temporary Works Forum
Project Ref:	SC-2909
Report Number:	SC-2909-RTT-01
Revision Number:	02
Report Date:	15/09/2022

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DOCUMENT CONTROL

Revision Number	Section	Details of revision	Revision by	Date
01	All	Incorporating comments from DT	CM	13/07/22
02	Notes on bottom of page 6	Incorporating comments from DT	CM	15/09/22

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GENERAL INFORMATION			
Client:	Temporary Works Forum		
Site Address:	Anchor Bay Wharf, Manor Road, Erith, DA8 2AW		
Client Contact:	David Thomas		
Inspection Date:	20, 21/06/2022		
Weather conditions:	Dry, approximate 16°C – 24°C		
Purpose of Test:	Preliminary Tests for proof of concept of the test rig, equipment and methodology		
Testing Brief:	SC-2909-TB-01		
Procedure:	As per SC-2909-MS-01	Revision No:	
Risk Assessment / Method Statement:	SC-2909-MS-01		

Test Carried Out By:	Conor McHugh and Mihai Chelmus		
Report By:	Name: Mihai Chelmus	Signature:	
Authorised By:	Name: Conor McHugh	Signature:	

TEST EQUIPMENT		
	Equipment	Swantest ID Number
Hydraulic Jack:	Staht Pull Tester	SN264
Measurement Gauge:	Staht String Pot	SN99

Tying wire details



Data Sheet in Appendix.

Black Soft Annealed Tying Wire is the most popular tying wire and is annealed to the highest standards.

- 16 gauge
- Diameter of wire: 1.6mm – confirmed with callipers to be 1.6mm
- 12kg coil
- Colour: Black
- Slightly oiled finish
- Tensile test: Passed
- Coil packaging inner: plastic
- Coil packaging outer: hessian

TEST DETAILS	
Type of Loading:	Tensile load
Incremental or Continuous:	Continuous
Required Proof Load:	• Each tie was tested to Failure. • Failure either consisted of a snapped tie or the tie elongated to the point where it continued to slip and could not maintain load. • Where 'slipping' was record as the failure mode, this is detailed on the "notes" section of each individual test report as "slipped".
TEST LOCATIONS	
Location:	Swantest Yard, Anchor Bay Wharf, Manor Road, Erith, DA8 2AW
Weather Conditions	• All tests were carried out outside, under cover. • The weather was dry, sunny, with temperatures ranging from 18°C up to 24°C •

1. Test parameters

Swantest has been appointed to load test 90no rebar tying ties installed on three different rebar sizes to failure (T12, T20 and T32). We ran the tests in three different configurations, 10no tests on each type of rebar, as shown in Figs. 2, 3, and 4 below.

For the load application system, we used a Staht tensile load tester. This is small hydraulic cylinder which allowed us to apply a slow controlled load and connect directly to the rebar.

The unit has been manually operated. We used draw string sensors and a pressure transducer, connected to the Staht tester to monitor load vs displacement.

The rig is formed using 4no. RMD slim shore solders, connected together using dywidag tie bars.

We used a variety of MBT rebar couplers as well as dywidag couplers to form the connections.

All ties were hand tied using a standard nips by an experienced steel fixer with 30+ years in the industry.

The position of each bar, whether it be rib to rib, or rib over rib, or ribs in different direction was completely random and not recorded.

For each test the system and connections were tightened up as much as possible by hand to remove slack.

The string pot displacement sensor is connected to the frame and the other end of the 'string' is connected to the rebar that we are applying the tensile load to.

For each test we recorded load vs displacement. There is also 'time' being recorded.

For each test we applied a very small amount of preload, to remove any final slack. This was 0.1kN. At this point we zeroed the system and started to record the test load vs displacement.

The number of turns on the handle of the pull test kit varied for this preload application.

Throughout each test the load was applied continuous and steady, loading each tie to failure. The rate of load application was approx. 1 turn of the handle every 3- 4 seconds.

NOTES:

- We used a reference system for each test name: Example Test reference T12-01-01 = 12mm rebar. Test set up Type 1. Test number 1.
- Where we reference "slipped" this indicates that the tie did not snap – but elongates to the point where it continue to slip over the bars.
- This is noted in the 'notes' section of each individual test result.
- Values for the maximum load and displacement presented are independent of each other, i.e. peak load does not occur at maximum test displacement
- For tests where a double tie has been used it can be said that the average capacity of a single doubled wire tie is half of the recorded values.

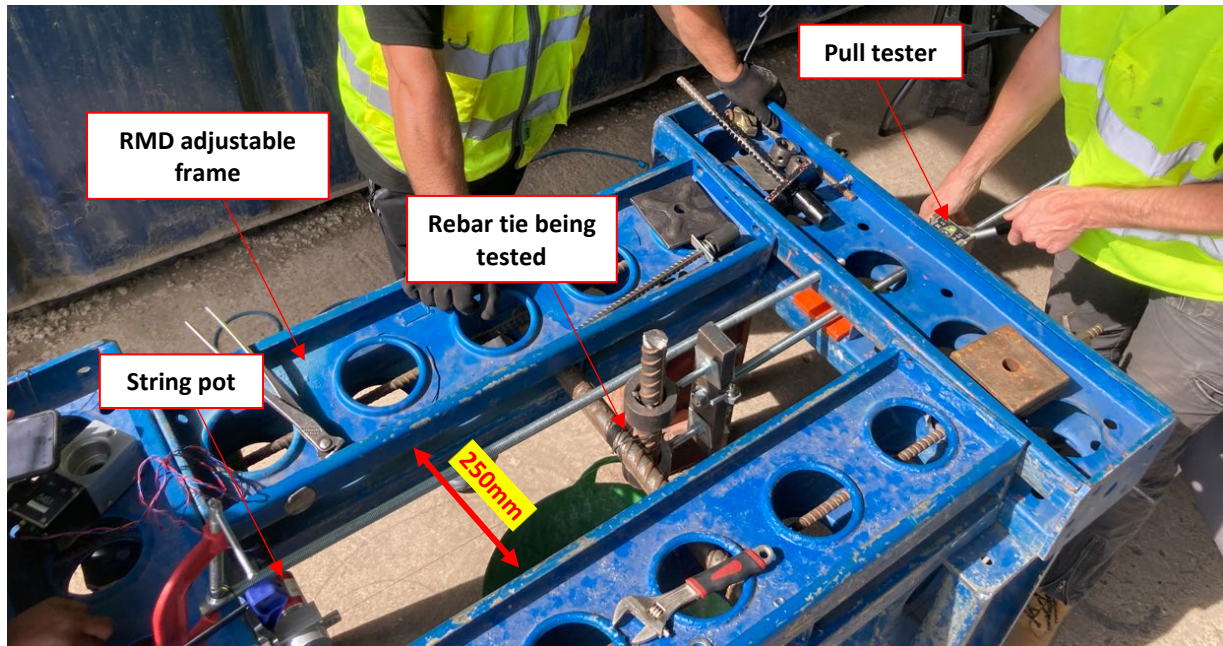


Fig. 1: Typical test setup

2. Test results

2.1. Test Type 1 Failure Results

Test Type 1								
12mm diameter bar Double crown tie			20mm diameter bar Double crown tie			32mm diameter bar Double crown tie		
	Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)
1	1.96	44.3	1	2.45	50.4	1	4.33	68.3
2	3.17	32.8	2	2.23	44.4	2	2.6	37
3	2.3	30.2	3	2.15	52.2	3	4.61	28.4
4	0.77*	3.7	4	2.84	67.7	4	2.68	28.1
5	3.26	24.8	5	1.64	27.5	5	2.6	26.8
6	2.39	26.5	6	2.08	48.8	6	2.12	26.9
7	1.99	33.1	7	2.3	31.3	7	2.92	40.4
8	2.32	21.6	8	2.53	39.6	8	3.39	36
9	2.0	26.8	9	1.02	19	9	2.78	27.8
10	3.17	19.1	10	3.15	42.4	10	2.61	28.2

*this 'low' test result was noted as being a result of the tie excess tie wire being cut to close to the tie.

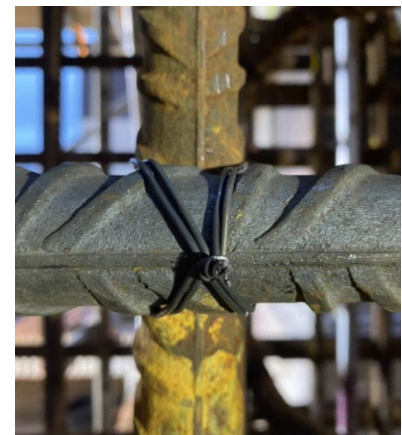
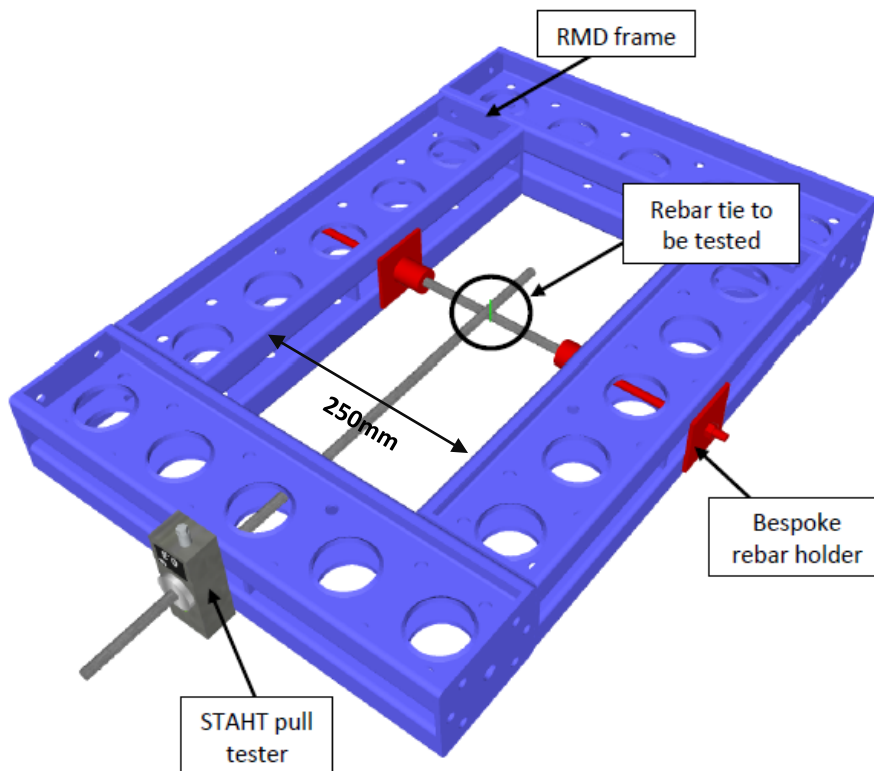


Fig. 2: Test Type 1 setup and example of double crown tie

2.2. Test Type 2 Failure Results

Test Type 2								
12mm diameter bar 2no single splice ties			20mm diameter bar 2no single splice ties			32mm diameter bar 2no single splice ties		
	Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)
1	3.32	33.8	1	3.84	40.7	1	1.85	31.5
2	3.59	28.9	2	2.22	29.6	2	2.34	29.1
3	3.08	36	3	2.46	25.6	3	2.42	28.2
4	2.85	29.6	4	2.83	31.6	4	1.86	33.1
5	2.34	34.6	5	2.98	23.7	5	1.5	30
6	2.31	24.7	6	2.9	41.2	6	2.38	29.9
7	2.92	21.7	7	2.91	32.3	7	2.8	49.9
8	3.27	20.9	8	3.48	30.6	8	1.75	45.8
9	2.54	23.4	9	2.4	33.9	9	2.64	36
10	3.24	29.5	10	2.87	41.7	10	1.94	29.9

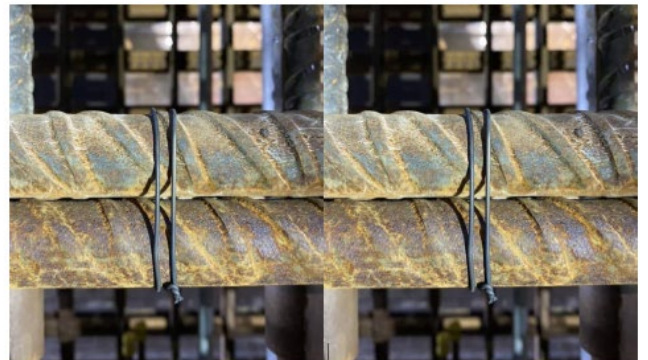
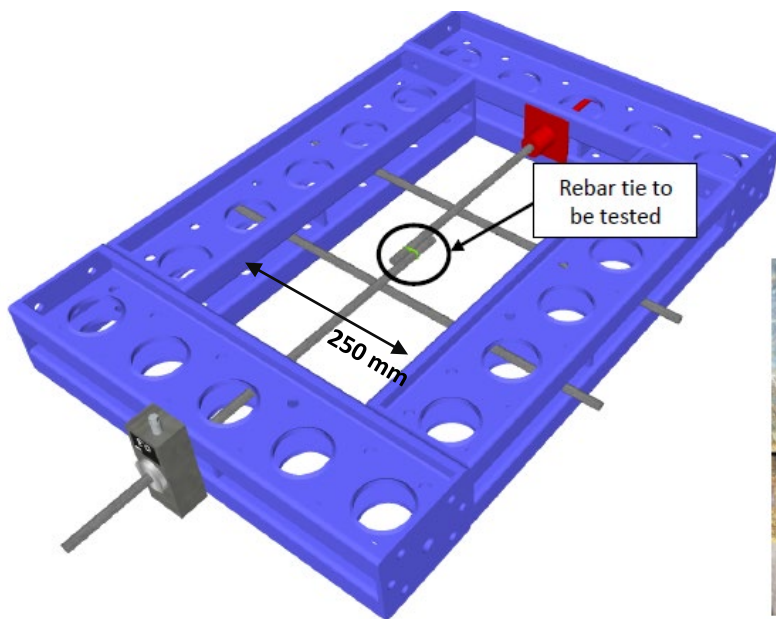


Fig. 3: Test Type 2 setup and example of 2no single splice ties
Note: On each test, 2no single splice ties were tested

Lap lengths varied between 120mm up to 350mm on different bar sizes.

2.3. Test Type 3 Failure Results

Test Type 3								
12mm diameter bar Double crown tie			20mm diameter bar Double crown tie			32mm diameter bar Double crown tie		
	Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)
1	2.54	17.9	1	2.43	13	1	3.52	20.3
2	2.34	13.6	2	2.98	18.7	2	3.8	16.8
3	2.48	18.9	3	2.96	17.9	3	3.32	19.9
4	2.7	16.2	4	3.07	16.8	4	3.61	17.7
5	2.39	26.5	5	3.19	19.2	5	3.37	16.2
6	2.47	19.3	6	2.89	18.1	6	3.14	17.6
7	2.3	13.9	7	2.9	16.8	7	3.54	19.6
8	2.68	14.4	8	2.38	17.3	8	3.55	19
9	2.94	17.2	9	2.88	14.6	9	3.2	19.8
10	2.94	19.8	10	3.01	17.9	10	2.94	18.6

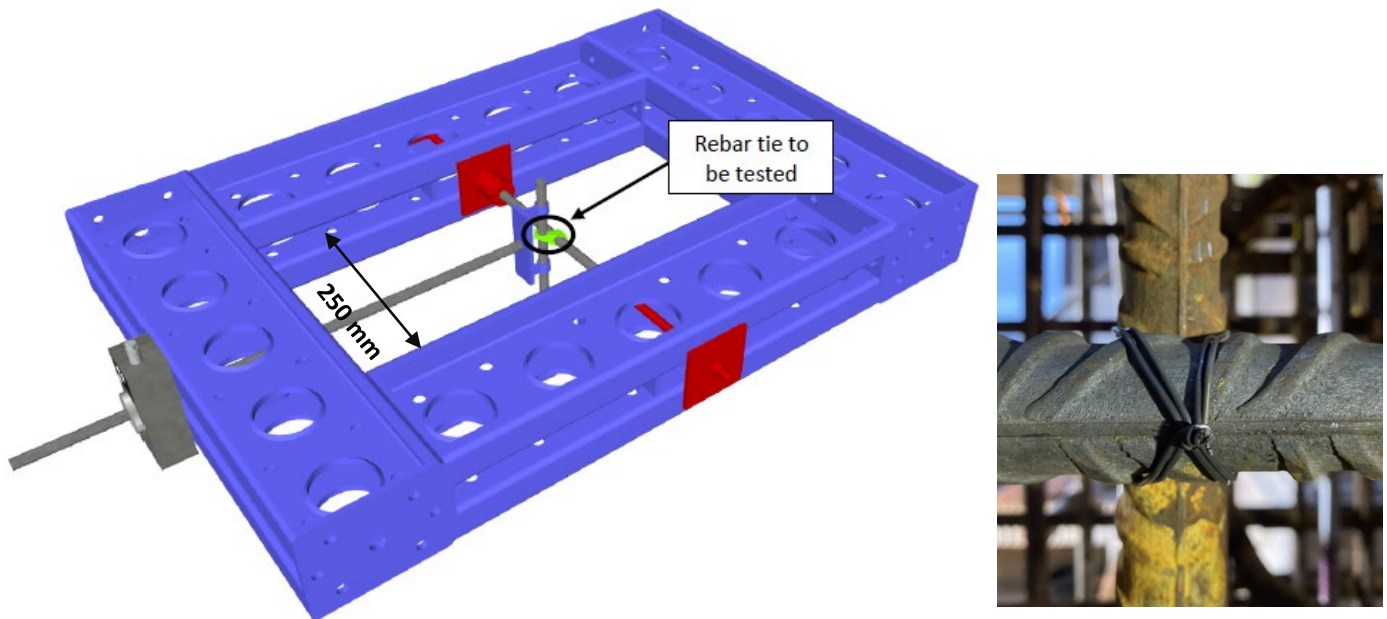


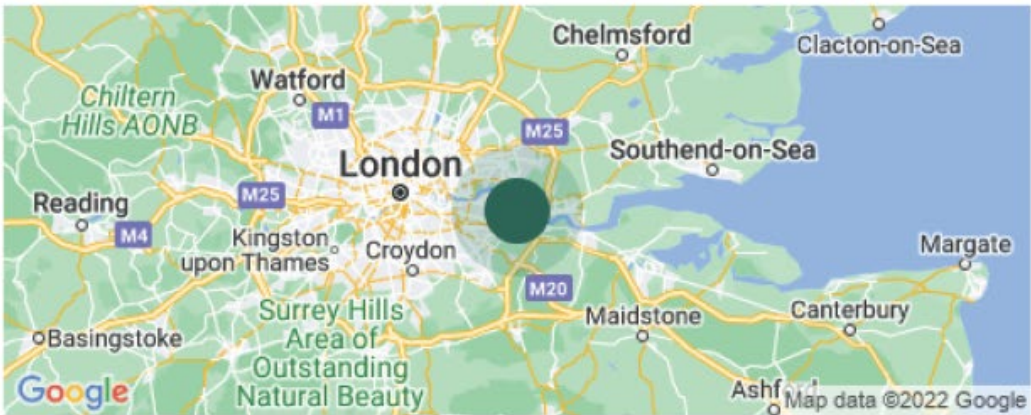
Fig. 4: Test Type 3 setup and example of double crown tie

3. Test Type 1 – T12 Rebar Force vs Displacement Graphs

Test Title 20-June-2022 16 : 36

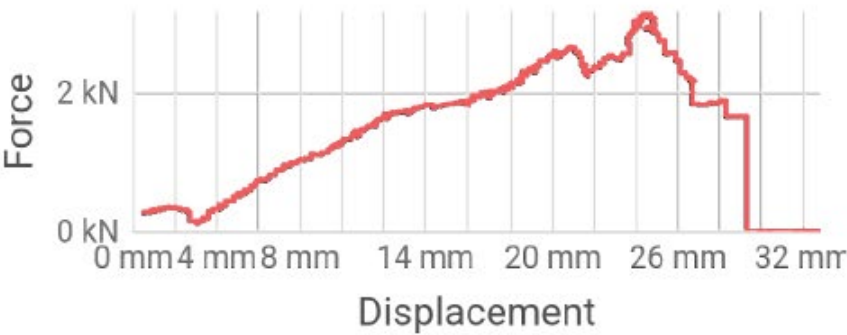


Date & Time 20 Jun 2022 15:36 Maximum Load Achieved 1.96 kN
Device SN Next Calibration Date
Max displacement 44.3 mm
Notes
T12-01-01 Slipped

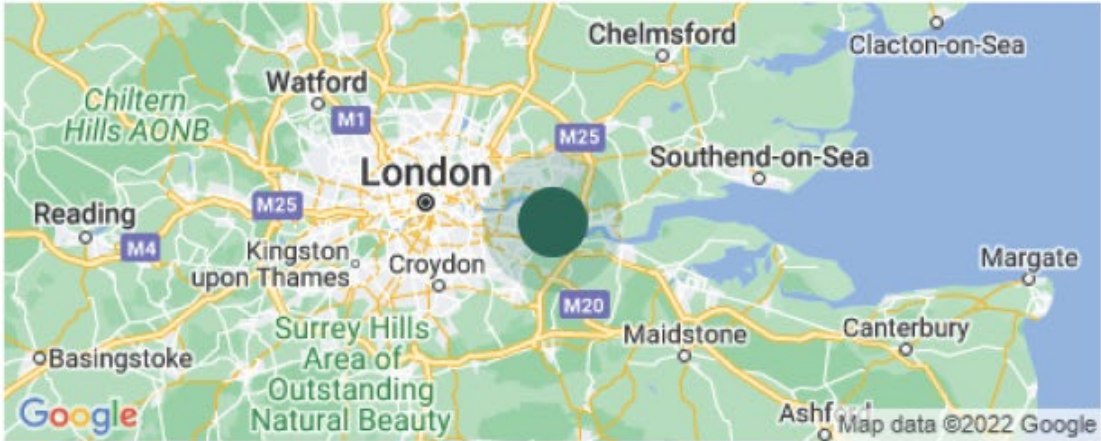


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Test Title 20-June-2022 16 : 38



Date & Time	20 Jun 2022 15:38	Maximum Load Achieved	3.17 kN
Device SN		Next Calibration Date	
Max displacement	32.8 mm		
Notes			
	T12-01-02		



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Test Title 20-June-2022 16 : 38

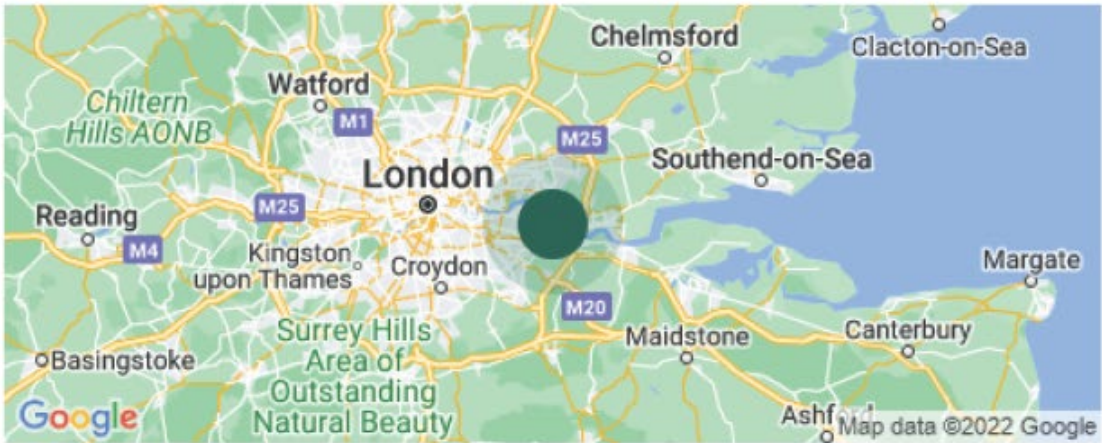


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Test Title 20-June-2022 16 : 41



Date & Time	20 Jun 2022 15:41	Maximum Load Achieved	2.3 kN
Device SN		Next Calibration Date	
Max displacement	30.2 mm		
Notes			
	T12-01-03		



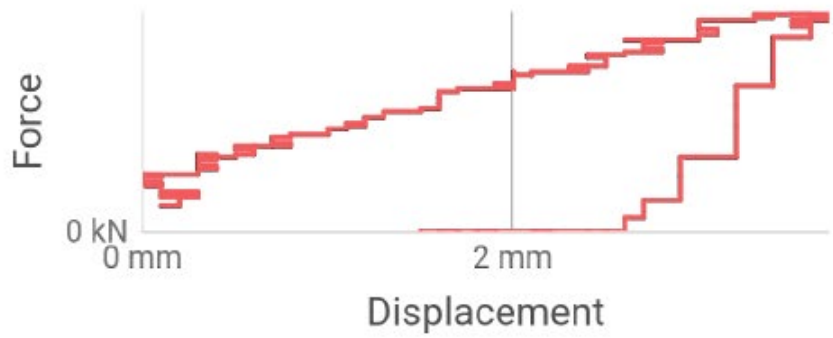
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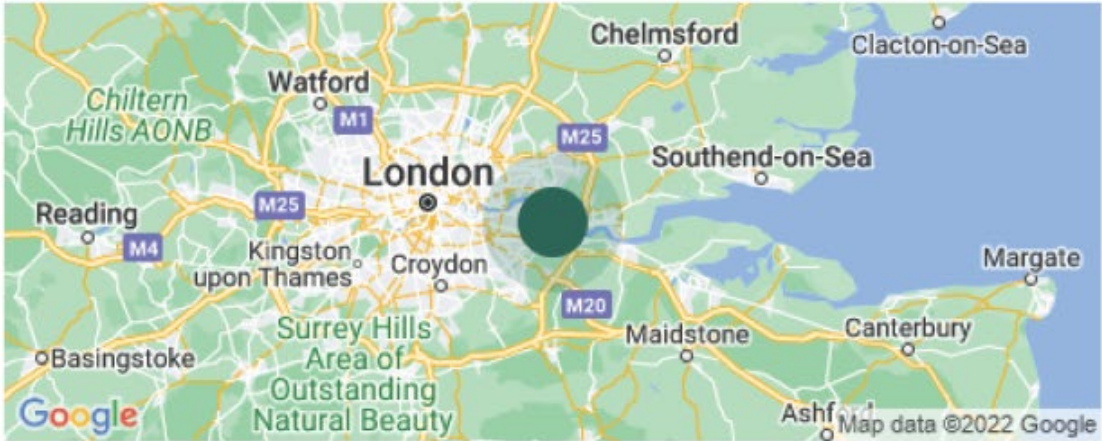


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Test Title 20-June-2022 16 : 46



Date & Time	20 Jun 2022 15:46	Maximum Load Achieved	0.77 kN
Device SN		Next Calibration Date	
Max displacement	3.7 mm		
Notes			

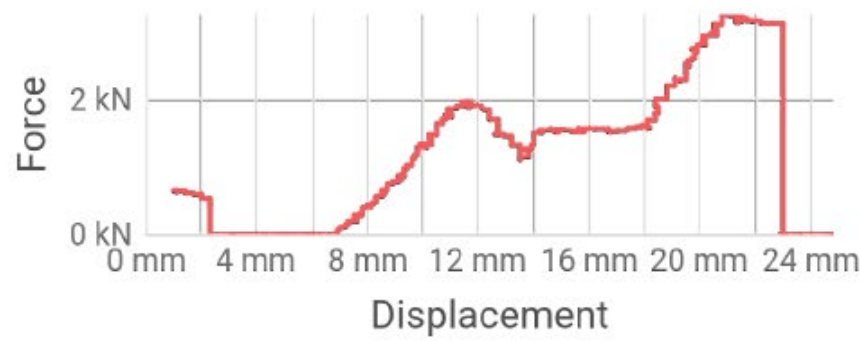


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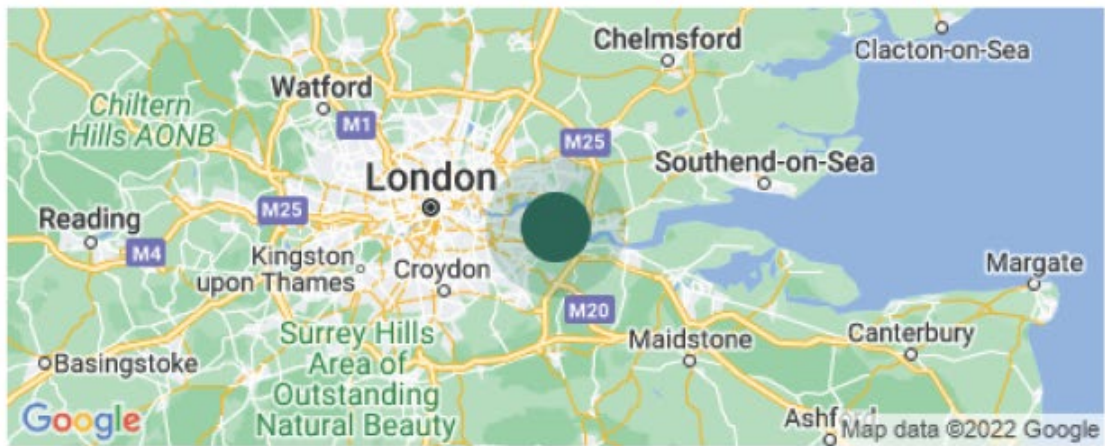
Test Title 20-June-2022 16 : 46



Test Title 20-June-2022 16 : 47



Date & Time	20 Jun 2022 15:47	Maximum Load Achieved	3.26 kN
Device SN		Next Calibration Date	
Max displacement	24.8 mm		
Notes			
	T12-01-05		



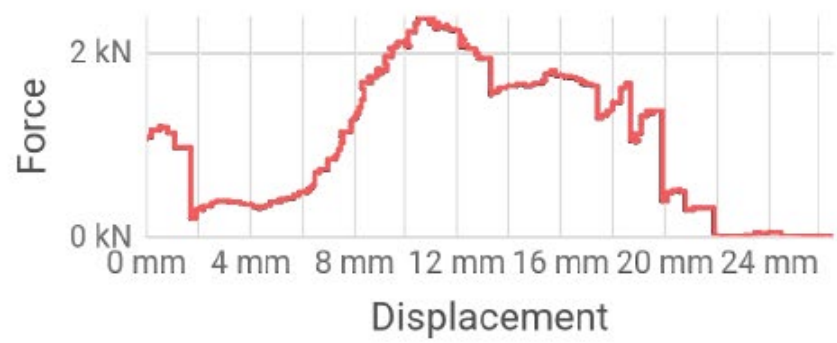
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Test Title 20-June-2022 16 : 47

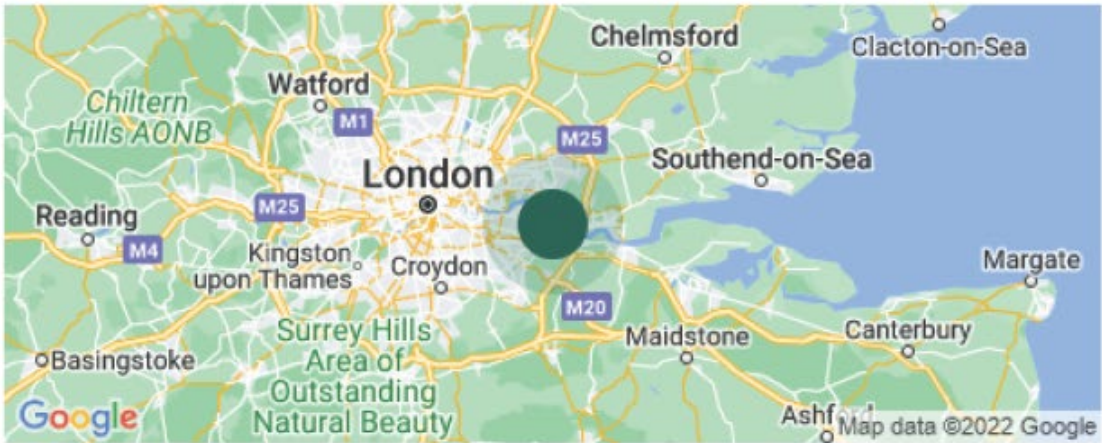


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Test Title 20-June-2022 16 : 49



Date & Time	20 Jun 2022 15:49	Maximum Load Achieved	2.39 kN
Device SN		Next Calibration Date	
Max displacement	26.5 mm		
Notes			
	T12-01-06		



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Test Title 20-June-2022 16 : 49

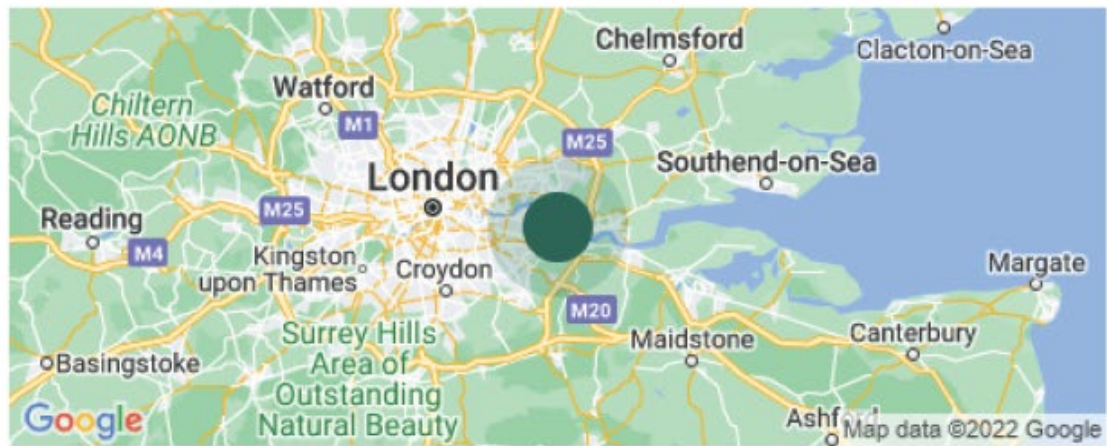


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Test Title 20-June-2022 16 : 52



Date & Time	20 Jun 2022 15:52	Maximum Load Achieved	1.99 kN
Device SN		Next Calibration Date	
Max displacement	33.1 mm		
Notes			
	T12-01-07		



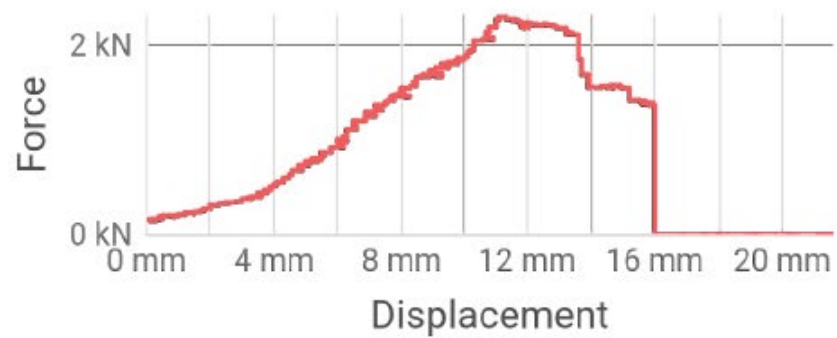
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Test Title 20-June-2022 16 : 52

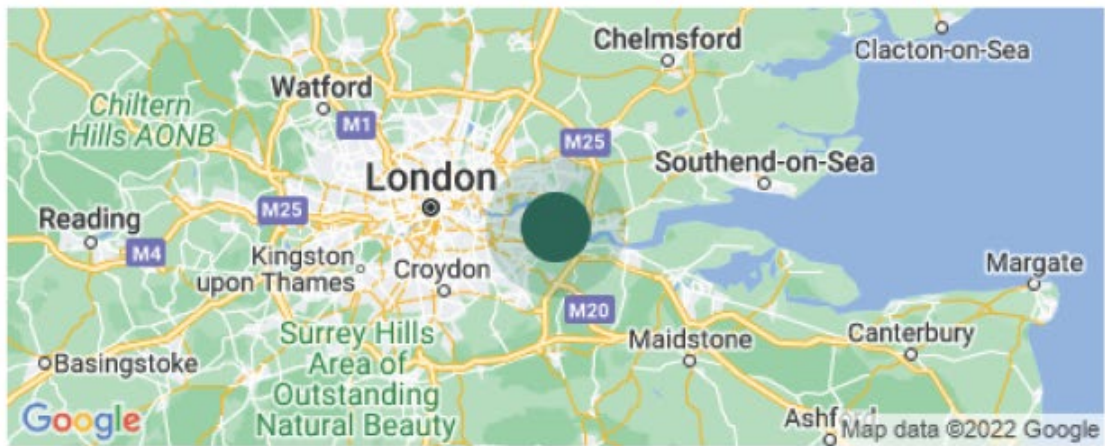


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Test Title 20-June-2022 16 : 55



Date & Time	20 Jun 2022 15:55	Maximum Load Achieved	2.32 kN
Device SN		Next Calibration Date	
Max displacement	21.6 mm		
Notes			
T12-01-08			



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Test Title 20-June-2022 16 : 55

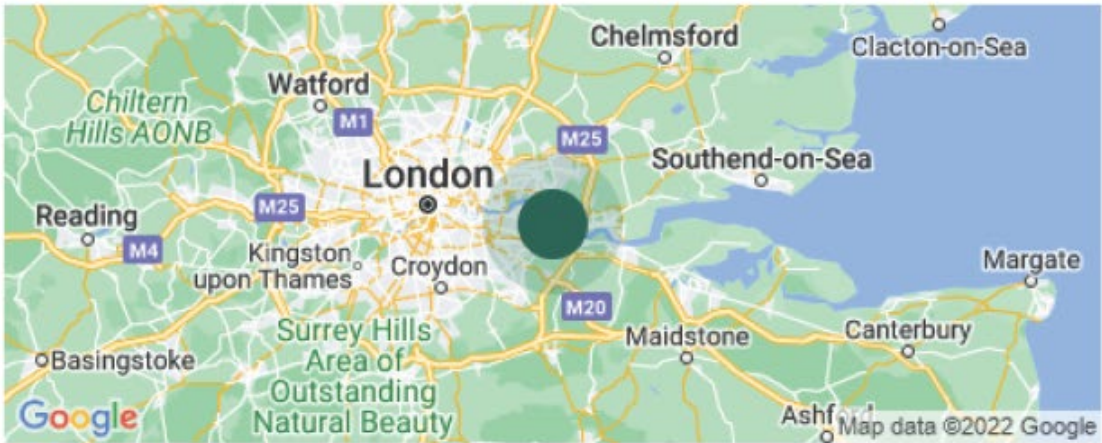


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Test Title 20-June-2022 16 : 57



Date & Time	20 Jun 2022 15:57	Maximum Load Achieved	2 kN
Device SN		Next Calibration Date	
Max displacement	26.8 mm		
Notes			
T12-01-09			



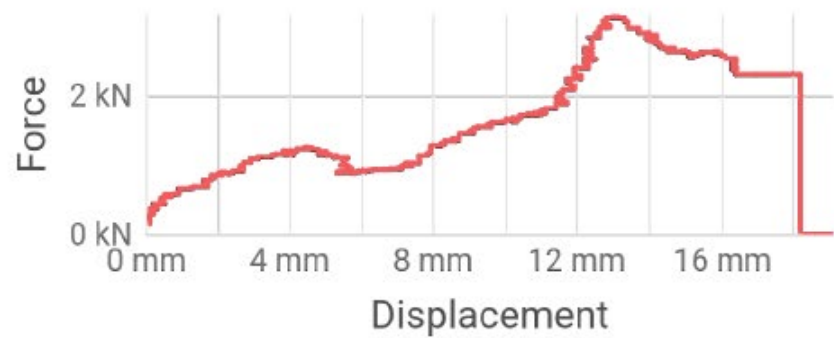
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Test Title 20-June-2022 16 : 57

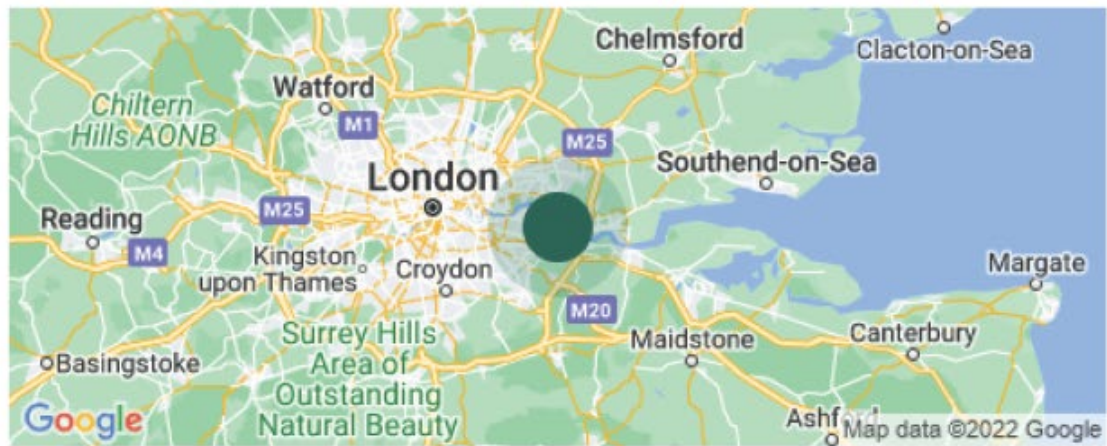


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Test Title 20-June-2022 16 : 59



Date & Time	20 Jun 2022 15:59	Maximum Load Achieved	3.17 kN
Device SN		Next Calibration Date	
Max displacement	19.1 mm		
Notes			
	T12-01-10		



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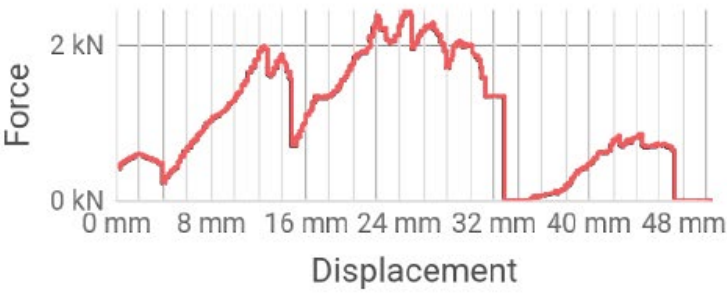
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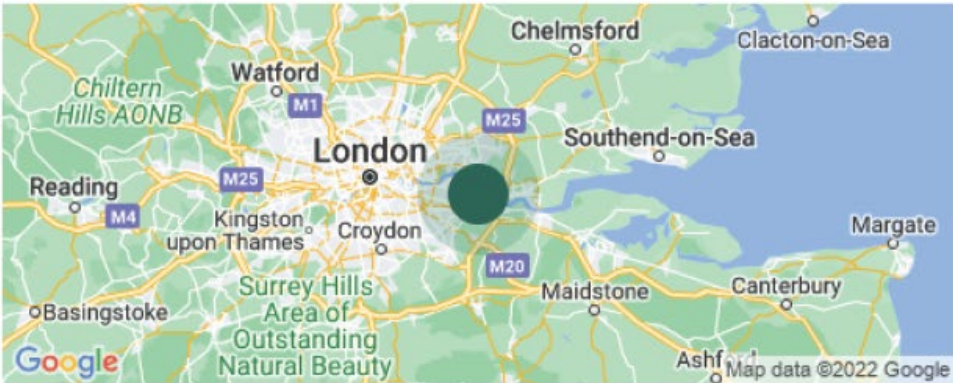
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4. Test Type 1 – T20 Rebar Force vs Displacement

Test Title 20-June-2022 15 : 30



Date & Time	20 Jun 2022 14:30	Maximum Load Achieved	2.45 kN
Device SN		Next Calibration Date	
Max displacement	50.4 mm		
Notes	T20-01-01		



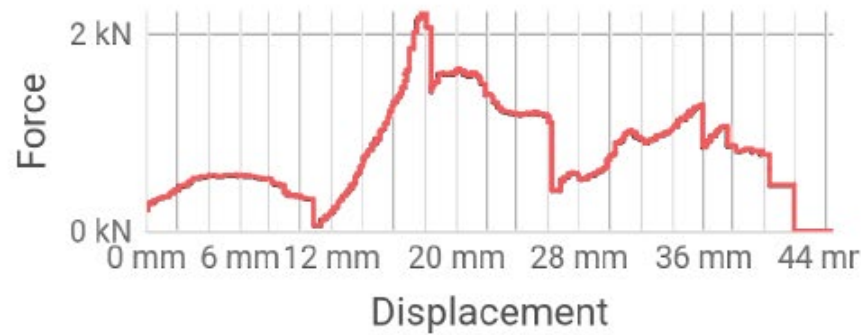
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Test Title 20-June-2022 15 : 30

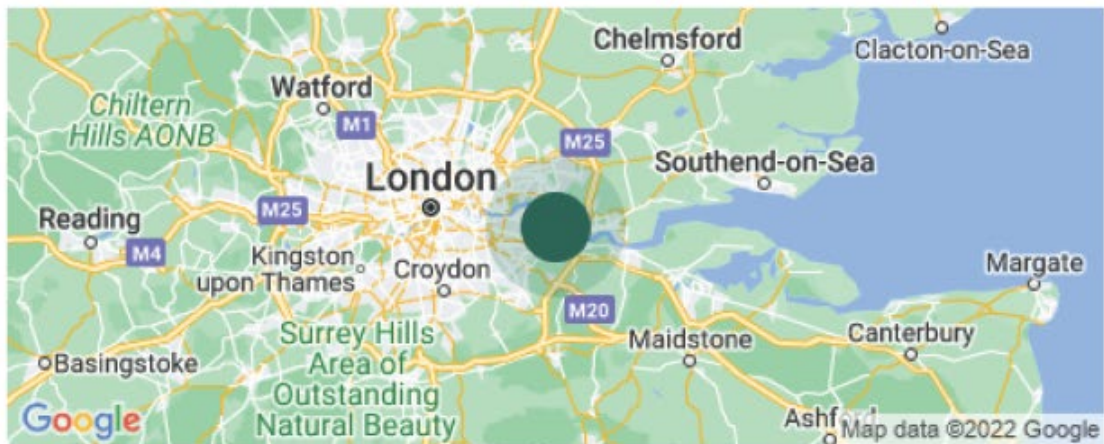


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Test Title 20-June-2022 15 : 33



Date & Time	20 Jun 2022 14:33	Maximum Load Achieved	2.23 kN
Device SN		Next Calibration Date	
Max displacement	44.4 mm		
Notes			
T20-01-02			



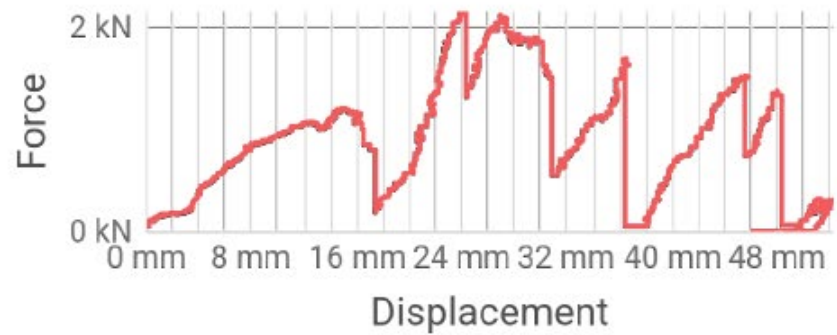
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Test Title 20-June-2022 15 : 33

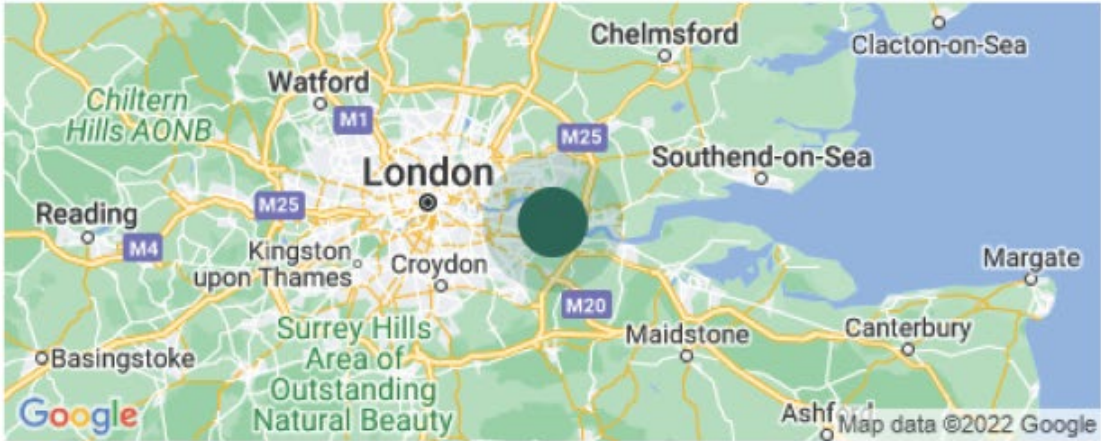


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Test Title 20-June-2022 15 : 36



Date & Time	20 Jun 2022 14:36	Maximum Load Achieved	2.15 kN
Device SN		Next Calibration Date	
Max displacement	52.2 mm		
Notes	T20-01-03 slipped		



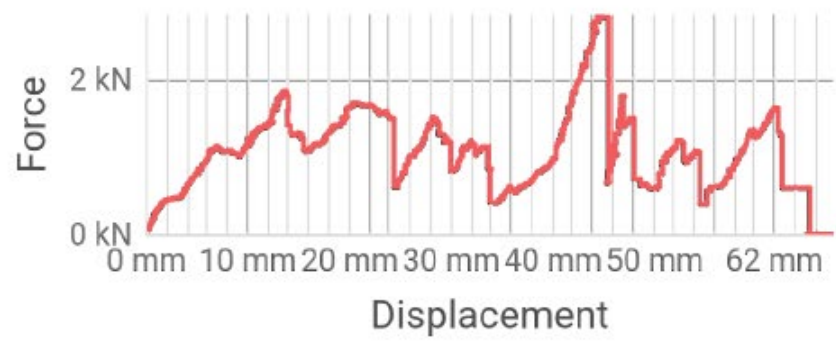
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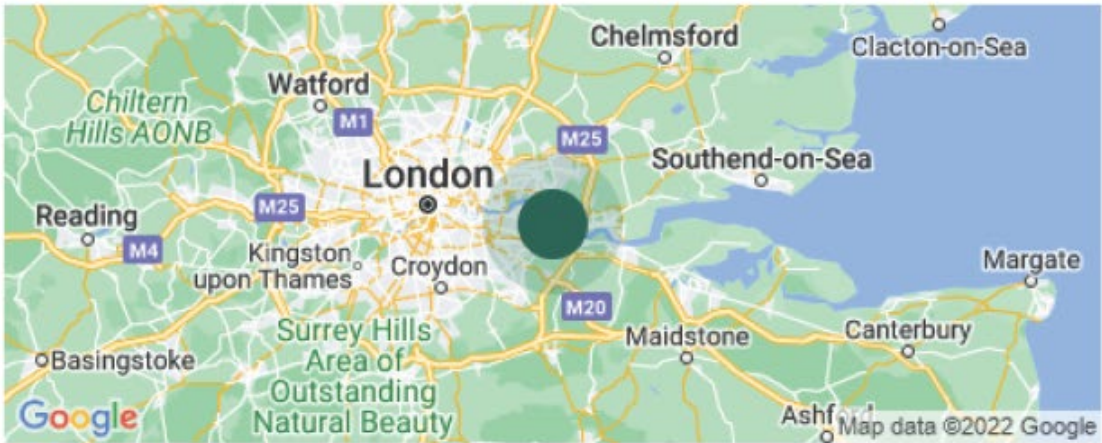


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Test Title 20-June-2022 15 : 39



Date & Time	20 Jun 2022 14:39	Maximum Load Achieved	2.84 kN
Device SN		Next Calibration Date	
Max displacement	67.7 mm		
Notes	T20-01-04 slipped		



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Test Title 20-June-2022 15 : 39

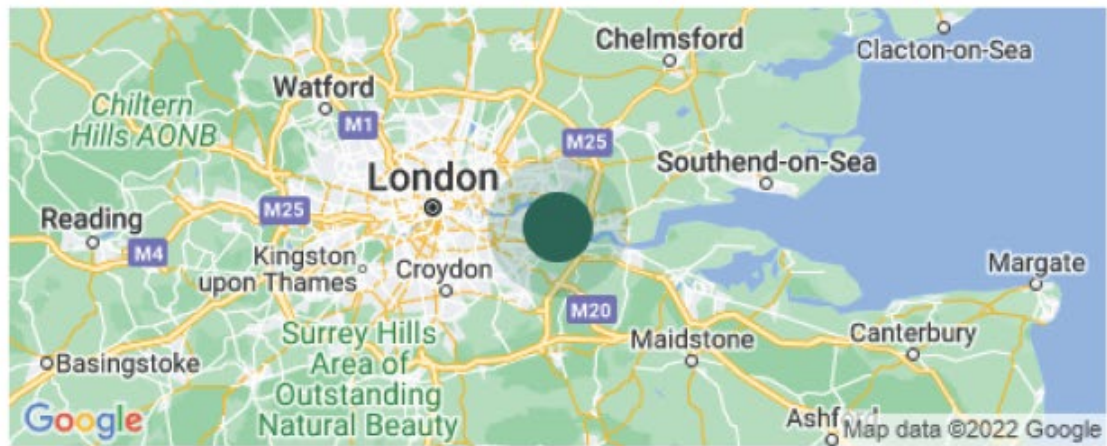


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Test Title 20-June-2022 15 : 42



Date & Time	20 Jun 2022 14:42	Maximum Load Achieved	1.64 kN
Device SN		Next Calibration Date	
Max displacement	27.5 mm		
Notes			
	T20-01-05		

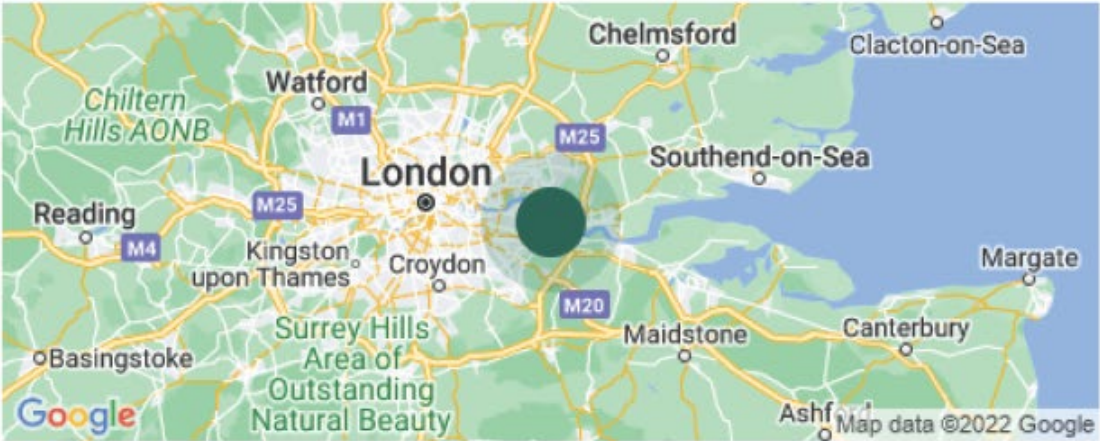


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Test Title 20-June-2022 15 : 46



Date & Time	20 Jun 2022 14:46	Maximum Load Achieved	2.08 kN
Device SN		Next Calibration Date	
Max displacement	48.8 mm		
Notes	T20-01-06 slipped		

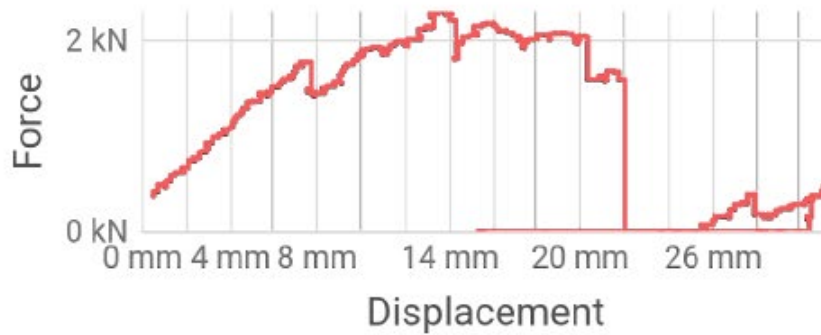


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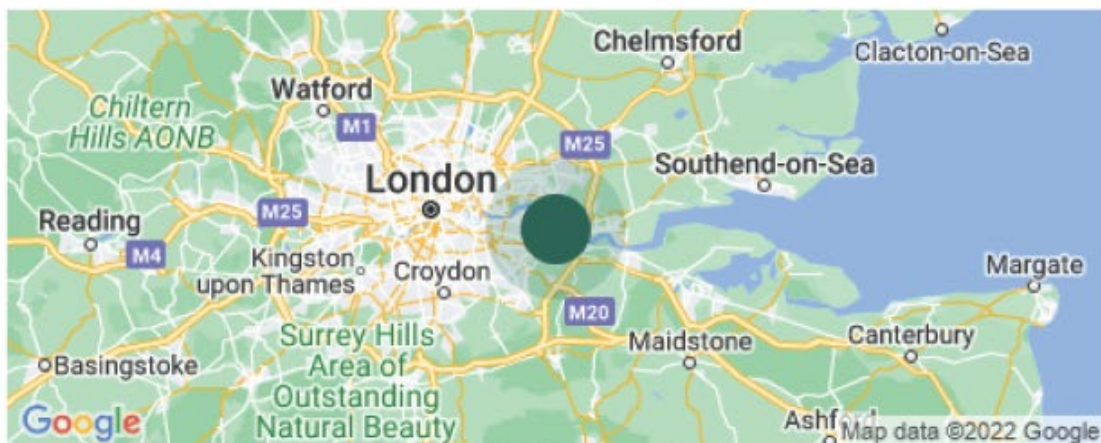


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Test Title 20-June-2022 15 : 49



Date & Time	20 Jun 2022 14:49	Maximum Load Achieved	2.3 kN
Device SN		Next Calibration Date	
Max displacement	31.3 mm		
Notes	T20-01-07 slipped		



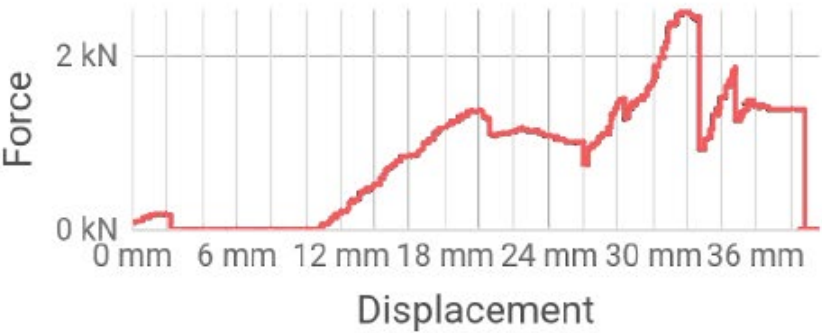
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Test Title 20-June-2022 15 : 49

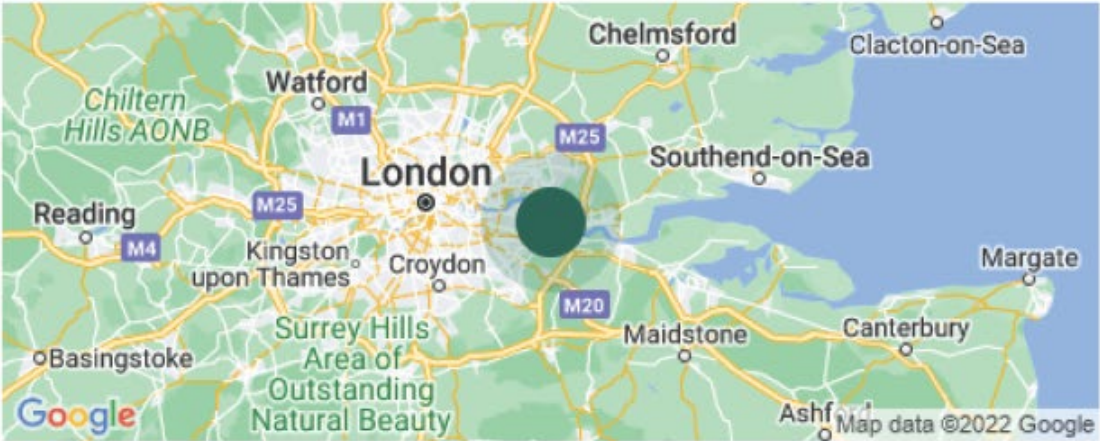


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Test Title 20-June-2022 15 : 52



Date & Time	20 Jun 2022 14:52	Maximum Load Achieved	2.53 kN
Device SN		Next Calibration Date	
Max displacement	39.6 mm		
Notes			
	T20-01-08		



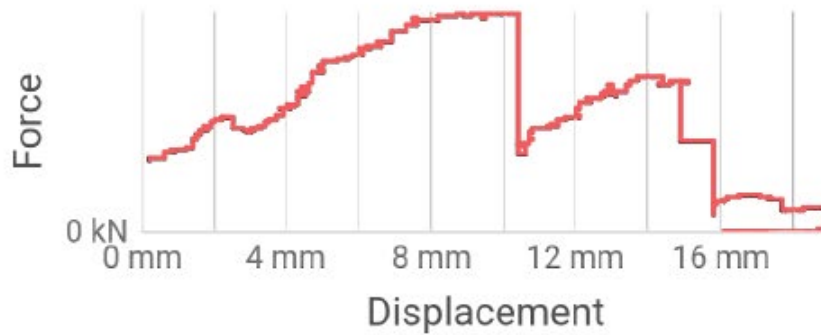
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Test Title 20-June-2022 15 : 52

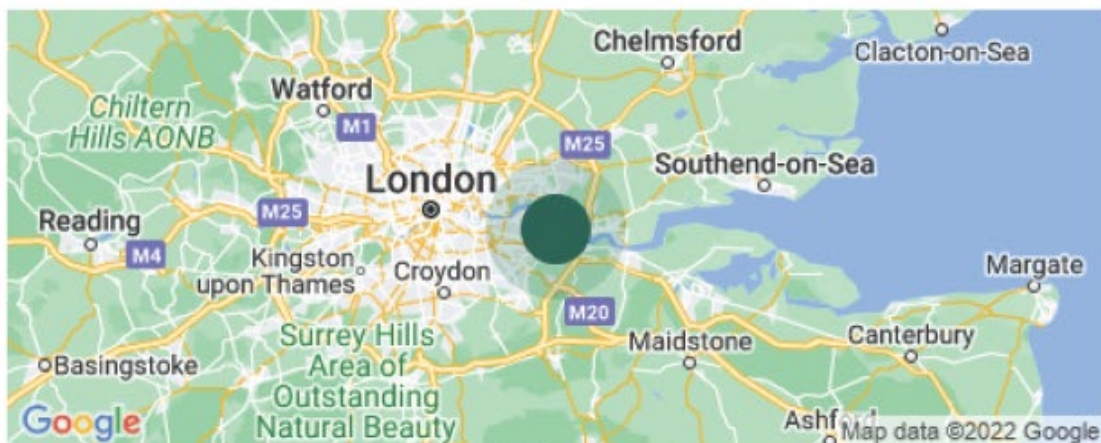


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Test Title 20-June-2022 15 : 54



Date & Time	20 Jun 2022 14:54	Maximum Load Achieved	1.02 kN
Device SN		Next Calibration Date	
Max displacement	19 mm		
Notes			
T20-01-09			



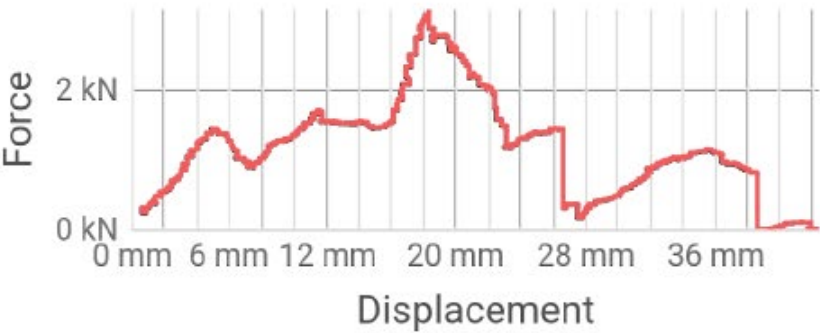
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Test Title 20-June-2022 15 : 54

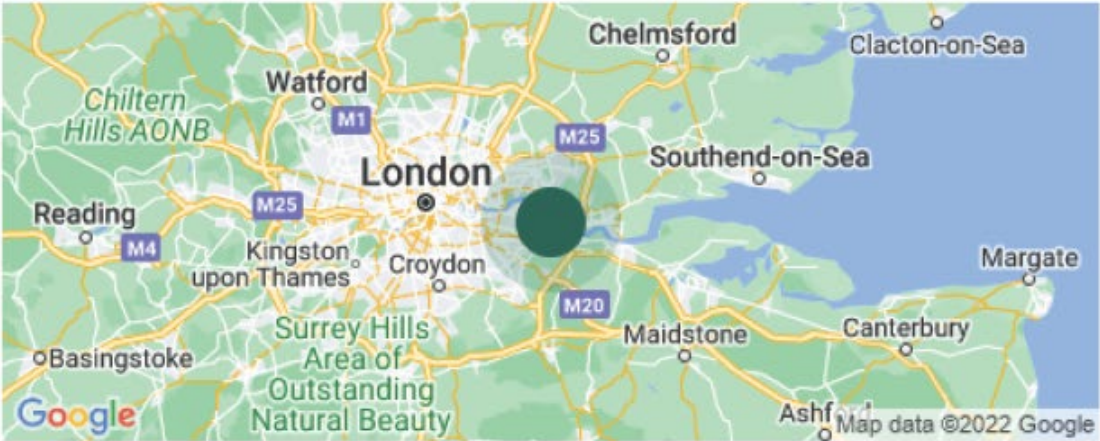


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Test Title 20-June-2022 15 : 56



Date & Time	20 Jun 2022 14:56	Maximum Load Achieved	3.15 kN
Device SN		Next Calibration Date	
Max displacement	42.4 mm		
Notes			
T20-01-10			



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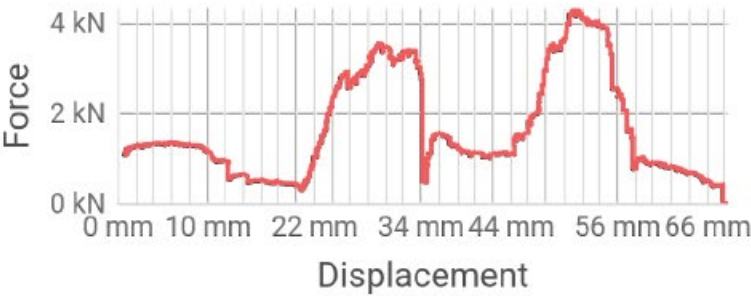
Test Title 20-June-2022 15 : 56



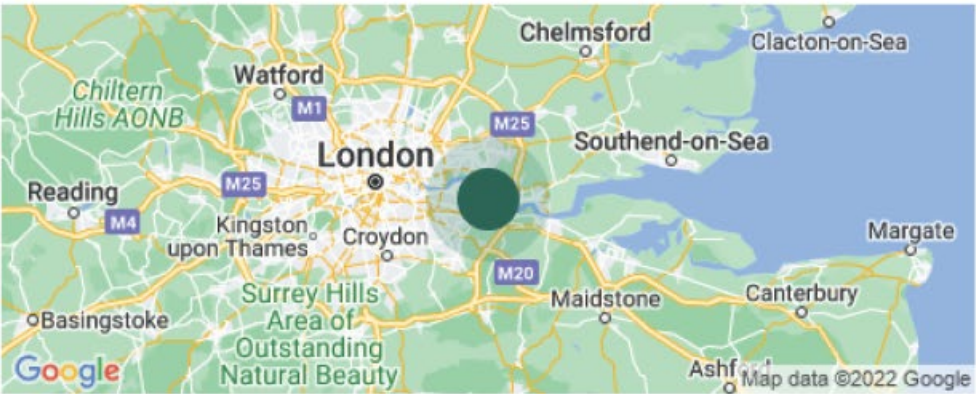
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5. Test Type 1 – T32 Rebar Force vs Displacement Graphs

Test Title 20-June-2022 16 : 04



Date & Time	20 Jun 2022 15:04	Maximum Load Achieved	4.33 kN
Device SN		Next Calibration Date	
Max displacement	68.3 mm		
Notes			
T32-01-01			



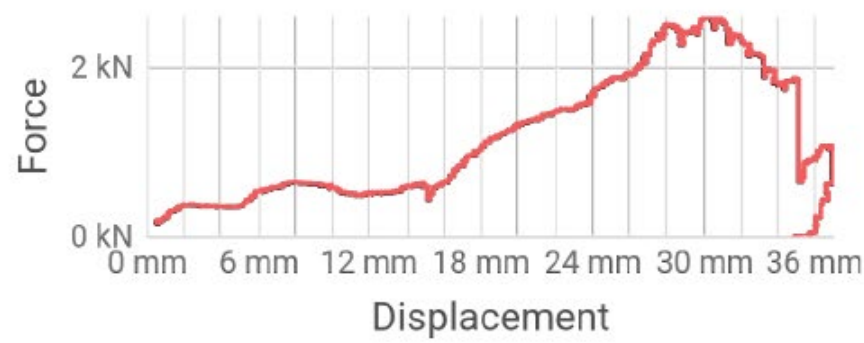
Powered by STAHT CONNECT

Test Title 20-June-2022 16 : 04

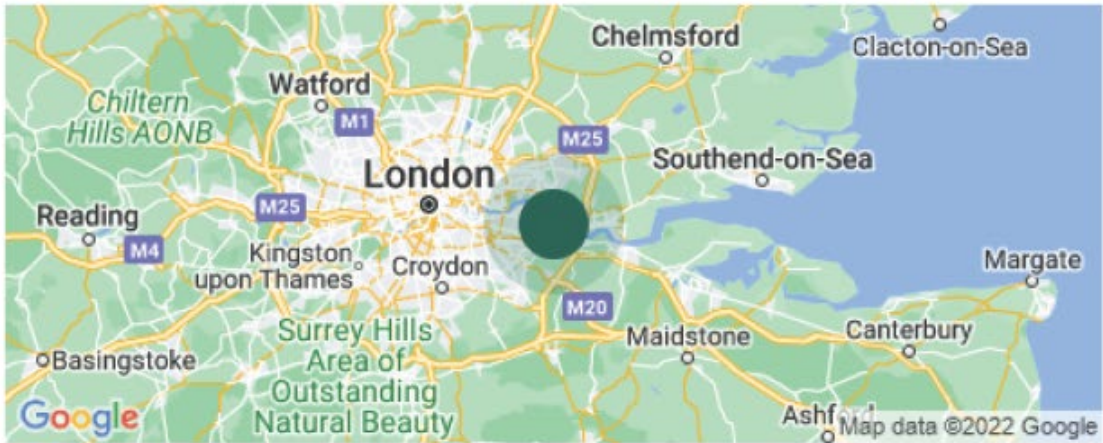


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Test Title 20-June-2022 16 : 09



Date & Time	20 Jun 2022 15:09	Maximum Load Achieved	2.6 kN
Device SN		Next Calibration Date	
Max displacement	37 mm		
Notes			
T32-01-02			



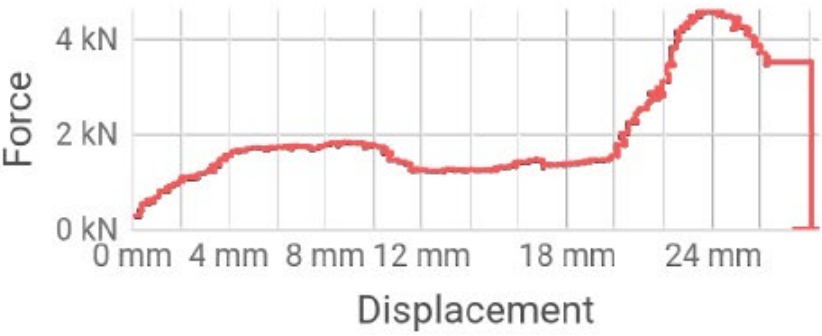
Powered by STAHT CONNECT

Test Title 20-June-2022 16 : 09

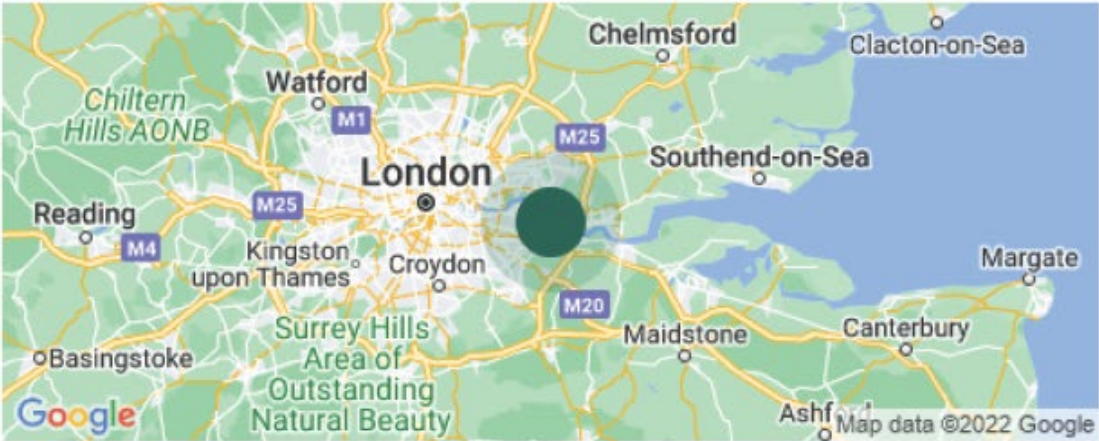


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Test Title 20-June-2022 16 : 12



Date & Time	20 Jun 2022 15:12	Maximum Load Achieved	4.61 kN
Device SN		Next Calibration Date	
Max displacement	28.4 mm		
Notes			
T32-01-03			



Test Title 20-June-2022 16 : 12

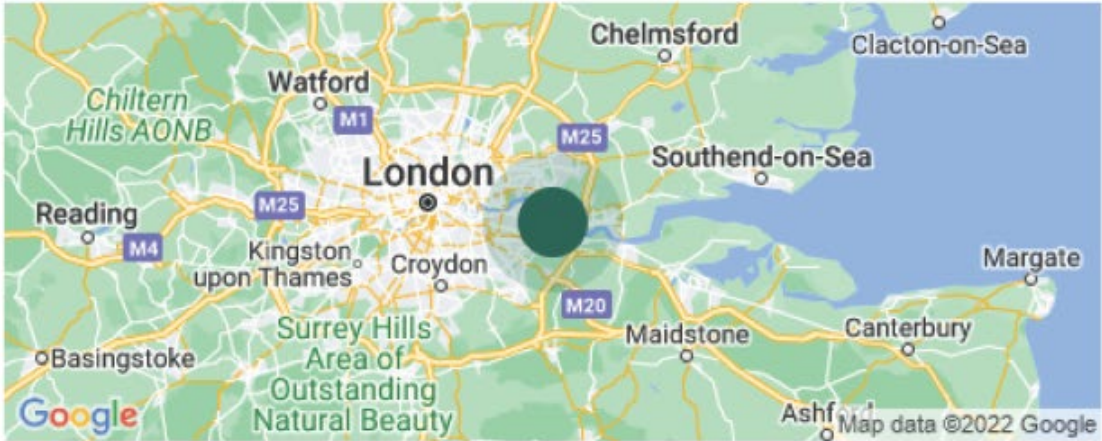


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Test Title 20-June-2022 16 : 14



Date & Time	20 Jun 2022 15:14	Maximum Load Achieved	2.68 kN
Device SN		Next Calibration Date	
Max displacement	28.1 mm		
Notes			
T32-01-04			



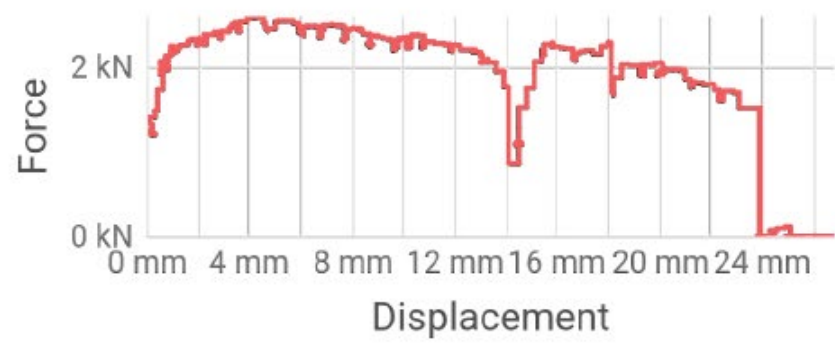
Powered by STAHT CONNECT

Test Title 20-June-2022 16 : 14

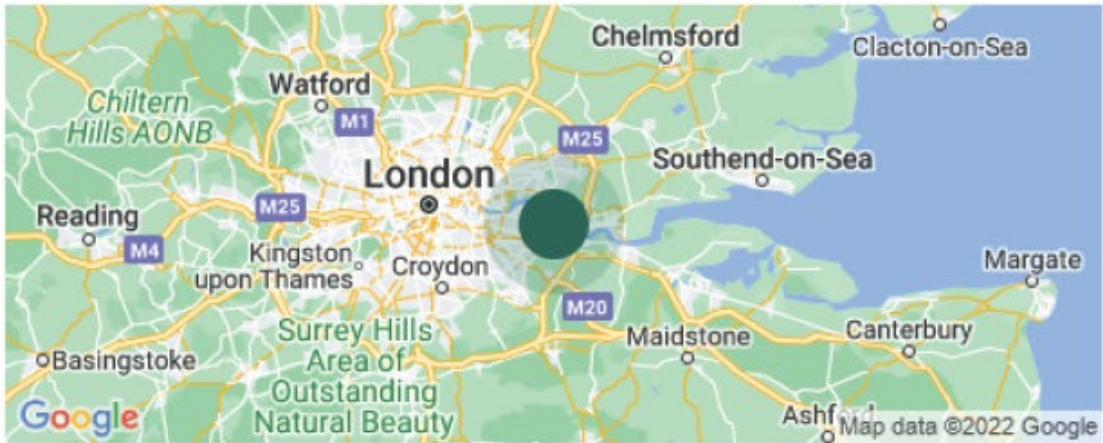


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Test Title 20-June-2022 16 : 16



Date & Time	20 Jun 2022 15:16	Maximum Load Achieved	2.6 kN
Device SN		Next Calibration Date	
Max displacement	26.8 mm		
Notes			
T32-01-05			



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Test Title 20-June-2022 16 : 16

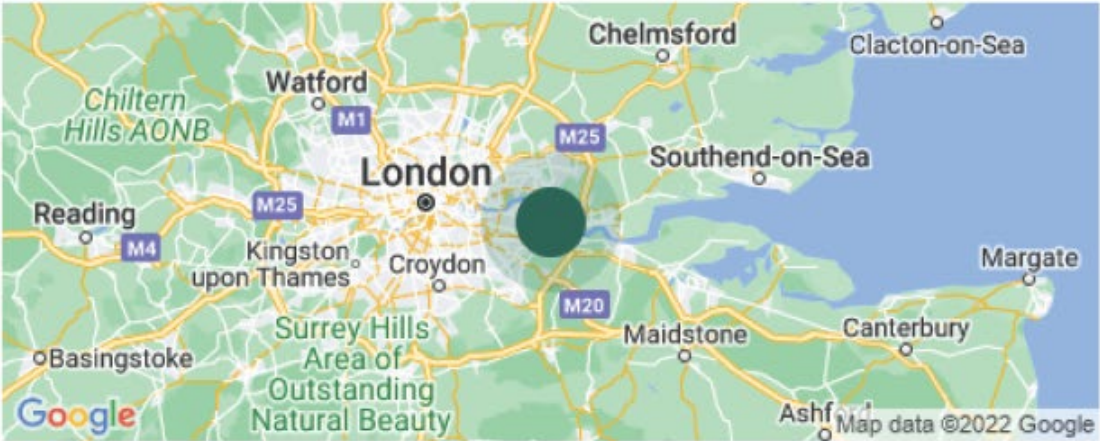


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Test Title 20-June-2022 16 : 17



Date & Time	20 Jun 2022 15:17	Maximum Load Achieved	2.12 kN
Device SN		Next Calibration Date	
Max displacement	26.9 mm		
Notes			
T32-01-06			



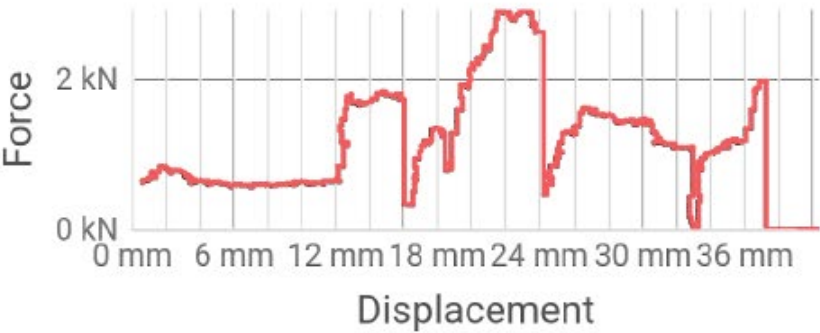
Powered by STAHT CONNECT

Test Title 20-June-2022 16 : 17

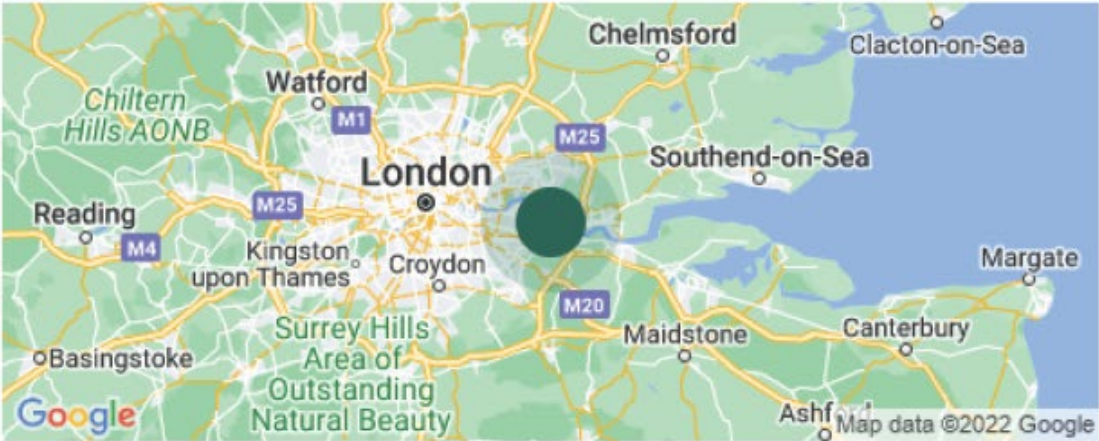


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Test Title 20-June-2022 16 : 19



Date & Time	20 Jun 2022 15:19	Maximum Load Achieved	2.92 kN
Device SN		Next Calibration Date	
Max displacement	40.4 mm		
Notes			
T32-01-07			

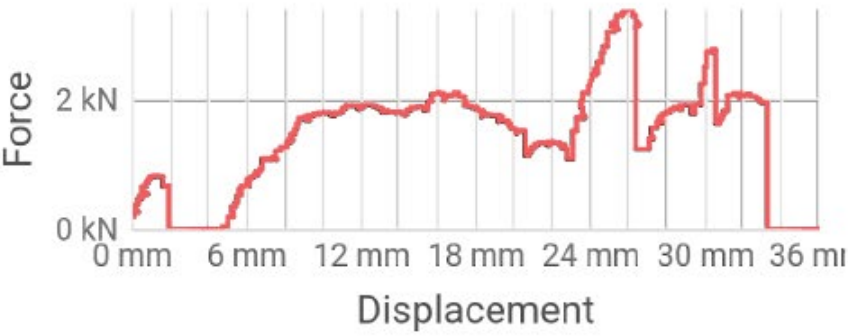


Test Title 20-June-2022 16 : 19

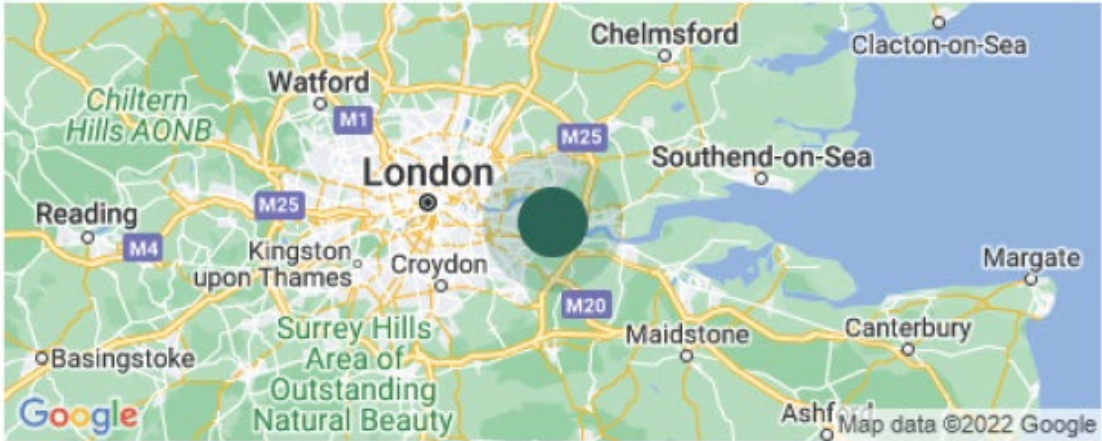


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Test Title 20-June-2022 16 : 22



Date & Time	20 Jun 2022 15:22	Maximum Load Achieved	3.39 kN
Device SN		Next Calibration Date	
Max displacement	36 mm		
Notes			
T32-01-08			



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Test Title 20-June-2022 16 : 22

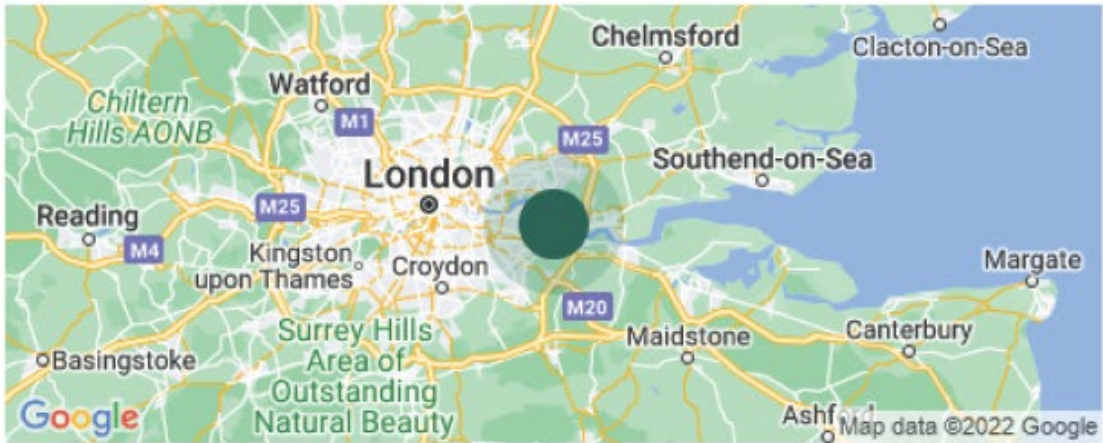


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Test Title 20-June-2022 16 : 24



Date & Time	20 Jun 2022 15:24	Maximum Load Achieved	2.78 kN
Device SN		Next Calibration Date	
Max displacement	27.8 mm		
Notes			
T32-01-09			



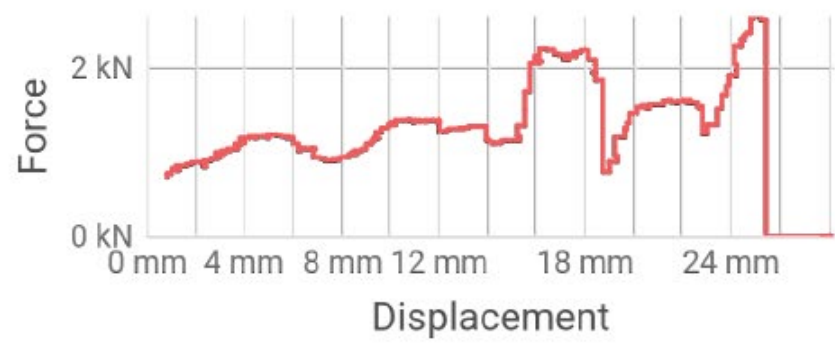
Powered by STAHT CONNECT

Test Title 20-June-2022 16 : 24

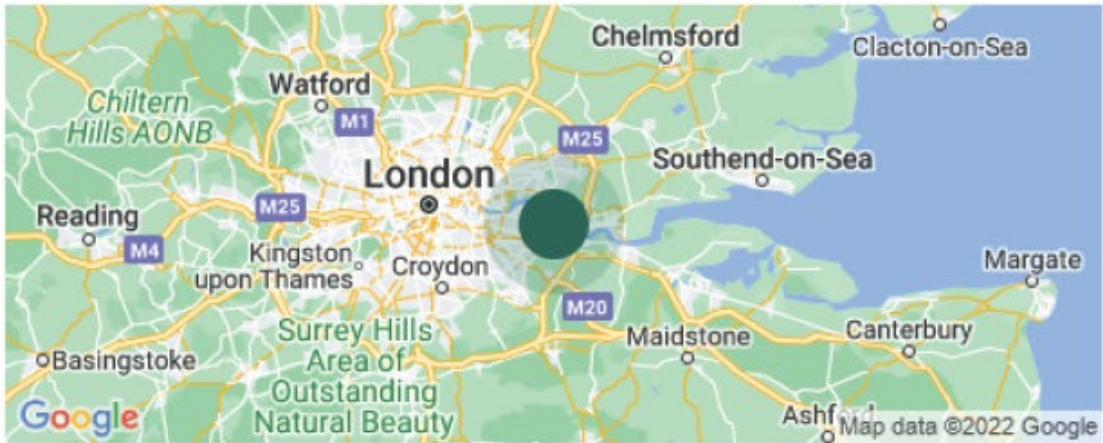


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Test Title 20-June-2022 16 : 25



Date & Time	20 Jun 2022 15:25	Maximum Load Achieved	2.61 kN
Device SN		Next Calibration Date	
Max displacement	28.2 mm		
Notes			
T32-01-10			



Test Title 20-June-2022 16 : 25



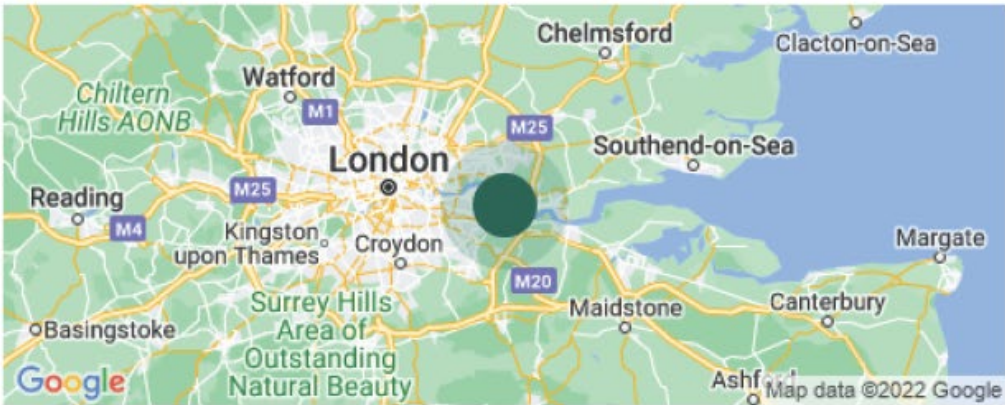
Powered by STAHT CONNECT

6. Test Type 2 – T12 Rebar Force vs Displacement Graphs

Test Title 20-June-2022 14 : 27



Date & Time	20 Jun 2022 13:27	Maximum Load Achieved	3.32 kN
Device SN		Next Calibration Date	
Max displacement	33.8 mm		
Notes	T12-02-01 wire stretch, no snap of the wire		



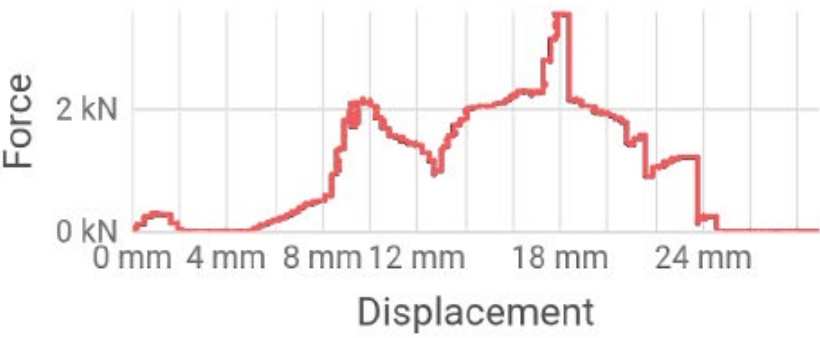
Powered by STAHT CONNECT

Test Title 20-June-2022 14 : 27

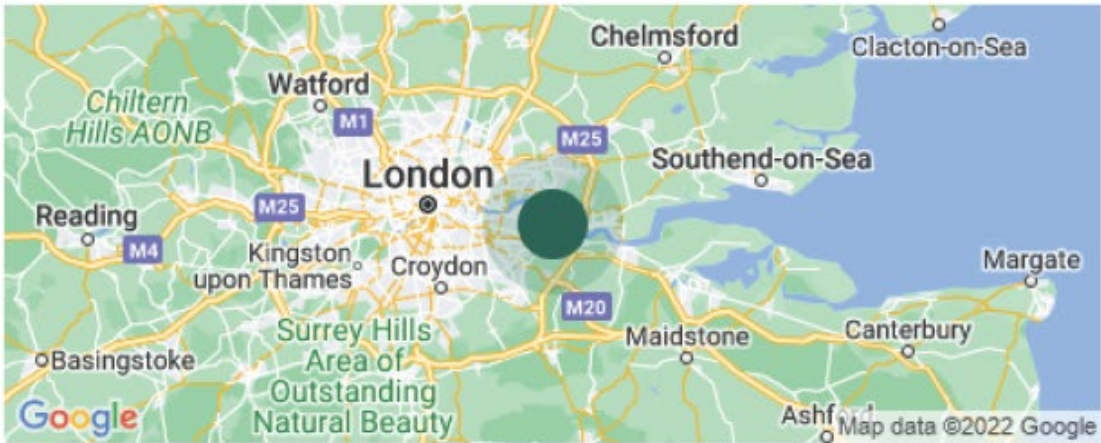


Powered by STAHT CONNECT

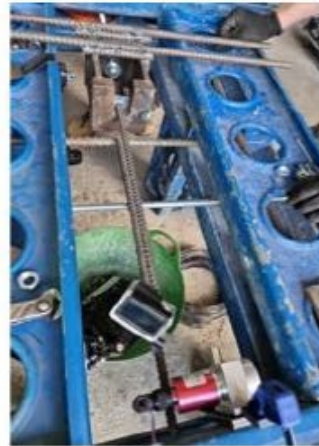
Test Title 20-June-2022 14 : 30



Date & Time	20 Jun 2022 13:30	Maximum Load Achieved	3.59 kN
Device SN		Next Calibration Date	
Max displacement	28.9 mm		
Notes			
T12-02-02			

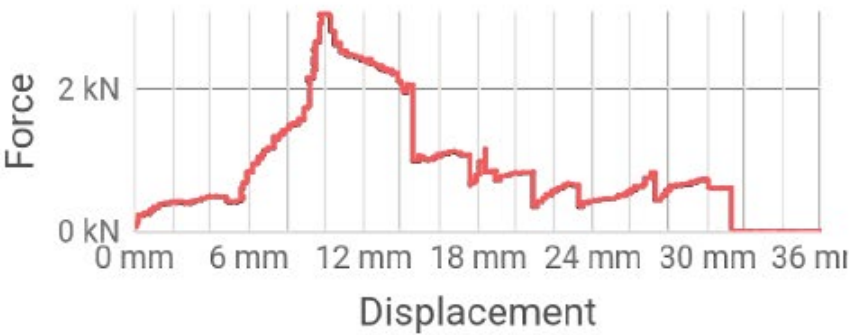


Test Title 20-June-2022 14 : 30

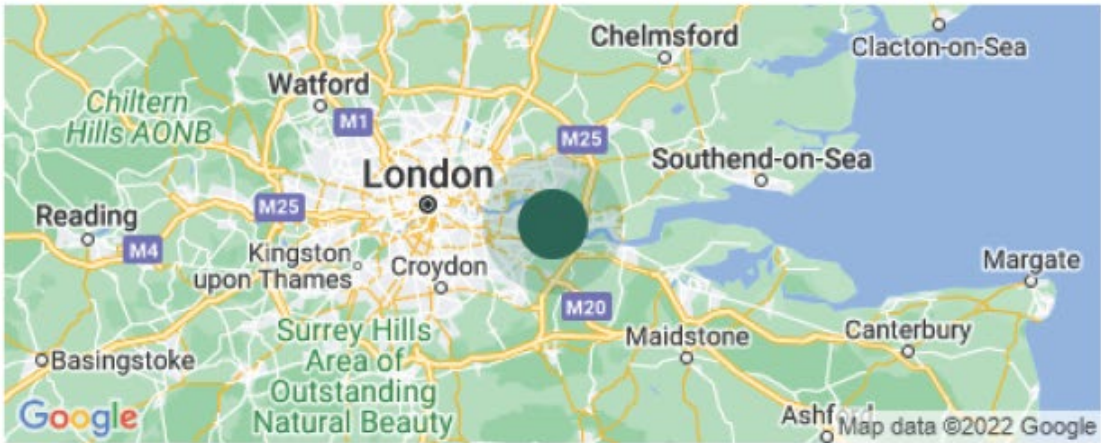


Powered by STAHT CONNECT

Test Title 20-June-2022 14 : 33



Date & Time	20 Jun 2022 13:33	Maximum Load Achieved	3.08 kN
Device SN		Next Calibration Date	
Max displacement	36 mm		
Notes			
T12-02-03			



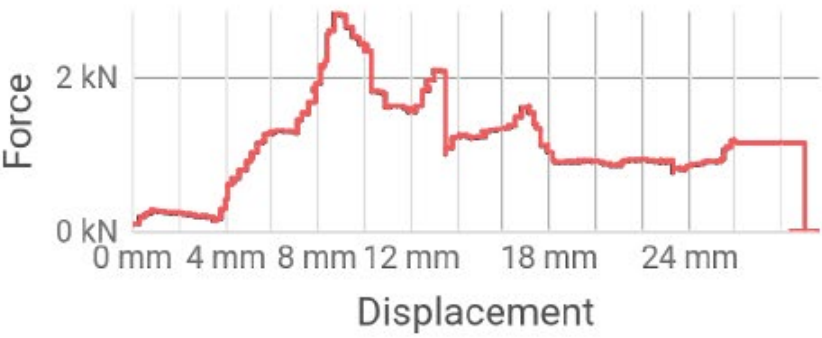
Powered by STAHT CONNECT

Test Title 20-June-2022 14 : 33

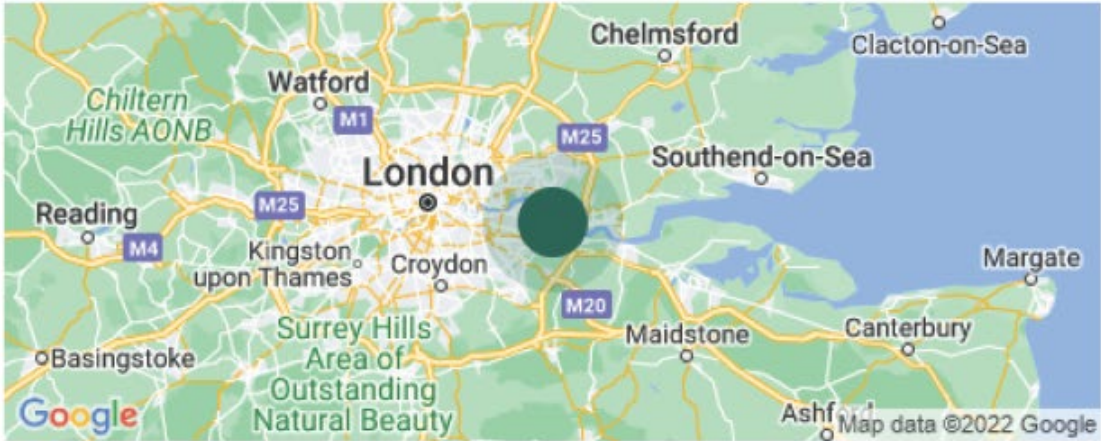


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Test Title 20-June-2022 14 : 35



Date & Time	20 Jun 2022 13:35	Maximum Load Achieved	2.85 kN
Device SN		Next Calibration Date	
Max displacement	29.6 mm		
Notes			
T12-02-04			

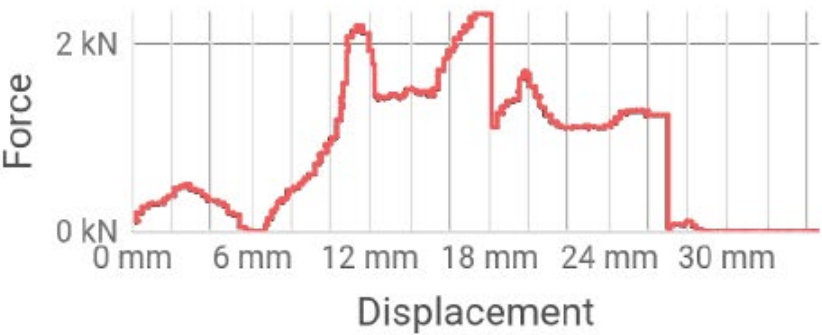


Test Title 20-June-2022 14 : 35

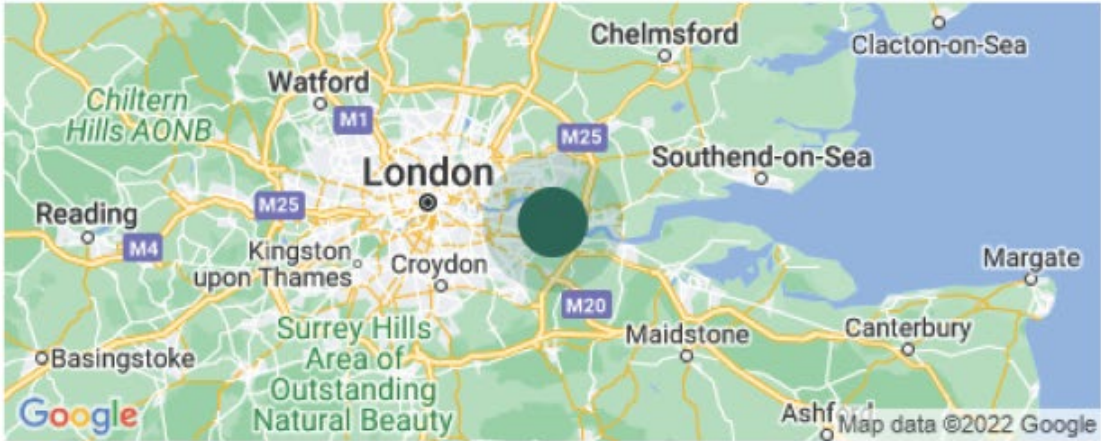


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Test Title 20-June-2022 14 : 38



Date & Time	20 Jun 2022 13:38	Maximum Load Achieved	2.34 kN
Device SN		Next Calibration Date	
Max displacement	34.6 mm		
Notes			
T12-02-05			



Test Title 20-June-2022 14 : 38

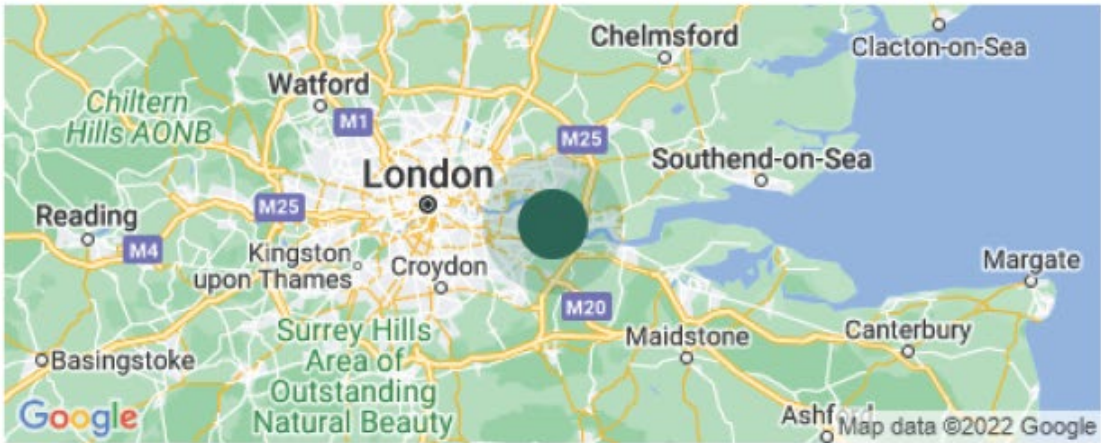


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Test Title 20-June-2022 14 : 40



Date & Time	20 Jun 2022 13:40	Maximum Load Achieved	2.31 kN
Device SN		Next Calibration Date	
Max displacement	24.7 mm		
Notes			
T12-02-06			



Test Title 20-June-2022 14 : 40

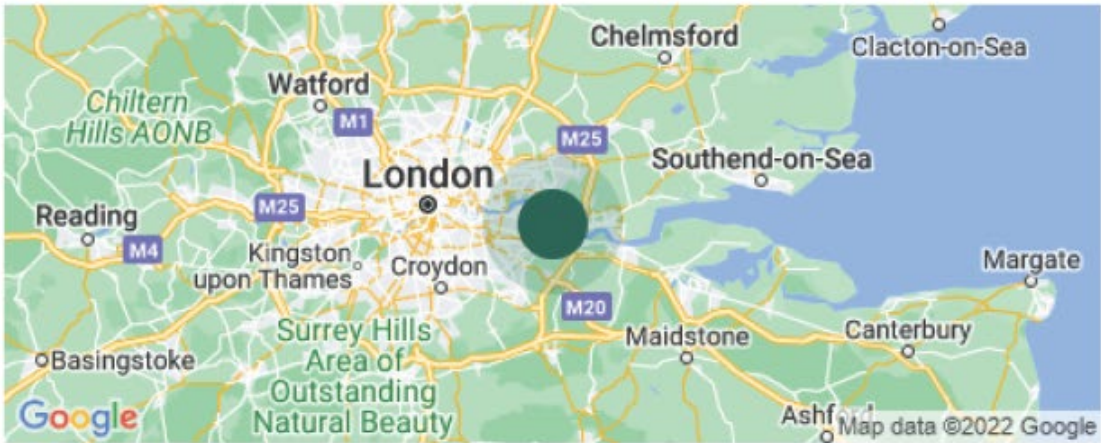


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Test Title 20-June-2022 14 : 43



Date & Time	20 Jun 2022 13:43	Maximum Load Achieved	2.92 kN
Device SN		Next Calibration Date	
Max displacement	21.7 mm		
Notes			
T12-02-07			



Test Title 20-June-2022 14 : 43

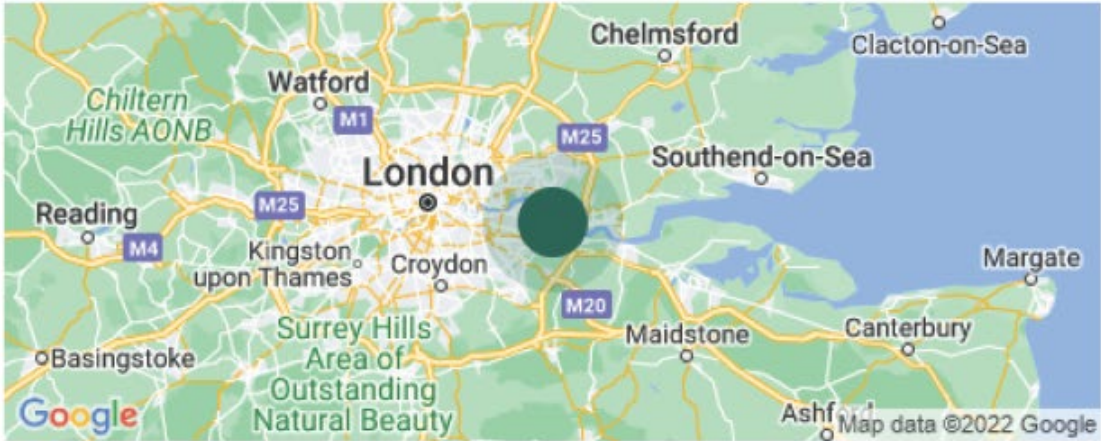


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Test Title 20-June-2022 14 : 45



Date & Time	20 Jun 2022 13:45	Maximum Load Achieved	3.27 kN
Device SN		Next Calibration Date	
Max displacement	20.9 mm		
Notes			
T12-02-08			



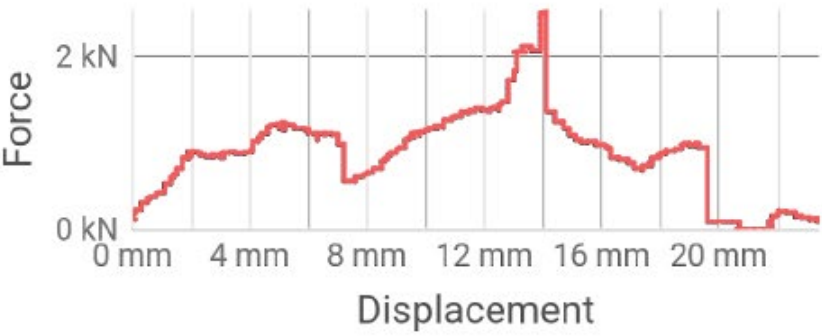
Powered by STAHT CONNECT

Test Title 20-June-2022 14 : 45

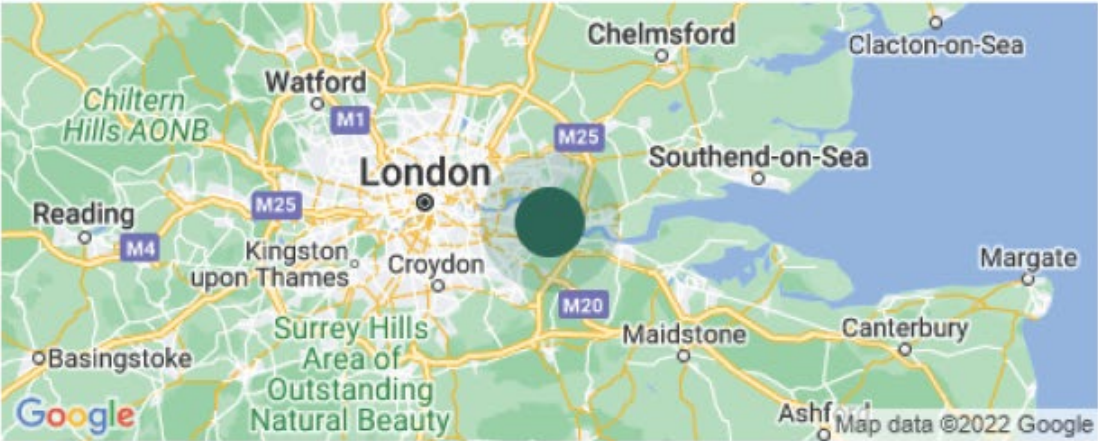


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Test Title 20-June-2022 14 : 47



Date & Time	20 Jun 2022 13:47	Maximum Load Achieved	2.54 kN
Device SN		Next Calibration Date	
Max displacement	23.4 mm		
Notes			
T12-02-09			



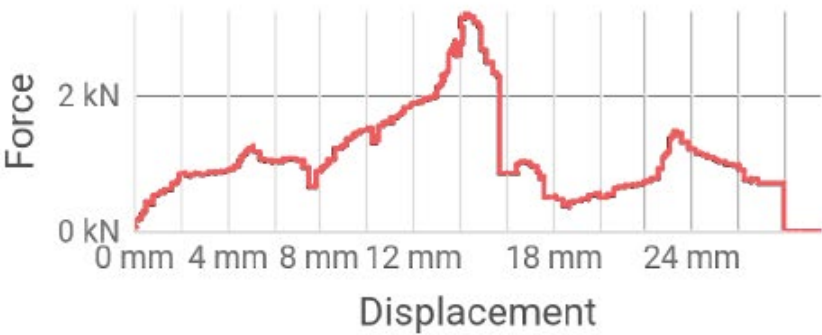
Powered by STAHT CONNECT

Test Title 20-June-2022 14 : 47

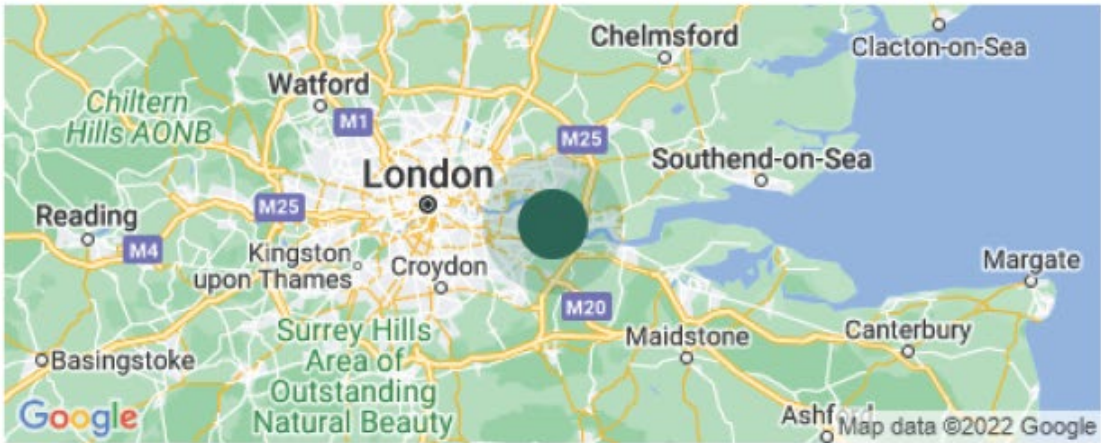


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Test Title 20-June-2022 14 : 49



Date & Time	20 Jun 2022 13:49	Maximum Load Achieved	3.24 kN
Device SN		Next Calibration Date	
Max displacement	29.5 mm		
Notes			
T12-02-10			



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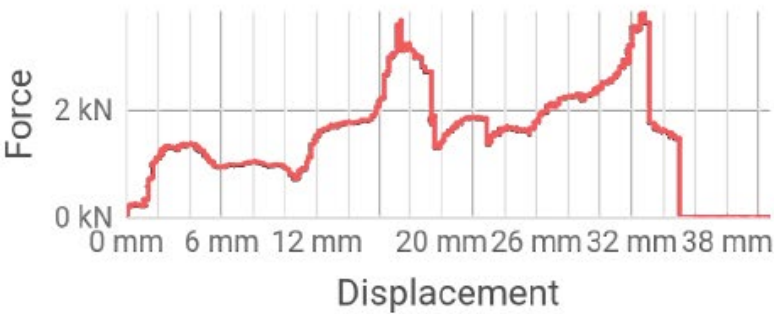
Test Title 20-June-2022 14 : 49



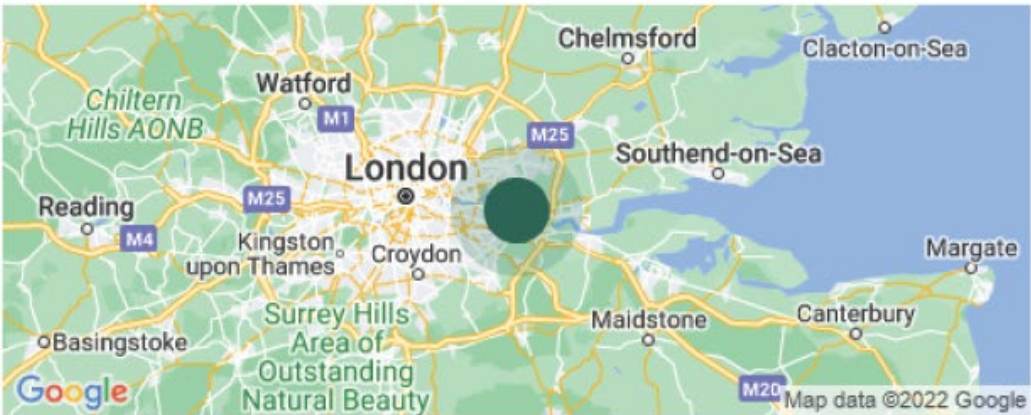
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7. Test Type 2 – T20 Rebar Force vs Displacement Graphs

Test Title 20-June-2022 13 : 31



Date & Time	20 Jun 2022 12:31	Maximum Load Achieved	3.84 kN
Device SN		Next Calibration Date	
Max displacement	40.7 mm		
Notes			
T20-02-01			

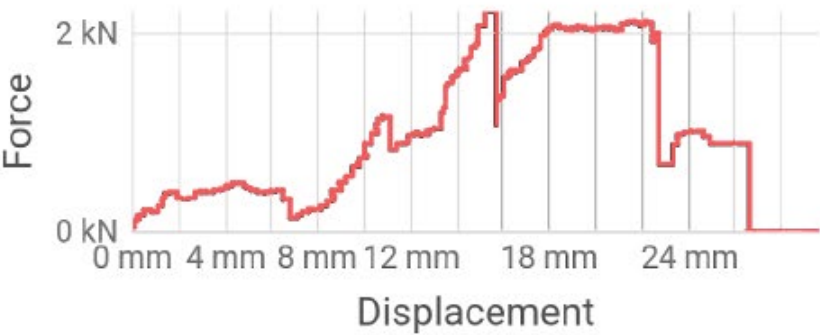


Test Title 20-June-2022 13 : 31

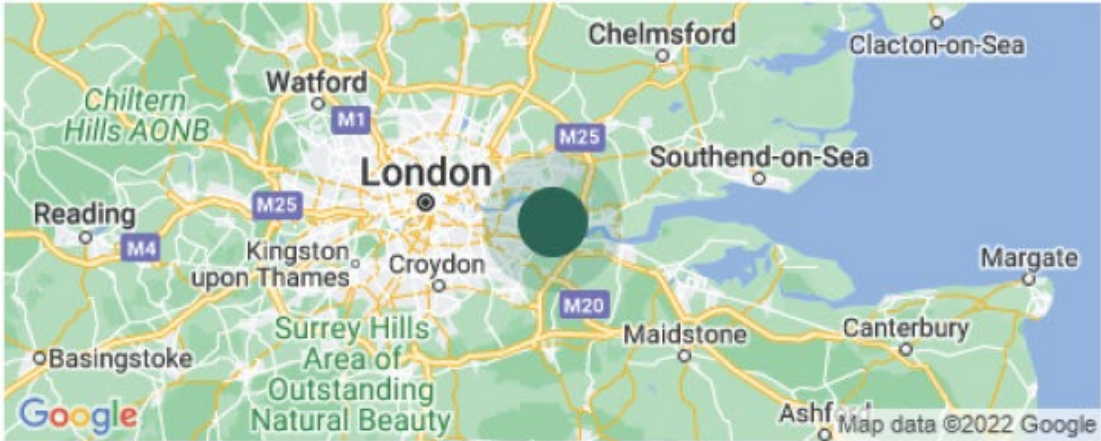


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Test Title 20-June-2022 13 : 36



Date & Time	20 Jun 2022 12:36	Maximum Load Achieved	2.22 kN
Device SN		Next Calibration Date	
Max displacement	29.6 mm		
Notes			
T20-02-02			



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Test Title 20-June-2022 13 : 36

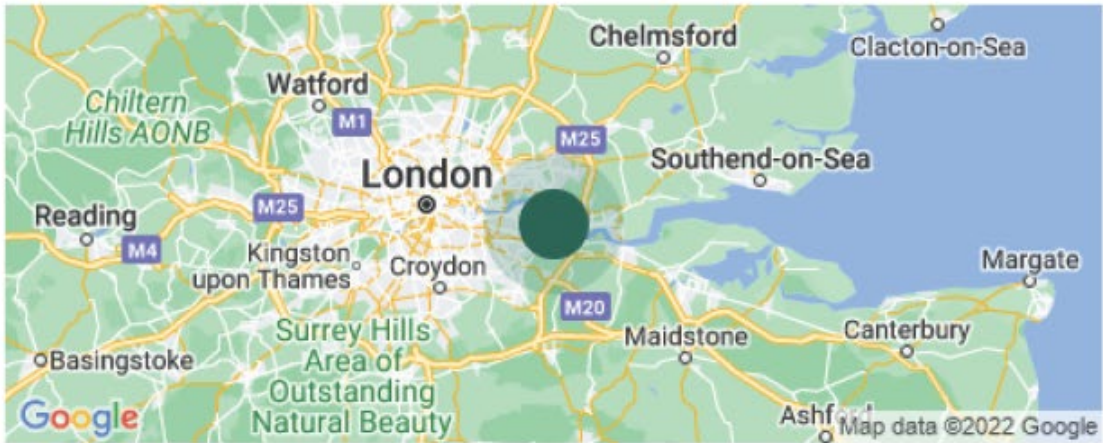


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Test Title 20-June-2022 13 : 39



Date & Time	20 Jun 2022 12:39	Maximum Load Achieved	2.46 kN
Device SN		Next Calibration Date	
Max displacement	25.6 mm		
Notes	T20-02-03		



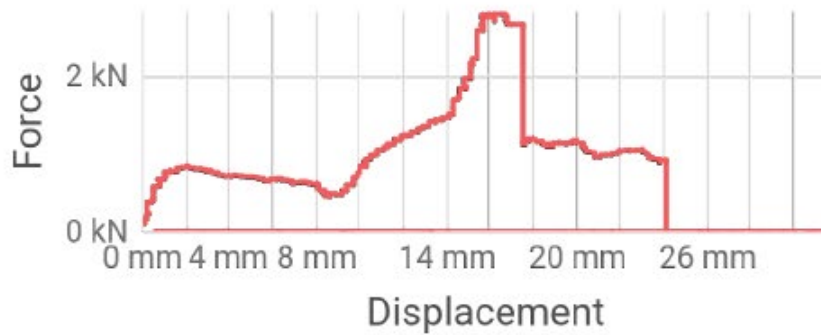
Powered by STAHT CONNECT

Test Title 20-June-2022 13 : 39

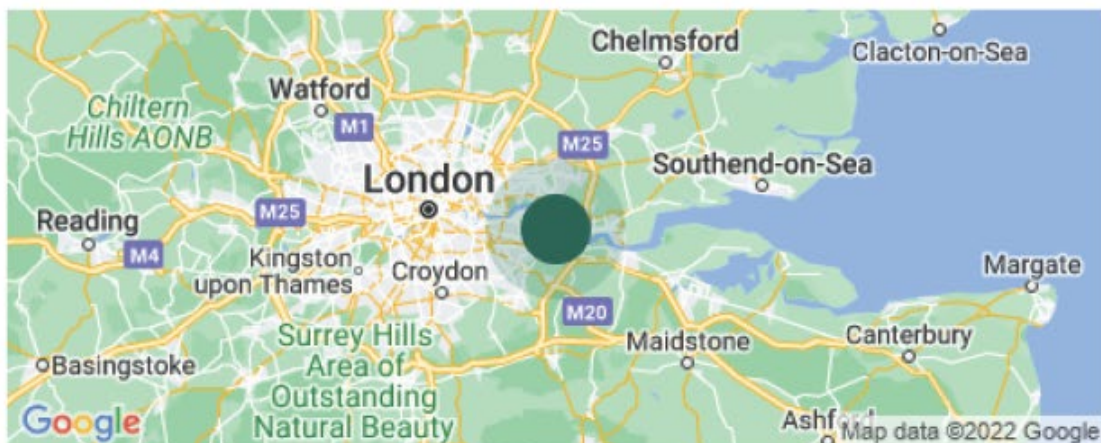


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Test Title 20-June-2022 13 : 42



Date & Time	20 Jun 2022 12:42	Maximum Load Achieved	2.83 kN
Device SN		Next Calibration Date	
Max displacement	31.6 mm		
Notes			
T20-02-04			



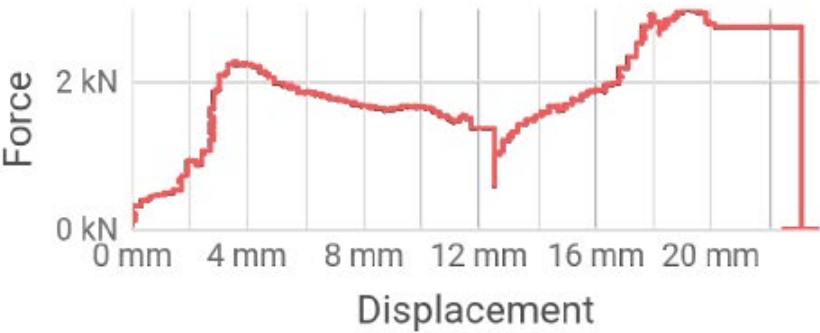
Powered by STAHT CONNECT

Test Title 20-June-2022 13 : 42

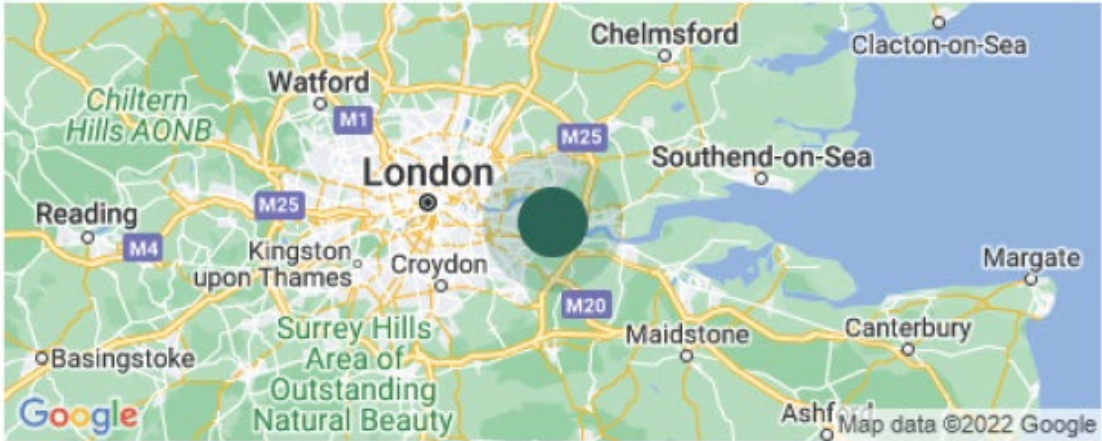


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Test Title 20-June-2022 13 : 44



Date & Time	20 Jun 2022 12:44	Maximum Load Achieved	2.98 kN
Device SN		Next Calibration Date	
Max displacement	23.7 mm		
Notes			
T20-02-05			



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Test Title 20-June-2022 13 : 44

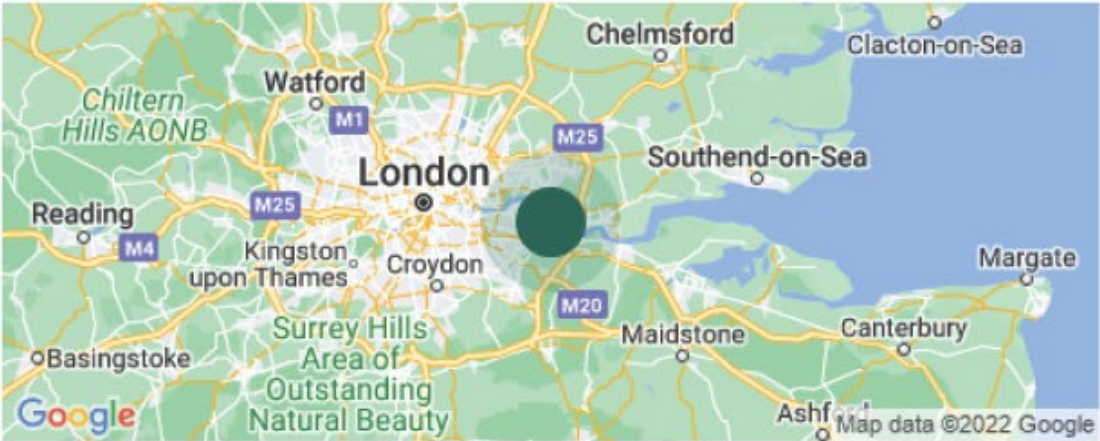


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Test Title 20-June-2022 13 : 48

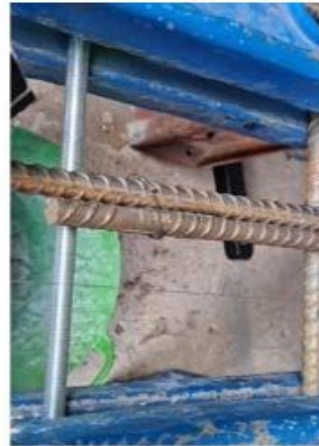


Date & Time	20 Jun 2022 12:48	Maximum Load Achieved	2.9 kN
Device SN		Next Calibration Date	
Max displacement	41.2 mm		
Notes	T20-02-06		



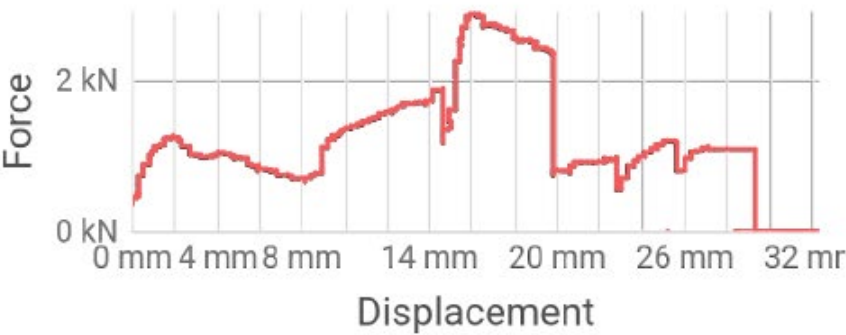
Powered by STAHT CONNECT

Test Title 20-June-2022 13 : 48

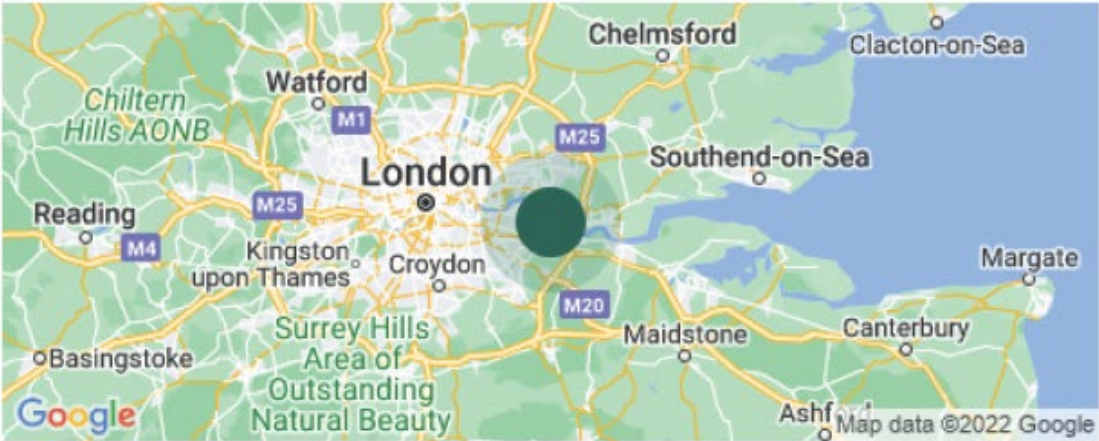


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Test Title 20-June-2022 13 : 50



Date & Time	20 Jun 2022 12:50	Maximum Load Achieved	2.91 kN
Device SN		Next Calibration Date	
Max displacement	32.3 mm		
Notes			
T20-02-07			



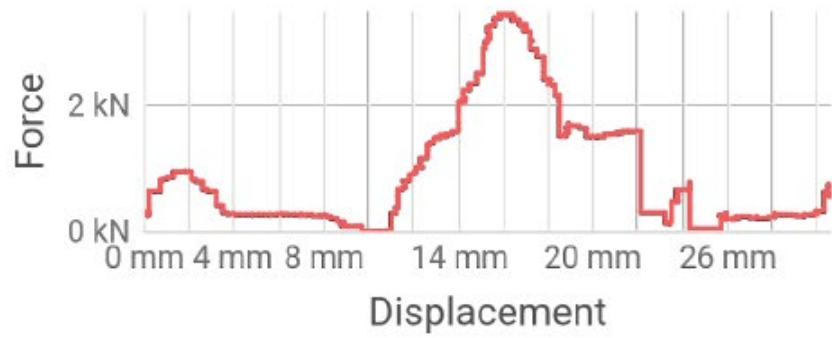
Powered by STAHT CONNECT

Test Title 20-June-2022 13 : 50

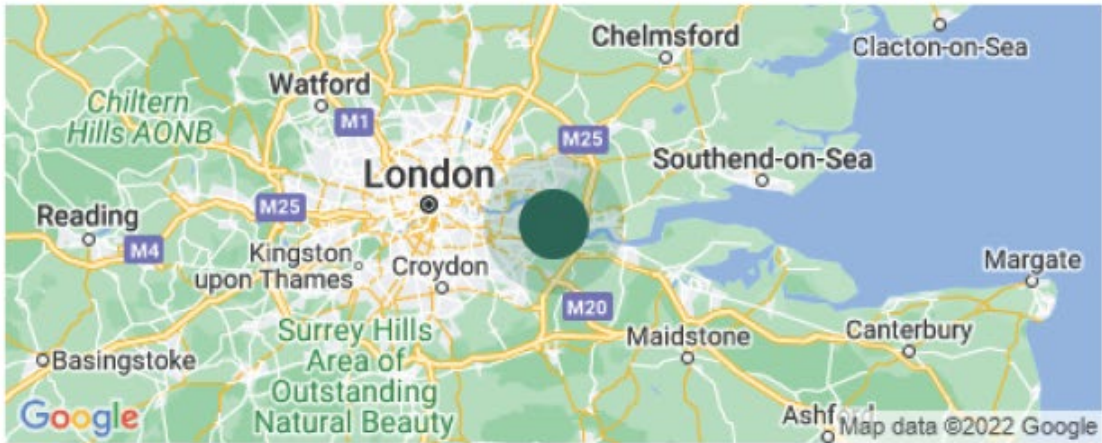


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Test Title 20-June-2022 13 : 53



Date & Time	20 Jun 2022 12:53	Maximum Load Achieved	3.48 kN
Device SN		Next Calibration Date	
Max displacement	30.6 mm		
Notes			
T20-02-08			



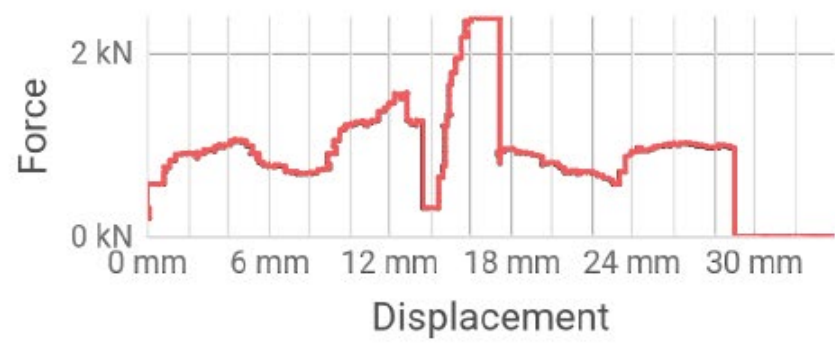
Powered by STAHT CONNECT

Test Title 20-June-2022 13 : 53

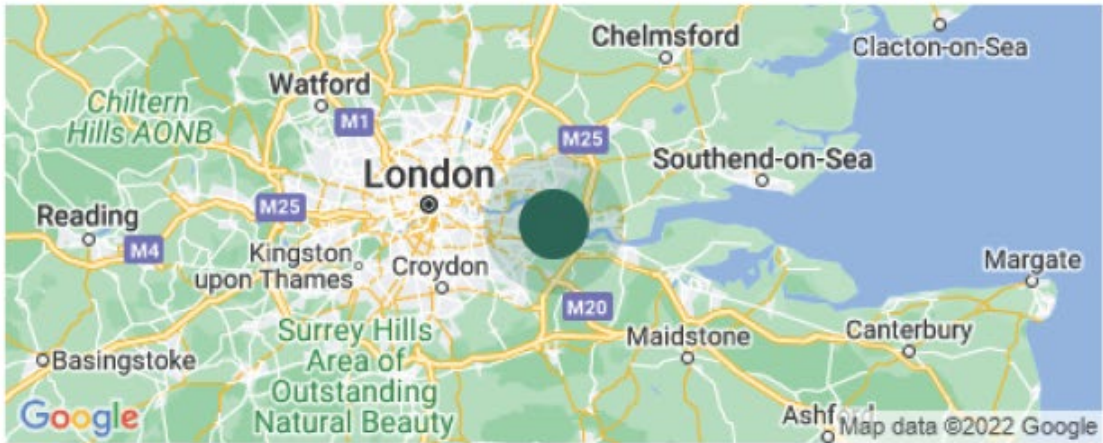


Powered by STAHT CONNECT

Test Title 20-June-2022 13 : 56

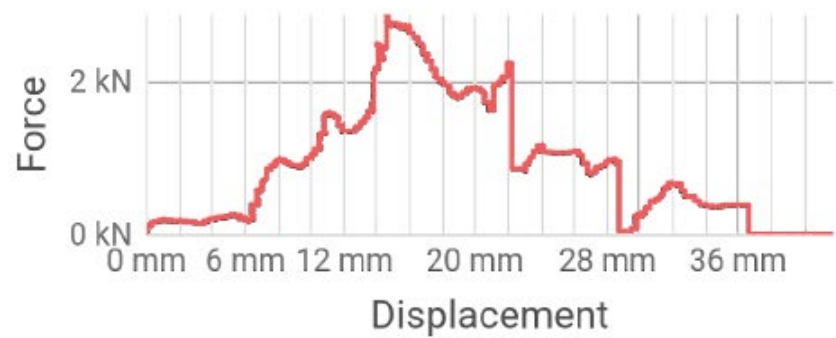


Date & Time	20 Jun 2022 12:56	Maximum Load Achieved	2.4 kN
Device SN		Next Calibration Date	
Max displacement	33.9 mm		
Notes			
T20-02-09			

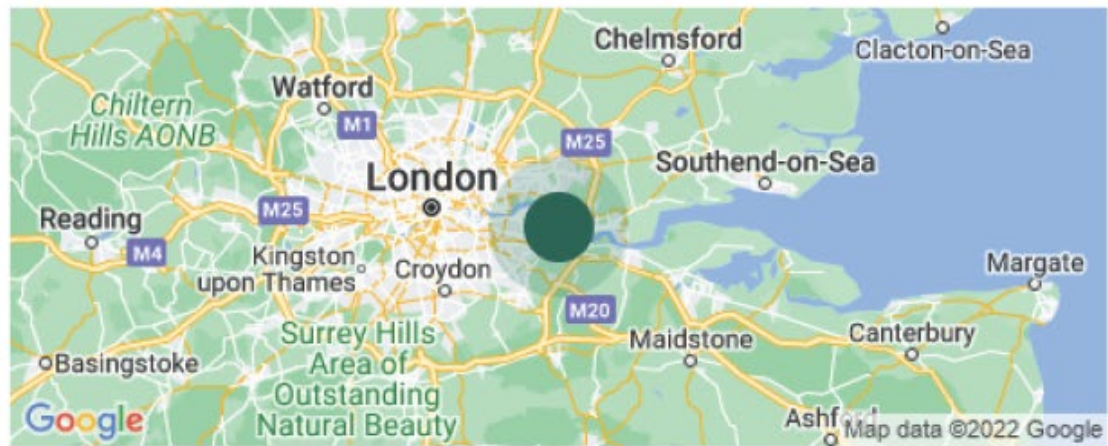


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Test Title 20-June-2022 14 : 00



Date & Time	20 Jun 2022 13:00	Maximum Load Achieved	2.87 kN
Device SN		Next Calibration Date	
Max displacement	41.7 mm		
Notes			
T20-02-10			



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Test Title 20-June-2022 14 : 00



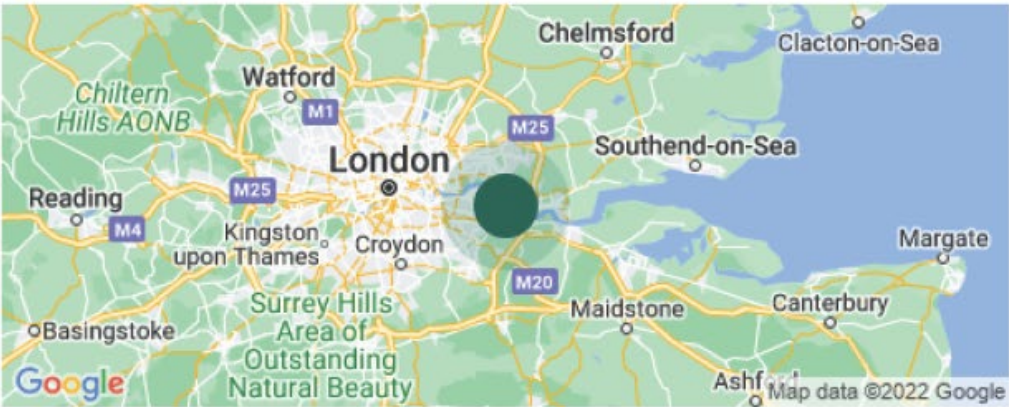
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8. Test Type 2 – T32 Rebar Force vs Displacement Graphs

Test Title 20-June-2022 14 : 57



Date & Time	20 Jun 2022 13:57	Maximum Load Achieved	1.85 kN
Device SN		Next Calibration Date	
Max displacement	31.5 mm		
Notes			
T32-02-01			



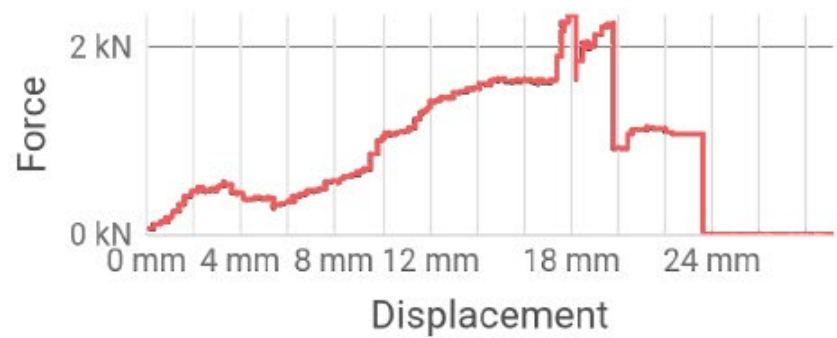
Powered by STAHT CONNECT

Test Title 20-June-2022 14 : 57

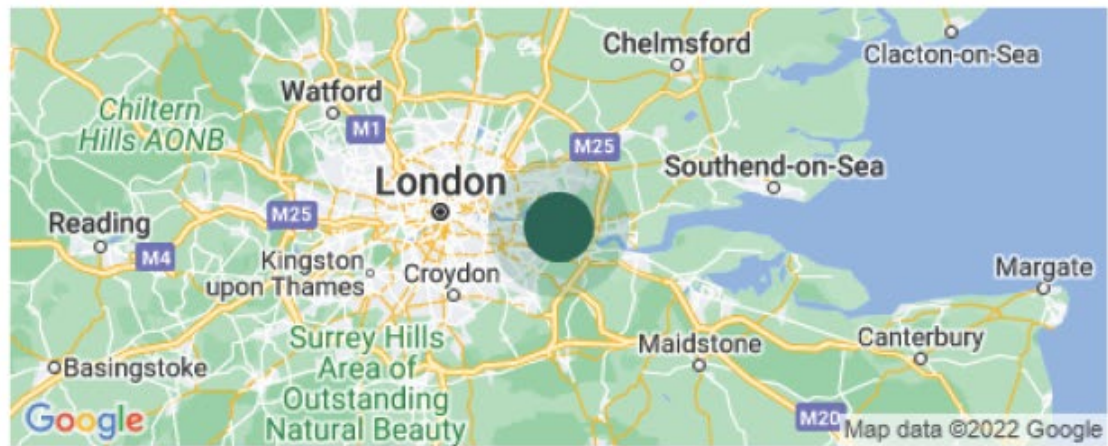


Powered by STAHT CONNECT

Test Title 20-June-2022 15 : 00



Date & Time	20 Jun 2022 14:00	Maximum Load Achieved	2.34 kN
Device SN		Next Calibration Date	
Max displacement	29.1 mm		
Notes			
T32-02-02			



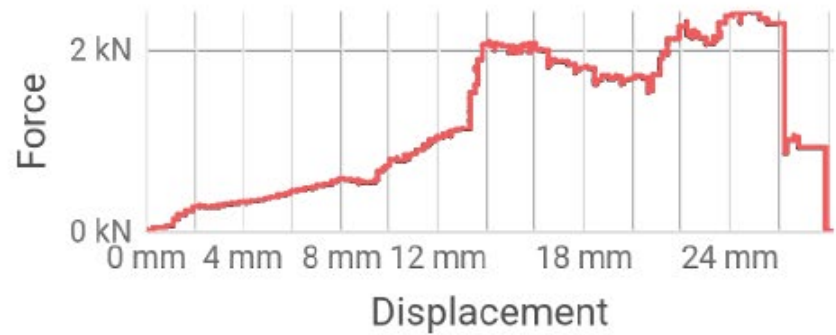
Powered by STAHT CONNECT

Test Title 20-June-2022 15 : 00



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Test Title 20-June-2022 15 : 03



Date & Time	20 Jun 2022 14:03	Maximum Load Achieved	2.42 kN
Device SN		Next Calibration Date	
Max displacement	28.2 mm		
Notes			
	T32-02-03		



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Test Title 20-June-2022 15 : 03

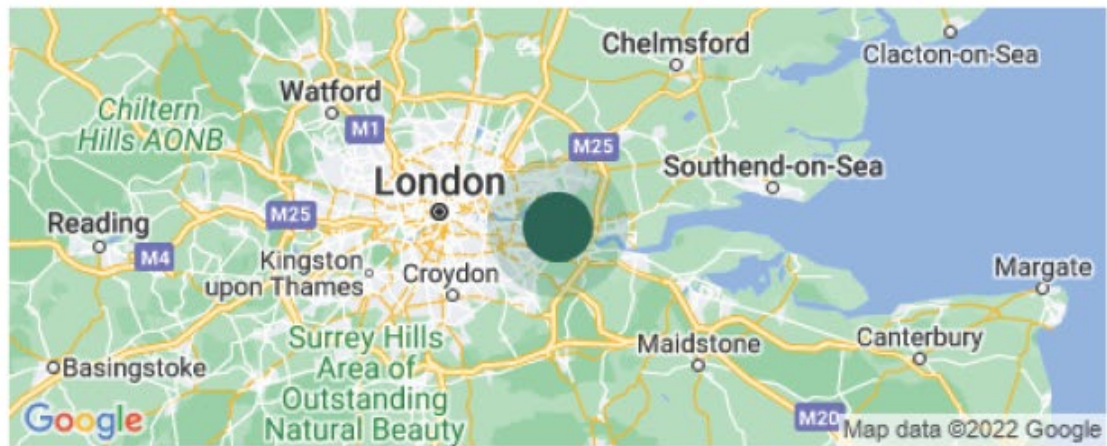


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Test Title 20-June-2022 15 : 07



Date & Time	20 Jun 2022 14:07	Maximum Load Achieved	1.86 kN
Device SN		Next Calibration Date	
Max displacement	33.1 mm		
Notes			
	T32-02-04		

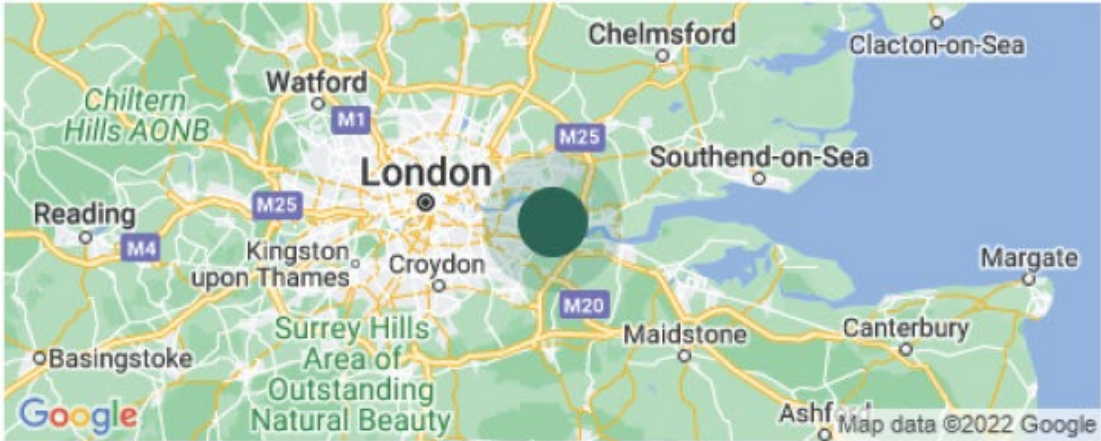


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Test Title 20-June-2022 15 : 09

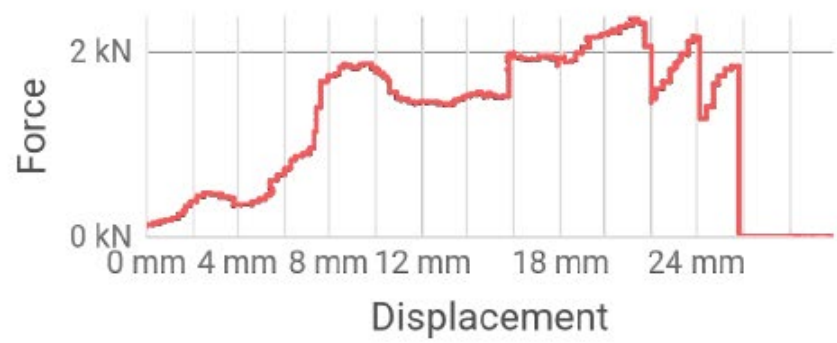


Date & Time	20 Jun 2022 14:09	Maximum Load Achieved	1.5 kN
Device SN		Next Calibration Date	
Max displacement	30 mm		
Notes			
T32-02-05			

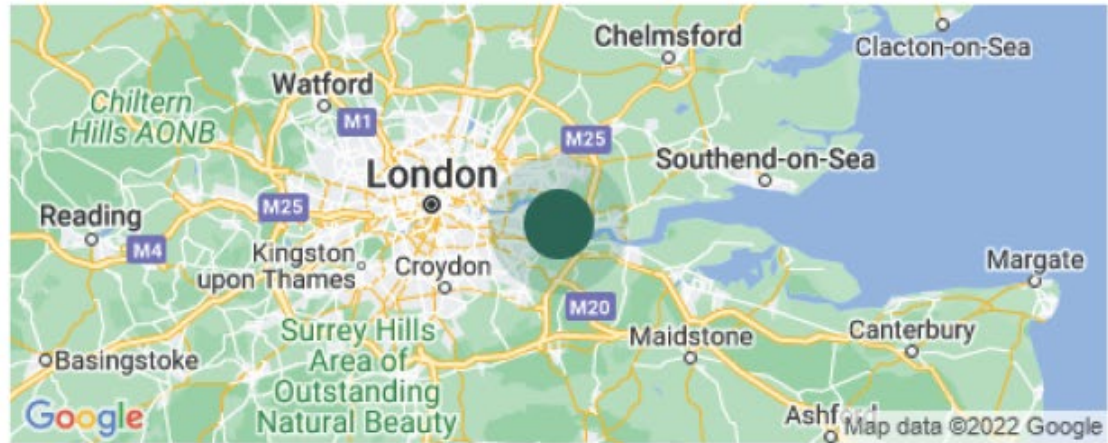


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Test Title 20-June-2022 15 : 13

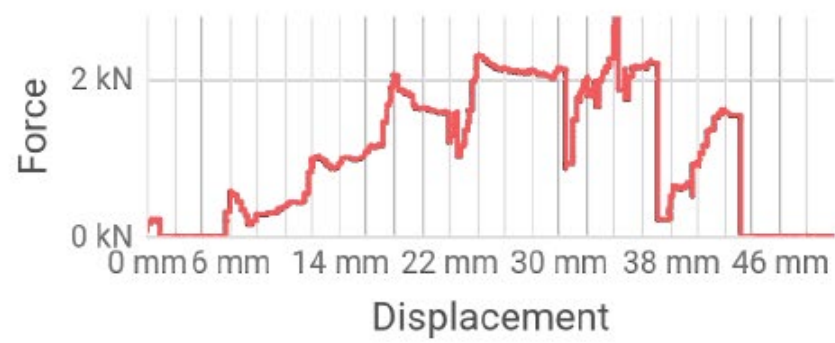


Date & Time	20 Jun 2022 14:13	Maximum Load Achieved	2.38 kN
Device SN		Next Calibration Date	
Max displacement	29.9 mm		
Notes			
	T32-02-06		

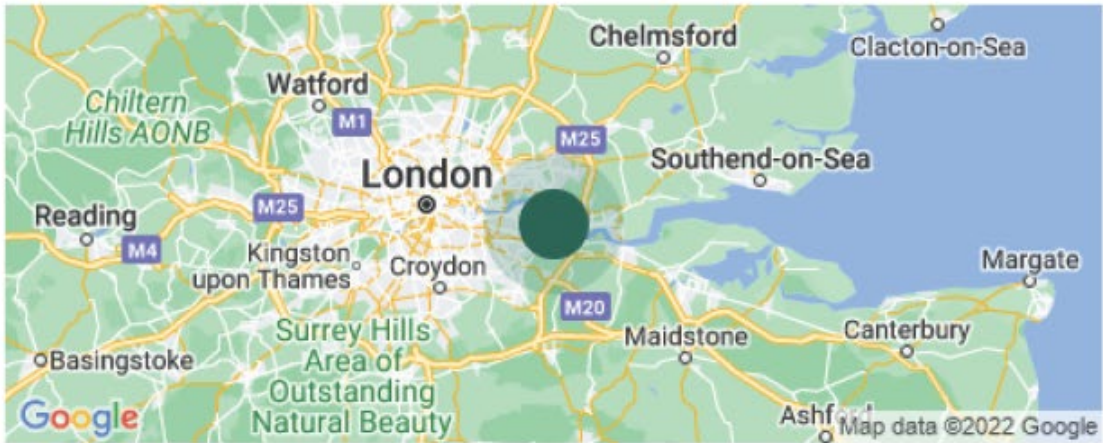


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Test Title 20-June-2022 15 : 15

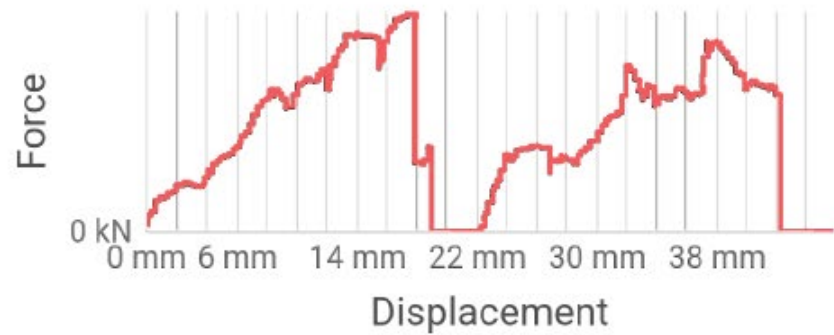


Date & Time	20 Jun 2022 14:15	Maximum Load Achieved	2.8 kN
Device SN		Next Calibration Date	
Max displacement	49.9 mm		
Notes			
T32-02-07			

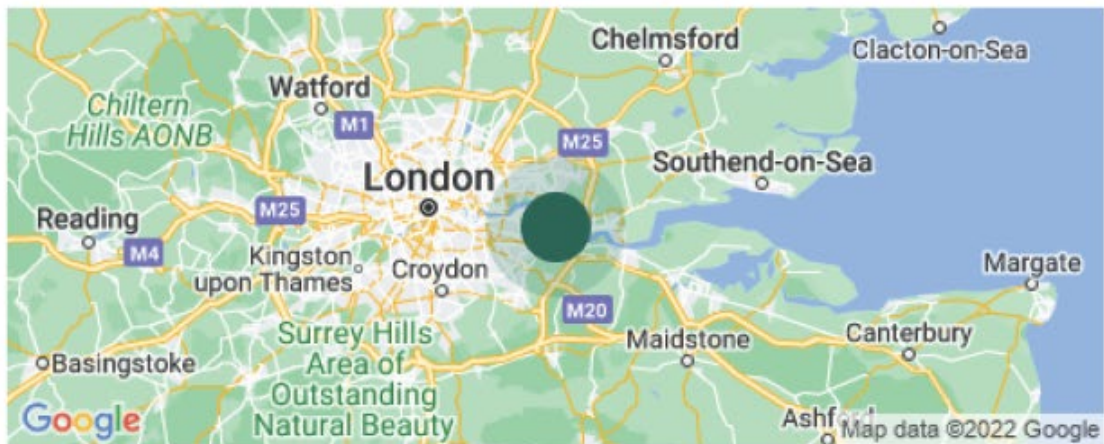


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Test Title 20-June-2022 15 : 18



Date & Time	20 Jun 2022 14:18	Maximum Load Achieved	1.75 kN
Device SN		Next Calibration Date	
Max displacement	45.8 mm		
Notes			
	T32-02-08		



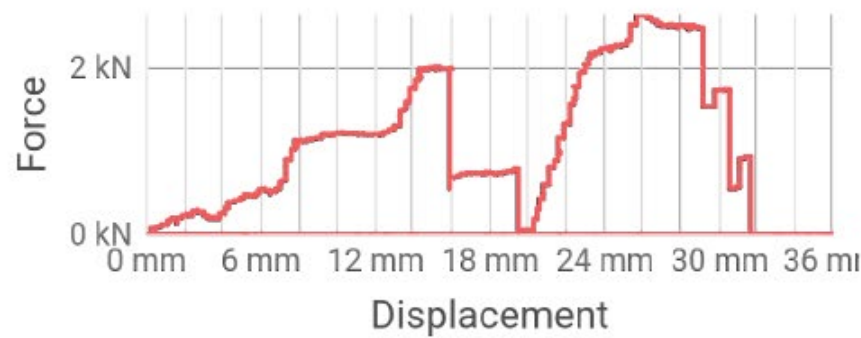
Powered by STAHT CONNECT

Test Title 20-June-2022 15 : 18

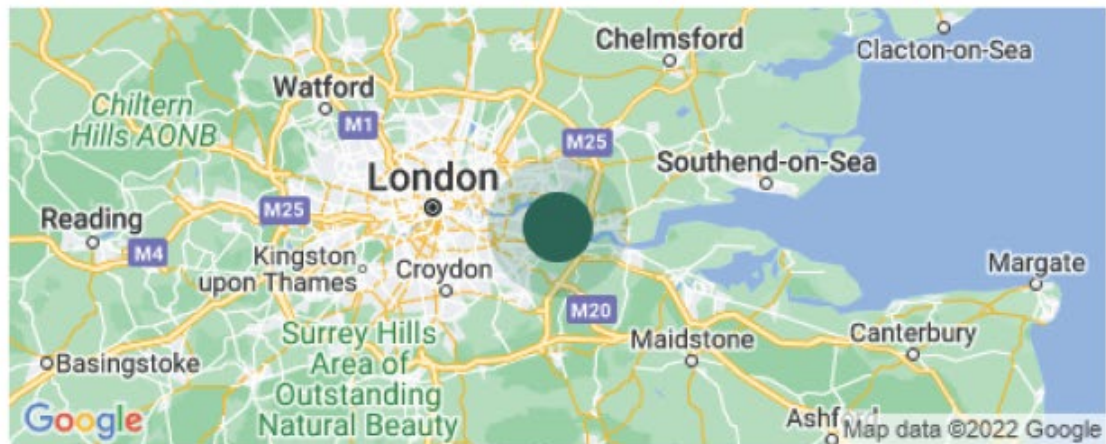


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Test Title 20-June-2022 15 : 22



Date & Time	20 Jun 2022 14:22	Maximum Load Achieved	2.64 kN
Device SN		Next Calibration Date	
Max displacement	36 mm		
Notes			
T32-02-09			



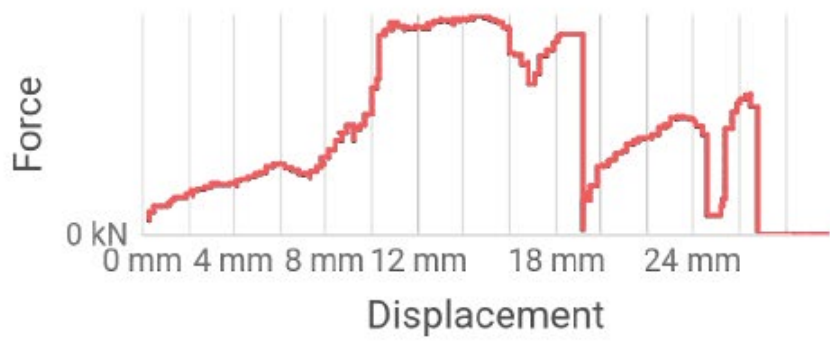
Powered by STAHT CONNECT

Test Title 20-June-2022 15 : 22

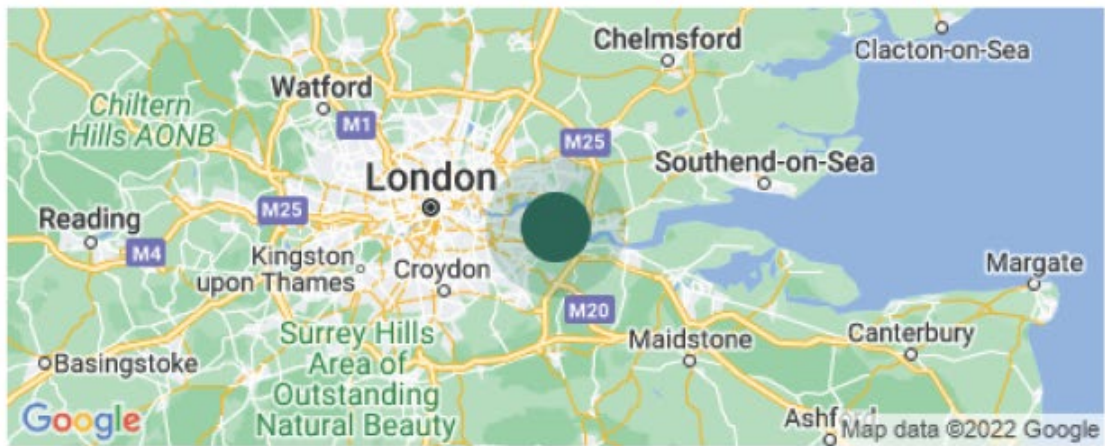


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Test Title 20-June-2022 15 : 25



Date & Time	20 Jun 2022 14:25	Maximum Load Achieved	1.94 kN
Device SN		Next Calibration Date	
Max displacement	29.9 mm		
Notes			
	T32-02-10		



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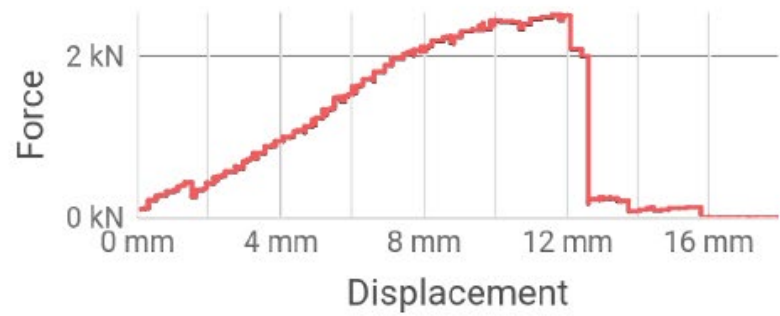
Test Title 20-June-2022 15 : 25



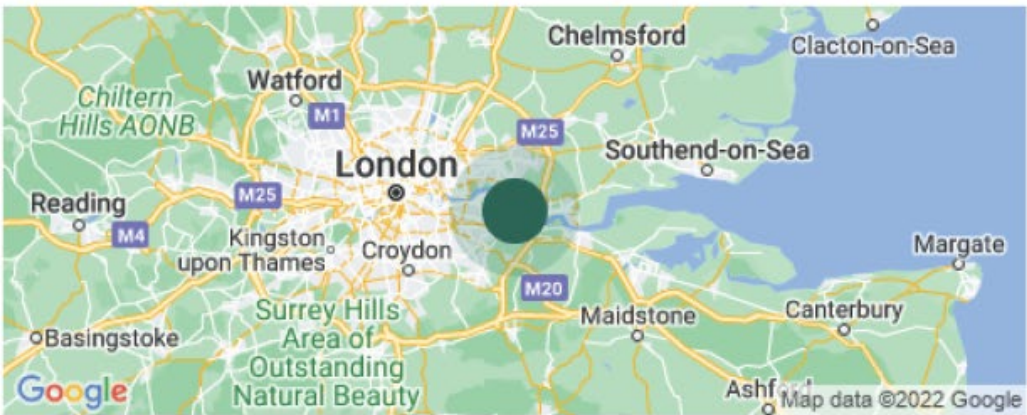
Powered by STAHT CONNECT

9. Test Type 3 – T12 Rebar Force vs Displacement Graphs

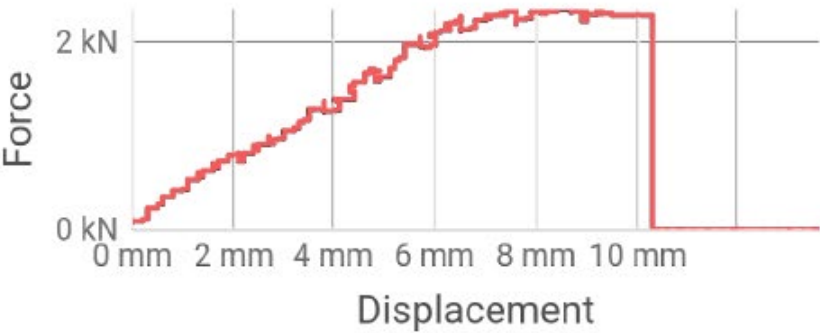
Test Title 21-June-2022 08 : 22



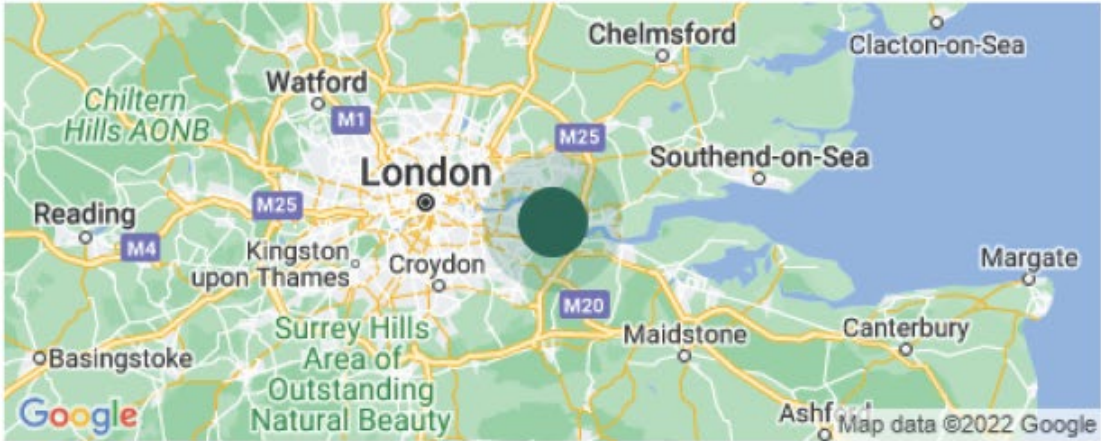
Date & Time	21 Jun 2022 07:22	Maximum Load Achieved	2.54 kN
Device SN		Next Calibration Date	
Max displacement	17.9 mm		
Notes			
T12-03-01			



Test Title 21-June-2022 08 : 27



Date & Time	21 Jun 2022 07:27	Maximum Load Achieved	2.34 kN
Device SN		Next Calibration Date	
Max displacement	13.6 mm		
Notes			
T12-03-02			



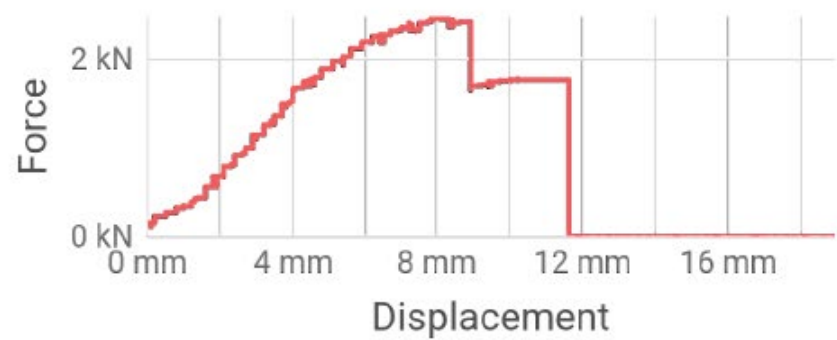
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 27

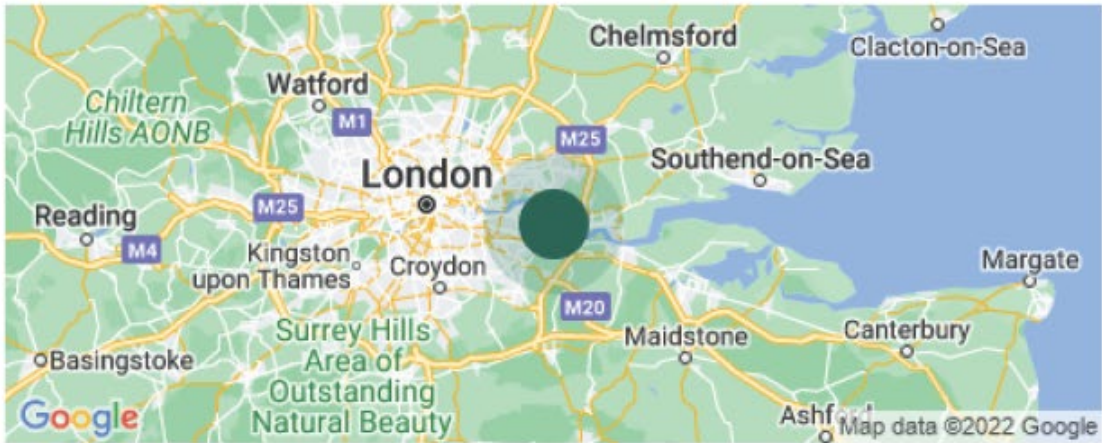


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Test Title 21-June-2022 08 : 30



Date & Time	21 Jun 2022 07:30	Maximum Load Achieved	2.48 kN
Device SN		Next Calibration Date	
Max displacement	18.9 mm		
Notes			
T12-03-03			



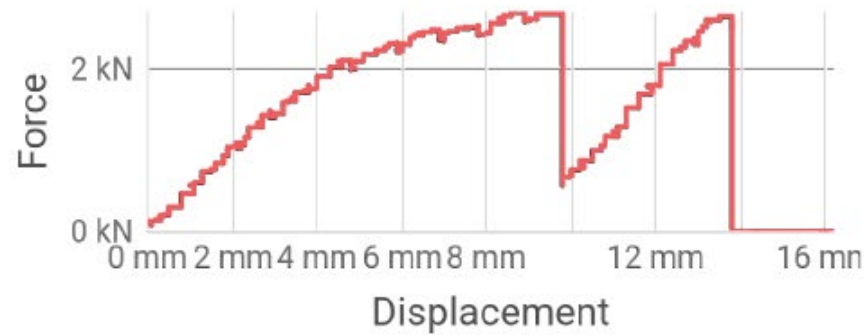
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 30

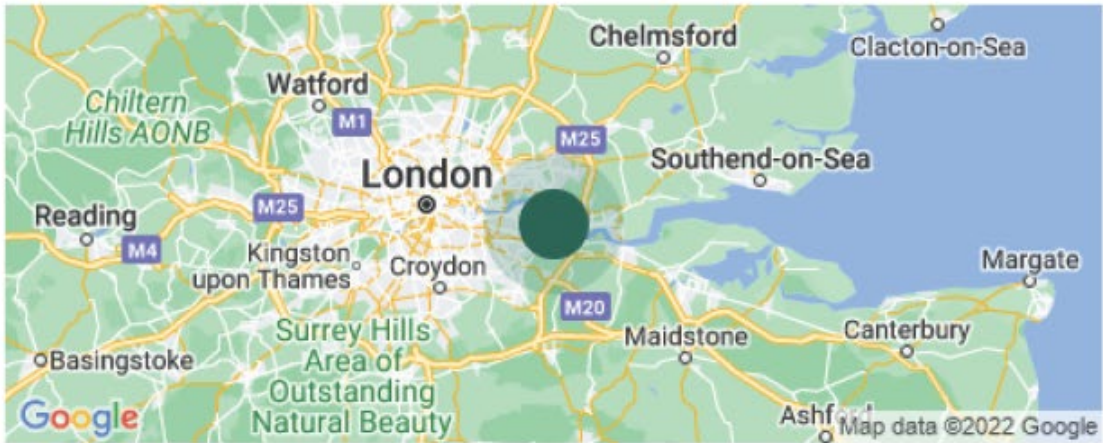


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Test Title 21-June-2022 08 : 32



Date & Time	21 Jun 2022 07:32	Maximum Load Achieved	2.7 kN
Device SN		Next Calibration Date	
Max displacement	16.2 mm		
Notes			
T12-03-04			



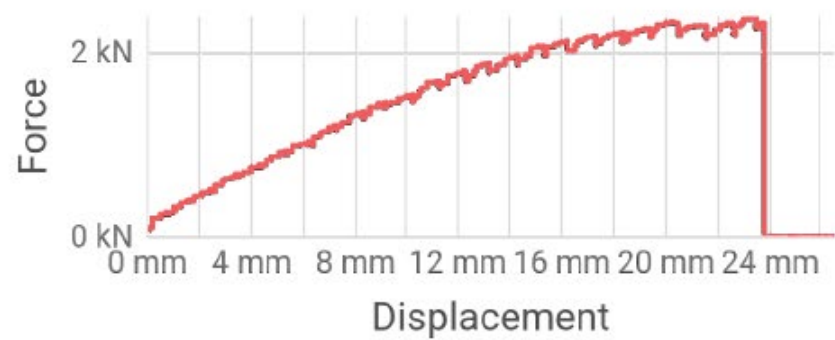
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 32

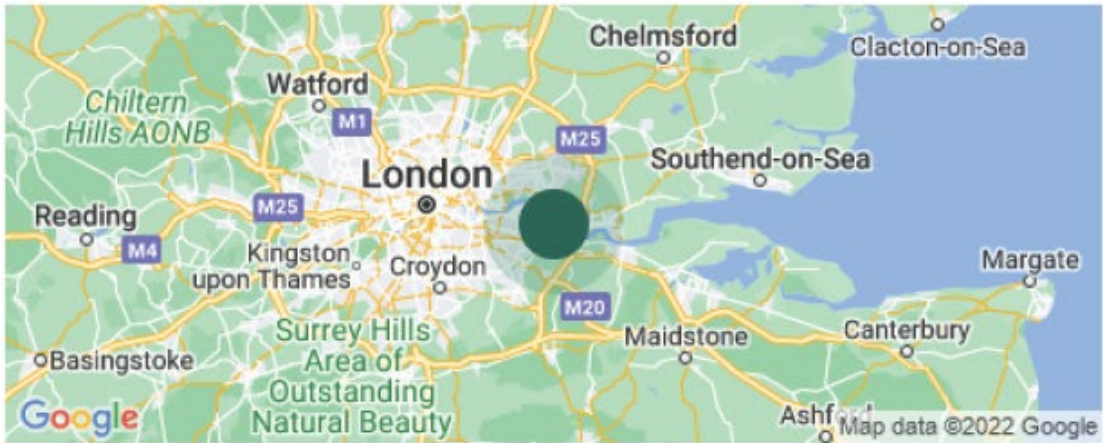


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Test Title 21-June-2022 08 : 38



Date & Time	21 Jun 2022 07:38	Maximum Load Achieved	2.39 kN
Device SN		Next Calibration Date	
Max displacement	26.5 mm		
Notes			
T12-03-05			



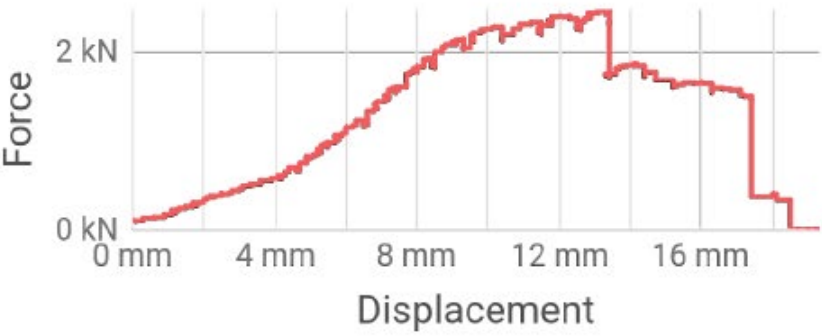
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 38

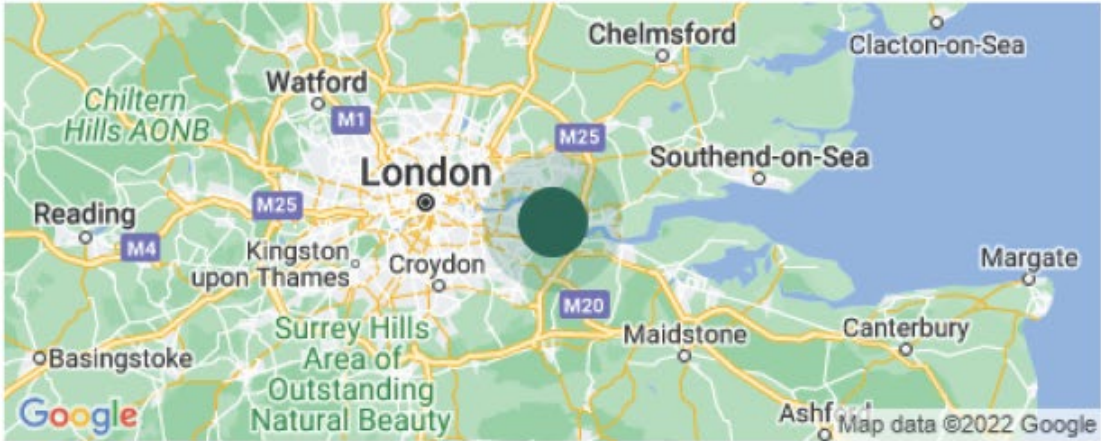


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Test Title 21-June-2022 08 : 40



Date & Time	21 Jun 2022 07:40	Maximum Load Achieved	2.47 kN
Device SN		Next Calibration Date	
Max displacement	19.3 mm		
Notes			
T12-03-06			



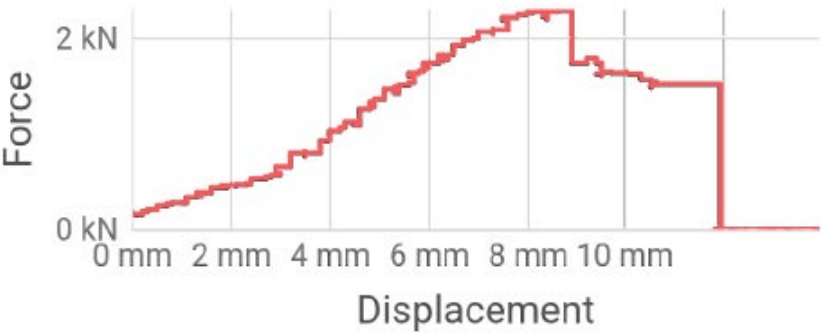
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 40

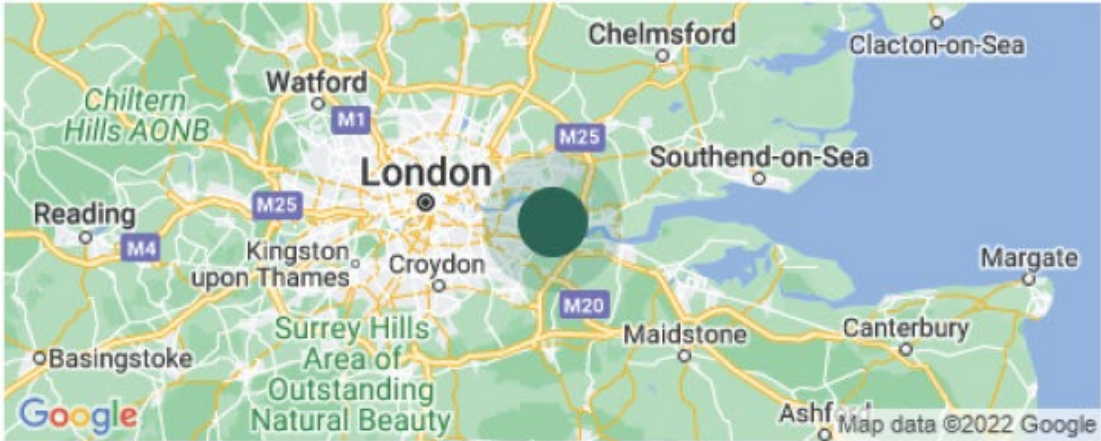


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Test Title 21-June-2022 08 : 42



Date & Time	21 Jun 2022 07:42	Maximum Load Achieved	2.3 kN
Device SN		Next Calibration Date	
Max displacement	13.9 mm		
Notes			
	T12-03-07		



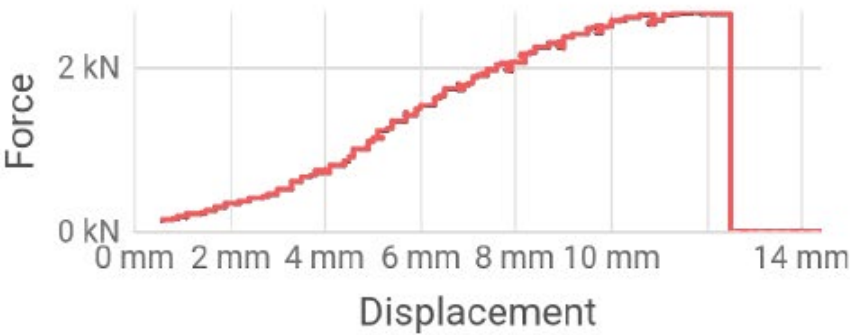
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 42

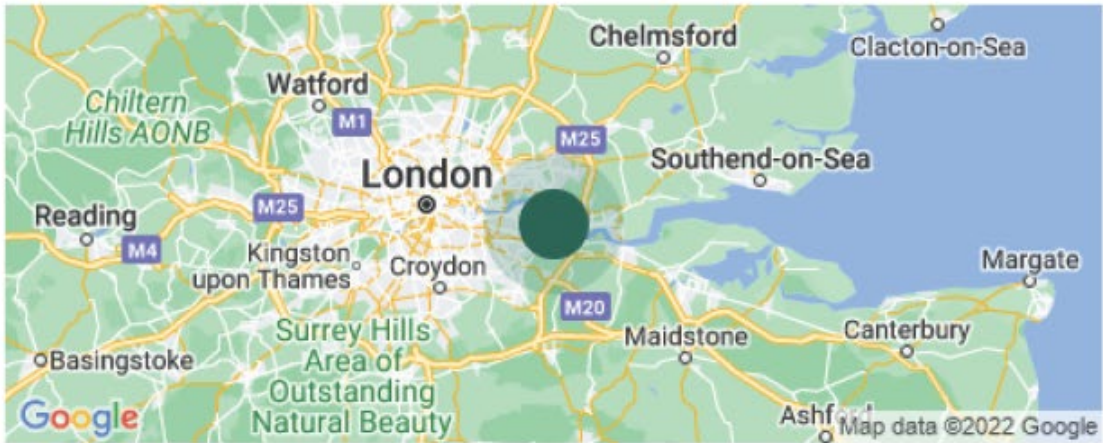


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Test Title 21-June-2022 08 : 44



Date & Time	21 Jun 2022 07:44	Maximum Load Achieved	2.68 kN
Device SN		Next Calibration Date	
Max displacement	14.4 mm		
Notes			
T12-03-08			



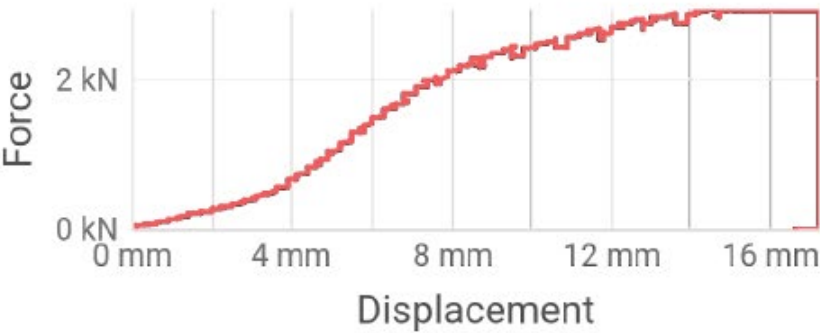
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 44

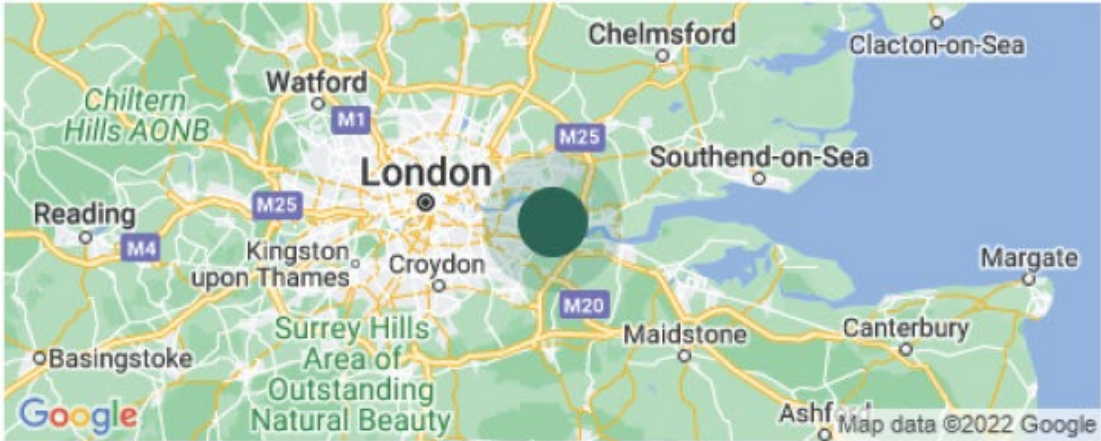


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Test Title 21-June-2022 08 : 46



Date & Time	21 Jun 2022 07:46	Maximum Load Achieved	2.94 kN
Device SN		Next Calibration Date	
Max displacement	17.2 mm		
Notes			
T12-03-09			



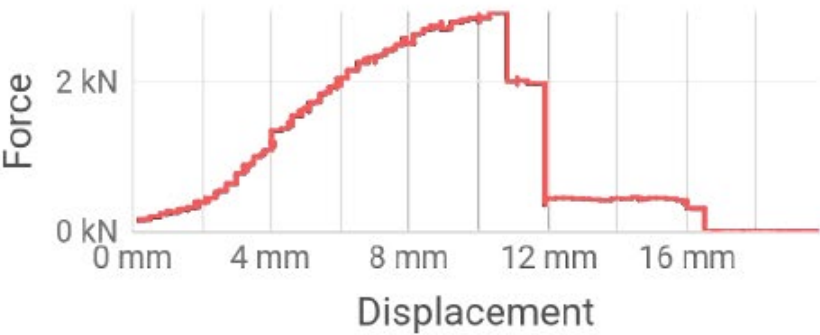
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 46

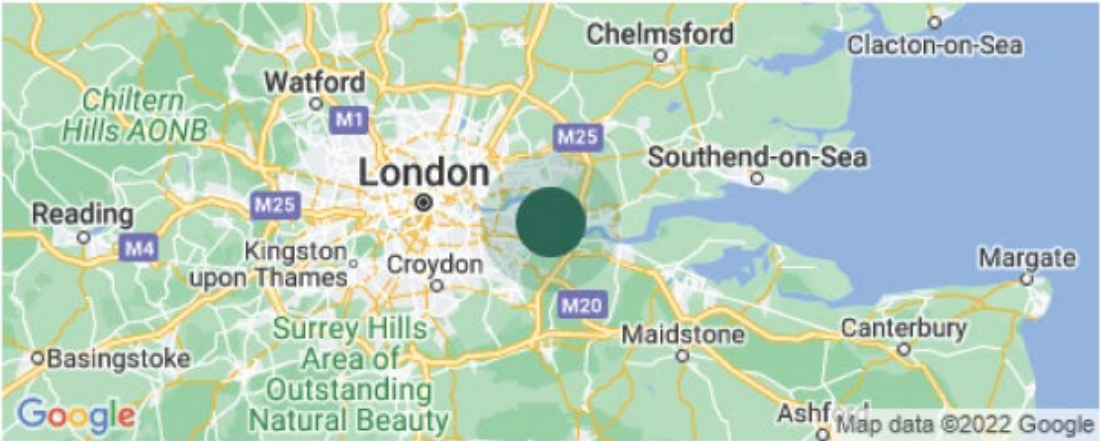


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Test Title 21-June-2022 08 : 48



Date & Time	21 Jun 2022 07:48	Maximum Load Achieved	2.94 kN
Device SN		Next Calibration Date	
Max displacement	19.8 mm		
Notes			
T12-03-10			



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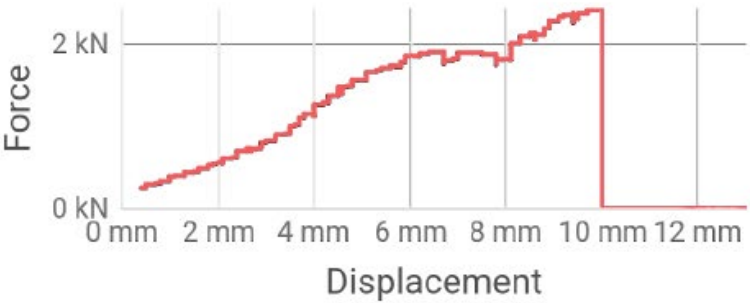
Test Title 21-June-2022 08 : 48



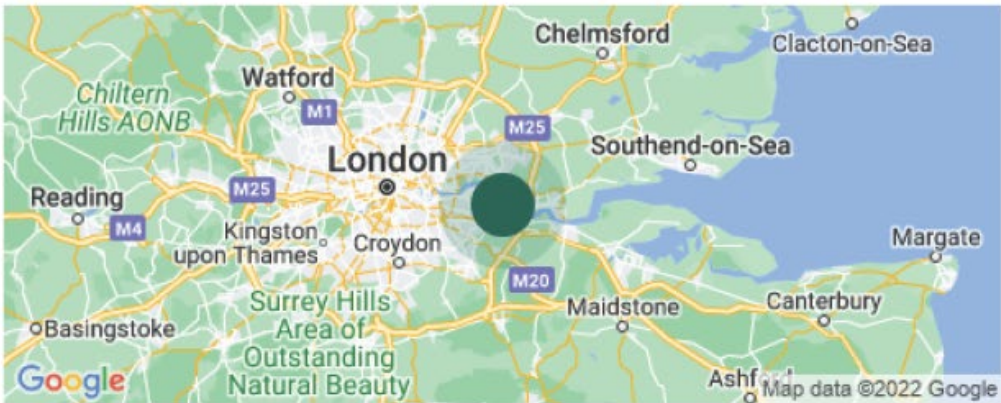
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10. Test Type 3 – T20 Rebar Force vs Displacement Graphs

Test Title 21-June-2022 08:55



Date & Time	21 Jun 2022 07:55	Maximum Load Achieved	2.43 kN
Device SN		Next Calibration Date	
Max displacement	13 mm		
Notes	T20-03-01		



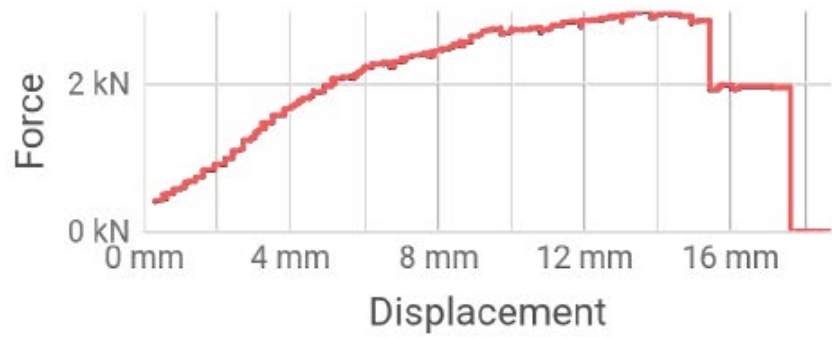
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 55

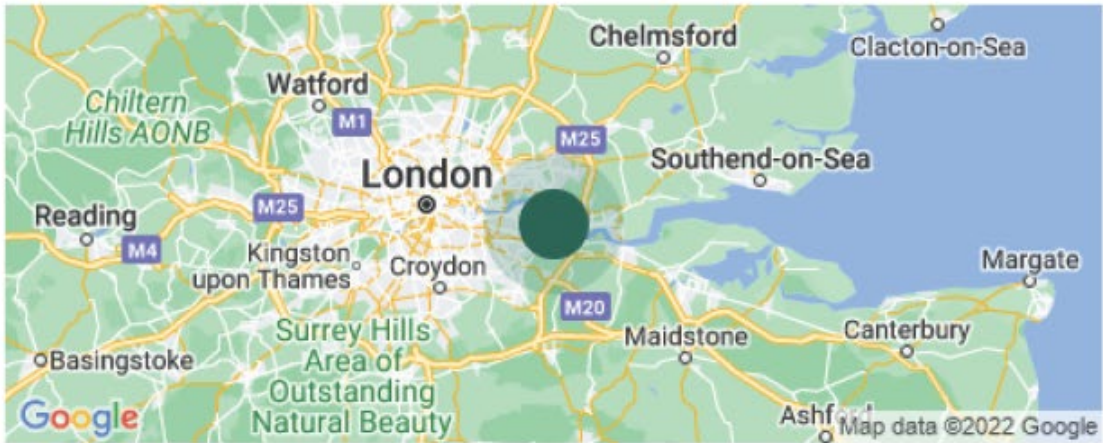


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Test Title 21-June-2022 08 : 59



Date & Time	21 Jun 2022 07:59	Maximum Load Achieved	2.98 kN
Device SN		Next Calibration Date	
Max displacement	18.7 mm		
Notes			
T20-03-02			



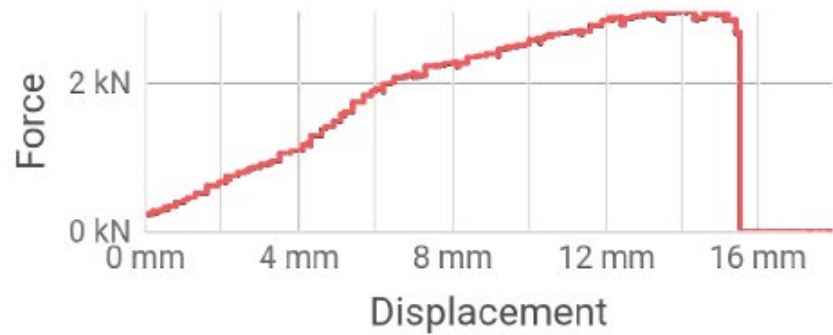
Powered by STAHT CONNECT

Test Title 21-June-2022 08 : 59

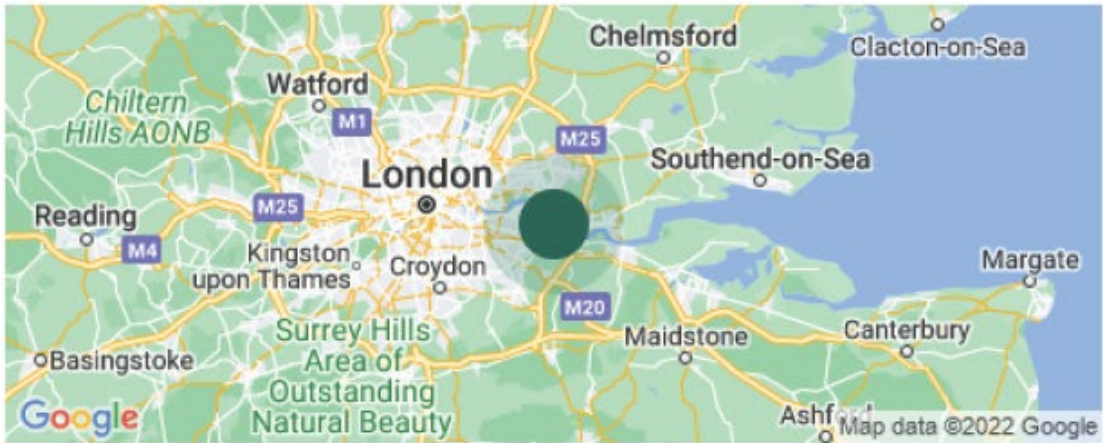


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Test Title 21-June-2022 09 : 02



Date & Time	21 Jun 2022 08:02	Maximum Load Achieved	2.96 kN
Device SN		Next Calibration Date	
Max displacement	17.9 mm		
Notes			
T20-03-03			



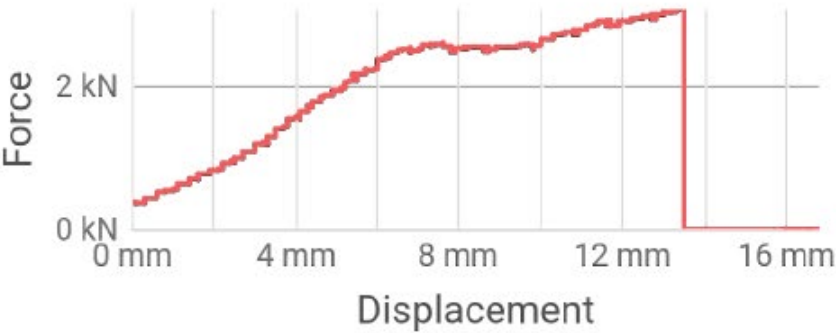
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 02

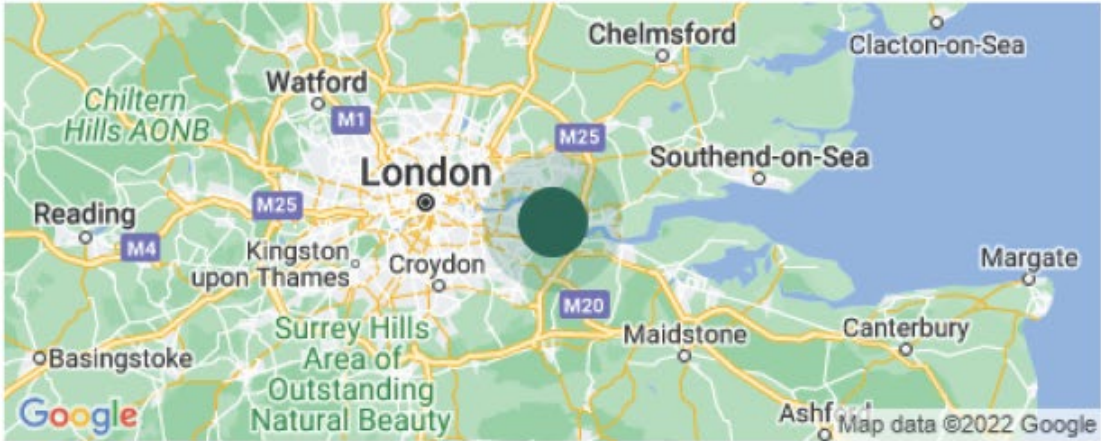


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Test Title 21-June-2022 09 : 04



Date & Time	21 Jun 2022 08:04	Maximum Load Achieved	3.07 kN
Device SN		Next Calibration Date	
Max displacement	16.8 mm		
Notes			
T20-03-04			

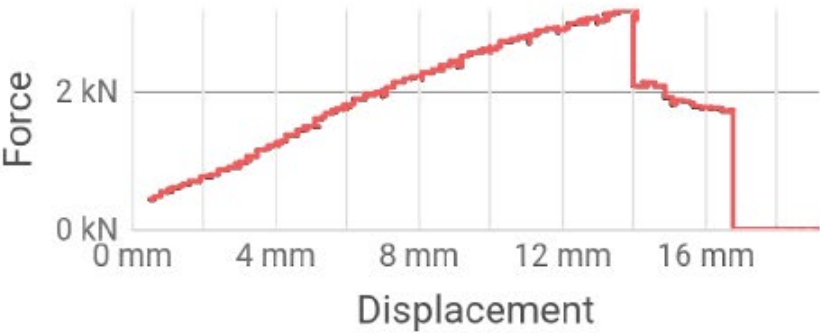


Test Title 21-June-2022 09 : 04

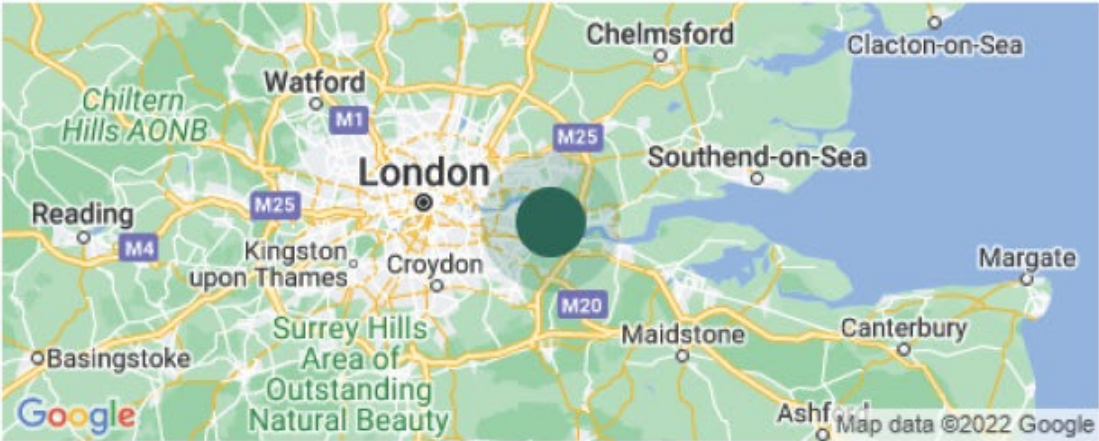


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Test Title 21-June-2022 09 : 06



Date & Time	21 Jun 2022 08:06	Maximum Load Achieved	3.19 kN
Device SN		Next Calibration Date	
Max displacement	19.2 mm		
Notes			
T20-03-05			



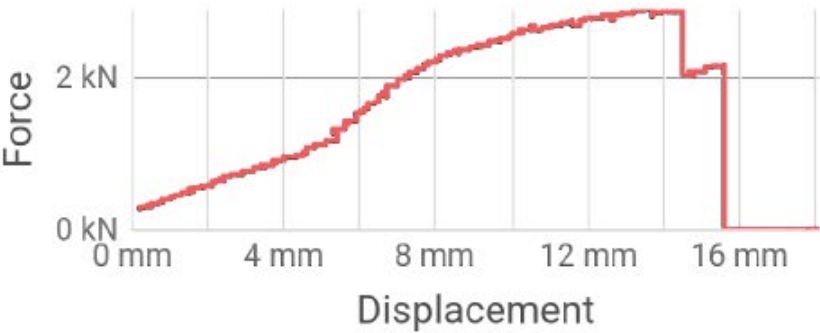
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 06

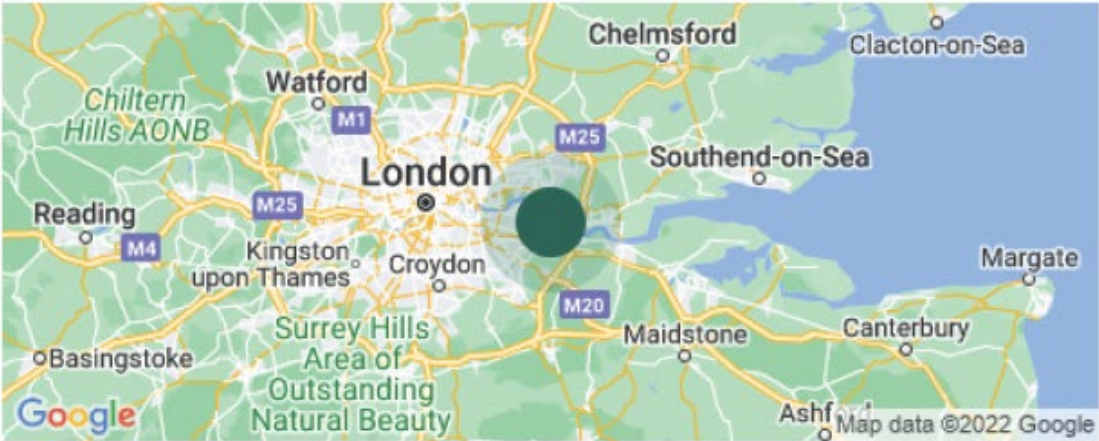


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Test Title 21-June-2022 09 : 08



Date & Time	21 Jun 2022 08:08	Maximum Load Achieved	2.89 kN
Device SN		Next Calibration Date	
Max displacement	18.1 mm		
Notes			
T20-03-06			



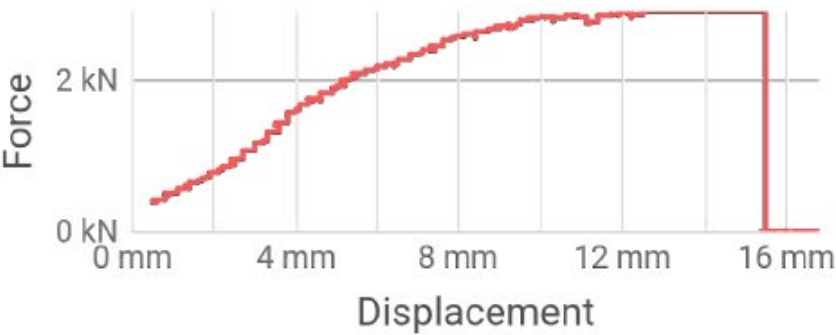
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 08

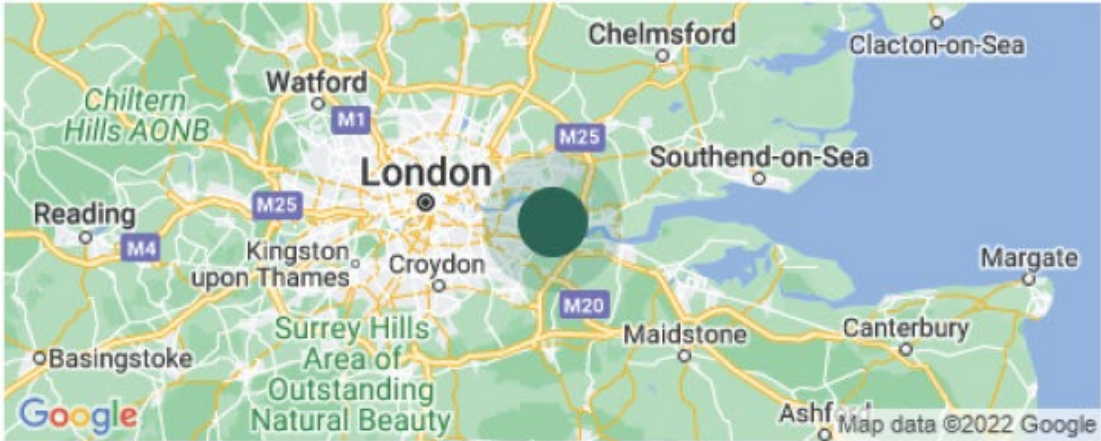


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Test Title 21-June-2022 09 : 14



Date & Time	21 Jun 2022 08:14	Maximum Load Achieved	2.9 kN
Device SN		Next Calibration Date	
Max displacement	16.8 mm		
Notes	T20-03-07		

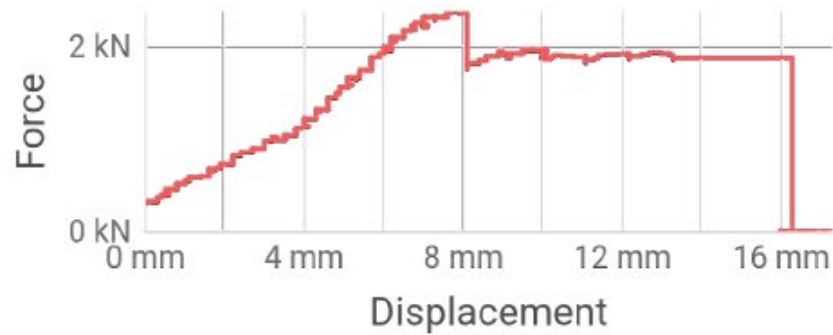


Test Title 21-June-2022 09 : 14

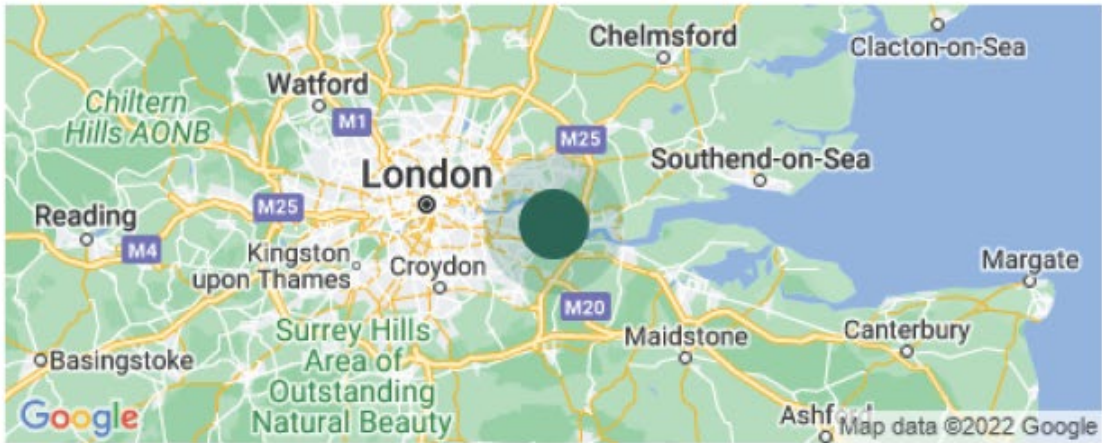


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Test Title 21-June-2022 09 : 16



Date & Time	21 Jun 2022 08:16	Maximum Load Achieved	2.38 kN
Device SN		Next Calibration Date	
Max displacement	17.3 mm		
Notes			
T20-03-08			



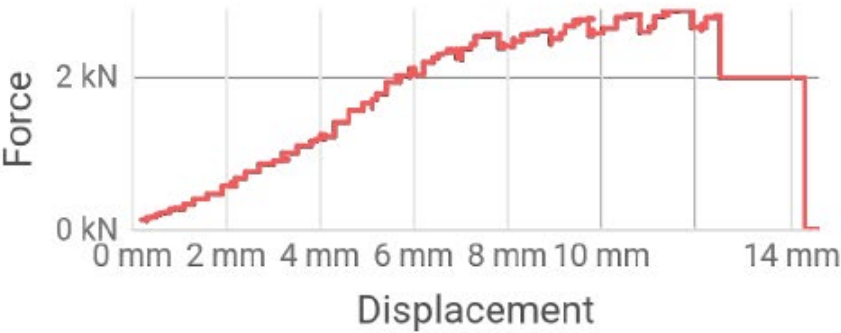
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 16

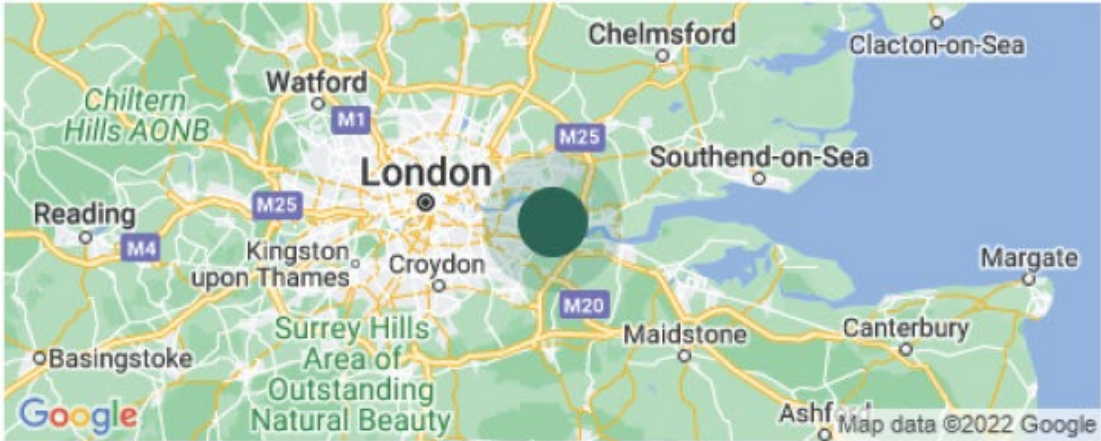


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Test Title 21-June-2022 09 : 18



Date & Time	21 Jun 2022 08:18	Maximum Load Achieved	2.88 kN
Device SN		Next Calibration Date	
Max displacement	14.6 mm		
Notes			
T20-03-09			

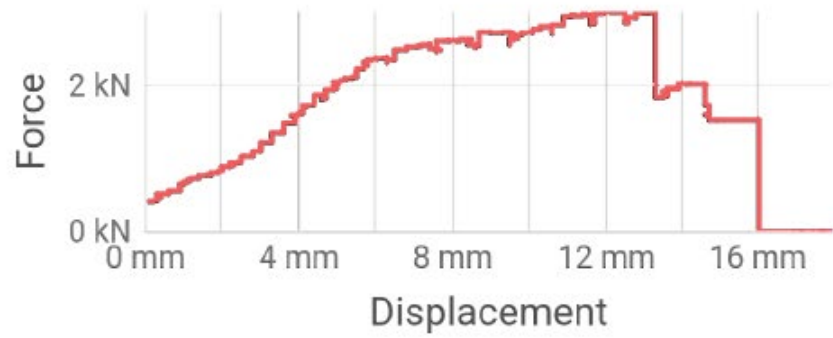


Test Title 21-June-2022 09 : 18

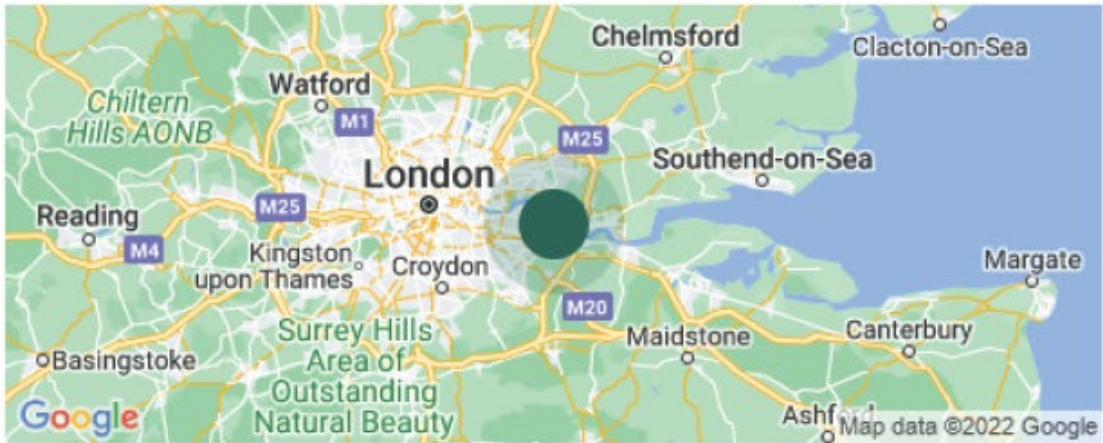


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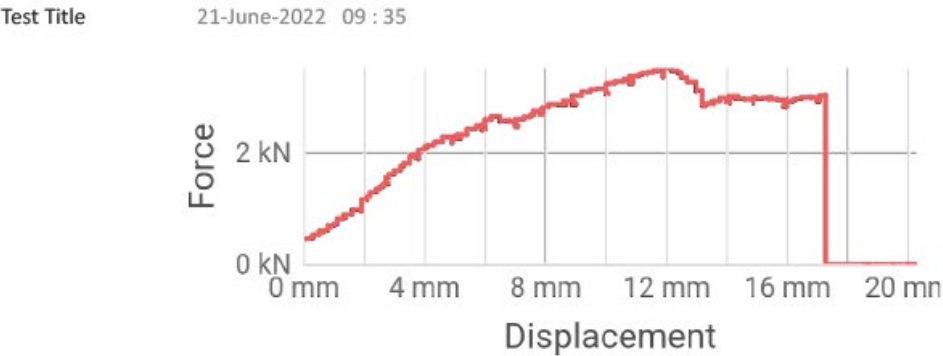
Test Title 21-June-2022 09 : 21



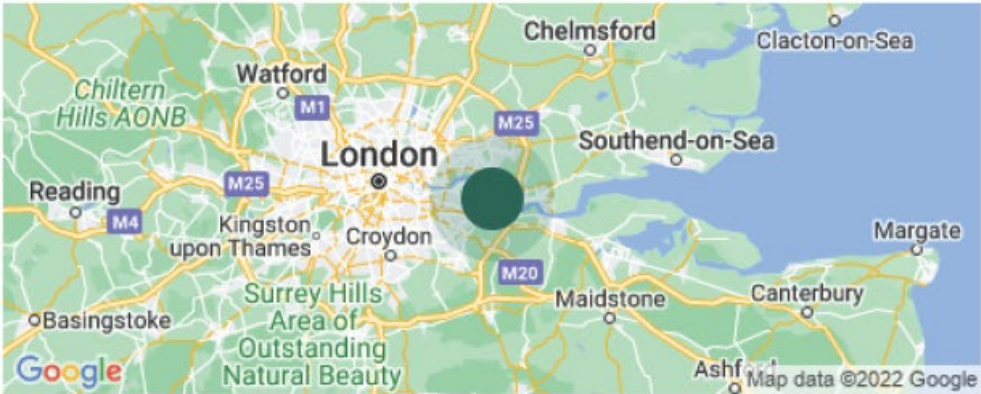
Date & Time	21 Jun 2022 08:21	Maximum Load Achieved	3.01 kN
Device SN		Next Calibration Date	
Max displacement	17.9 mm		
Notes			
T20-03-10			



11. Test Type 3 – T32 Rebar Force vs Displacement Graphs



Date & Time	21 Jun 2022 08:35	Maximum Load Achieved	3.52 kN
Device SN		Next Calibration Date	
Max displacement	20.3 mm		
Notes			
T32-03-01			

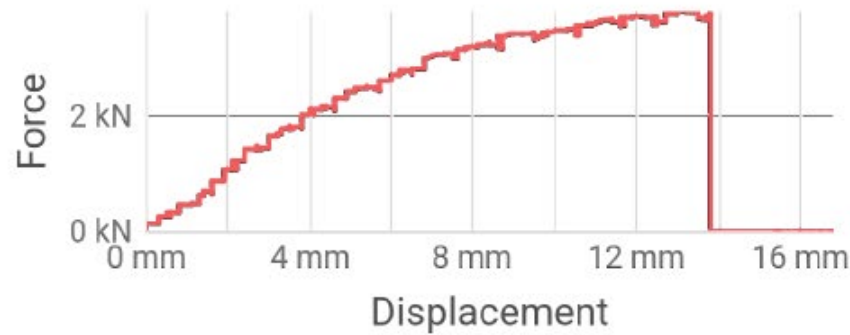


Test Title 21-June-2022 09 : 35

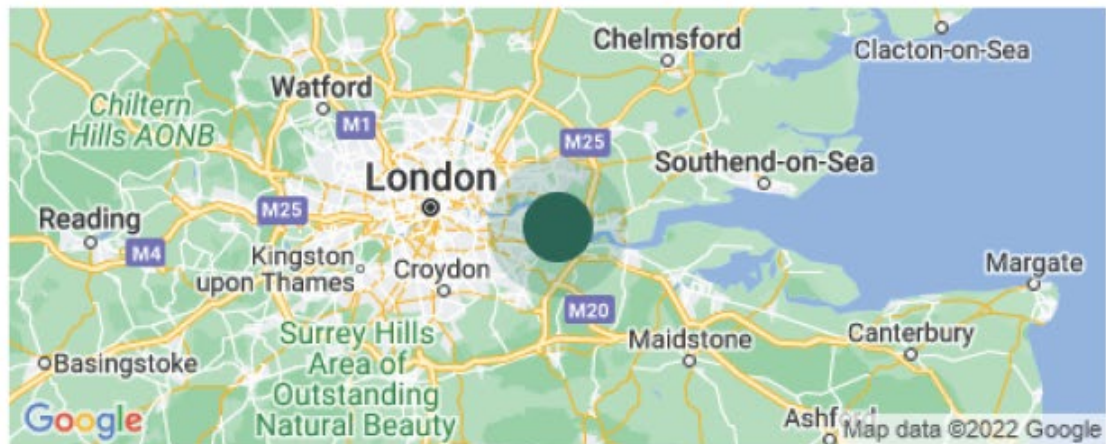


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Test Title 21-June-2022 09 : 37



Date & Time	21 Jun 2022 08:37	Maximum Load Achieved	3.8 kN
Device SN		Next Calibration Date	
Max displacement	16.8 mm		
Notes			
	T32-03-02		



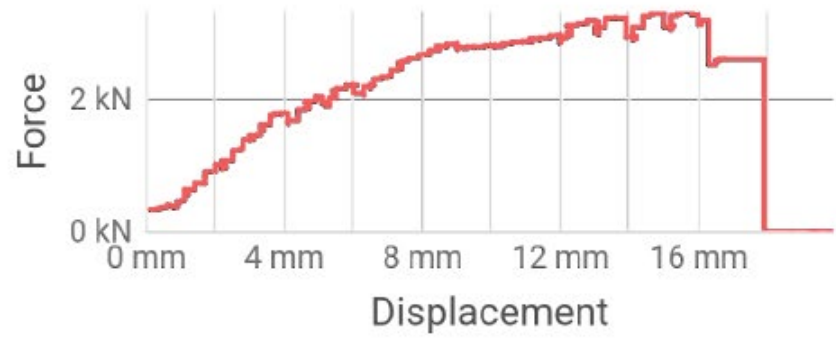
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 37

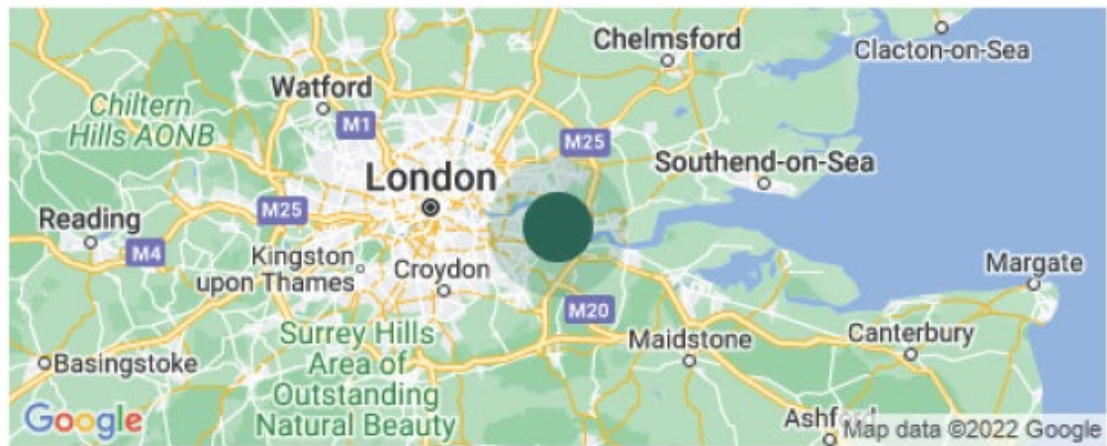


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Test Title 21-June-2022 09 : 40



Date & Time	21 Jun 2022 08:40	Maximum Load Achieved	3.32 kN
Device SN		Next Calibration Date	
Max displacement	19.9 mm		
Notes			
	T32-03-03		



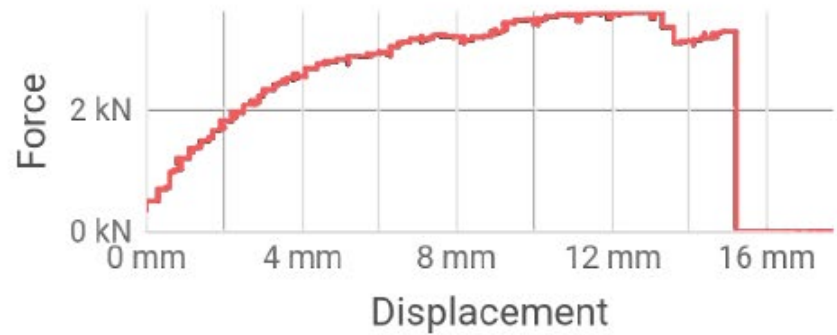
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 40

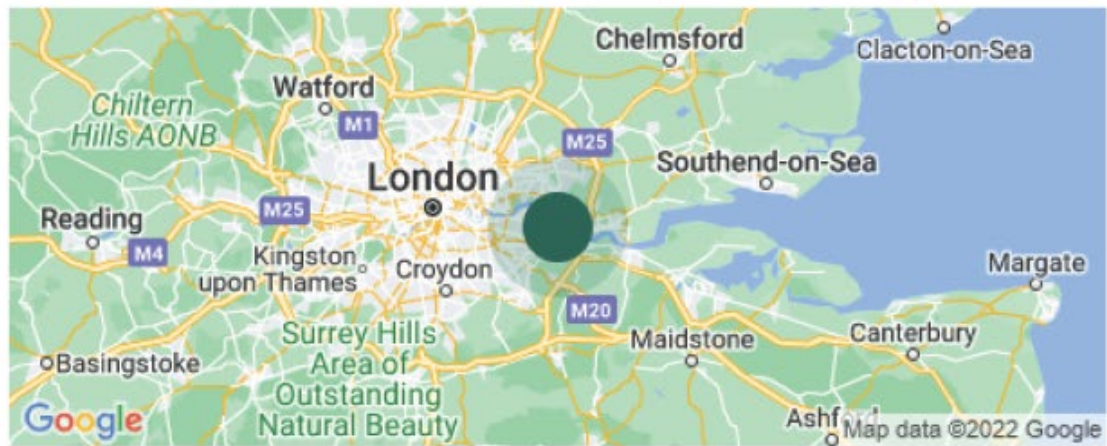


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Test Title 21-June-2022 09 : 42



Date & Time	21 Jun 2022 08:42	Maximum Load Achieved	3.61 kN
Device SN		Next Calibration Date	
Max displacement	17.7 mm		
Notes			
	T32-03-04		



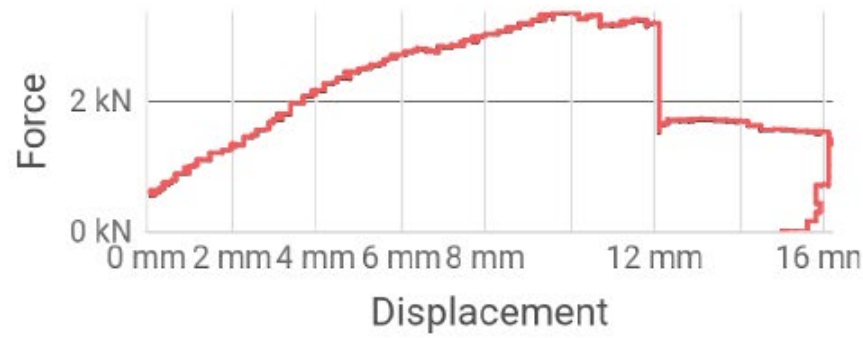
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 42

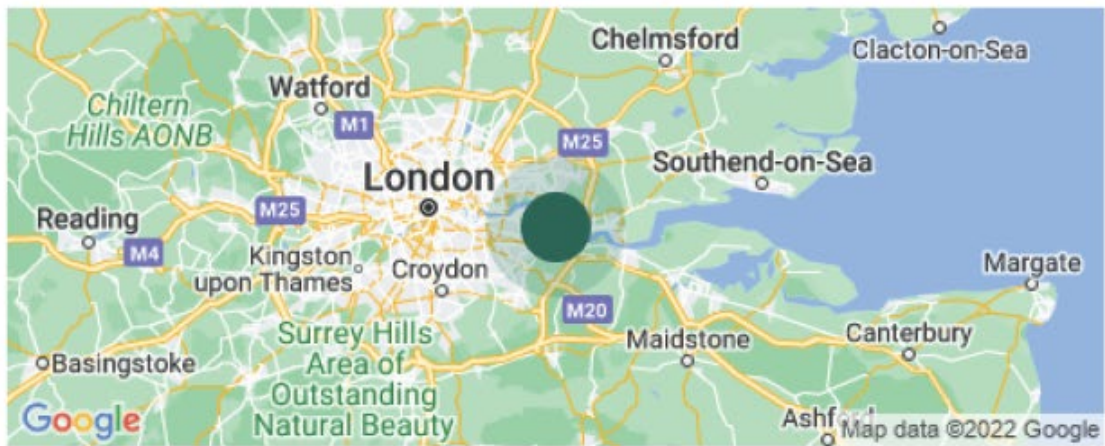


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Test Title 21-June-2022 09 : 45



Date & Time	21 Jun 2022 08:45	Maximum Load Achieved	3.37 kN
Device SN		Next Calibration Date	
Max displacement	16.2 mm		
Notes			
	T32-03-05		



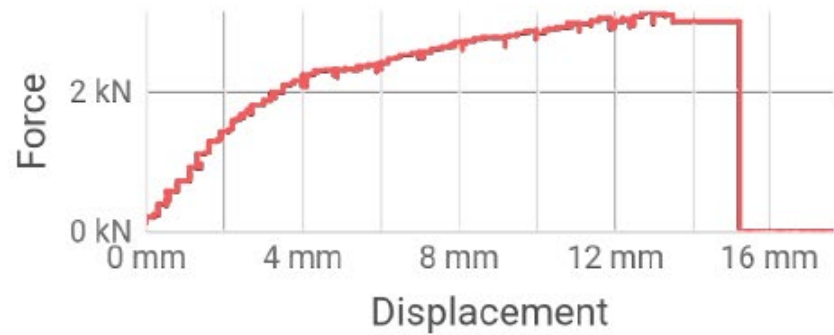
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 45

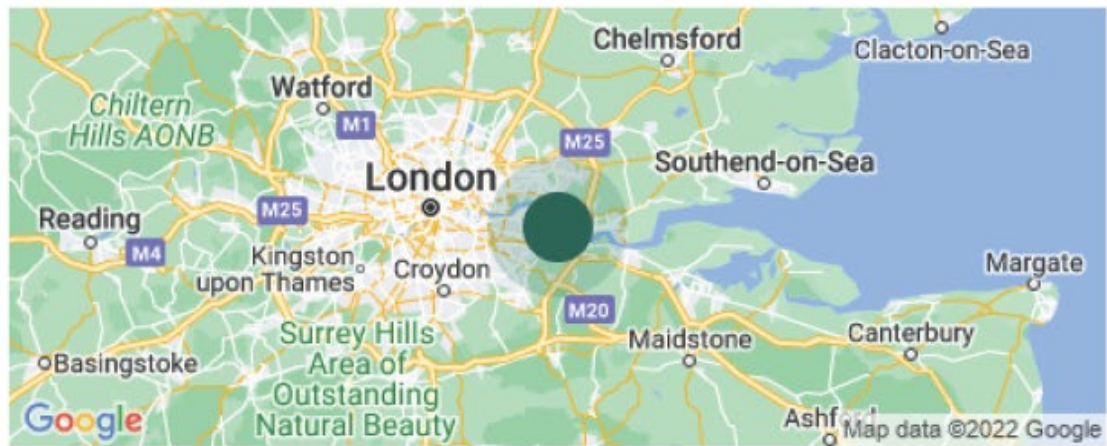


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Test Title 21-June-2022 09 : 47



Date & Time	21 Jun 2022 08:47	Maximum Load Achieved	3.14 kN
Device SN		Next Calibration Date	
Max displacement	17.6 mm		
Notes			
	T32-03-06		



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Test Title 21-June-2022 09 : 47

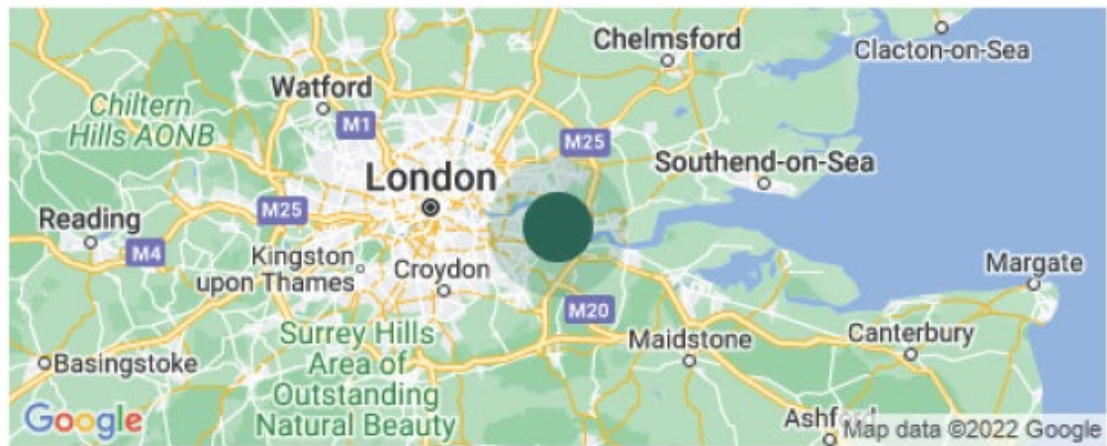


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Test Title 21-June-2022 09 : 49



Date & Time	21 Jun 2022 08:49	Maximum Load Achieved	3.54 kN
Device SN		Next Calibration Date	
Max displacement	19.6 mm		
Notes			
	T32-03-07		



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Test Title 21-June-2022 09 : 49

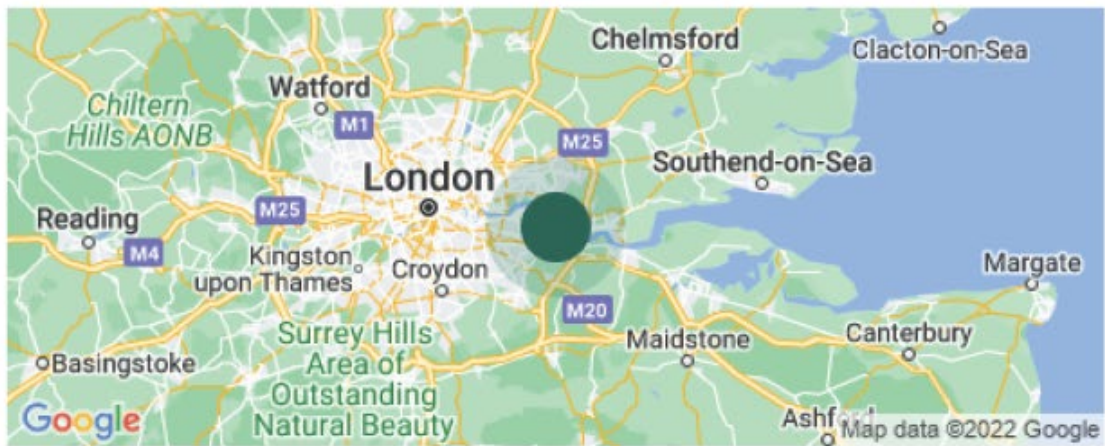


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Test Title 21-June-2022 09 : 51



Date & Time	21 Jun 2022 08:51	Maximum Load Achieved	3.55 kN
Device SN		Next Calibration Date	
Max displacement	19 mm		
Notes			
	T32-03-08		



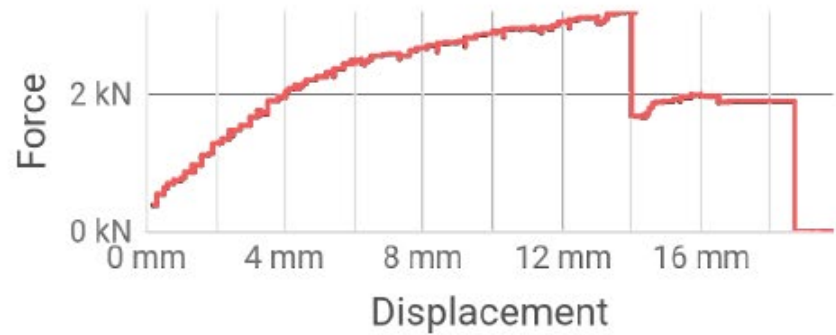
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 51

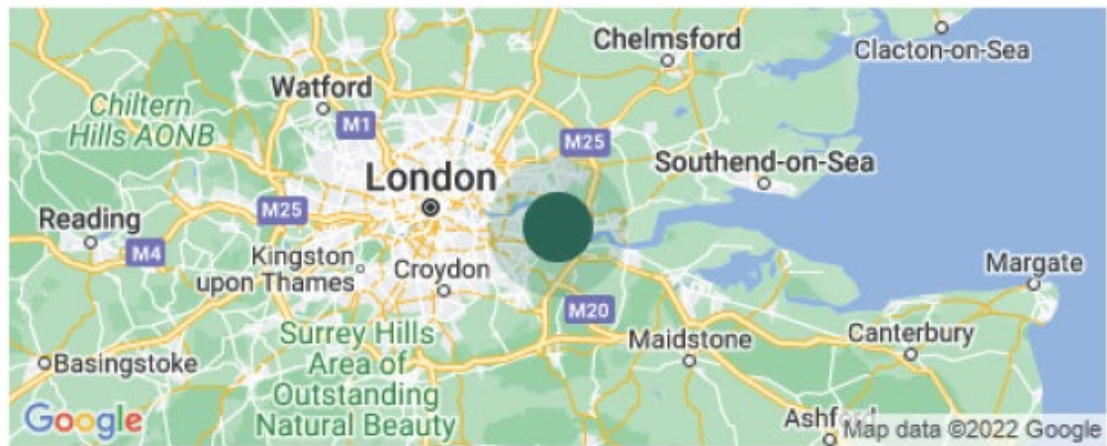


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Test Title 21-June-2022 09 : 53



Date & Time	21 Jun 2022 08:53	Maximum Load Achieved	3.2 kN
Device SN		Next Calibration Date	
Max displacement	19.8 mm		
Notes			
	T32-03-09		



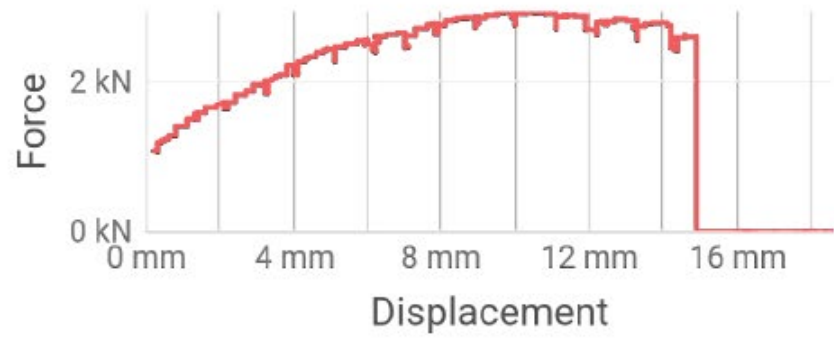
Powered by STAHT CONNECT

Test Title 21-June-2022 09 : 53

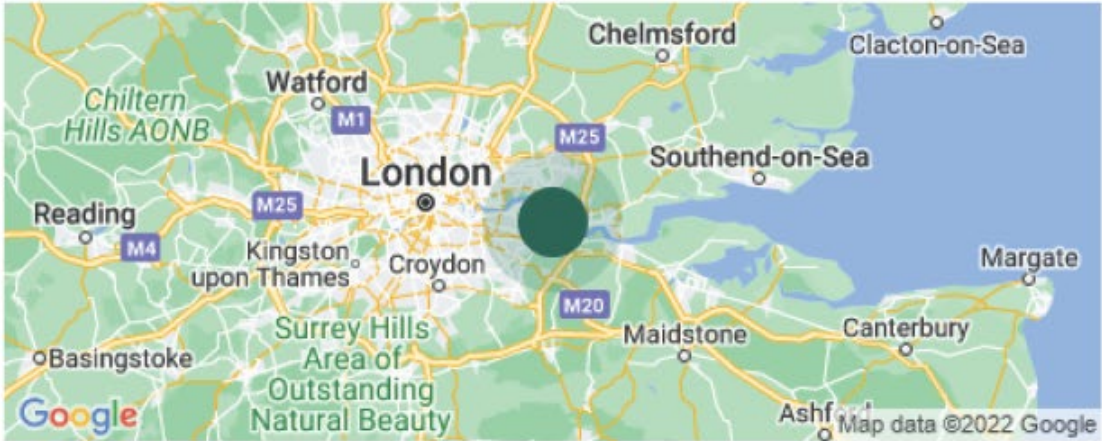


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Test Title 21-June-2022 09 : 56



Date & Time	21 Jun 2022 08:56	Maximum Load Achieved	2.94 kN
Device SN		Next Calibration Date	
Max displacement	18.6 mm		
Notes			
	T32-03-10		



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Test Title 21-June-2022 09 : 56



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12. Test photos



Photo 02: Test Type 1 – Double crown tie after testing



Photo 03: Test Type 1 – Double crown tie after testing



Photo 04: Test Type 1 – Double crown tie after testing



Photo 05: Test Type 1 – Double crown tie after testing



Photo 06: Test Type 2 – 2no single splice ties before testing



Photo 07: Test Type 2 – 2no single splice ties before testing



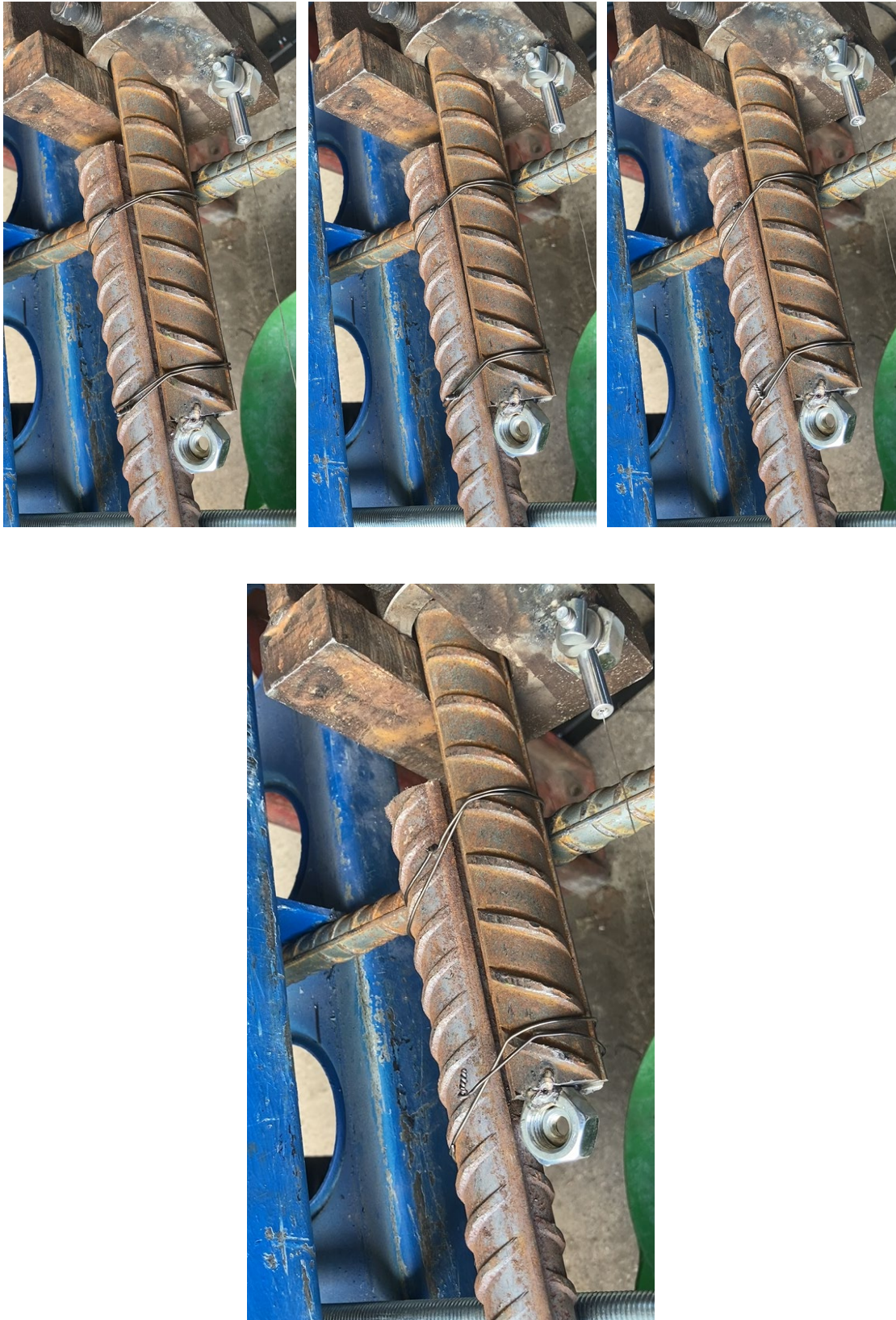


Photo 08, 09, 10, 11: Test Type 2 – 2no single splice ties before, during and after testing

Photo 12: Test Type 3 – Double crown tie before testing



Photo 13: Test Type 3 – Double crown tie after testing

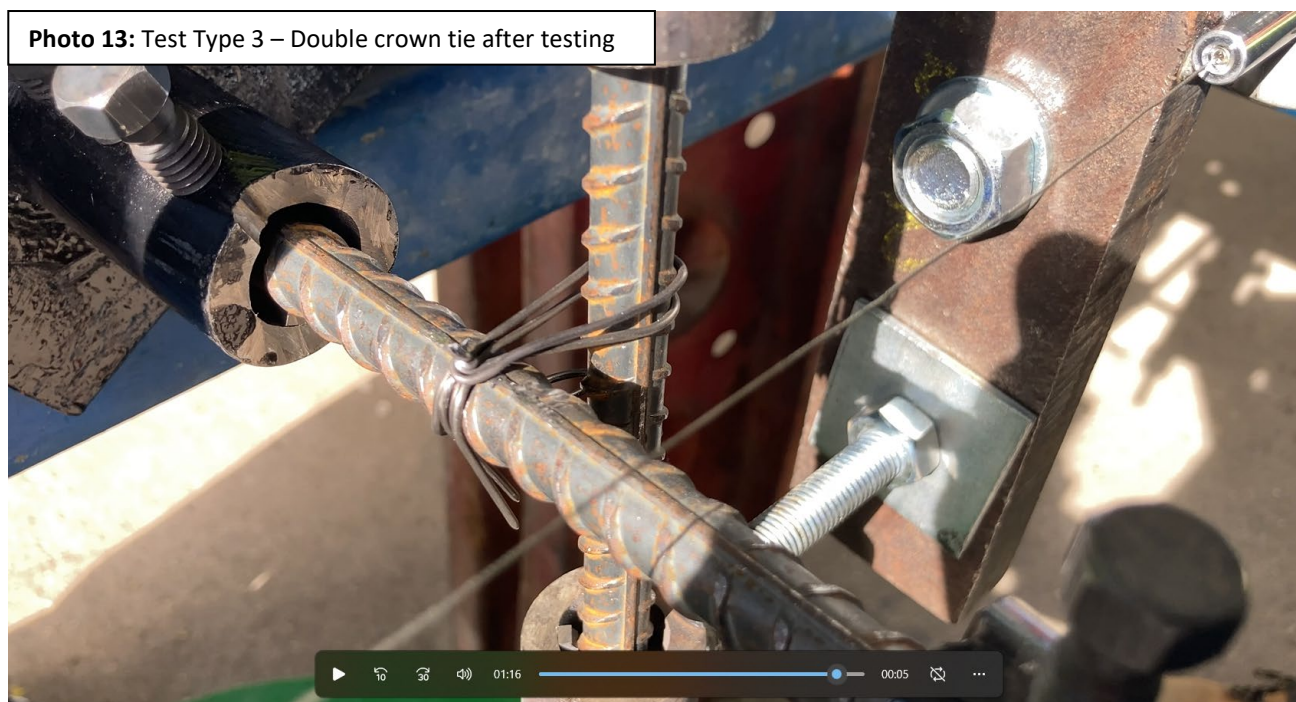




Photo 14, 15, 16, 17: Test Type 3 – Double crown tie before during and after testing



Photo 18, 19, 20, 21: Test Type 3 – Double crown tie before during and after testing

APPENDIX B - Tie Wire Data Sheet

DATA SHEET CMT



CMT

GROUP

CREATE. DELIVER. SUSTAIN.



Black Annealed Tying Wire

Black Soft Annealed Tying Wire is the most popular tying wire and is annealed to the highest standards.

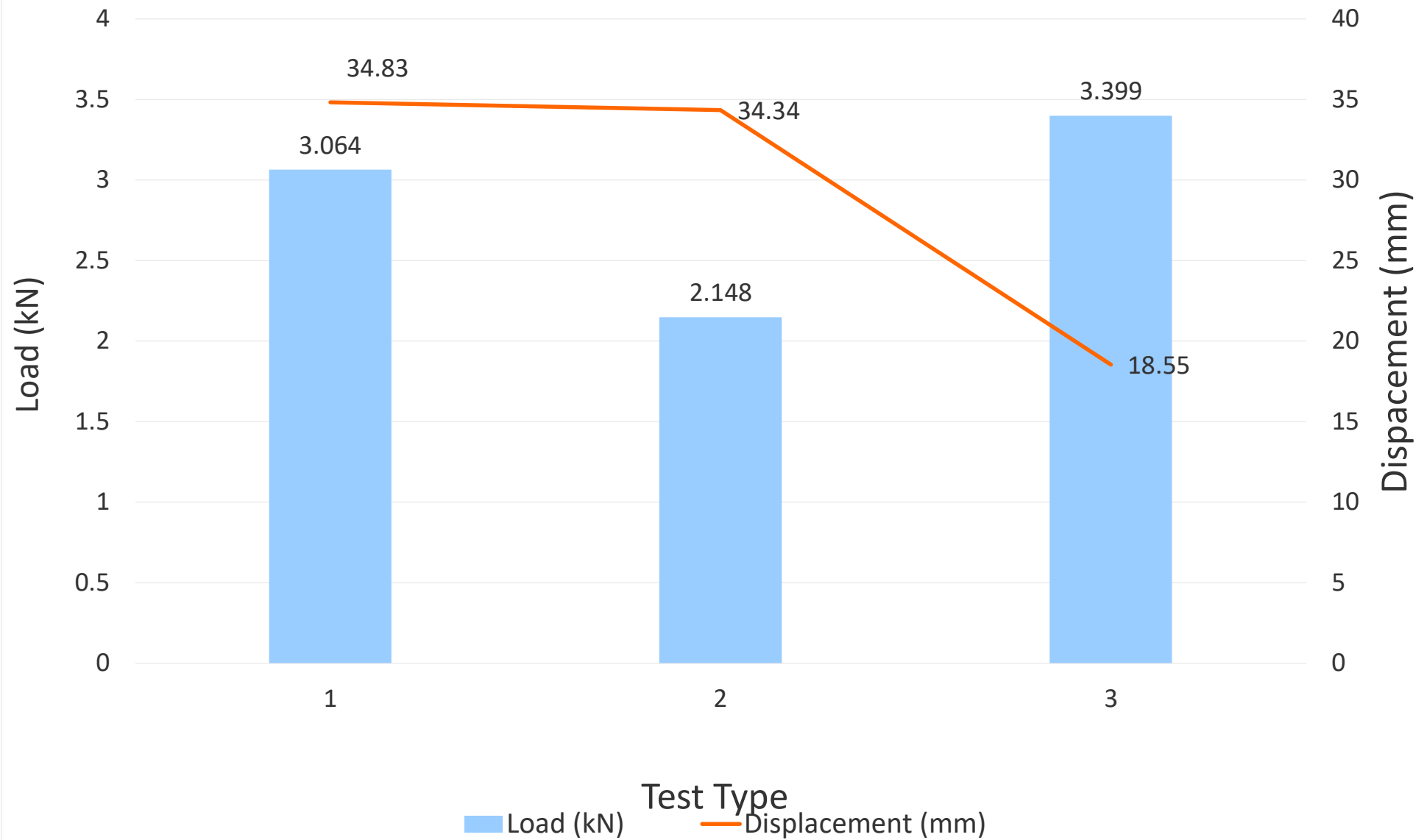
- 16 gauge
- 12kg coil
- Colour: Black
- Slightly oiled finish
- Tensile test: Passed
- Coil packaging inner: plastic
- Coil packaging outer: hessian

	Allowed	Found	Notes
Critical defectives	0.0%	0	Critical defective: A defect that judgment and experience indicate is likely to result in hazardous or unsafe conditions; product or assembly failure or regulations are not respected.
Major defectives	1.0%	0	Major defective: A defect that judgment and experience indicate is likely to affect product performance or reduce the usability of the product for its intended purpose.
Minor defectives	4.0%	0	Minor defectives: A departure from established standards that is not likely to reduce the usability of the item or assembly for its intended purpose.

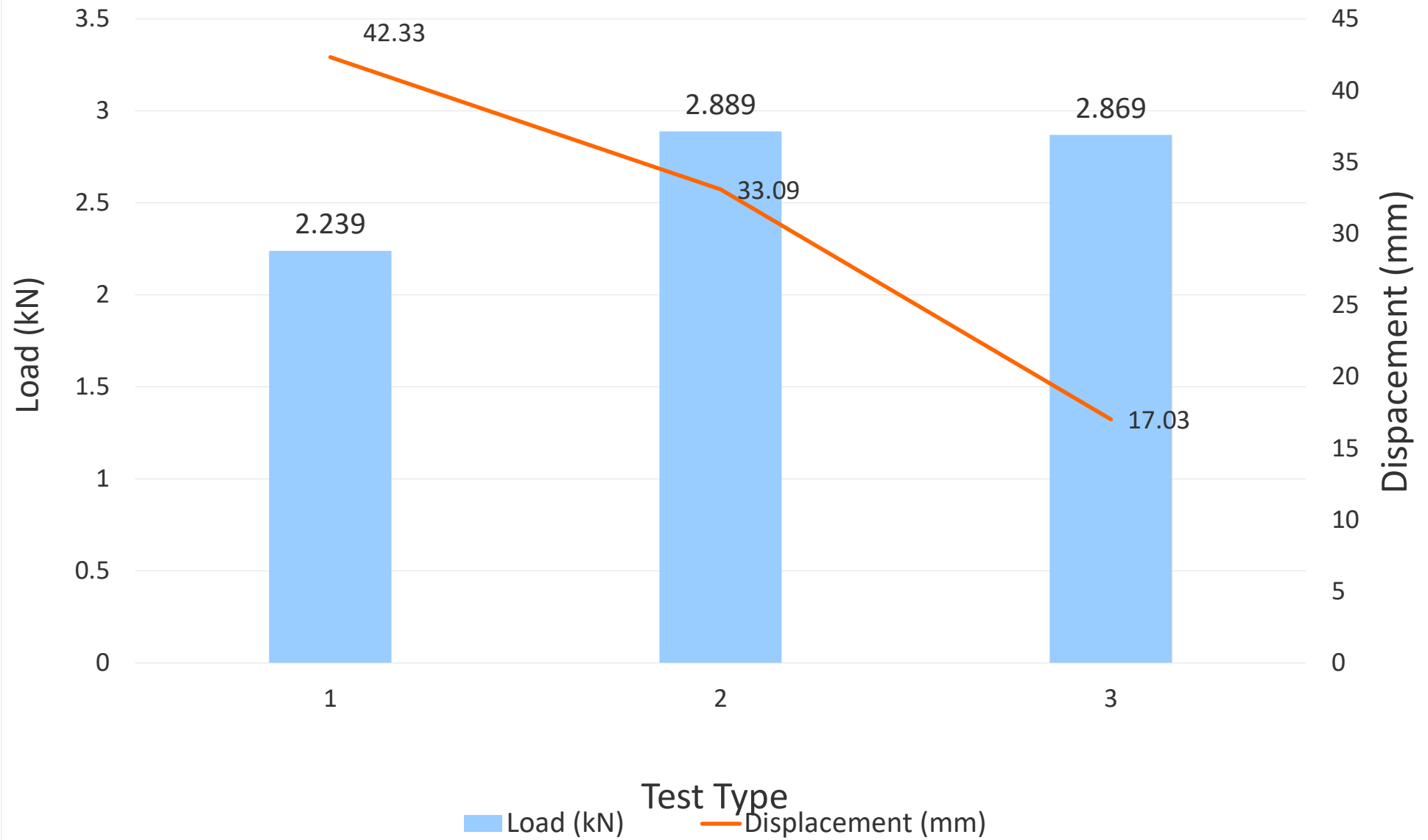
Code: **TYWBA**

APPENDIX C – Additional data review graphs (added into pdf)

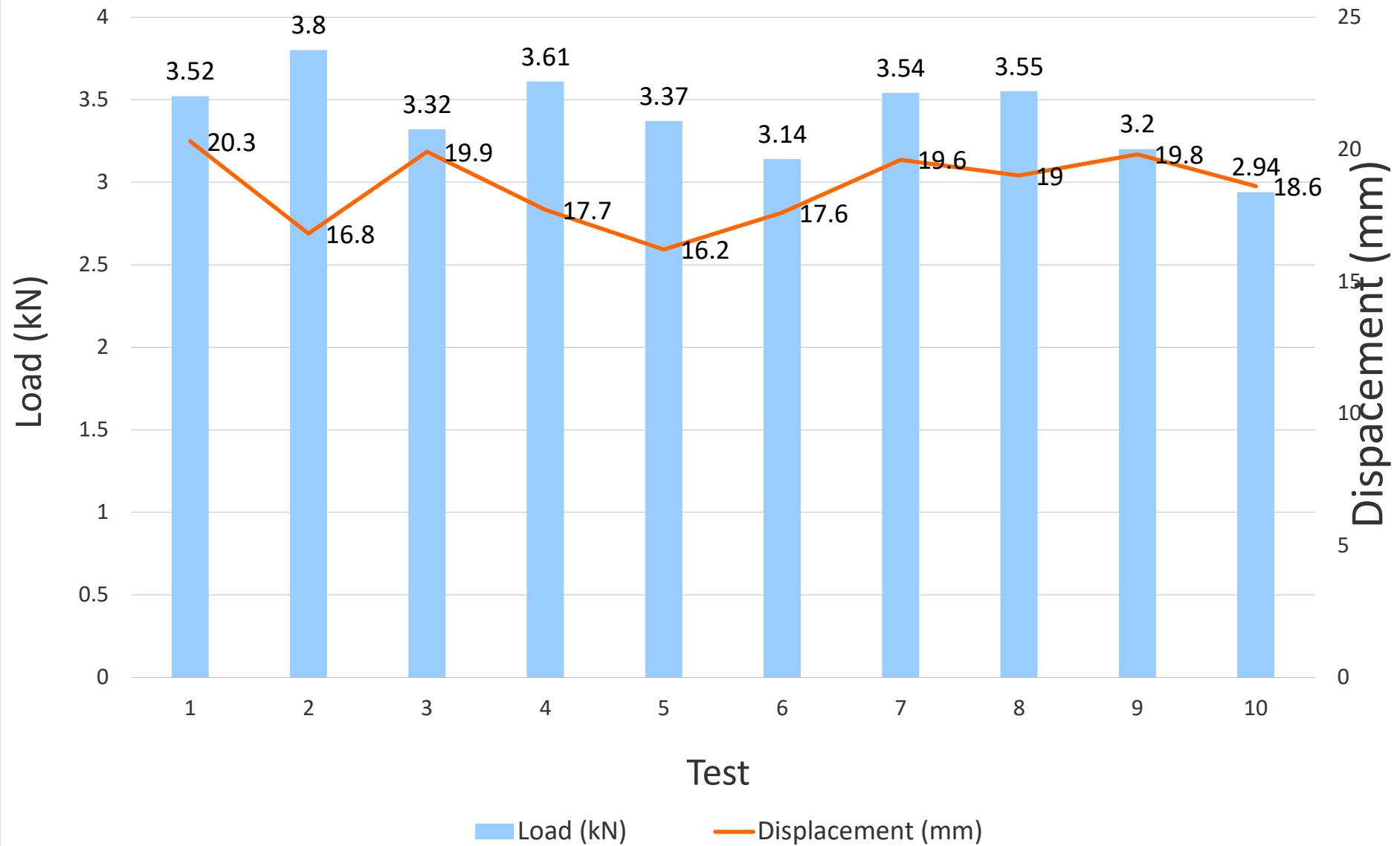
32mm diameter bar



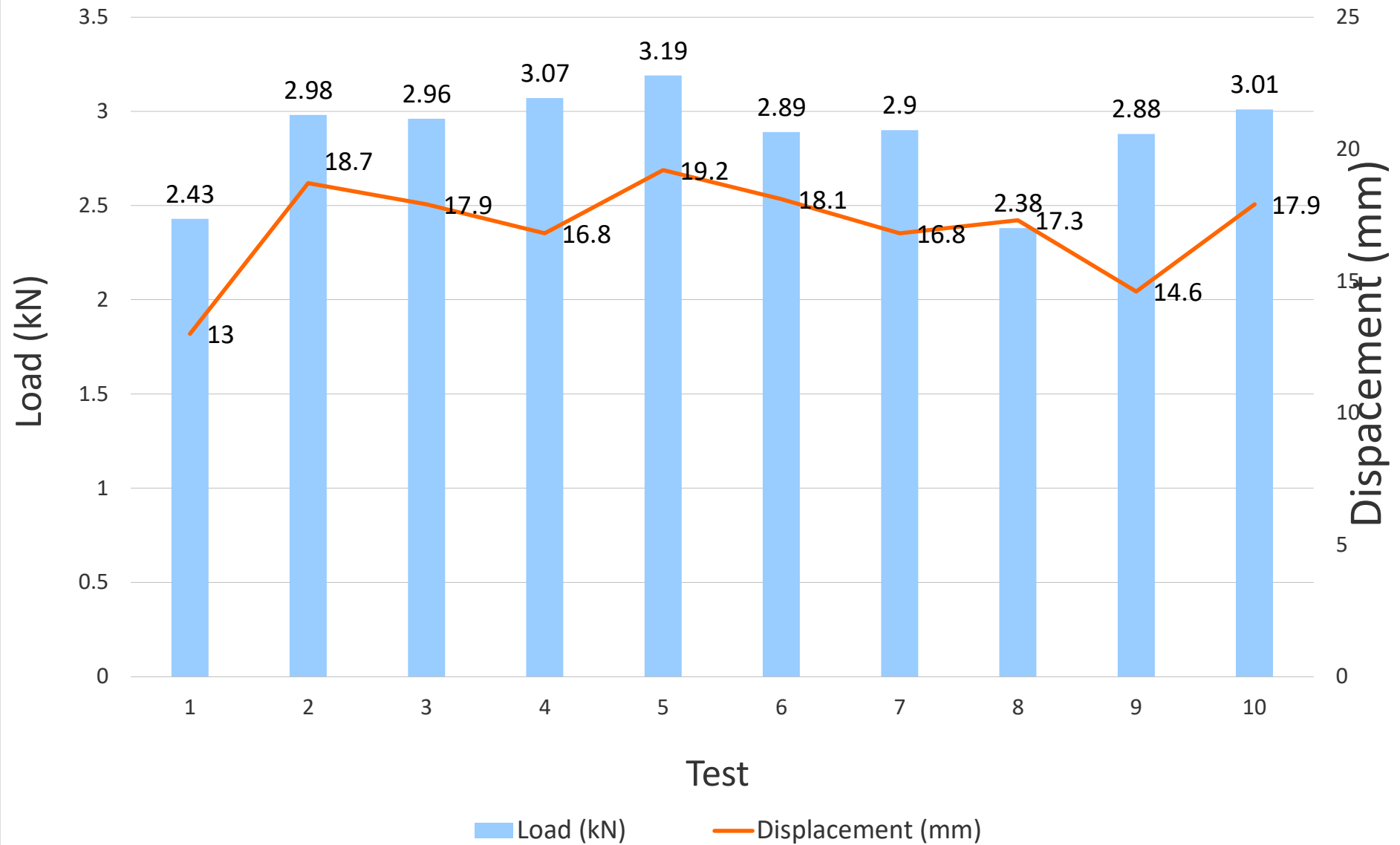
20mm diameter bar



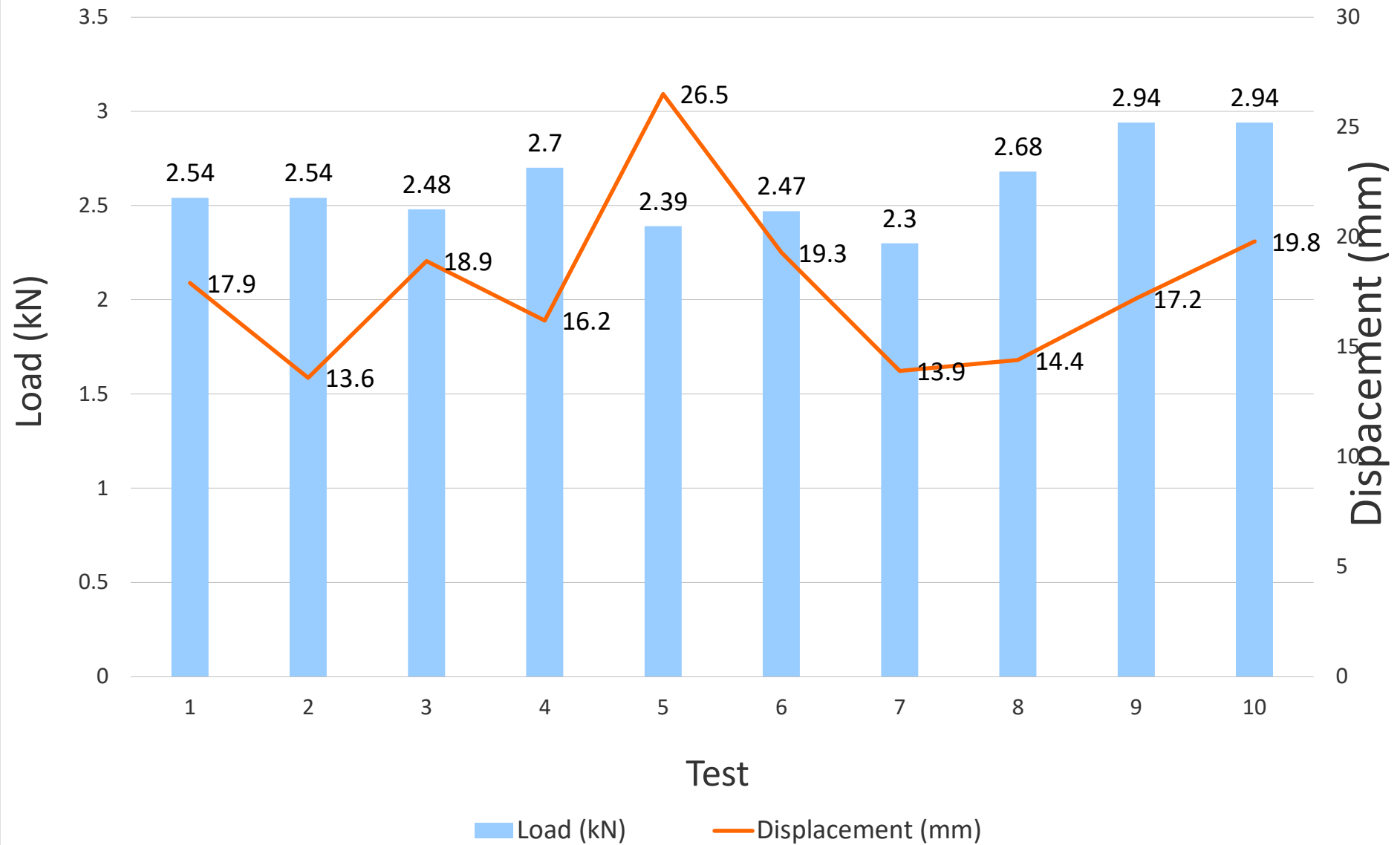
Type 3 Test - 32mm diameter bar - Double crown



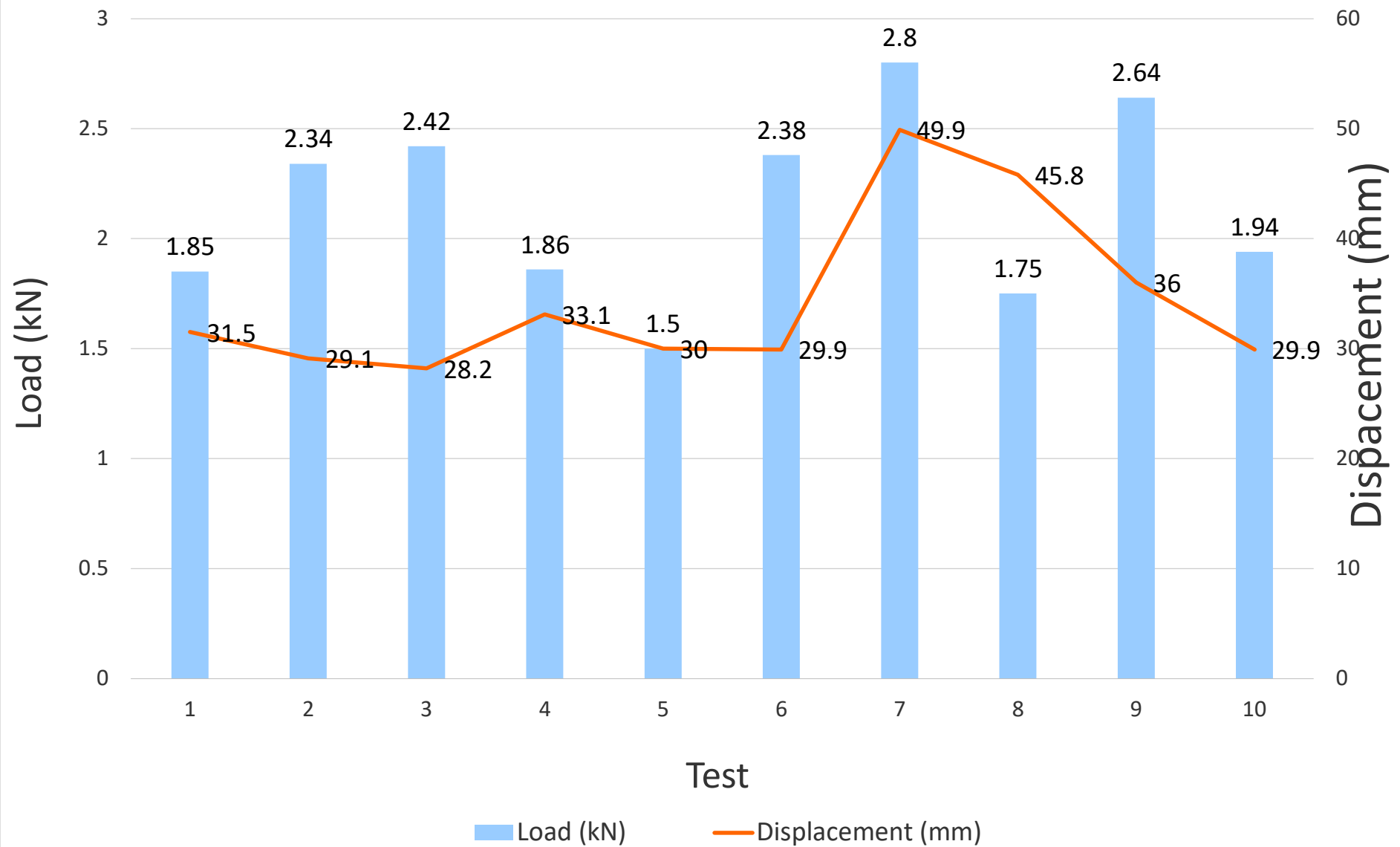
Type 3 Test - 20mm diameter bar - Double crown



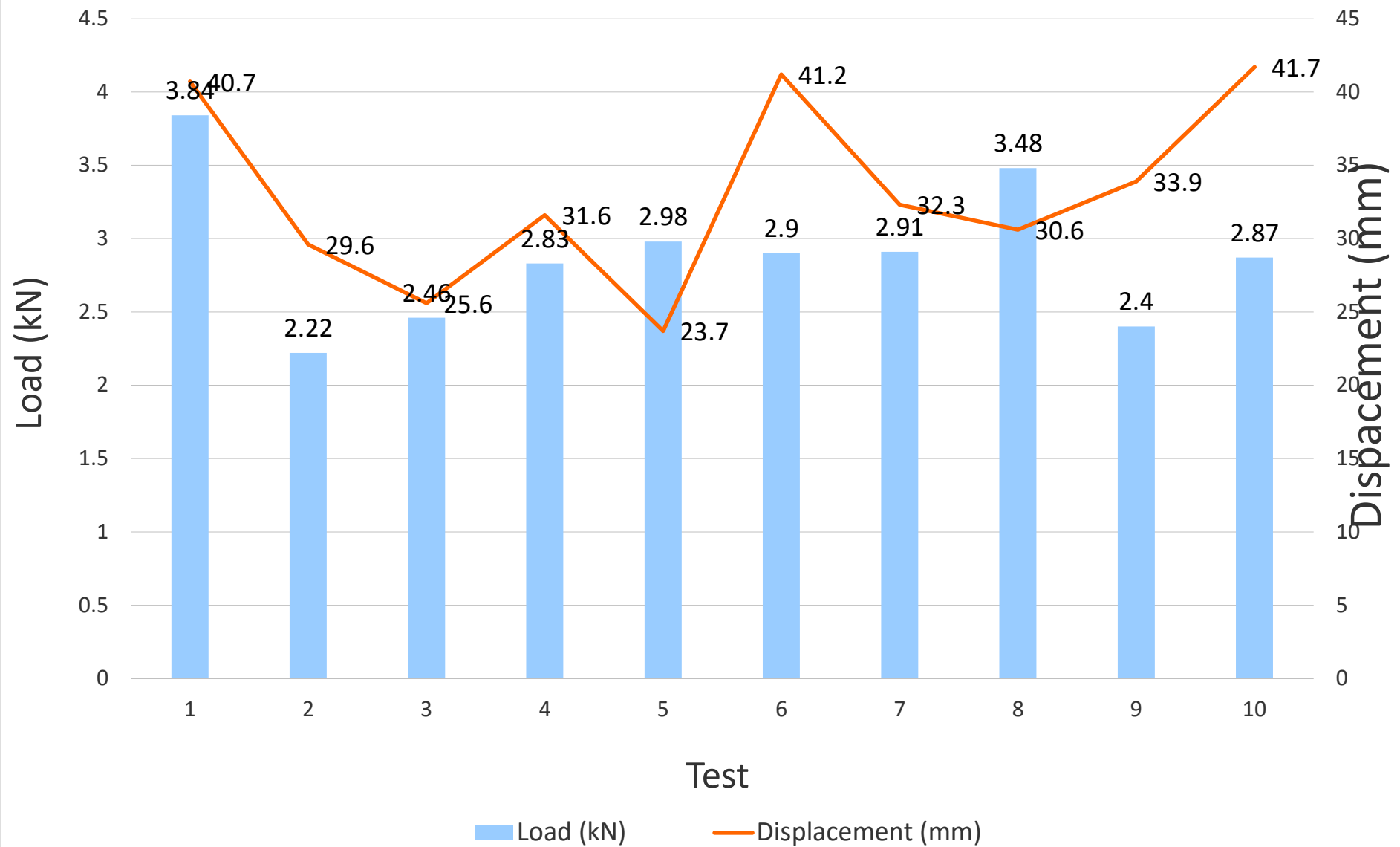
Type 3 Test - 12mm diameter bar - Double crown



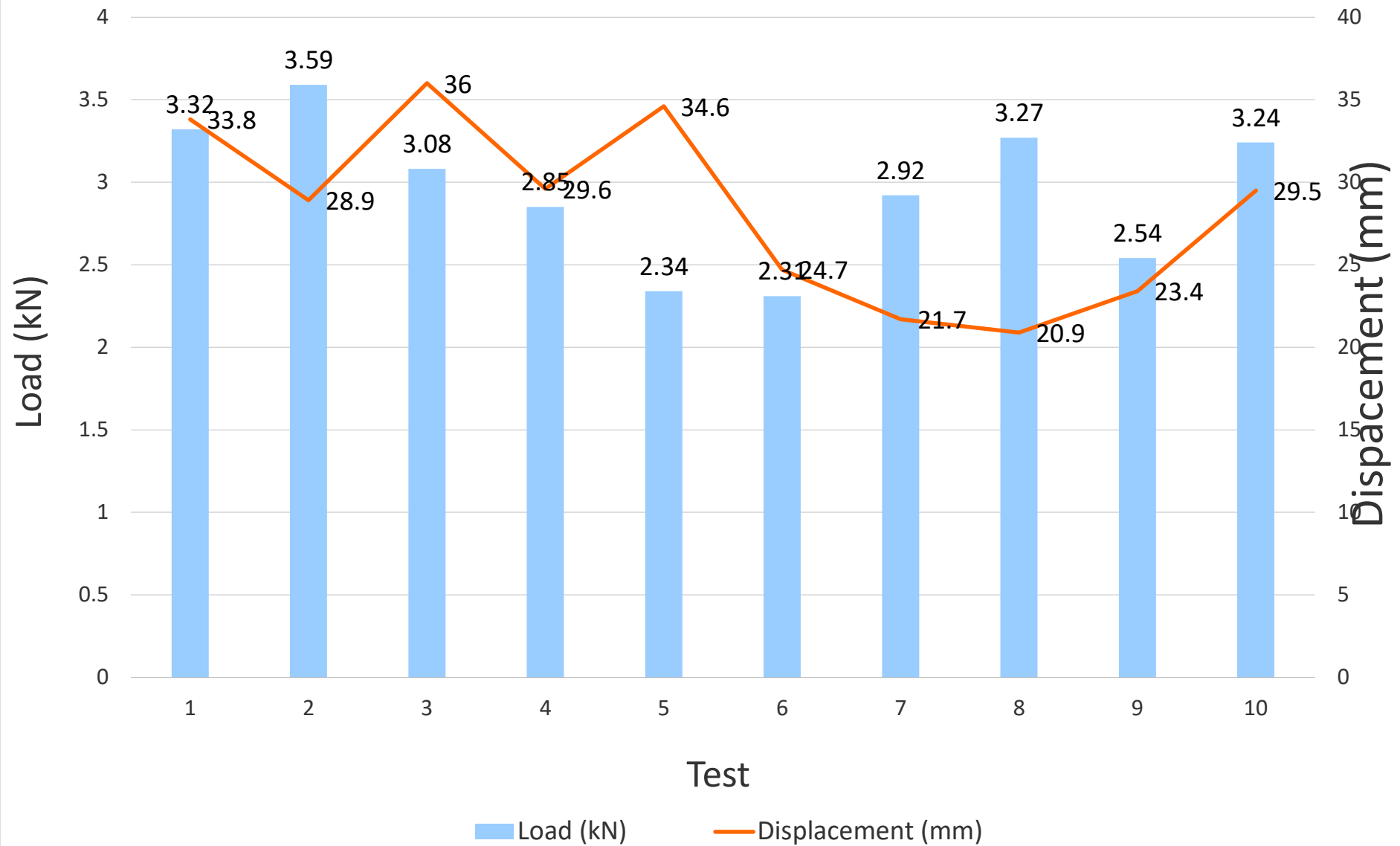
Type 2 Test - 32mm diameter bar - 2 x Single splice



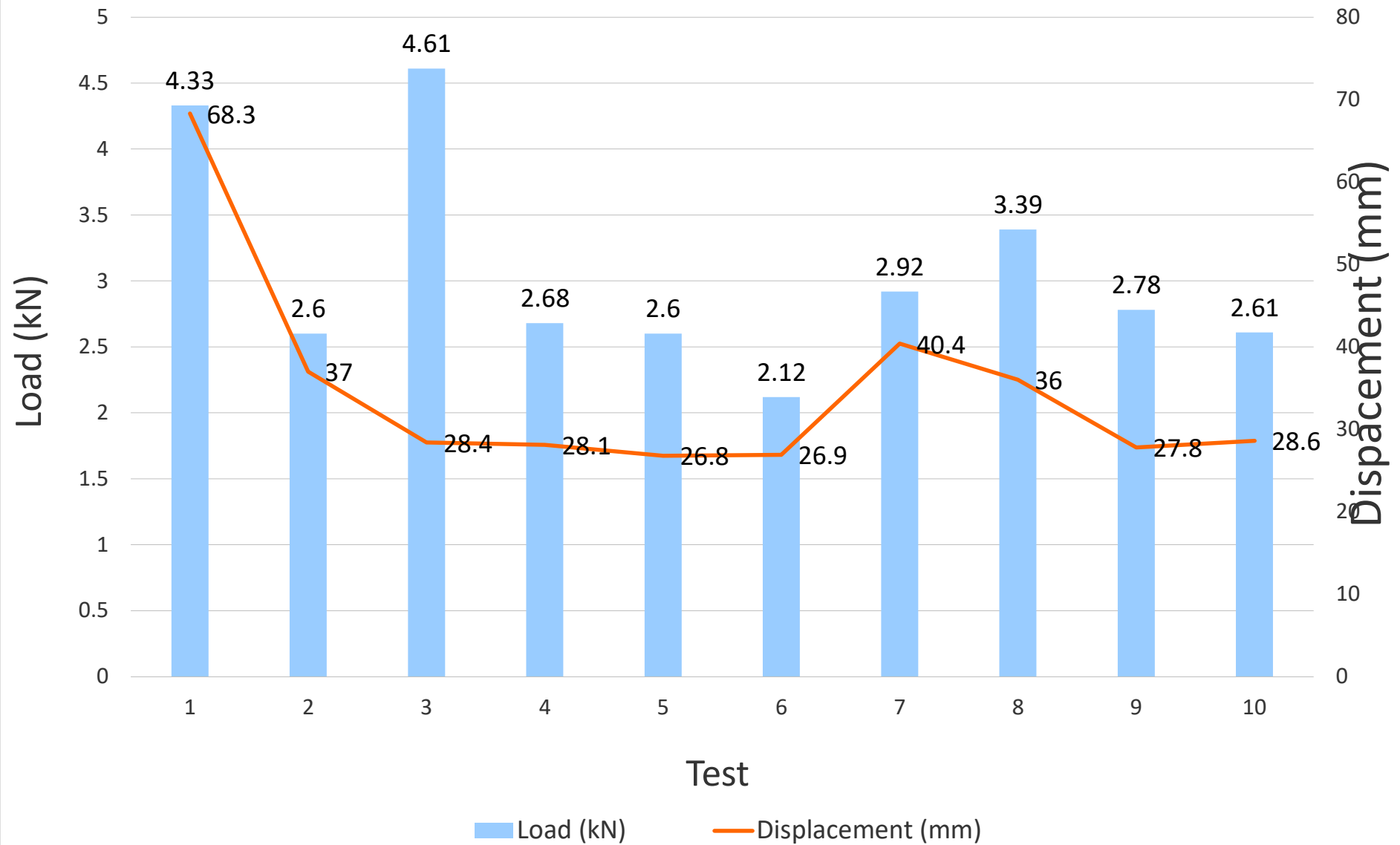
Type 2 Test - 20mm diameter bar - 2 x Single splice



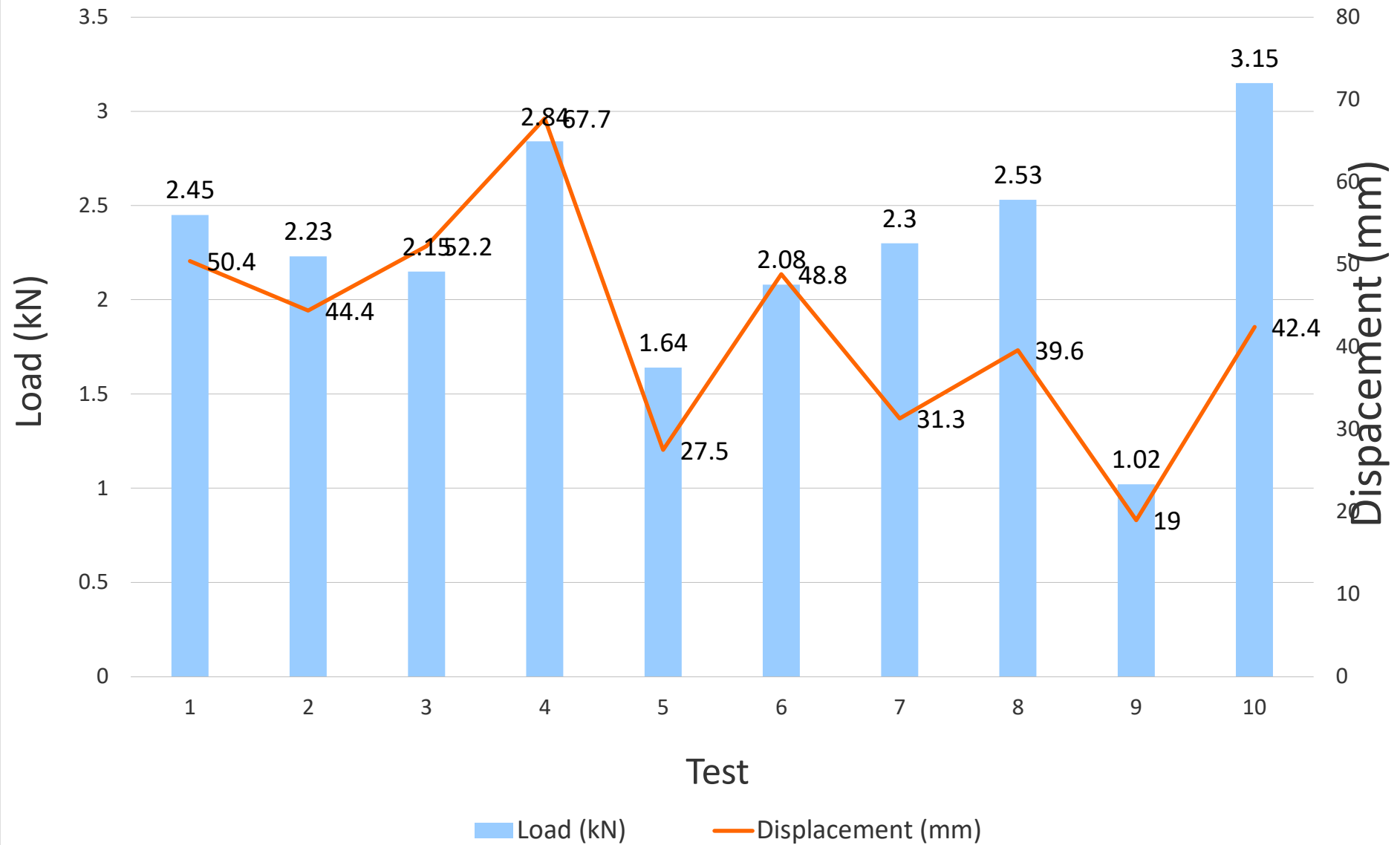
Type 2 Test - 12mm diameter bar - 2 x Single splice



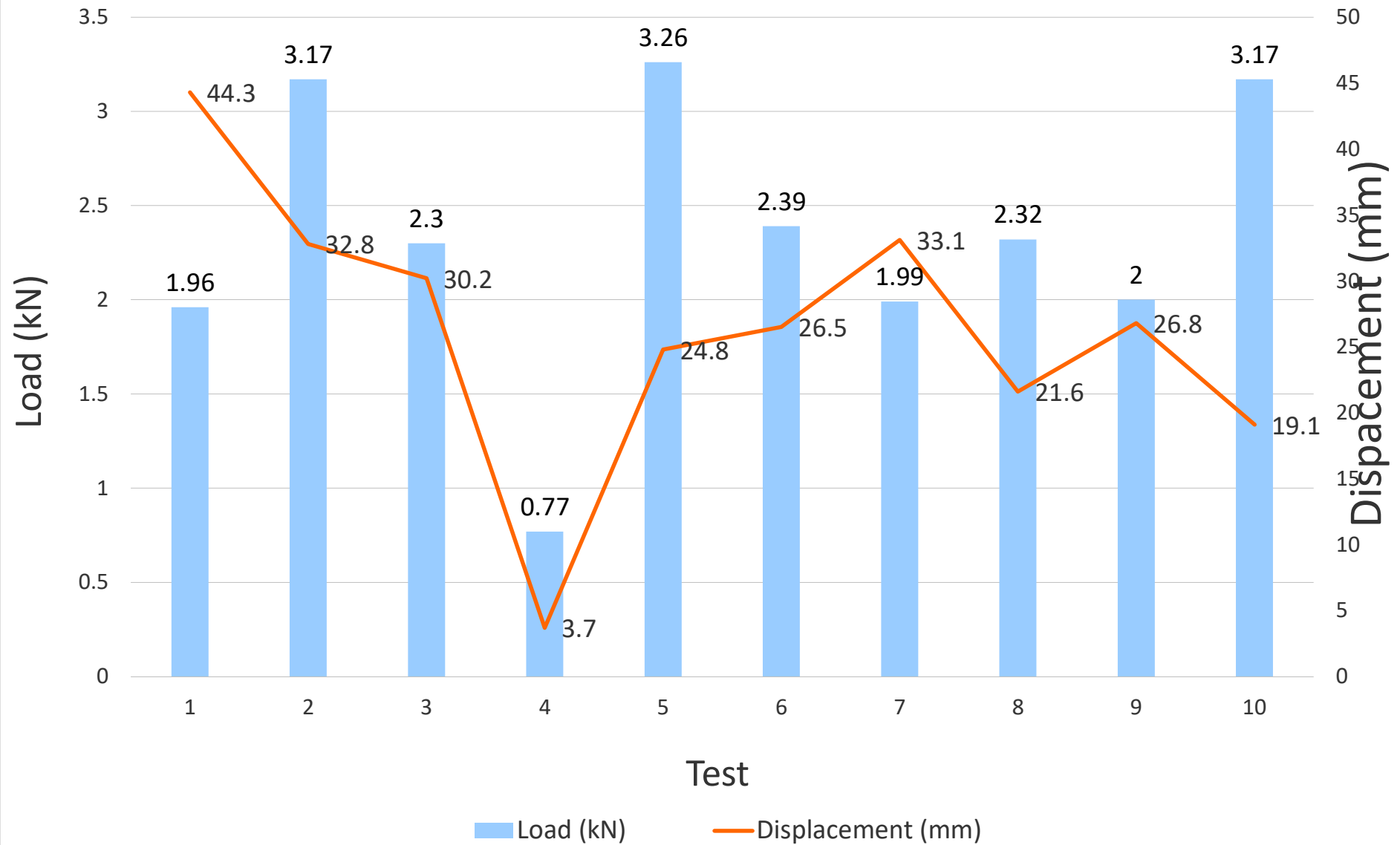
Type 1 Test - 32mm diameter bar - Double crown tie



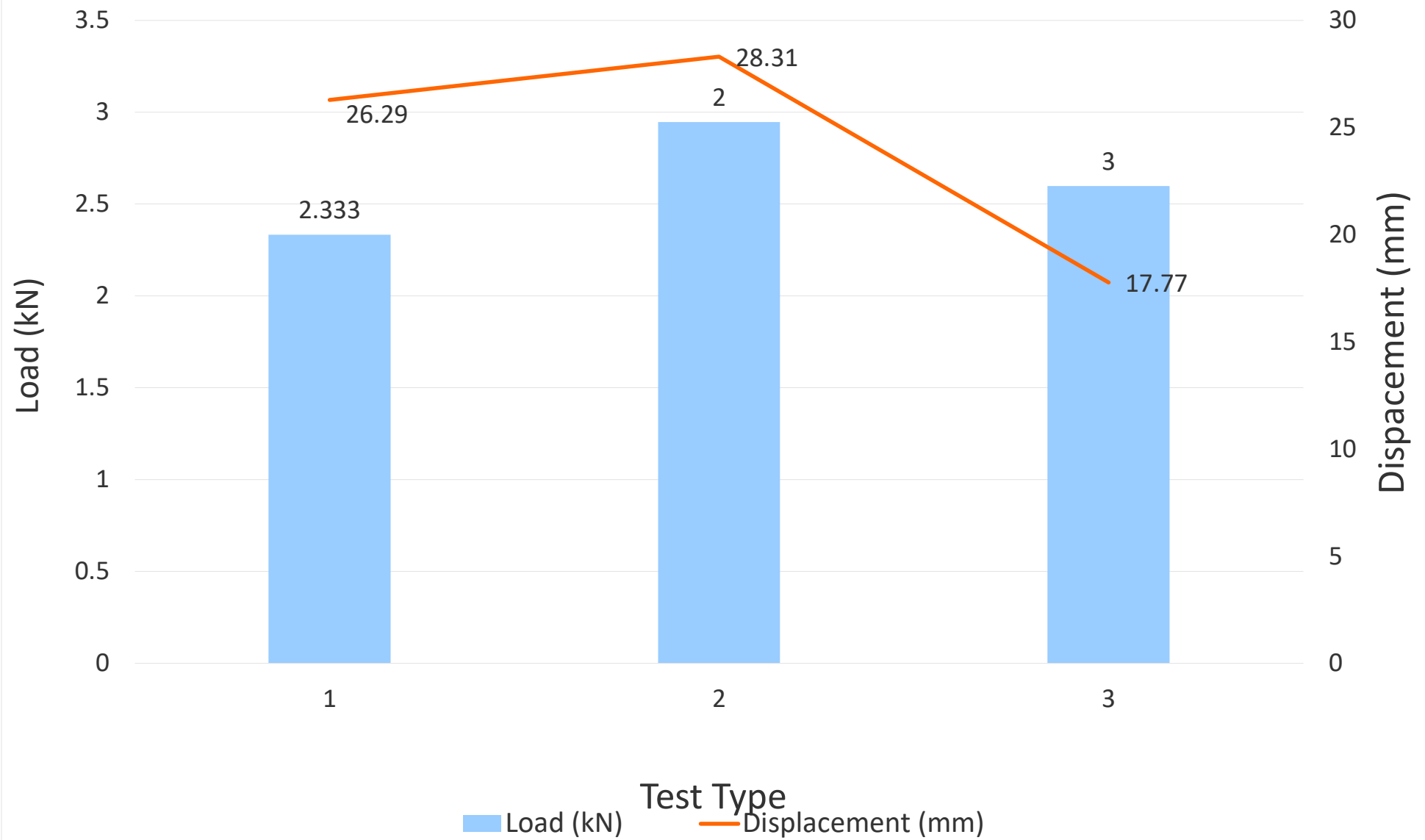
Type 1 Test - 20mm diameter bar - Double crown tie



Type 1 Test - 12mm diameter bar - Double crown tie



12mm diameter bar



Test Type 1								
12mm diameter bar Double crown tie			20mm diameter bar Double crown tie			32mm diameter bar Double crown tie		
	Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)
1	1.96	44.3	1	2.45	50.4	1	4.33	68.3
2	3.17	32.8	2	2.23	44.4	2	2.6	37
3	2.3	30.2	3	2.15	52.2	3	4.61	28.4
4	0.77	3.7	4	2.84	67.7	4	2.68	28.1
5	3.26	24.8	5	1.64	27.5	5	2.6	26.8
6	2.39	26.5	6	2.08	48.8	6	2.12	26.9
7	1.99	33.1	7	2.3	31.3	7	2.92	40.4
8	2.32	21.6	8	2.53	39.6	8	3.39	36
9	2	26.8	9	1.02	19	9	2.78	27.8
10	3.17	19.1	10	3.15	42.4	10	2.61	28.6
	2.333	26.29		2.239	42.33		3.064	34.83

Test Type 2								
12mm diameter bar 2 x Single splice			20mm diameter bar 2 x Single splice			32mm diameter bar 2 x Single splice		
	Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)
1	3.32	33.8	1	3.84	40.7	1	1.85	31.5
2	3.59	28.9	2	2.22	29.6	2	2.34	29.1
3	3.08	36	3	2.46	25.6	3	2.42	28.2
4	2.85	29.6	4	2.83	31.6	4	1.86	33.1
5	2.34	34.6	5	2.98	23.7	5	1.5	30
6	2.31	24.7	6	2.9	41.2	6	2.38	29.9
7	2.92	21.7	7	2.91	32.3	7	2.8	49.9
8	3.27	20.9	8	3.48	30.6	8	1.75	45.8
9	2.54	23.4	9	2.4	33.9	9	2.64	36
10	3.24	29.5	10	2.87	41.7	10	1.94	29.9
	2.946	28.31		2.889	33.09		2.148	34.34

Test Type 3								
12mm diameter bar Double crown tie			20mm diameter bar Double crown tie			32mm diameter bar Double crown tie		
	Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)		Max Load (kN)	Max Displacement (mm)
1	2.54	17.9	1	2.43	13	1	3.52	20.3
2	2.54	13.6	2	2.98	18.7	2	3.8	16.8
3	2.48	18.9	3	2.96	17.9	3	3.32	19.9
4	2.7	16.2	4	3.07	16.8	4	3.61	17.7
5	2.39	26.5	5	3.19	19.2	5	3.37	16.2
6	2.47	19.3	6	2.89	18.1	6	3.14	17.6
7	2.3	13.9	7	2.9	16.8	7	3.54	19.6
8	2.68	14.4	8	2.38	17.3	8	3.55	19
9	2.94	17.2	9	2.88	14.6	9	3.2	19.8
10	2.94	19.8	10	3.01	17.9	10	2.94	18.6
	2.598	17.77		2.869	17.03		3.399	18.55