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TESMEC

Independent Testing & Engineering Services

Report and Load Survey of: Turnlok loading bay scaffold components

Document number: *TES000142*

Client: *VR Access Solutions Ltd*

Address: *1A Swan Court Yard*
Charles Edwards Road
Birmingham
B26 1BU

Date of applied testing/survey: *Start date 25th June 2016 to 4th July 2016*

Item description: *Free issue Turnlok loading bay scaffold components.*
4 number vertical node ladder beam sections, 48.3mm tube x 3.2mm wall, material stated S355/Q345.
2.5m overall length, main longitudinal sections at 305mm centers, blade centers at 500mm.
Materials finish Galvanized.
6 number rectangular hollow section board bearers, 2.5m long 50mm x 90mm section complete with welded plate hook terminations at each end to suit 48.3mm tube diameter.
Turnlok vertical standards, Turnlok 48.3mm tubular ledgers, 6 number adjustable screw base jacks.
All material finish galvanized.

Identification mark affixed to item: *Turnlok Ladder beam numberedVRS85 02/16 RS.*
Board bearers numbered VRS86 02/16 RS.
Vertical standards numbered VRS50C 01/16 X
Tubular ledger numbered VRS52G 02/16 RS
Adjustable base jacks numbered VRS66 1B 02/16 RS

Client submitted drawing numbers: *Drg N° 85 revision A, VR Access Solutions Ltd 2.5m Loading Bay Beam*

Client design review Ref: *S-Mech to review all findings*

Quantity submitted for test: *Minimum assemblies required for test and failure analysis as stated above.*

Client submitted British standard or procedure number*: S-Mech verbal load requirements*

Address of where testing /surveys were conducted: *TESMEC Limited;*
Independent Testing and Engineering services.
Test House
Unit 19, Newey Business Park
Sedgley Road West
Tipton, West Midlands
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Number of pages contained in this report: 28

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1.1 TESMEC mission statement

It is the intention of TESMEC Limited; Independent Testing and Engineering services to continuously provide independent advice in addition to a professional and confidential Engineering service to all of its trusted clients and where applicable, engage in incessant professional development through review, investment and training to further our existing service and to support the increasing requirements of our customers.

1.2 Test/survey requirements

The client requested a load survey to be conducted to the submitted Turnlok components in accordance with S-Mech Engineering consultants verbal instructions and submitted load factors and configurations.
Load bay beams subject to a concentrated uniformly applied load at each vertical node point and a central point load condition. Uniform loads applied at a SLS & ULS condition, each sample was then subject to a failure application. CPL application applied through to failure.
SHS beam bearers subject to a Uniformly distributed load applied across a pair of beams set at a distance of 1000mm centres, dynamic live mass application applied at a SLS & ULS condition.
A concentrated point load was applied to one sample through to failure.
3 number adjustable screw base jacks were subject to compressive load failure survey, 3 height conditions applied.
An additional blade to cup pull apart load application was conducted through to failure.
SLS & ULS load factors submitted by *S-Mech Engineering consultants.*

1.3 Equipment arrangement

Typical image of Load Bay Beam test assembly

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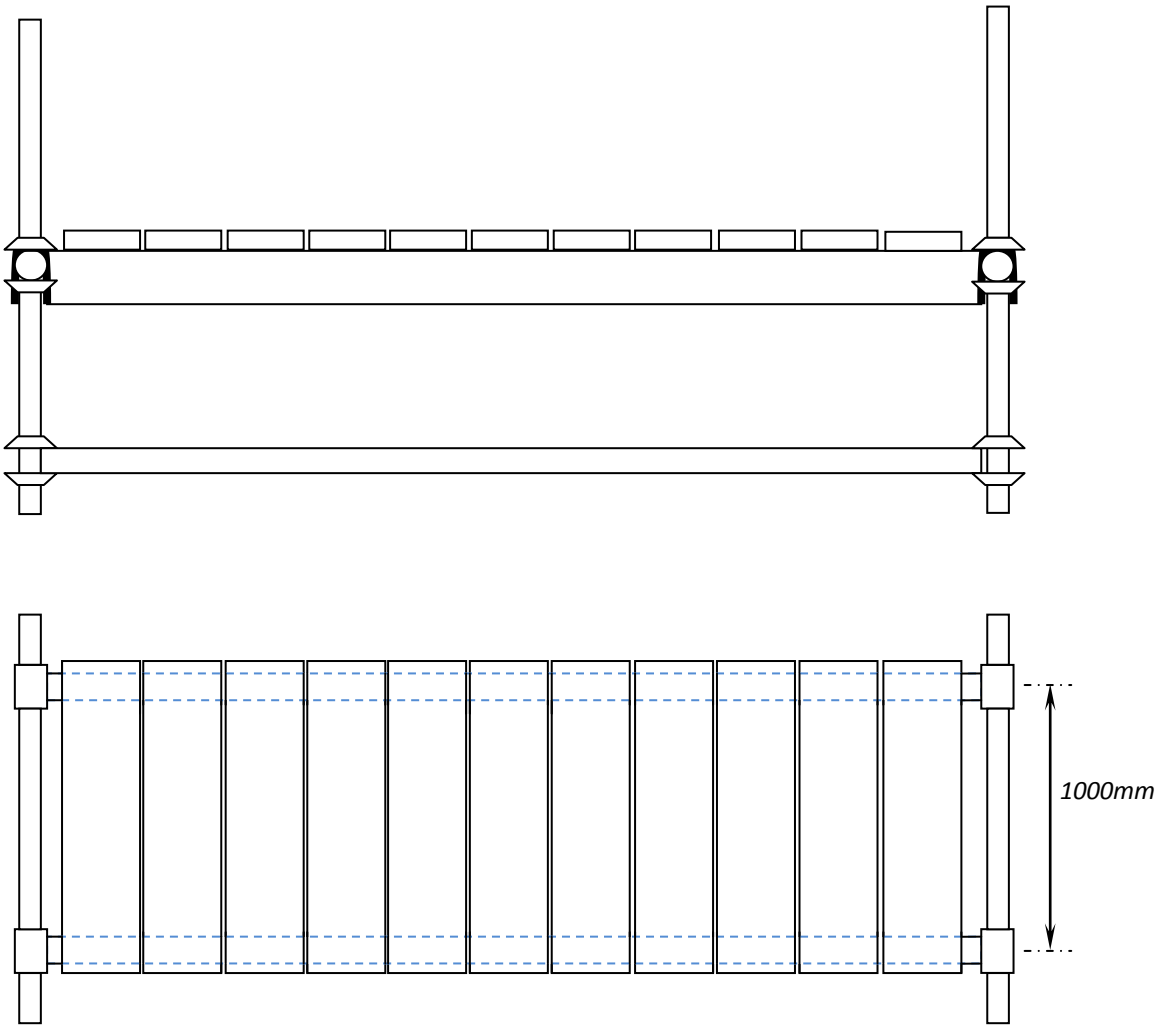
1.3.1. Typical diagram of board bearer assembly.



1.4. *Test equipment & Instrument calibration*

Enerpac 106 actuators complete with 20000psi digital, single acting hand pump complete with manifold.
5000kg of 25kg hand weights
Denison Mayes 500kN universal test machine: calibration number C6592
Class 1: machine number 921-2

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Section 2: Loading Bay Beam study

2.1. *Uniform SLS load condition.*
The submitted load for SLS condition for the VR Turnlok load bay beams = 15.6kN/m
Total applied load: 15.6kN x 2.5m = 39kN
Load beam displacements monitored and recorded at 39 increments

2.1.1. *Samples 1 to 3 SLS application results table*

LOAD BEAM SAMPLE 1		*LOAD BEAM SAMPLE 2*		*SAMPLE 3 LOAD BEAM*	
kN	*mm*	*kN*	*mm*	*kN*	*mm*
0	*0*	0	0	0	0
1	0.13	1	0.3	1	0.13
2	0.36	2	0.53	2	0.28
3	0.57	3	0.73	3	0.41
4	0.8	4	0.94	4	0.64
5	1.06	5	1.19	5	0.86
6	1.32	6	1.41	6	1.05
7	1.6	7	1.62	7	1.24
8	1.85	8	1.81	8	1.43
9	2.12	9	2.02	9	1.66
10	2.38	10	2.22	10	1.86
11	2.61	11	2.4	11	2.02
12	2.86	12	2.6	12	2.21
13	3.12	13	2.81	13	2.41
14	3.34	14	3.03	14	2.59
15	3.58	15	3.23	15	2.8
16	3.8	16	3.44	16	3.01
17	4.01	17	3.65	17	3.23
18	4.23	18	3.89	18	3.42
19	4.47	19	4.1	19	3.62
20	4.68	20	4.32	20	3.81
21	4.9	21	4.54	21	4.01
22	5.17	22	4.8	22	4.17
23	5.38	23	5	23	4.35
24	5.63	24	5.23	24	4.59
25	5.86	25	5.48	25	4.81
26	6.07	26	5.7	26	5
27	6.28	27	5.93	27	5.17
28	6.52	28	6.14	28	5.37
29	6.76	29	6.4	29	5.59
30	7	30	6.64	30	5.77
31	7.23	31	6.89	31	5.98
32	7.48	32	7.12	32	6.18
33	7.71	33	7.38	33	6.41
34	7.98	34	7.64	34	6.65
35	8.25	35	7.9	35	6.92
36	8.46	36	8.13	36	7.13
37	8.74	37	8.39	37	7.38
38	8.98	38	8.64	38	7.63
39	9.26	39	8.94	39	7.94
0	0.1	0	0.01	0	0.17

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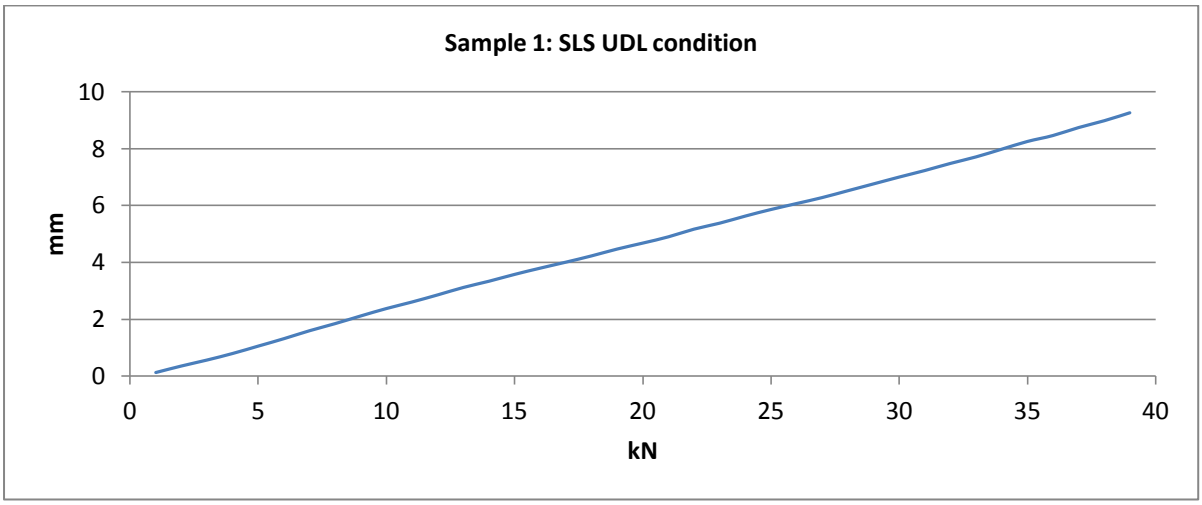
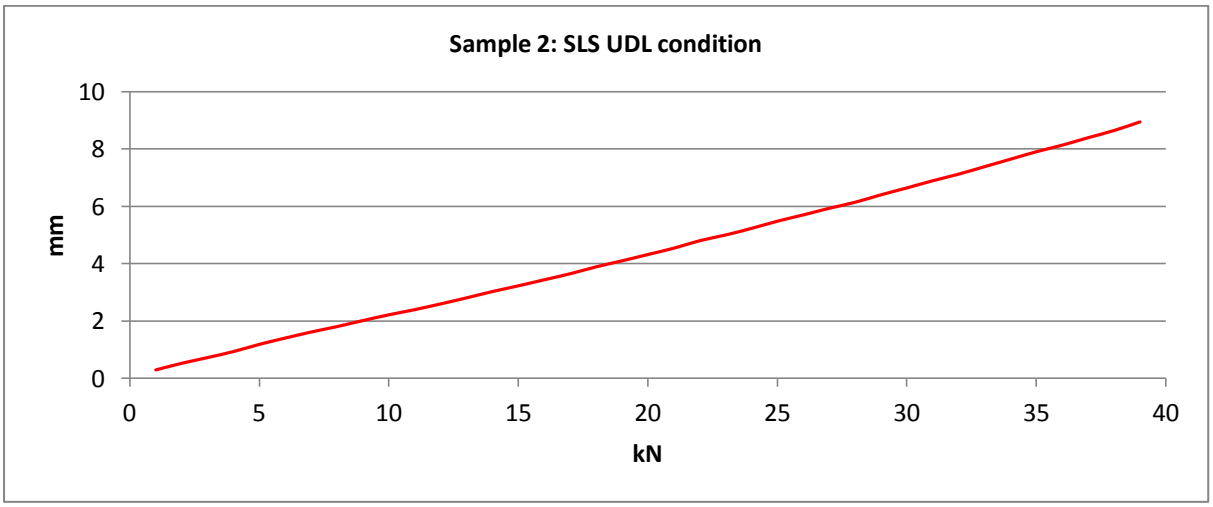
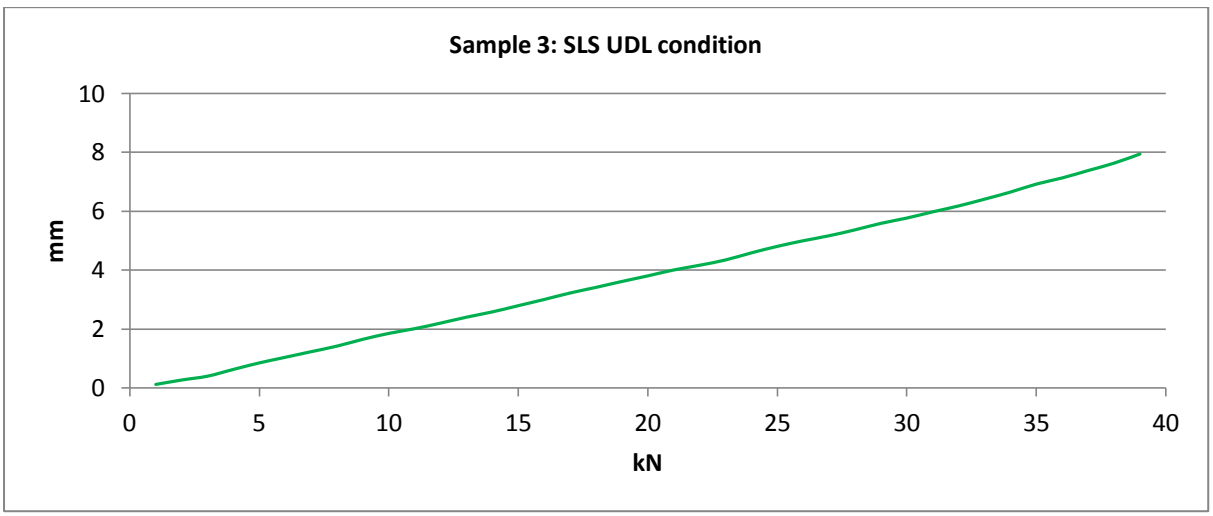
2.1.2. *Load displacement graphs samples 1-3 SLS concentrated UDL*







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2.2. *Uniform ULS load condition*

The submitted load for ULS condition for the VR Turnlok loading bay beams = 25.8kN/m Total applied load: 25.8kN x 2.5m = 64.5kN

Load beam displacements monitored and recorded at 13 increments

2.2.1. *Samples 1 to 3 ULS application results table*

LOAD BEAM SAMPLE 1		*LOAD BEAM SAMPLE 2*		*SAMPLE 3 LOAD BEAM*	
kN	*mm*	*kN*	*mm*	*kN*	*mm*
0	0	0	0	0	0
5	1.15	5	1.21	5	1.07
10	2.44	10	2.22	10	2.05
15	3.67	15	3.12	15	2.94
20	4.76	20	4.05	20	3.92
25	5.92	25	5.12	25	4.9
30	7.04	30	6.18	30	5.85
35	8.26	35	7.24	35	6.98
40	9.48	40	8.29	40	8.03
45	10.72	45	9.48	45	9.52
50	12.13	50	10.85	50	11.05
55	13.65	55	12.35	55	12.65
60	15.25	60	13.76	60	14.57
64.5	16.92	64.5	15.05	64.5	16.35

2.2.2. *Typical image of load beam subject to concentrated UDL application*

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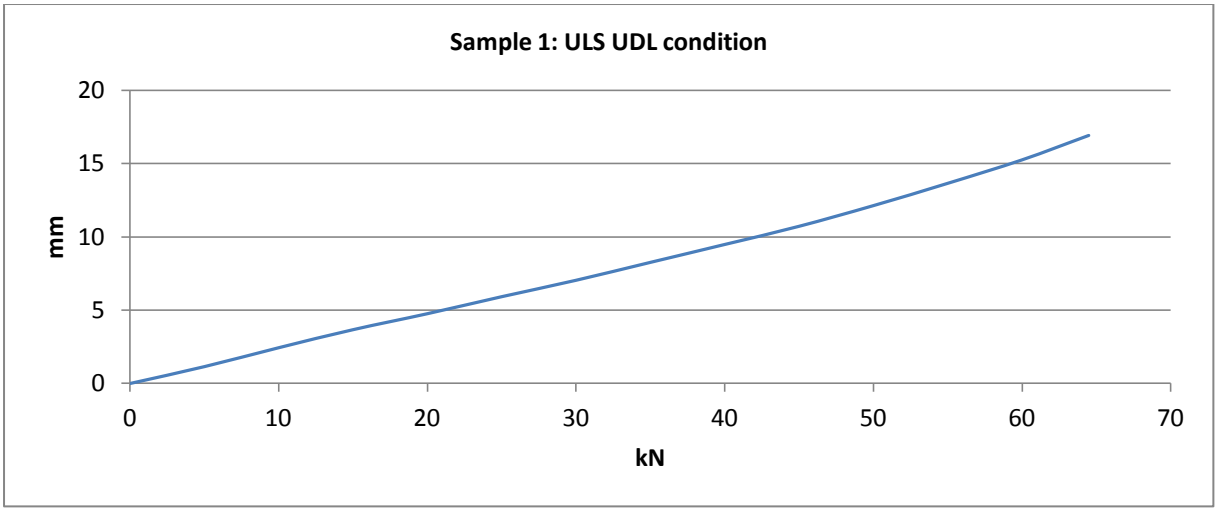
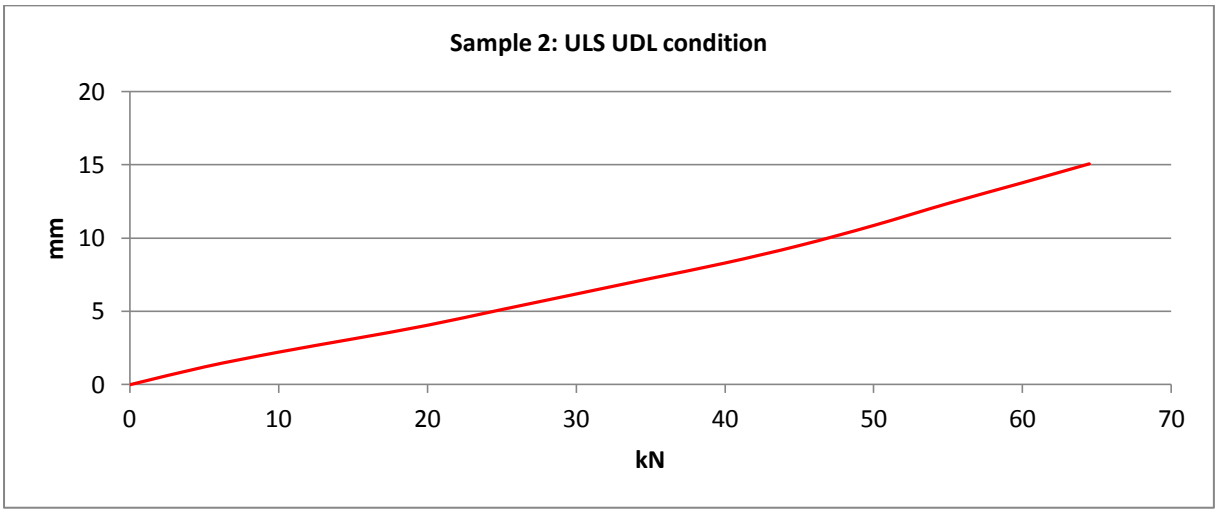
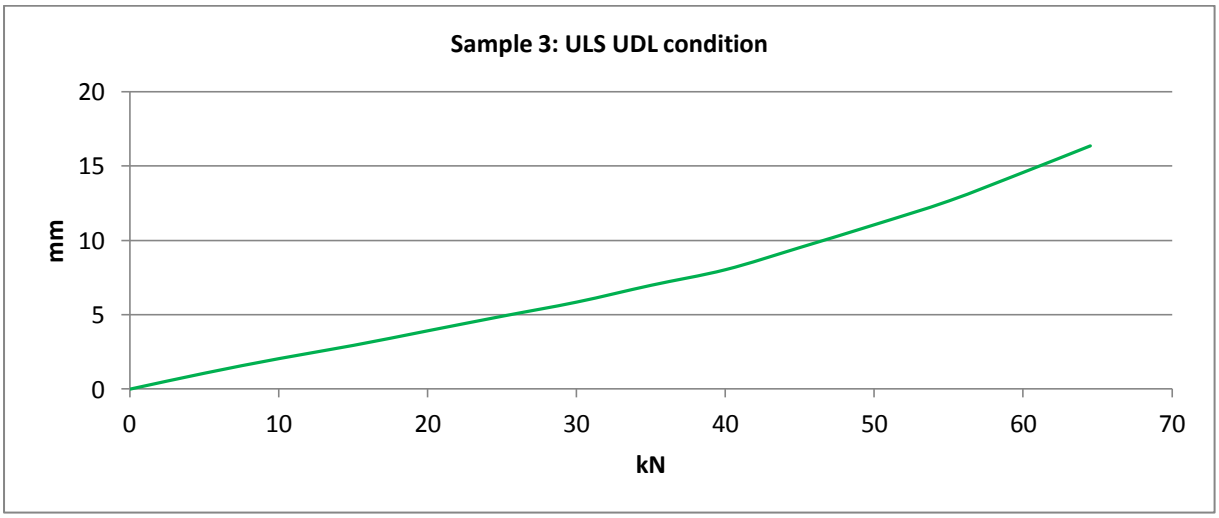
2.2.3. *Load displacement graphs samples 1-3 ULS concentrated UDL*







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2.3. *Failure load*

Each sample upon achieving the requested ULS load was then subject to an increased load through to failure.

LOAD BEAM SAMPLE 1		*LOAD BEAM SAMPLE 2*		*SAMPLE 3 LOAD BEAM*	
kN	*mm*	*kN*	*mm*	*kN*	*mm*
0	0	0	0	0	0
5	1.15	5	1.21	5	1.07
10	2.44	10	2.22	10	2.05
15	3.67	15	3.12	15	2.94
20	4.76	20	4.05	20	3.92
25	5.92	25	5.12	25	4.9
30	7.04	30	6.18	30	5.85
35	8.26	35	7.24	35	6.98
40	9.48	40	8.29	40	8.03
45	10.72	45	9.48	45	9.52
50	12.13	50	10.85	50	11.05
55	13.65	55	12.35	55	12.65
60	15.25	60	13.76	60	14.57
64.5	16.92	64.5	15.05	64.5	16.35
69.2	18.85	69.2	16.52	69.2	18.5
73.74	20.08	73.74	18.49	73.74	21.4
79	23.33	79	21.12	79	24.72
83.06	26.1	83.06	25.62	83.06	27.31
89	30.81	89.08	N/A	89	32.1
92.54	33.14			92.54	35.71
97.35	39.97			95.13	N/A
101.86	42.39				
106.39	49.53				
111.14	59.35				

2.3.1. Post load observations:

Sample 1: No more load could be achieved past the recorded 111.14kN. Node weld fractures evident and cup weld fractures evident upon visual examination

Sample 2: Audible weld fracture recorded at 89.08kN. Test stopped, examination showed fractures around the vertical nodes at sections 1,2 and 3 propagating from the drilled holes at the node base.

Sample 3: Minor weld fracture recorded at 92.54kNat the third vertical node base weld propagating from the drilled holes at the node base.

Ultimate load achieved 95.13kN

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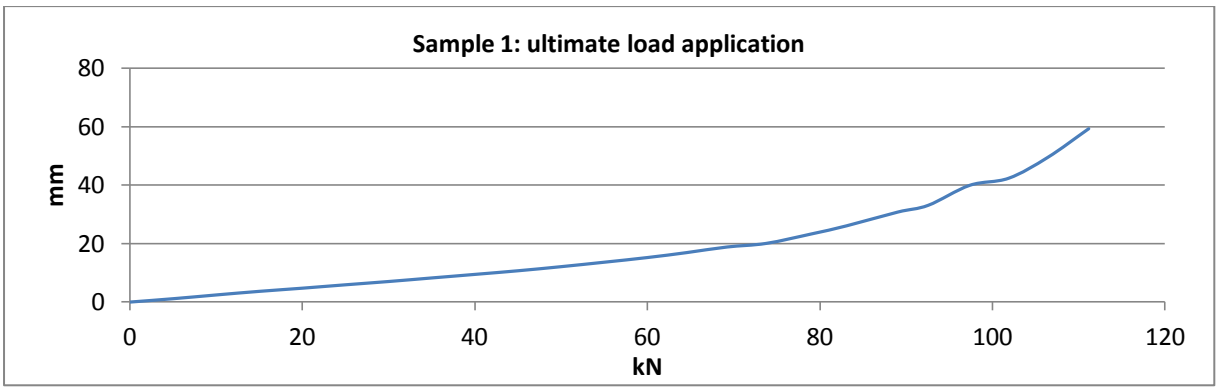
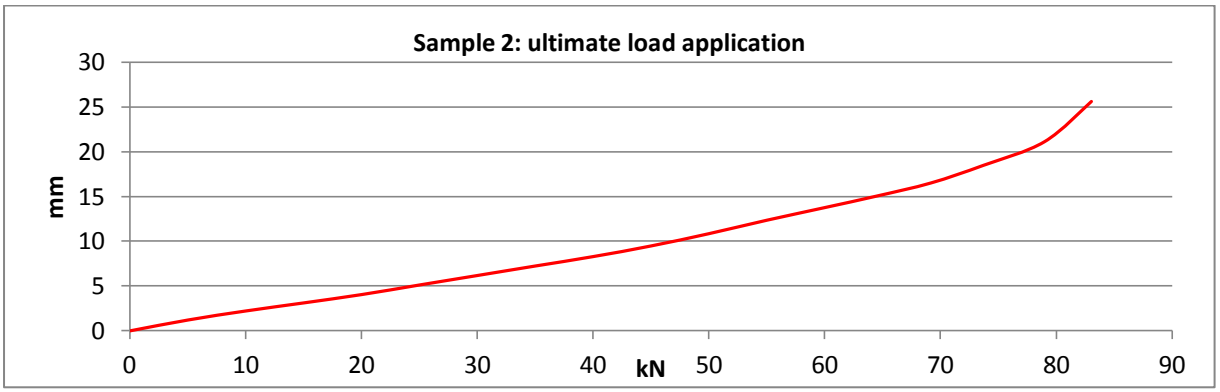
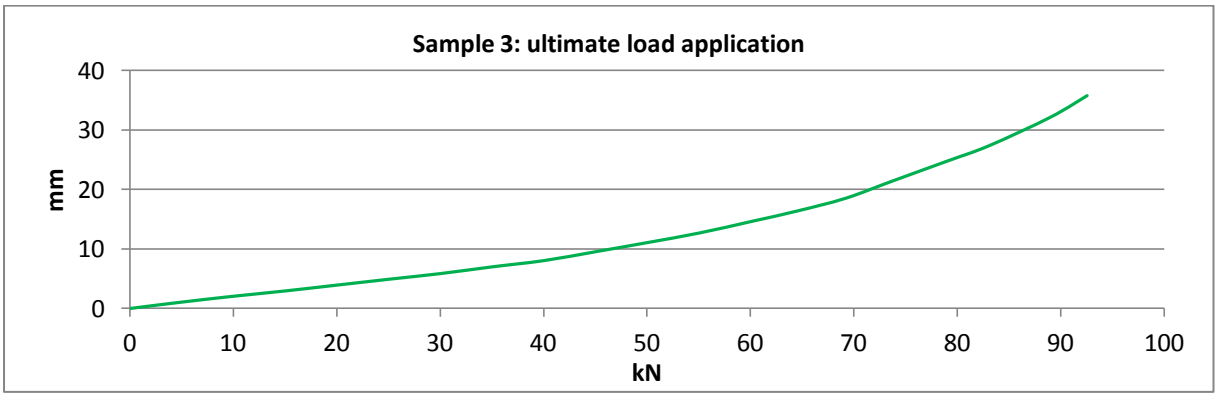
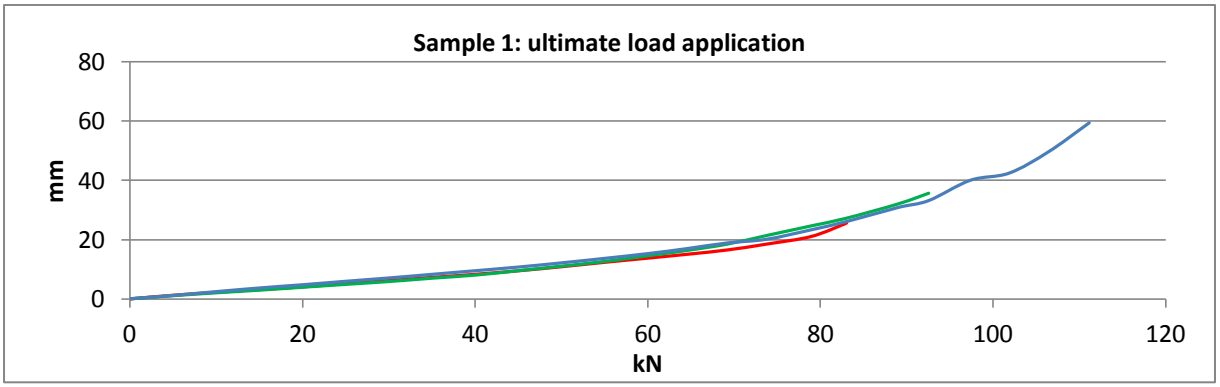
2.3.2. *Ultimate load displacement graphs samples 1-3*









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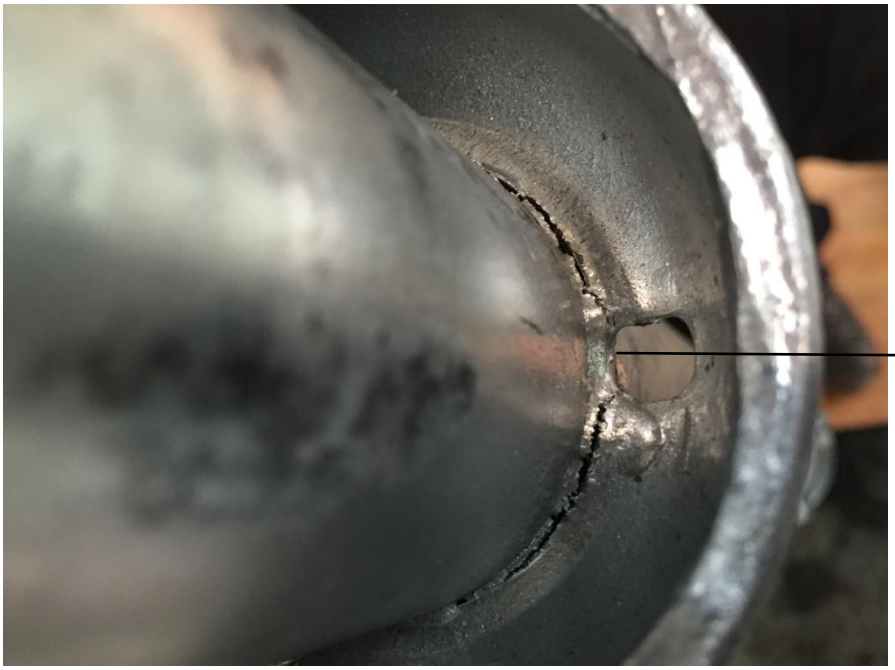
2.3.3. *Post load failure images*



Radial weld fracture Sample 1 post failure load, propagating from galvanizing relief hole.

Typical weld fracture propagating from galvanising relief holes. Upper load bearing chord welds in tension.
The relief hole is a man made stress raiser and prevents the weld from being complete and is therefore weaker and any stresses will relieve themselves in that stop / start weld area
The weld deposition / fusion may not be equal to both faces and will render the joint weaker

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2.4. *CPL load application to Loading bay beam*

Load survey to a single loading bay ladder beam through to ultimate failure. Concentrated load application as per digital image 2.2.1.

2.4.1. *Load survey arrangement*

2.4.2. Load displacement table CPL

KN	mm	kN	mm
1	0.07	24	8.8
2	0.34	25	9.17
3	0.72	26	9.77
4	1.05	27	10.26
5	1.42	28	10.75
6	1.72	29	11.38
7	2.12	26	9.77
8	2.44	27	10.26
9	2.8	28	10.75
10	3.15	29	11.38
11	3.57	30	11.94
12	4.05	31	12.57
13	4.47	32	13.27
14	4.75	33	14.12
15	5.12	34	14.83
16	5.53	35	15.73
17	5.92	36	16.18
18	6.25	37	16.9
19	6.67	38	17.8
20	7.14	39	18.66
21	7.71	40	19.82
22	7.99	45	25.99
23	8.28	50	34.34

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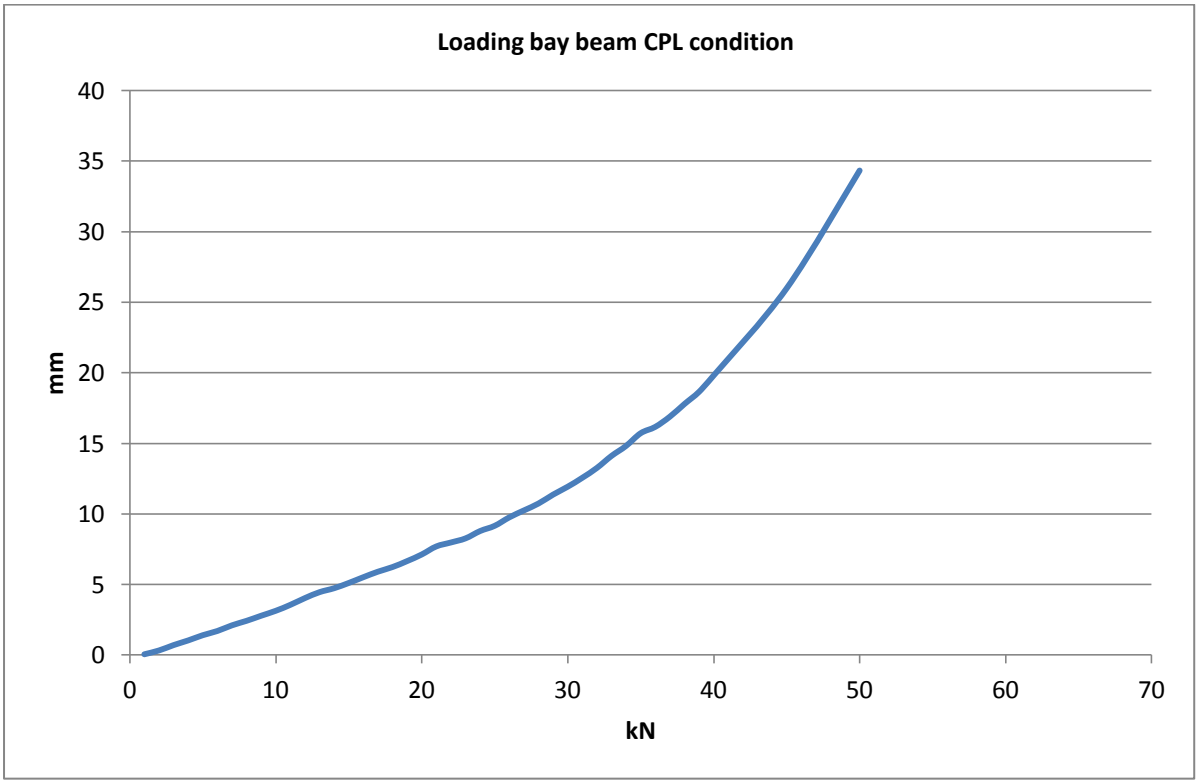
2.4.3. *Load displacement graph CPL condition*



Vertical node weld to lateral tube fracture recorded at 50kN; 2nd an 3rd node from end upper chord (load bearing chord welds in tension).
Permanent displacement recorded at 16.91mm after load removal.

2.2.4. *Load bay beam under CPL condition*

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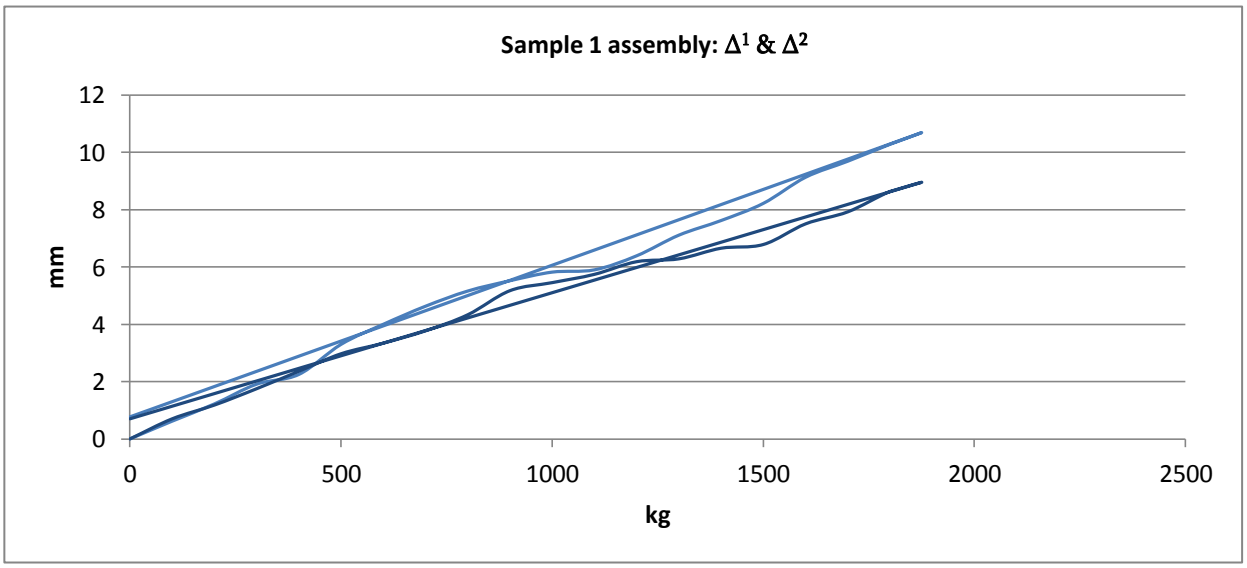
3.0. Board Bearer load study.

3.1. *Board Bearer SLS UDL load study*
Arrangement as per 1.3.1.
Requested SLS load 3.8kN/M
3.8 x 2 =7.6kN/m^2; total application 7.6 x 2.4 = 18.24kN
18.24kN =1859kg actual applied 1875kg exclusive of boards

3.1.2. *Sample 1 results SLS UDL*

kg	Δ^1 mm	Δ^2 mm
0	0	0
100	0.62	0.7
200	1.22	1.18
300	1.91	1.75
400	2.25	2.36
500	3.3	2.97
600	4	3.34
700	4.63	3.77
800	5.16	4.33
900	5.52	5.17
1000	5.82	5.45
1100	5.9	5.74
1200	6.39	6.18
1300	7.11	6.28
1400	7.62	6.65
1500	8.22	6.78
1600	9.13	7.5
1700	9.69	7.92
1800	10.28	8.63
1875	10.69	8.95
0	0.77	0.7



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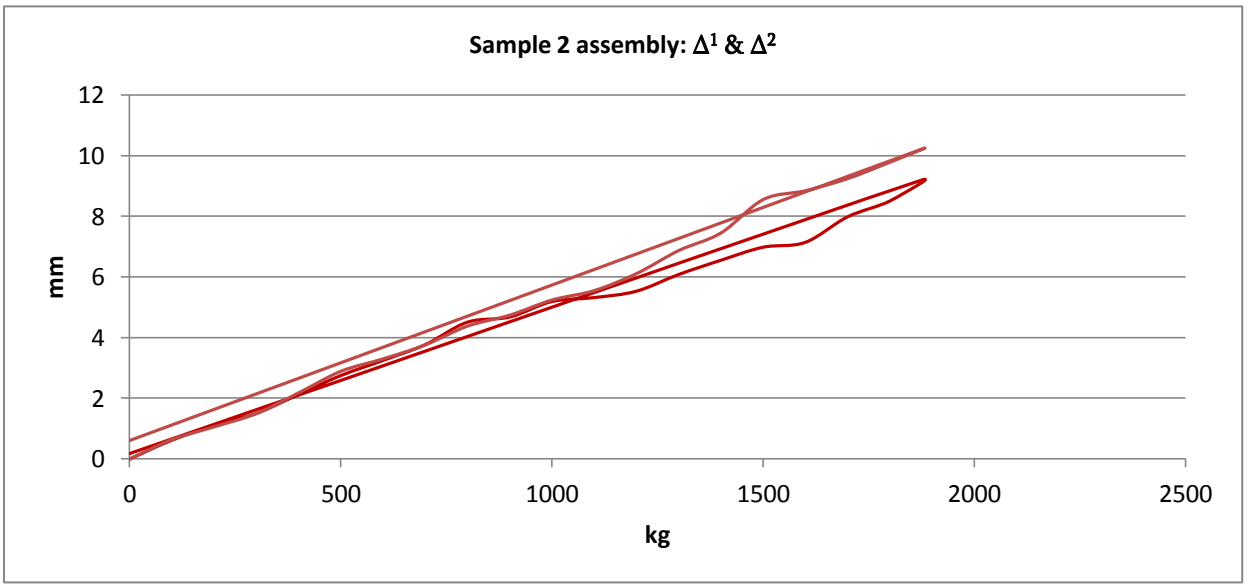
3.1.3. *Sample 2 results SLS UDL*

kg	Δ^1 mm	Δ^2 mm
0	0	0
100	0.62	0.64
200	1.1	1.06
300	1.5	1.5
400	2.13	2.18
500	2.75	2.89
600	3.25	3.3
700	3.77	3.76
800	4.51	4.38
900	4.68	4.74
1000	5.19	5.24
1100	5.32	5.55
1200	5.53	6.11
1300	6.08	6.87
1400	6.55	7.45
1500	6.98	8.55
1600	7.14	8.84
1700	7.98	9.24
1800	8.5	9.78
1875	9.19	10.21
0	0.18	0.61



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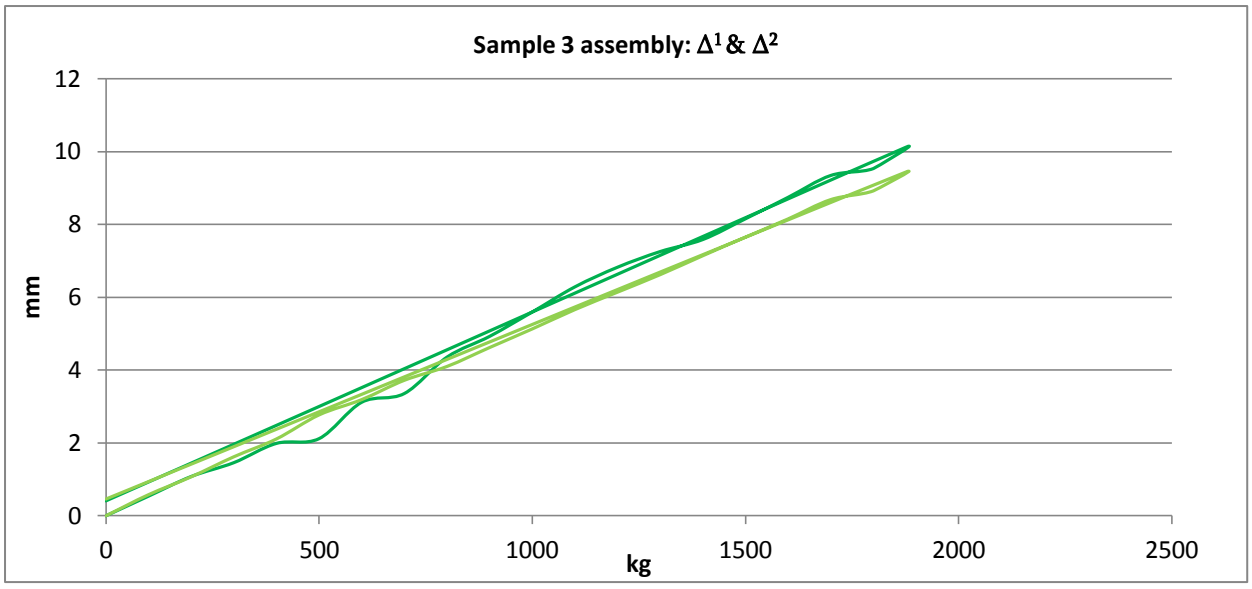
3.1.4. *Sample 3 results SLS UDL*

kg	Δ^1 mm	Δ^2 mm
0	0	0
100	0.54	0.58
200	1.08	1.07
300	1.46	1.62
400	1.99	2.11
500	2.12	2.77
600	3.12	3.19
700	3.36	3.72
800	4.36	4.1
900	4.93	4.62
1000	5.6	5.13
1100	6.29	5.66
1200	6.83	6.14
1300	7.26	6.62
1400	7.59	7.14
1500	8.16	7.65
1600	8.75	8.15
1700	9.35	8.68
1800	9.54	8.92
1875	10.12	9.43
0	0.41	0.46



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3.2. *Board Bearer ULS UDL load study*

Arrangement as per 1.3.1.
Requested SLS load 6.23kN/M
6.23x 2 =12.46kN/m^2; total application 12.5x 2.4 = 30kN
30kN =kg actual applied 3075kg exclusive of boards

Sample 1 assembly			Sample 2 assembly			Sample 3 assembly		
kg	mm Δ^1	mm Δ^2	kg	mm Δ^1	mm Δ^2	kg	mm Δ^1	mm Δ^2
0	0	0	0	0	0	0	0	0
200	0.92	1,01	200	1.15	1.7	200	0.85	1.24
400	1.63	1,96	400	1.9	2.72	400	1.96	2.31
600	2.5	2.87	600	2.63	3.73	600	2.89	3.15
800	3.41	3.82	800	3.68	5.13	800	3.79	4.24
1000	4.35	4.77	1000	4.61	6.01	1000	4.68	5.32
1200	5.18	5.59	1200	5.51	7.16	1200	5.42	6.3
1400	6.29	6.85	1400	6.2	8	1400	6.37	7.34
1600	7.36	7.97	1600	6.82	8.93	1600	7.31	8.41
1800	8.19	8.9	1800	7.84	9.95	1800	8.13	9.44
2000	9.08	10	2000	8.55	11.04	2000	9.05	10.41
2200	10.02	11.5	2200	9.57	12.05	2200	9.92	11.6
2400	10.63	12.6	2400	10.21	13.11	2400	10.75	12.67
2600	11.7	13.7	2600	11.08	14.12	2600	11.74	13.59
2800	12.7	14.89	2800	12.27	15.46	2800	12.68	14.52
3000	13.5	16.12	3000	13.25	16.64	3000	13.38	16.54
3075	14.26	16.87	3075	13.7	17.27	3075	14.29	17.11
0	0.42	1.18	0	0.56	1.18	0	0.61	0.99

3.2.1. *SLS and ULS digital images*

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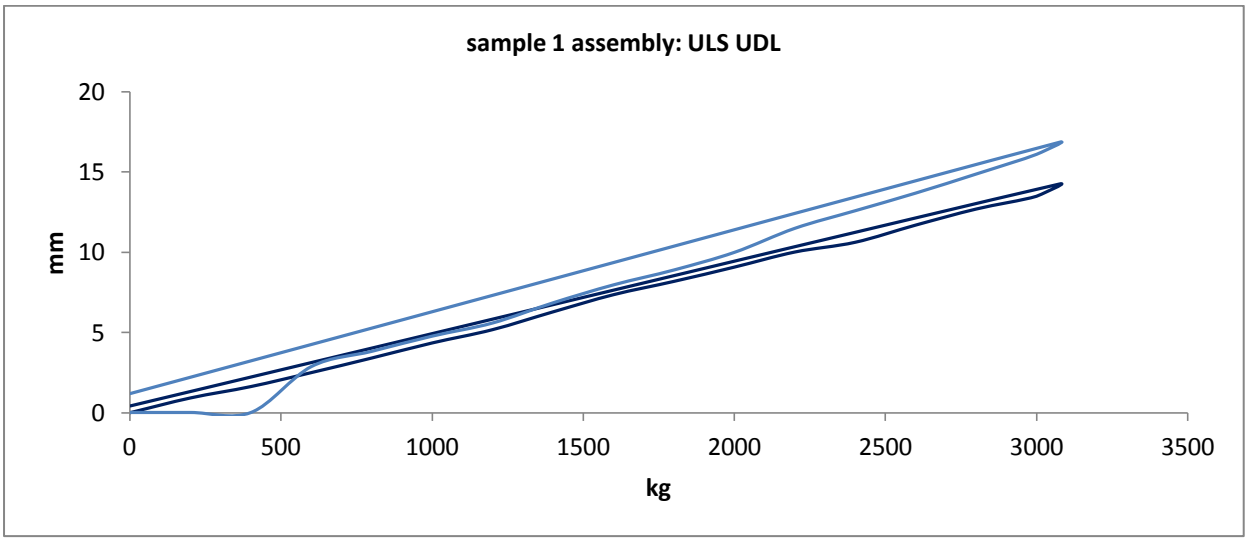
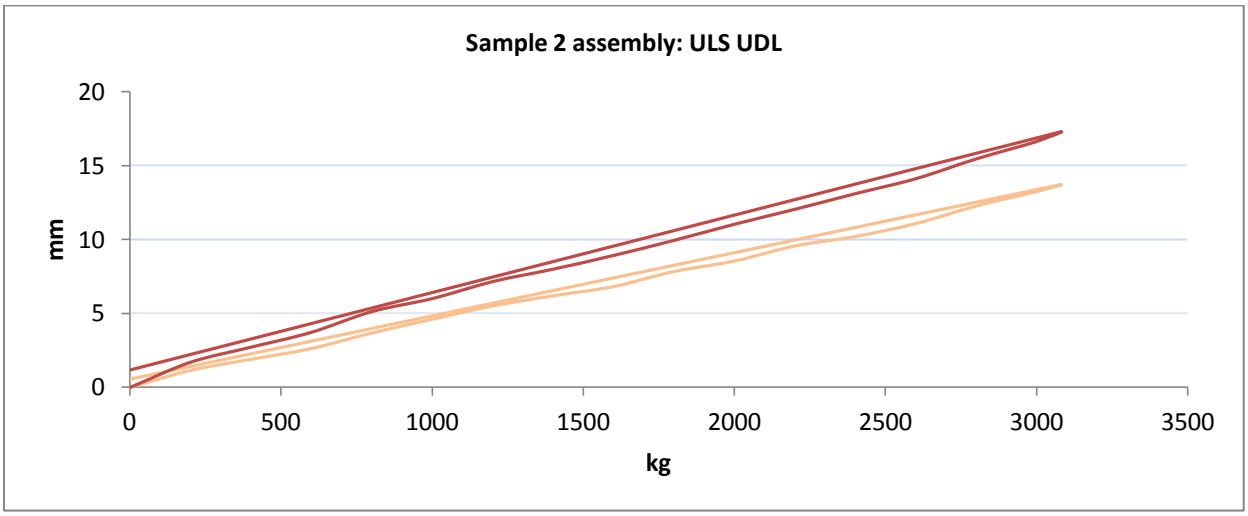
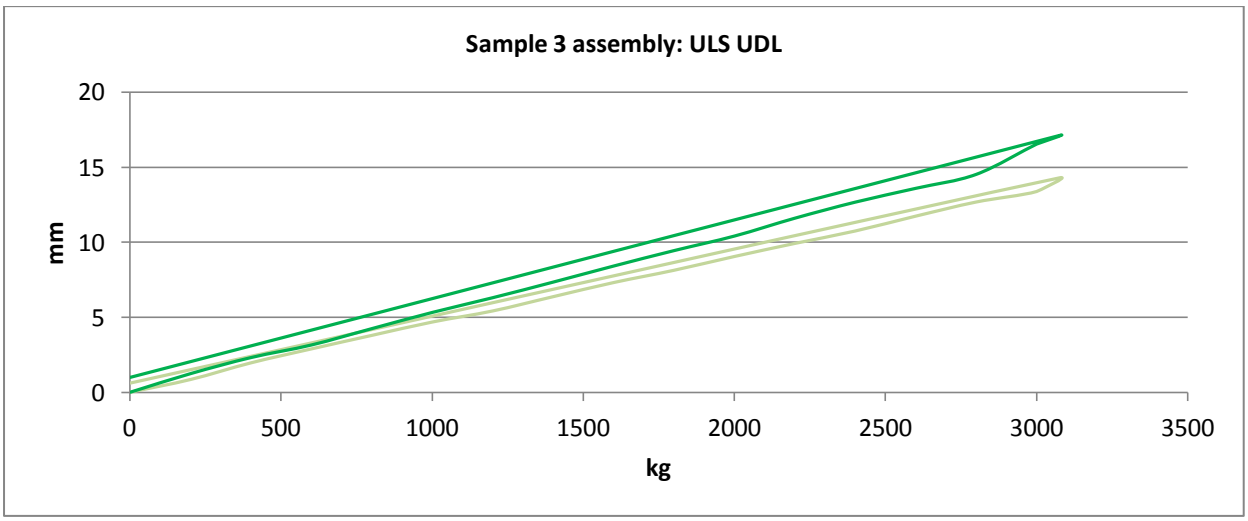
3.2.2. *Load displacement graphs ULS condition*







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3.3. *Board bearers CPL load survey to failure*

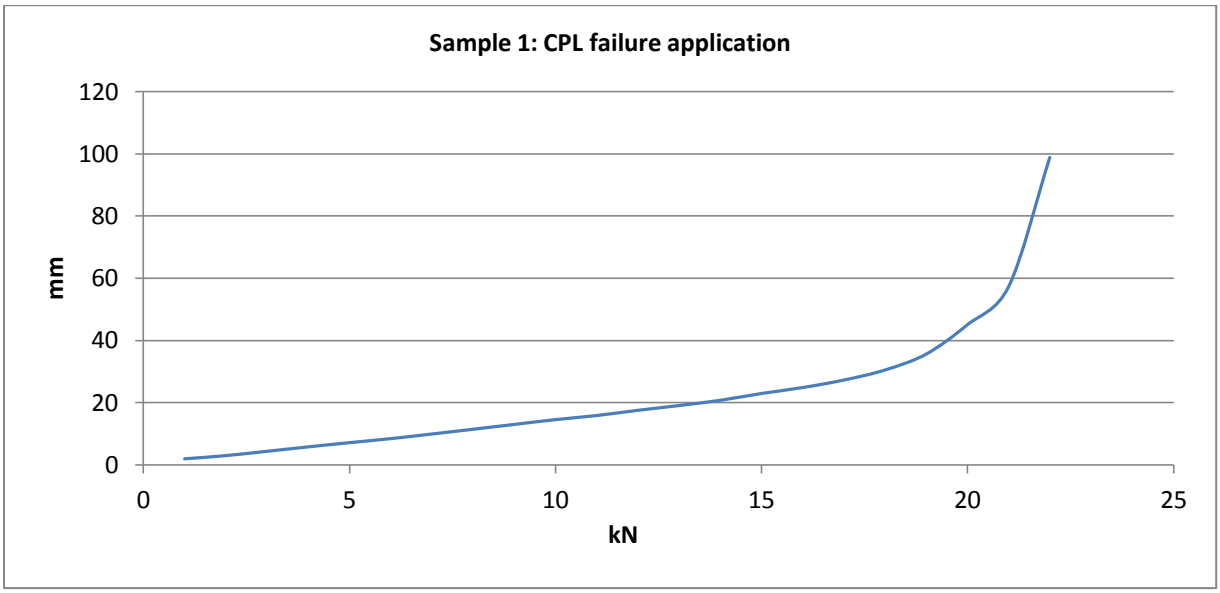
A sample board bearer was subject to a CPL load condition through to ultimate failure.
A concentrated central point load was applied to a simply supported section as requested.

3.3.1. *Load displacement table*

kN	mm	kN	mm
1	1.9	12	17.48
2	2.93	13	19.02
3	4.32	14	20.71
4	5.74	15	22.89
5	7.09	16	24.8
6	8.38	17	27.21
7	9.87	18	30.45
8	11.4	19	35.56
9	12.95	20	44.99
10	14.49	21	57.22
11	15.81	22	98.76

Permanent displacement recorded at 16.91mm, no more load achievable at a maximum recorded 22.36kN
Minor weld fracture noted upon vertical node at 22.36kN

3.3.2. *Load displacement graph CPL*



R^2=0.9953

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3.3.3. *Typical assembly for board bearer CPL post load*

3.3.4. Post load digital image showing permanent displacement to section

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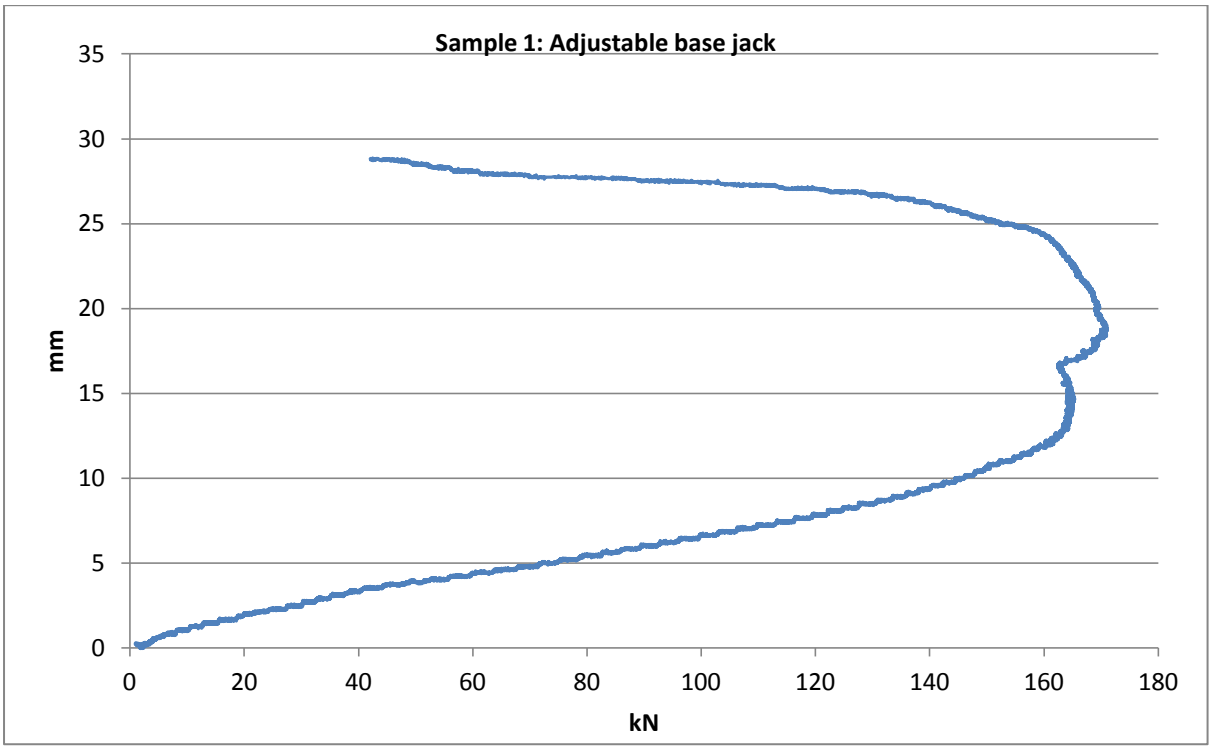
Section 4.0 Adjustable screw base jack compressive load study.

4.1. *Sample 1 bottom scale adjustment approx 100mm thread exposed.*
Pre load applied at 2kN displacement recorded at pre load.
Ultimate peak value logged at 171.1kN
Load rate applied at 2mm/min
Log intervals at 0.02



4.1.1. *Digital image showing ultimate failure mode.*

The material fracture shown in image 4.1.1. occurred after the base jack had showed signs of yield.
Fracture at base of tube location nut due to the bending of the jack body.
No visual signs of weld fracture at screw thread to main base connection.

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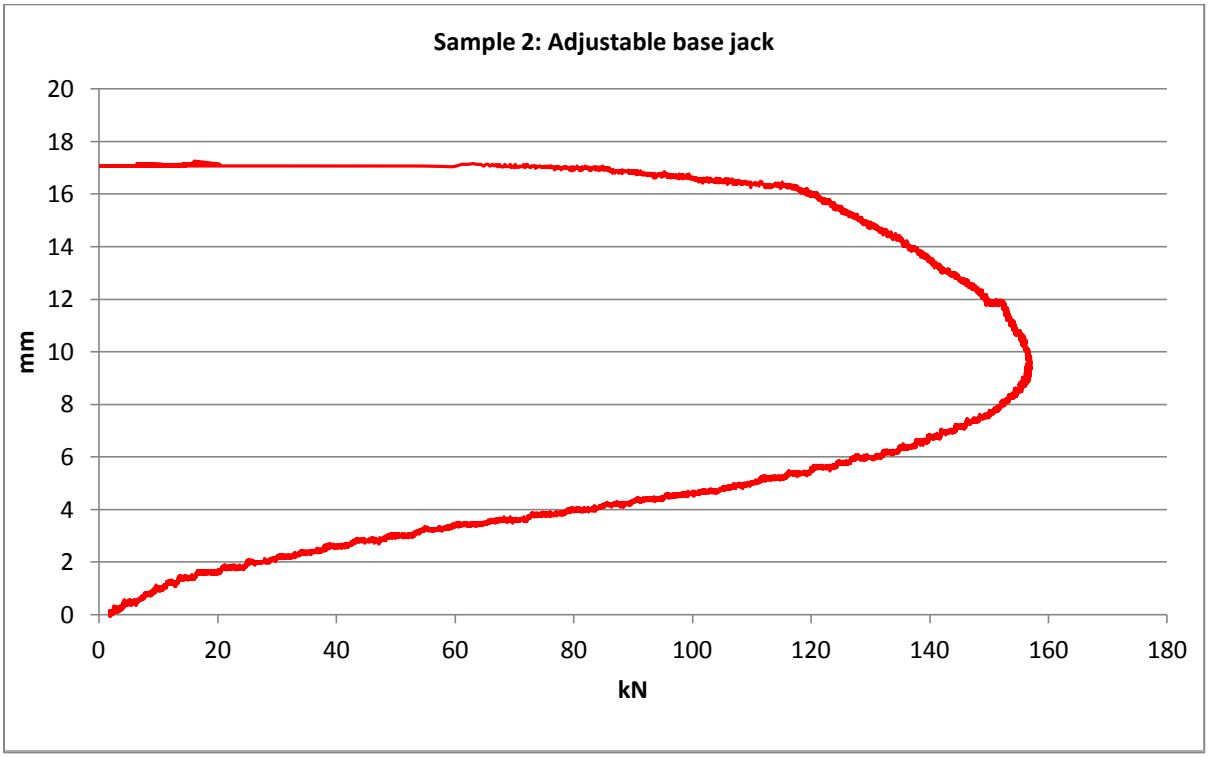
4.2. *Sample 2 mid scale adjustment approx 250mm thread exposed.*
Pre load applied at 2kN displacement recorded at pre load.
Ultimate peak value logged at 157.05kN
Load rate applied at 2mm/min
Log intervals at 0.02



4.2.1. *Digital image showing ultimate failure mode*

The material fracture shown in image 4.2.1. occurred after the base jack had showed signs of yield.
Fracture at base of tube location nut due to the bending of the jack body.
No visual signs of weld fracture at screw thread to main base connection.

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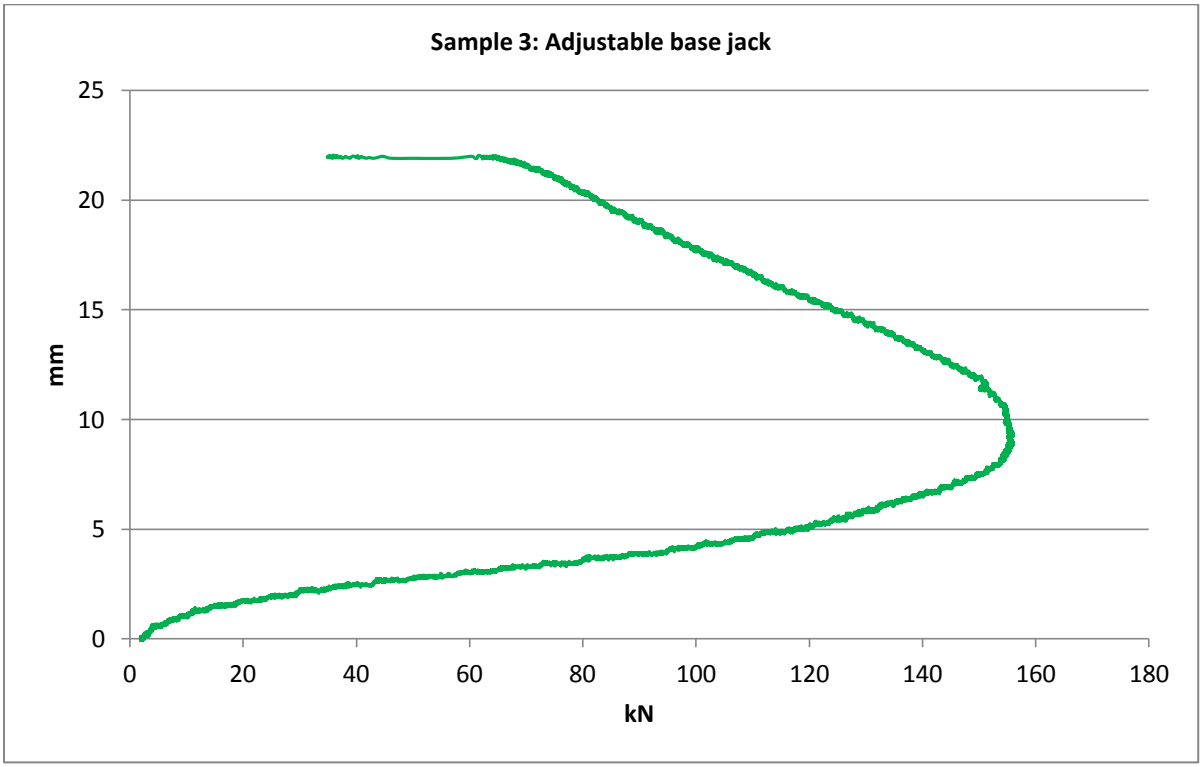
4.3. *Sample 3 upper scale adjustment approx 450mm thread exposed.*
Pre load applied at 2kN displacement recorded at pre load.
Ultimate peak value logged at 156.03kN
Load rate applied at 2mm/min
Log intervals at 0.02



4.3.1. *Digital image showing ultimate failure mode*

Digital image 4.3.1. showing mode of failure at extended height of 450mm. No visual signs of tread form fracture.
No visual signs of weld fracture at screw thread to main base connection

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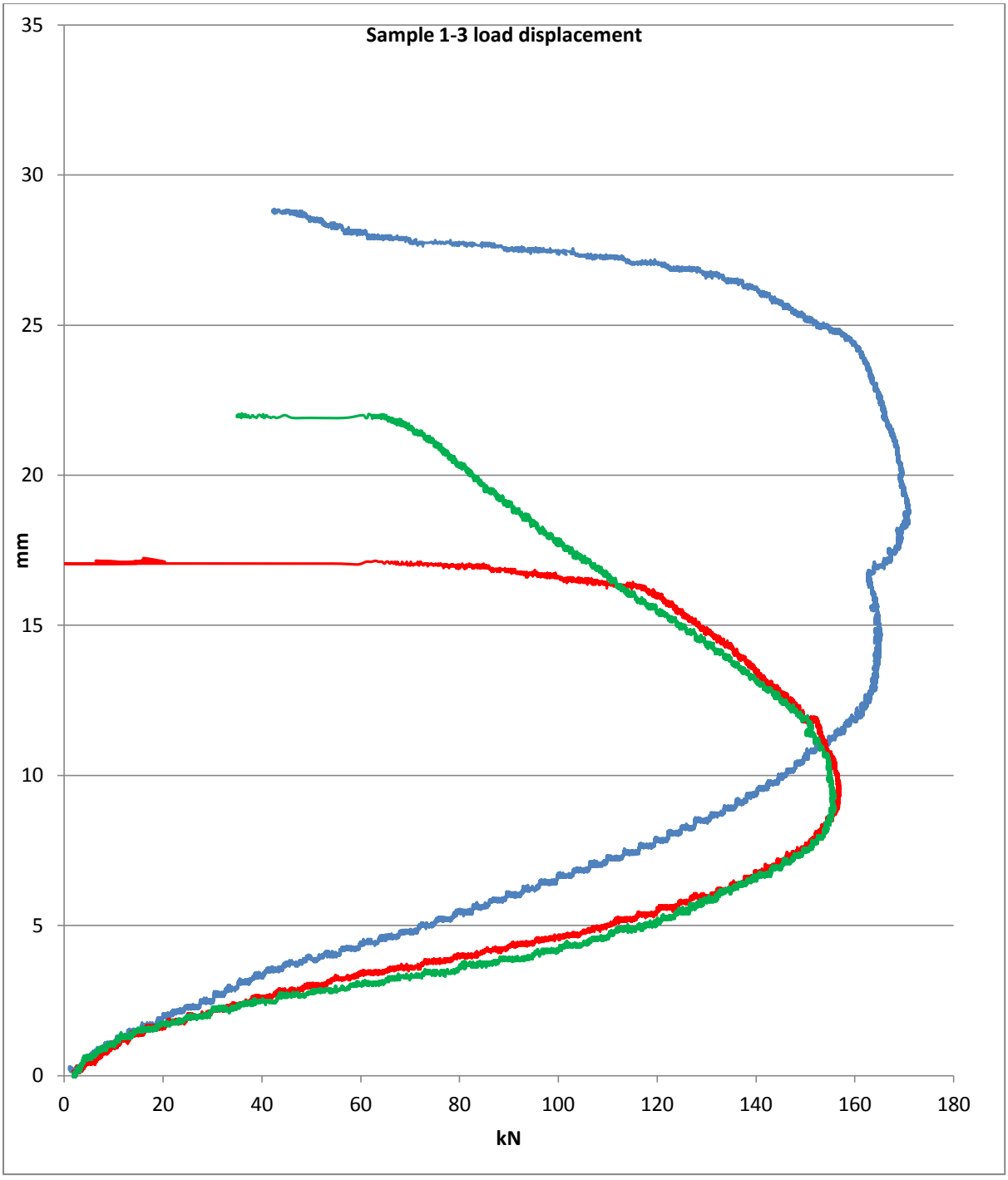
4.4. *Load displacement graph samples 1*



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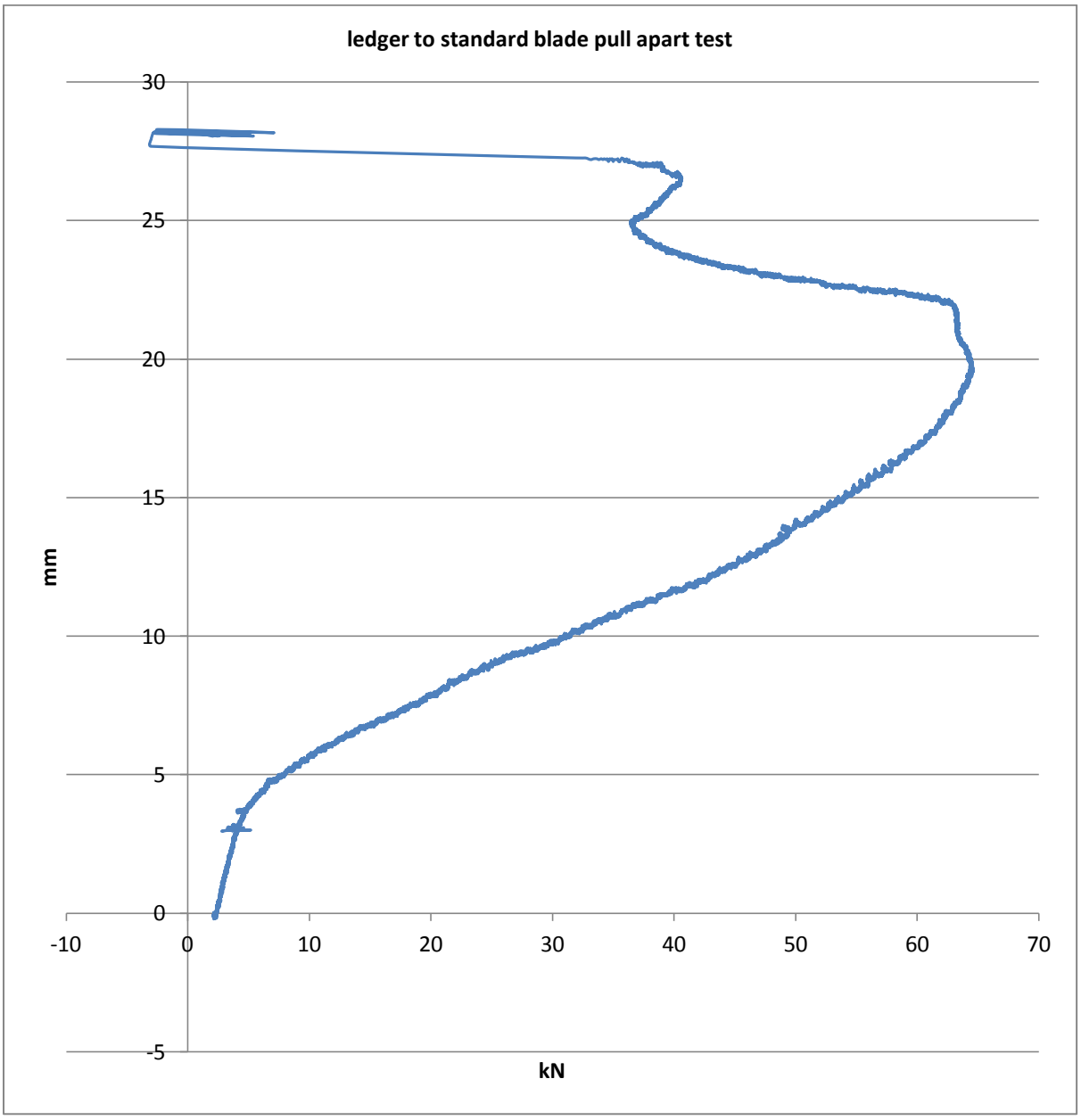
5.0. Blade to cup axial pull apart test.

A sample of two tubular ledgers and an isolated standard section were subject to an axial tensile pull apart test to ascertain failure mode and load.

Pre load applied at 2kN: displacement recorded at pre load.
Ultimate peak value logged at 64.63kN
Load rate applied at 2mm/min
Log intervals at 0.02



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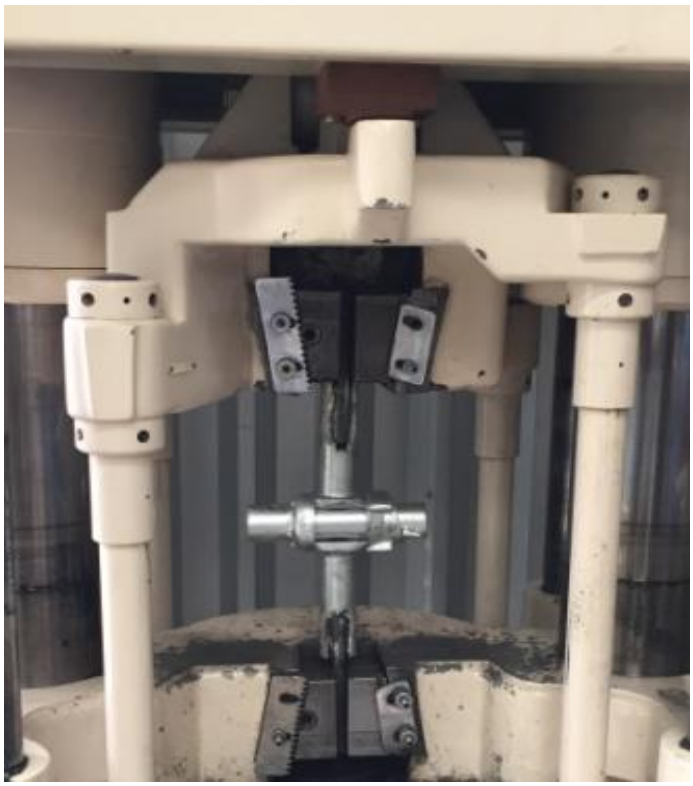
5.2. *Digital test images*



Sample subject to pull apart application pre load.

Post load image showing separation. Blade and cup yield evident, blade tip Distortion and cup distortion evident.

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The UDL applications applied to the loading bay beam samples were of a concentrated nature to show most unfavourable condition.
When subject to imposed UDL load conditions in the complete system arrangement the displacements should in theory dissipate through all components giving a greater displacement tolerance.

The collated data should be subject to technical review and cross referenced to all sections of the relevant codes.

The information and data recorded in this document is for the purposes of technical review and analysis by others.
The testing and results herein only apply to the items submitted at time of test.
Testing applied in accordance with submitted verbal procedure by the client and S-Mech consultant Engineers

Testing conducted by TESMEC Limited; Independent Testing and Engineering Services
Test House, unit 19 Newey Business Park
Sedgley Road West
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West Midlands
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Date of report issue: 6th July 2016

Signed: 

Mr S.J.Rogers Senior Test Engineer
Mr A Farmer Test technician.
On behalf of TESMEC Limited.

Report and testing conducted for: VR Scaffold Solutions Ltd

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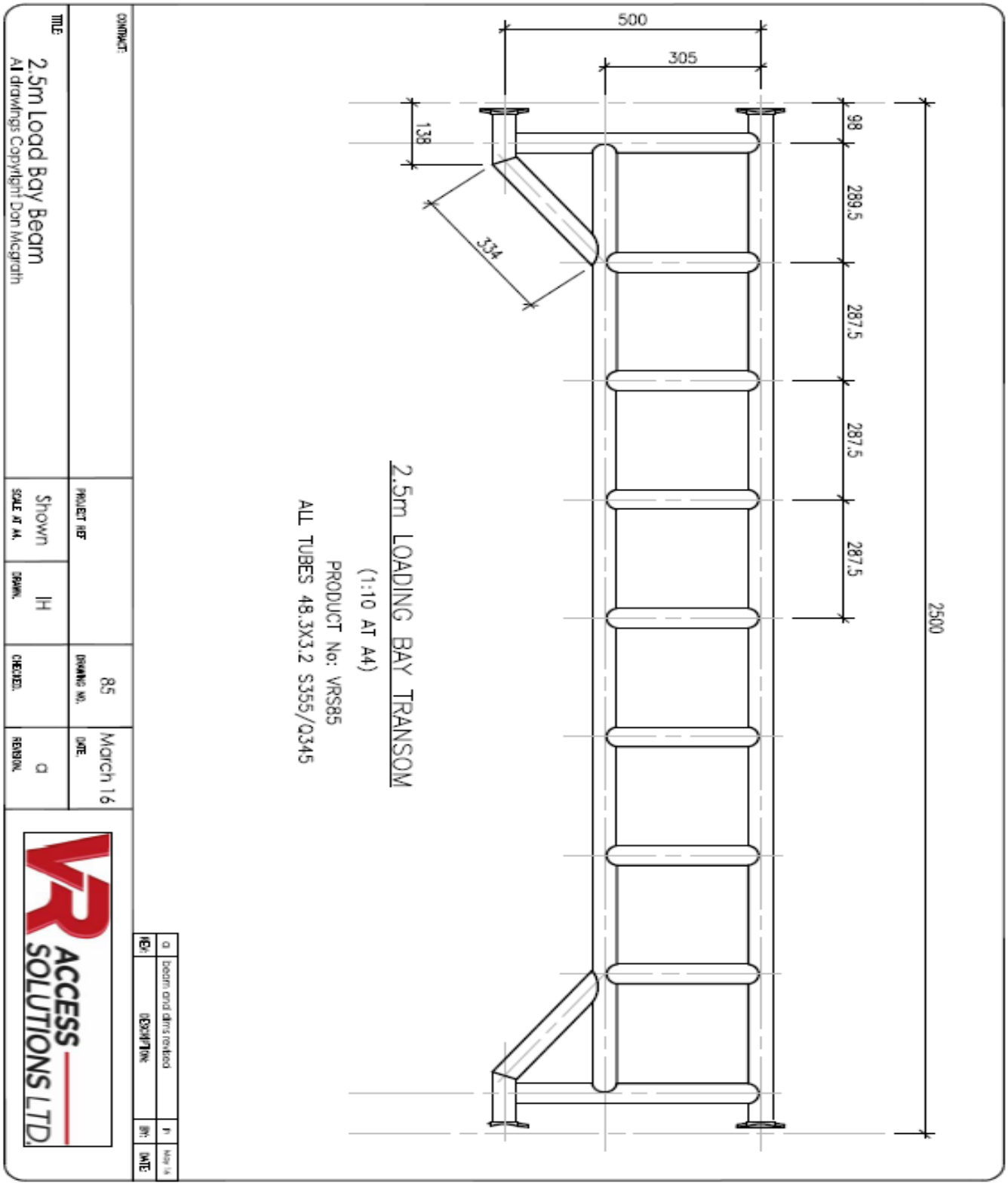
Appendix A: general arrangement drawing.



END OF REPORT