MTR Corporation Limited

South Island Line (East)

Operational Ground-borne Noise Mitigation Measures Plan

July 2014

Verified by:

Thomas Chan

Thomas Chan
Independent Environmental Checker

Date:

2 July 2014

MTR Corporation Limited

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Certified by:

Richard Kwan
Environmental Team Leader

Date:

02 JUL 2014

South Island Line (East)

Operational Ground-borne Noise Mitigation Measures Plan

MTR Corporation Limited
July 2014

Background

Referred to the EP Condition 2.26 (EP-407/2010/D), MTRCL shall deposit with the Director of EPD an Operational Ground-borne Noise Mitigation Measures Plan showing:

(a) Type 1a Trackform – Resilient Baseplate shall be installed at the track section between Chainage 16730 and 16980 as shown in Figure 10; and

(b) any additional or changes in noise mitigation measures as required in accordance with the Operational Ground-borne Noise Review Plan deposited under Condition 2.25.

Review of the upgraded trackform for SIL(E)

In accordance with the approved SIL(E) EIA report, Type 1a trackform was proposed along the SIL(E) alignment. With reference to Section 3.5.2.3 of the approved SIL(E) EIA report, full compliance with the ground-borne Acceptable Noise Level (ANL) could be achieved by the use of incline turnout and Type 1a resilient baseplated trackform within the SOH station between chainage 16730 and 16980. It was verified in the Operational Ground-borne Noise Review Plan submitted under EP Condition 2.25 (EP-407/2010/D) with updated on-site measured Line Source Response and ground vibration conditions.

With a more conservative approach for better performance and service to the community, an upgrade of trackform would be employed in SIL(E). A review of the upgraded trackform provision and the trackform proposed in the approved SIL(E) EIA Report is summarized in the *Table 1.1* below:

Table 1.1 Review of Trackform for SIL(E)

Chainage (Approx.)	Trackform proposed in the approved SIL(E) EIA Report	Upgraded Trackform for SIL(E)
DN 9915—10130 UP 9915—10130	Type 1a Resilient Baseplate Trackform [1]	Type 1 BCT Trackform Delkor Alt 1 Baseplate [2]
DN 10130—10250 UP 10130—10250		Turnout Trackform [3]
DN 10250—13310 UP 10250—13310		Type 1 BCT Trackform Delkor Alt 1 Baseplate
DN 13310—13530 UP 13310—13530		Type 1 FST Trackform Delkor Alt 1 Baseplate[4]
DN 13530—14055 UP 13530—14075		Type 1 BCT Trackform Delkor Alt 1 Baseplate
DN 14055—14080		Turnout Trackform
DN 14080—14310		Type 1 BCT Trackform Delkor Alt 1 Baseplate
DN 14310—14335 UP 14075—14100		Turnout Trackform
DN 14335—14445 UP 14100—14525		Type 1 BCT Trackform Delkor Alt 1 Baseplate
DN 14445—14470 UP 14525—14550		Turnout Trackform

Chainage (Approx.)	Trackform proposed in the approved SIL(E) EIA Report	Upgraded Trackform for SIL(E)
DN 14470—15800 UP 14550—15800	Type 1a Resilient Baseplate Trackform	Type 1 BCT Trackform Delkor Alt 1 Baseplate
DN 15800—15900 UP 15800—15900		Type 2 Trackform Web Supported Baseplate (i.e. Vanguard Baseplate)[5]
DN 15900—16715 UP 15900—16720		Type 1 BCT Trackform Delkor Alt 1 Baseplate
DN 16715—16840 UP 16720—16830	Incline turnout and Type 1a Resilient Baseplate Trackform between Chainage 16730—16980	Turnout Trackform
DN 16840—16850 UP 16830—16850		Type 1 BCT Trackform Delkor Alt 1 Baseplate
DN 16850—16925 UP 16850—16930		Type 1 FST Trackform Delkor Alt 1 Baseplate
DN 16925—16970 UP 16930—16980		Type 1 BCT Trackform Delkor Alt 1 Baseplate

Remarks:

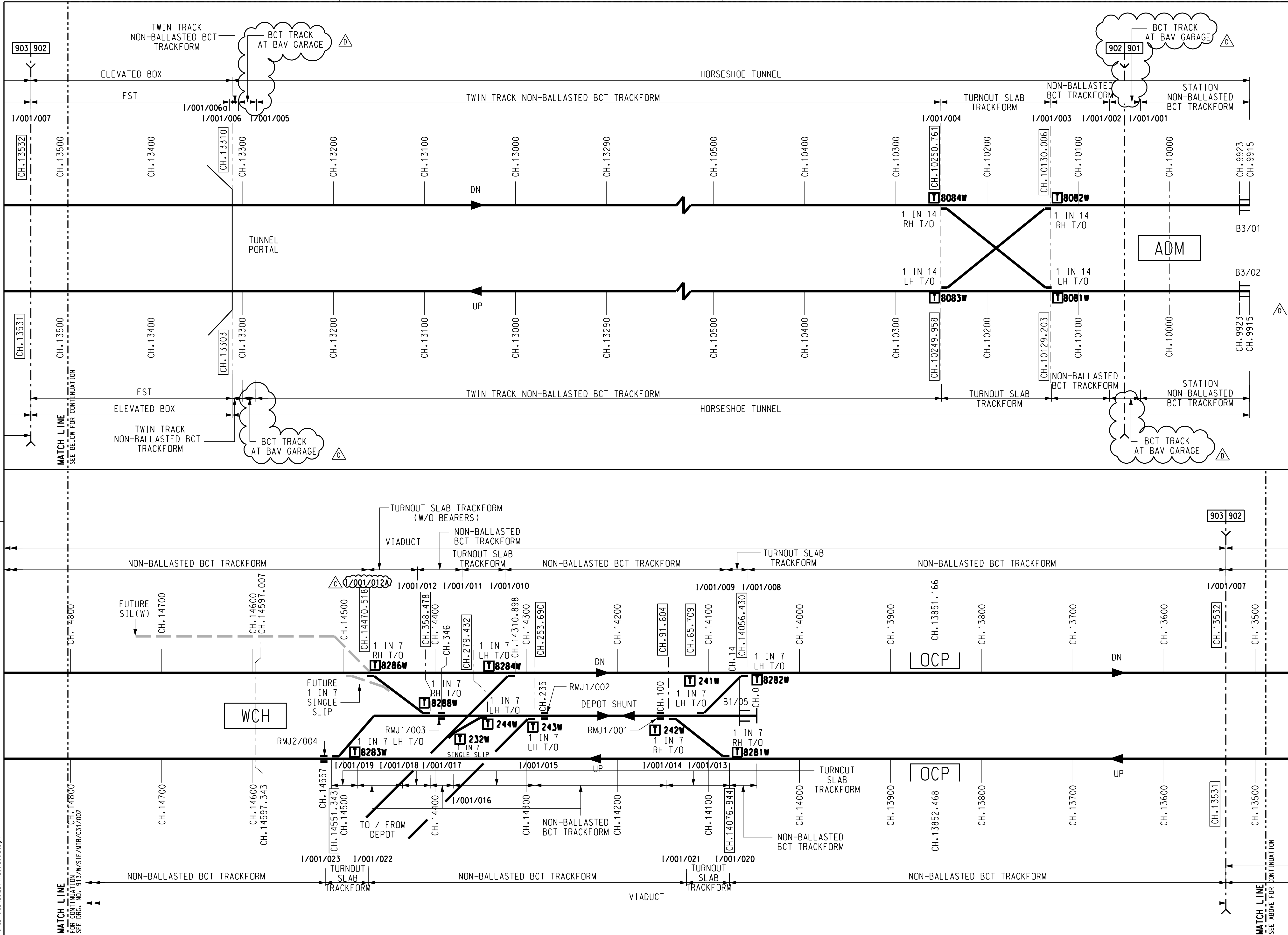
1. Type 1a Trackform is the resilient baseplated trackform with stiffness of 25 kN/mm
2. Type 1 BCT (Baseplated Concrete Tie) Trackform is the resilient baseplated trackform with track slab casted in-situ with sleepers. The trackform assembly is the same as Type 1a and using Delkor Alt 1 Baseplate with track stiffness of 20-25 kN/mm
3. Turnout Trackform is trackform at turnout location with resilient baseplate pad with overall stiffness of 25 kN/mm and inclined at 1 in 20
4. Type 1 FST (Floating Slab Track) Trackform is the resilient baseplated trackform with precast slab supported by rubber bearings underneath. The trackform assembly is the same as Type 1a and using Delkor Alt 1 Baseplate with track stiffness of 20-25 kN/mm
5. Type 2 Trackform with Web Supported Baseplate is the resilient baseplated trackform with track slab casted in-situ with sleepers. The baseplate is Vanguard Baseplate and track stiffness of 3-5 kN/mm

As shown in the *Table 1.1* above, the type of trackform proposed in the approved SIL(E) EIA Report would be upgraded to BCT Trackform, Turnout Trackform, FST Trackform with Delkor Alt 1 baseplate or Type 2 Trackform with Vanguard baseplate. The track schematics of SIL(E) are shown in **Appendix 1** and results of performance test for different trackfroms are given in **Appendix 2**.

The upgraded trackform is more resilience than that proposed in the approved SIL(E) EIA report, and hence would have better vibration attenuation. With the upgrade of trackform, the ground-borne noise impact from the operation of SIL(E) on the community will be less than it is predicted in the EIA Report.

Appendix 1

Track Schematics for SIL(E)



NOTES

1. FOR GENERAL NOTES AND LEGEND, REFER TO DRAWING NO. 913/W/SIE/MTR/C01/001.
2. CHAINAGES SHOWN FOR TURNOUTS ARE AT TANGENT POINTS (TC).

DRAWING REFERENCE:

VOLUME 2 : SCHEMATICS

INTERFACE SCHEDULE & BUFFER STOP SCHEDULE	- C31/011

VOLUME 4 : JUNCTION LAYOUT

TURNOUT	- C33/001 TO C33/009

VOLUME 5 : STANDARD DETAILS

TWIN TRACK HORSESHOE TUNNEL BCT	- C32/001
HORSESHOE TUNNEL WEB SUPPORTED BASEPLATE TRACKFORM	- C32/002
BCT TRACK AT BAV GARAGE	- C32/003
HORSESHOE TUNNEL BCT	- C32/004
STATION BCT	- C32/005 & 006
STATION FST	- C32/007
RECTANGULAR TUNNEL BCT	- C32/008
VIADUCT BCT	- C32/010 & 011
ELEVATED BOX FST	- C32/012
HORSESHOE TUNNEL TURNOUT SLAB	- C32/015
VIADUCT TURNOUT SLAB (W/BEARERS)	- C32/016
VIADUCT TURNOUT SLAB (W/O BEARERS)	- C32/017

REV	DESCRIPTION	BY	DATE	APPROVED
D	TRACKFORM TYPE REVISED	TIM	19NOV13	CK
C	INTERFACE NUMBER ADDED	CHW	30AUG13	CK
B	TRACKFORM EXTENT NAM FUNG VB REVISED	CHW	09NOV12	CK
A	ISSUE FOR CONSTRUCTION	KLT	08FEB12	DE

DRAWN	KLT
DESIGNED	ML
CHECKED	BT
APPROVED	DE
DATE	08/02/2012

MTR

SOUTH ISLAND LINE (EAST)

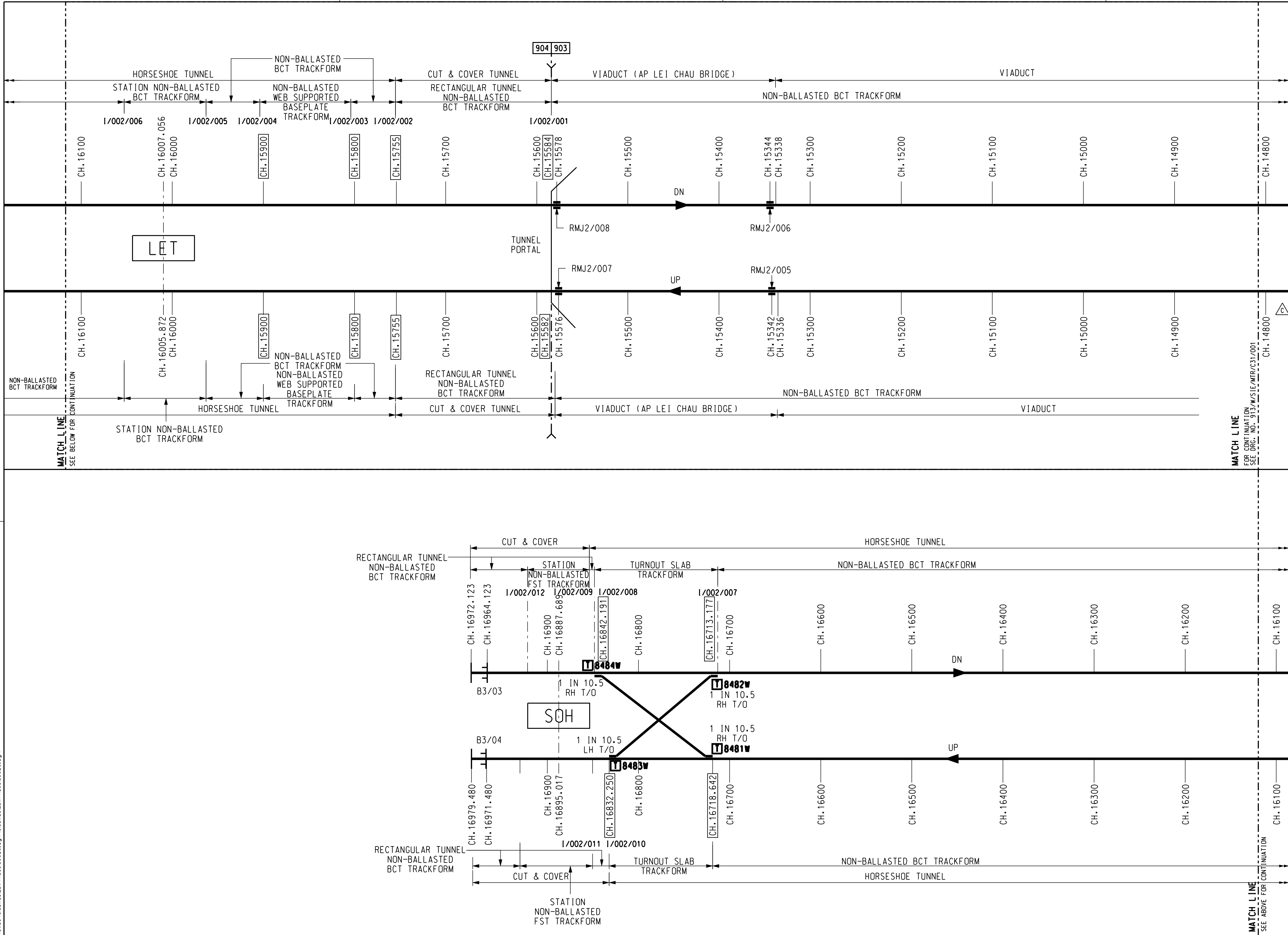
ORIGINATOR: PROJECTS DIVISION | CIVIL & PLANNING DEPARTMENT

CADD REF. 913_W_SIE_MTR_C31_001D.dgn

TITLE

CONTRACT 913
TRACK SCHEMATICS
ADMIRALTY TO WONG CHUK HANG

SCALE: NTS | DRAWING NO. 913/W/SIE/MTR/C31/001 | REV. D



NOTES

1. FOR GENERAL NOTES AND LEGEND, REFER TO DRAWING NO. 913/W/SIE/MTR/C01/001.
2. CHAINAGES SHOWN FOR TURNOUTS ARE AT TANGENT POINTS (TC).

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TWIN TRACK HORSESHOE TUNNEL BCT	- C32/001
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BCT TRACK AT BAV GARAGE	- C32/003
HORSESHOE TUNNEL BCT	- C32/004
STATION BCT	- C32/005 & 006
STATION FST	- C32/007
RECTANGULAR TUNNEL BCT	- C32/008
VIADUCT BCT	- C32/010 & 011
ELEVATED BOX FST	- C32/012
HORSESHOE TUNNEL TURNOUT SLAB	- C32/015
VIADUCT TURNOUT SLAB (W/BEARERS)	- C32/016
VIADUCT TURNOUT SLAB (W/O BEARERS)	- C32/017

REV	DESCRIPTION	BY	DATE	APPROVED
C	TRACKFORM TYPE REVISED	TIM	19NOV13	CK
B	TYPO CORRECTED	KLT	29JUL13	CK
A	ISSUE FOR CONSTRUCTION	KLT	08FEB12	CK

DRAWN	KLT
DESIGNED	ML
CHECKED	BT
APPROVED	BE
DATE	08/02/2012

MTR

SOUTH ISLAND LINE (EAST)

ORIGINATOR: PROJECTS DIVISION | CIVIL & PLANNING DEPARTMENT

CADD REF. 913_W_SIE_MTR_C31_002C.dgn

TITLE

CONTRACT 913
TRACK SCHEMATICS

WONG CHUK HANG TO SOUTH HORIZONS

SCALE: NTS | DRAWING NO. 913/W/SIE/MTR/C31/002 | REV. C

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Appendix 2

Results of Performance Test for Trackforms

New Material Test Center of CSR ZELRI Co., Ltd

TEST REPORT

(№: 2013013141)

Product Description **Delkor Alt 1 Resilient Baseplate (SIL/KTE MTR)**

Drawing RF 0.04.192CL-TMT

Client **TMT-Delkor Rail Pty Ltd.**

Test Type **Third-party Inspection**

Notice

1. Test report is invalid without the stamp of "Dedicated Center Seal".
2. The copy of the test report is invalid without the remarked stamp of "Dedicated Test Seal" or "Test Center Seal".
3. The test report is invalid without the signatures of drafting, verification and approval persons.
4. The Test with any modifications is invalid.
5. The test report with missing pages is invalid.
6. To protect your benefit, in case of any disagreement on the test report, please inform the Test Center within 15 days, counting from the date of postmark by the receiving place, upon receipt of the test report.
7. The entrusted inspection is responsible for the provided sample only, and should not be regarded as basis for judgment of mass products.
8. The test report should have page-spanning seal.

Address: 58# Block, Liyu Industrial Park, Tianyuan District, Zhuzhou, Hunan -P.R. China
Postcode: 412007 **TEL**: 86-731-28491610/28491656 **Fax**: 86 731-28491600 **E-mail**: liuguojun@teg.cn

New material Test center of CSR ZELRI Co., Ltd
Test Report

№: 2013013141

Product Description	Delkor RF192 Alt 1 Resilient Baseplate (For SIL/KTE Project)	Product No.	TX0090323
Client	TMT-Delkor Rail Pty Ltd.	Drawing No.	RF0.04.192CL-TMT
Address	18# Haitian Road, Tianyuan District, Zhuzhou, Hunan	Sample grade	/
Inspected Unit	/	Sample Quantity	4pcs
Manufacturer	TMT	Production Date/Batch	/
Sampling scheme	/	Sampling date	/
Test Type	Third-party Inspection	Contact Person	Li yi
Sample Condition	No visible defects.	Sample received date	Jan 22, 2013
Test Basis	Delkor Alt 1 MAB Test Procedure – SIL/KTE MTR rev B	Test Date	Jan 23~Feb 18, 2013
Test parameters	Dynamic and Static Stiffness Test; Longitudinal Restraint Test; Electrical Test; Vertical and Lateral Repeated Load Test.		
Main Equipments	FCS 12 Channel Electro-hydraulic Servo Loading Testing System; CSS-44600 Electro Omnipotence Testing Machine; Special tools; INSTRON8802 Dynamic Property Testing Machine; Megger.		
Test Conclusion	According to the test procedure, the test samples were qualified. Issue Date: 2013Year 02 Month 27 Day 检验专用章 Special stamp for test report		
Remark			

Prepared by	[signature]	Reviewed by	高翔	Authorized by	[signature]

1. General

This test report includes Dimensional Check, Dynamic Stiffness Test, Static Stiffness Test, Longitudinal Restraint Test, Electrical Test and Repeated Load Test (3 million cycles).

2. Testing Aim

To confirm the rail fastening system as a whole can meet the design requirements as Delkor Alt 1 MAB Test Procedure – SIL/KTE MTR.

3. General Condition

3.1 Time intervals

3.1.1 Time intervals: The time intervals between the property tests and cure were no less than 24h to ensure the stability of the property.

3.1.2 Conditioning: Before testing, condition the specimen at temperature (23+/-2) °C for no less than 24h.

3.1.3 During the testing, the temperature (23+/-5)°C was maintained.

3.2 Test equipment and set-up

Test equipment: 12 Channel Electro-hydraulic Servo Loading Testing System, CSS-55100 Electro Omnipotence Testing Machine, Special tools, INSTRON8802 Dynamic Property Testing Machine, Megger.

Test Set-Up I: one baseplate was assembled to a steel plate and the rail fastening was used to hold a 300mm length of UIC 60 rail.

Test Set-Up II: two baseplates at nominal 600mm spacing were used to hold a 1m length of UIC 60 rail.

Components for the above test were as below:

1. Delkor Alt 1 RF 192 (RF 0.04.192 CL)
2. Serrated washers (RF 3.00.015 S)
3. 12mm shim/base pad (RF3.09.192 BP)
4. Pandrol e 2007 clips
5. Delkor rail pad (RP5.UIC60.01)
6. Pandrol 5720 insulator
7. Rail UIC60
8. Steel plate

4. Testing Preparation

4.1 Four direct fixation rail fasteners were randomly selected, designated as Sample 1#, 2#, 3# and 4# by Mr. Duncan K. B. Lam from MTR Corporation Limited and Driss FILALI from Alstom Transportation.

4.2 The dimension and appearance of the four samples were inspected accordingly.

4.3 Sample 1#, 2#, 3# and 4# were subjected to the tests specified below.

Test Sequence

1#	2#	3#	4#
Dimensional Check 5.1	Dimensional Check 5.1	Electrical Test 5.5	Electrical Test 5.5
Static Stiffness Test 5.2	Static Stiffness Test 5.2	-	-
Dynamic Stiffness Test 5.3	Dynamic Stiffness Test 5.3	-	
Longitudinal Test 5.4		-	-
Repeated Load Test 5.5	-	-	-

5. Test Record and Result

5.1 Dimensional Check

5.1.1 Test Result

Requirements	Results	
	Sample 1#	Sample 2#
43±1.5	43.6	43.9
168(+1.5/-0.5)	168.4	167.9
Cant 1:20	1:20	1:20
Flatness≤0.5	0.1	0.2
425(+1.0/-1.5)	425.2	425.3
250±1.0	249.7	250.9
245±1.0	245.2	245.8
300±1.0	300.1	300.1

Table 1 Dimensional Check Record of Sample 1# &2#

5.1.2 Test Conclusion

Samples were passed the test.

5.1.3 Test Photo

Photo 1 Dimensional Check Photo

5.2 Static Stiffness Test

Test Set Up I was used in the test as shown (See *Photo* 2). The vertical load was applied to the center of the rail head. Set two dial gauges in the symmetric center to the load of the rail head to record the vertical displacement.

5.2.1 Procedure

The baseplate was stabilized by applying 10 loading cycles of a vertical load from 0 to 70KN at the rate of approximately 150kN/min.

Apply a vertical Load from 0 to 70KN at the rate of approximately 20kN/min for 3 cycles. Record the displacement of the final cycle in the increment of 2.5KN. The Load, Deflection and Static Stiffness was calculated and tabled for each 2.5kN load increment.

An additional load cycle was done. When the load reached 50kN, the loading was paused and an inspection on the base plate was carried out to check for any signs of failure. The loading was to continue to 70kN and then at the completion of the loading cycle, the final deflection of the rail was recorded after one minute.

The vertical deflection was measured at both ends of the rail and the average value taken.

5.2.2 Test Acceptance Criteria

The stiffness should be not more 25kN/mm when measured between the vertical deflections of 0.4 to 3.0mm-nominal range 20 to 25kN/mm.

5.2.3 Test conclusion

Samples were passed the test.

5.2.4 Test Result

Test Item	Criteria	Results	
		Sample 1#	Sample 2#
Stiffness value under the deflections of 0.4 to 3.0mm	20~25KN/mm	21.61KN/mm	22.90KN/mm

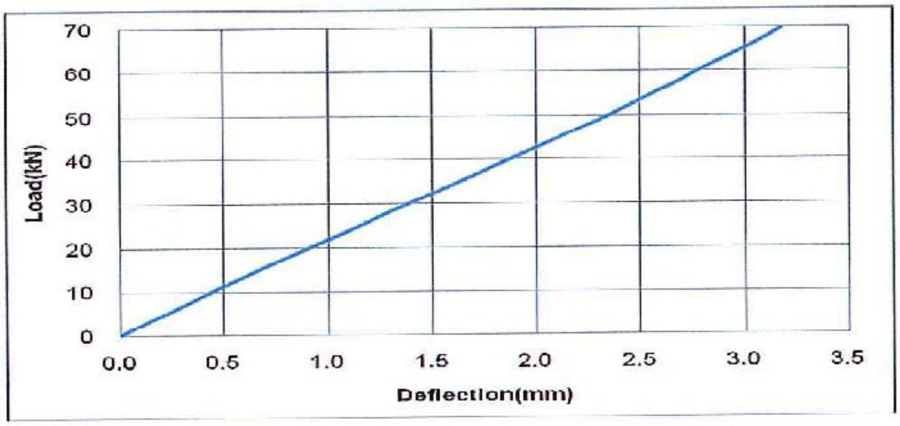
5.2.5 Test Records and Curves

Load (KN)	Deflection (mm)		
	Reading 1	Reading 2	Average
0.00	0.00	0.00	0.00
2.50	0.08	0.13	0.11
5.00	0.19	0.25	0.22
7.50	0.30	0.36	0.33
10.00	0.40	0.48	0.44
12.50	0.51	0.60	0.56
15.00	0.62	0.72	0.67
17.50	0.74	0.83	0.79
20.00	0.86	0.95	0.91
22.50	0.98	1.08	1.03
25.00	1.10	1.20	1.15
27.50	1.21	1.31	1.26
30.00	1.34	1.43	1.39
32.50	1.47	1.55	1.51
35.00	1.60	1.67	1.64
37.50	1.71	1.8	1.76
40.00	1.83	1.91	1.87
42.50	1.96	2.03	2.00
45.00	2.08	2.15	2.12
47.50	2.2	2.26	2.23
50.00	2.32	2.38	2.35
52.50	2.42	2.49	2.46
55.00	2.53	2.59	2.56
57.50	2.65	2.7	2.68
60.00	2.75	2.79	2.77
62.50	2.86	2.89	2.88
65.00	2.97	3	2.99
67.50	3.07	3.11	3.09
70.00	3.17	3.19	3.18

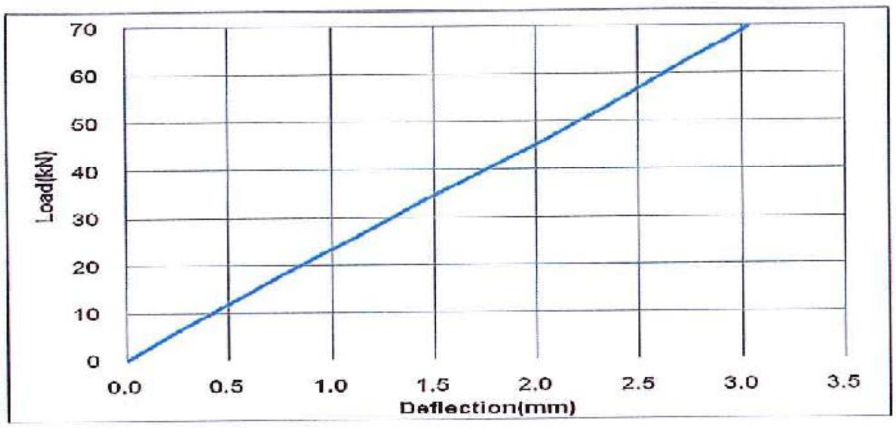
Table 1 Vertical Stiffness Test Data of Sample 1#

Load (KN)	Deflection (mm)		
	Reading 1	Reading 2	Average
0.00	0.00	0.00	0.00
2.50	0.08	0.11	0.10
5.00	0.17	0.22	0.20
7.50	0.26	0.34	0.30
10.00	0.37	0.46	0.42
12.50	0.47	0.57	0.52
15.00	0.57	0.69	0.63
17.50	0.67	0.80	0.74
20.00	0.78	0.91	0.85
22.50	0.89	1.02	0.96
25.00	1.01	1.14	1.08
27.50	1.12	1.25	1.19
30.00	1.23	1.36	1.30
32.50	1.34	1.46	1.40
35.00	1.45	1.58	1.52
37.50	1.57	1.70	1.64
40.00	1.69	1.81	1.75
42.50	1.81	1.92	1.87
45.00	1.93	2.04	1.99
47.50	2.04	2.15	2.10
50.00	2.15	2.25	2.20
52.50	2.27	2.36	2.32
55.00	2.37	2.47	2.42
57.50	2.48	2.56	2.52
60.00	2.58	2.66	2.62
62.50	2.69	2.75	2.72
65.00	2.79	2.86	2.83
67.50	2.91	2.97	2.94
70.00	3.01	3.06	3.04

Table 2 Vertical Stiffness Test Data of Sample 2#



Graph 1 Vertical Stiffness Test Curve of Sample 1#



Graph 2 Vertical Stiffness Test Curve of Sample 2#

5.2.6 Test Photos

Photo 2 Vertical Stiffness Test

REPORT NO: 85162-3

Customer Confidential

Testing of a PANDROL Brand VANGUARD Assembly type 15475-C to SIL/KTE Contract 913/1020 Specifications

(Ref EWR 5266)

ISSUE No.	1
AUTHORISED BY :	[signature]
POSITION :	TECHNICAL DIRECTOR
DATE :	7/10/13

PANDROL TRACK SYSTEMS

© DELACHAUX GROUP

Pandrol Limited

Development Laboratory, Gateford Road, Worksop, Notts, S81 7AX

Telephone: 01909 476101 Telefax: 01909 482989

Test work in Report No. 85162-3 was carried out by :-

Test	Technician	Signature	Date
Vertical stiffness	A Brown	ABrown	27/9/13
Rail head vertical load	A Brown	ABrown	27/9/13
Vertical dynamic stiffness	A Slowe	AS	27.9.13
Longitudinal rail restraint	A Slowe	AS	27.9.13
Repeated load	A Slowe	AS	27.9.13
Corrosion testing of baseplate coating	J Baiden	[illegible]	27/09/13
Electrical resistance	A Brown	ABrown	27/9/13

SUMMARY

To test a PANDROL Brand Rail Assembly type 145475-C to the test methods prescribed in SIL/KTE Contract 913/1020 for Hong Kong

Vertical static stiffness (kN/mm)		
4.85	**Specification**	**6.00 max**

Railhead combined vertical and lateral load test		
Average rail head lateral deflection (mm)		
0.65	**Specification**	**1.20 max**

Dynamic stiffness / static stiffness ratio		
1.27	**Specification**	**1.40 max**

Fastening longitudinal restraint (kN)		
15.08	**Specification**	**7 min**

Track gauge before and after repeated load			
Before (mm)	**After (mm)**	**Change (mm)**	**Specification**
1431.5	1433	1.5	**<3.0 mm**

Maximum rail head rotation during repeated load (mm)		
Assembly 1	**Assembly 2**	**Specification**
0.33	1.38	**4.0 max**

Maximum rail foot slippage following repeated load (mm)		
Assembly 1	**Assembly 2**	**Specification**
0.57	0.57	**1.0 max**

Electrical insulation (Ω)		
1,000,000	**Specification**	**20,000 min**

Baseplate coating 300 hours		
Corrosivity Category of C3. Medium durability rating	**Specification**	**N/A**

CONTENTS

1. INTRODUCTION and OBJECTIVES

To test a PANDROL Brand Rail Assembly type 15475-C to the test methods prescribed in SIL/KTE Contract 913/1020 for Hong Kong.

Test location	Pandrol Limited Development Laboratory
Standard referred	Hong Kong SIL/KTE Contract 913/1020 Particular Specification (PS) , Materials and Workmanship Specification for Trackwork (M&W), Coatings Corrosion Resistance ISO 4628-3:2003
Exceptions	None

Test regime		**Standard**
i.	Combined vertical and lateral load	PS 2.14(6)
ii.	Vertical dynamic stiffness	PS 2.14(6)
iii.	Longitudinal rail restraint	M&W 5.31
iv.	Repeated Load	M&W 5.29
v.	Baseplate paint protective coating	ISO 4628-3:2003
vi.	Electrical insulation	M&W 5.30

Component list	
Description	**Part number**
60 E1	-
Concrete block	Pandrol Cast
PANDROL Brand Baseplate	9764
PANDROL Brand Hook In Shoulder	9705
PANDROL Brand Bump Stop Pad	9243
PANDROL Brand Sideplate	9765
PANDROL Brand Adjustment Wedge	9242
PANDROL Brand Rubber Assembly	9769
PANDROL Brand Retention Clip	7920
PANDROL Brand Conforming Shim	15448
M24 Plain Washer	Supplied by Alstom
Double Helical Spring Fe6	Supplied by Alstom
Plastic Dowel SDU 20	Supplied by Alstom
SS8 Screw Spike	Supplied by Alstom
PANDROL Brand Serrated Washer	10284

2. TEST METHODS and RESULTS

2.1 Vertical Static Stiffness and Rail Head Combined Vertical and Lateral Load Test. – PS 2.14(6)
The test arrangement is shown in Figure 2.1.1
Measured results, graphs are shown in Figure 2.1.2 and 2.1.3
The test parameters and results are shown in Table 2.1.4
Method: Assemble fastener on a rigid concrete block with a section of rail not less than 300 mm in length. Mount transducers to accurately and continuously measure (within 0.01 mm) displacement of: • Rail foot vertical using four transducers mounted at the edge of each corner of the rail foot. • Rail head lateral using two transducers mounted at a point 14 mm below rail head top level. • Align one lateral loading actuator with a dome-shaped end to ensure normal loading is maintained when rail deflects. The lateral load cylinder should be mounted to apply a normal load to the rail head 14 mm below the top of rail head along the centre line of the assembly. Align the other vertical loading actuator to apply a vertical load on the centre line of the rail section in both aspects. Ensure that rail assembly has stabilised to a temperature of 20+/-5 °C for at least four hours and maintain this temperature during the test. Apply a vertical load to the rail up to 50 kN at a rate of between 0.5 and 2 kN/s. Release load and repeat two further times. Zero the rail foot vertical transducers and apply a load of 50 kN at a rate between 2.5 and 10 kN/minute and record load and the vertical deflection of the rail at each of the vertical transducers at 2.5 kN load increments. With the vertical load maintained at 50 kN, apply a lateral load up to 20 kN. Release lateral load, but maintain vertical load. Apply and release lateral load a further two times to bed in assembly. With the vertical load at 50 kN and lateral at zero, set the lateral transducers to zero and gradually increase lateral load to 20 kN in increments of 1 kN, recording the output from every transducer at each increment. Remove lateral load and record final readings on each transducer. Calculate rail vertical deflection as average of each of four vertical displacement positions. From a plot of vertical load versus deflection, calculate the secant static vertical stiffness between 0 and 30 kN.

Calculate the lateral deflection at 20 kN load as the average net deflection of the two transducers on the rail head. Vertical secant static stiffness shall be 6 kN/mm maximum. Lateral static rail head deflection shall be 1.2 mm maximum.

Figure 2.1.1. Vertical Static Stiffness and Rail Head Combined Vertical and Lateral Load Test

Figure 2.1.2. Vertical static stiffness

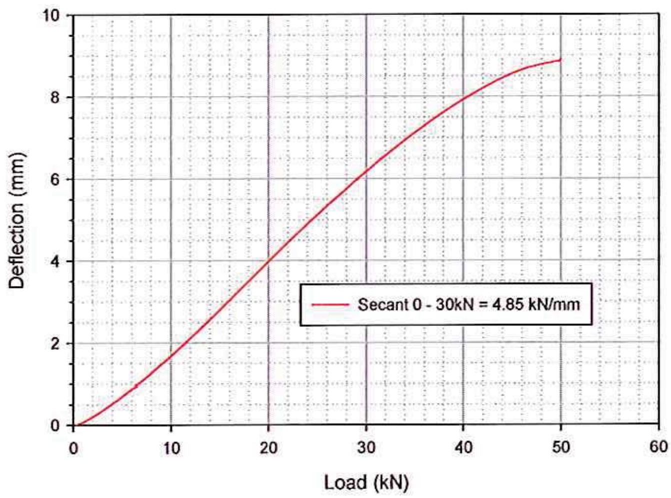


Figure 2.1.3. Lateral rail head deflection

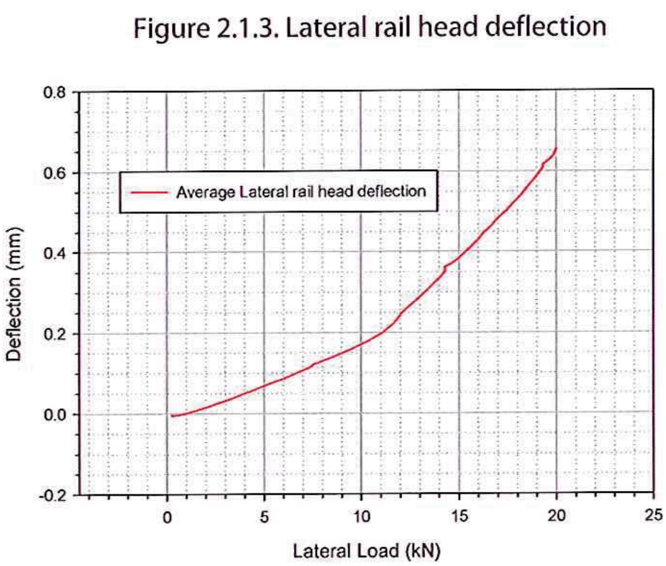


Table 2.1.4. Vertical Static Stiffness and Rail Head Load Test Results

Test	Test Result	Specification
Vertical Static Stiffness at 0 - 30 kN	4.85 kN/mm	6 kN/mm max
Average Railhead Lateral Deflection at 20 kN	0.65 mm	1.2 mm max

2.2 Vertical Dynamic Stiffness – PS 2.4 (6)
The test arrangement is shown in Figure 2.2.1
Measured results, graphs are shown in Figures 2.2.2, 2.2.3 and 2.2.4
The test parameters and results are shown in Table 2.2.5
Method: The assembly was mounted on a rigid baseplate beneath a hydraulic actuator according to the standard requirements. A load of 0 kN to 30 kN at a frequency of 4 Hz was applied to the assembly The deflection of the rail at its four corners was logged for 10 cycles during the final 100 cycles of the test, and the dynamic stiffness calculated from the mean results. From this test result, and the result of test carried out in section 2.1 of the report, a dynamic/static stiffness ratio was calculated.

Figure 2.2.1. Vertical dynamic stiffness test arrangement

Figure 2.2.2. Dynamic stiffness

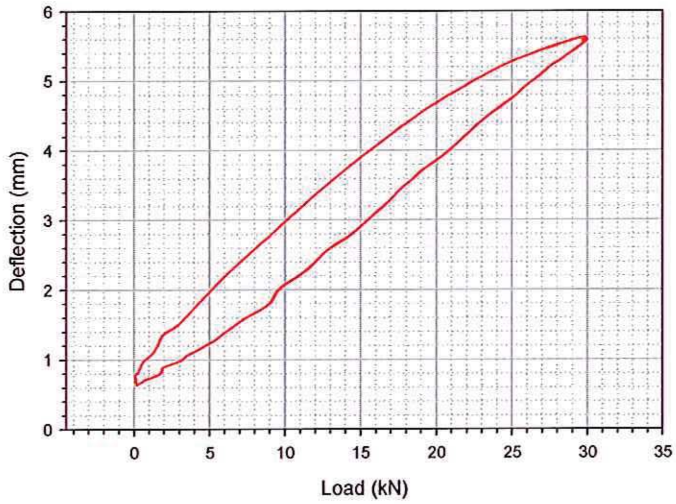


Figure 2.2.3. Average vertical rail deflection v time

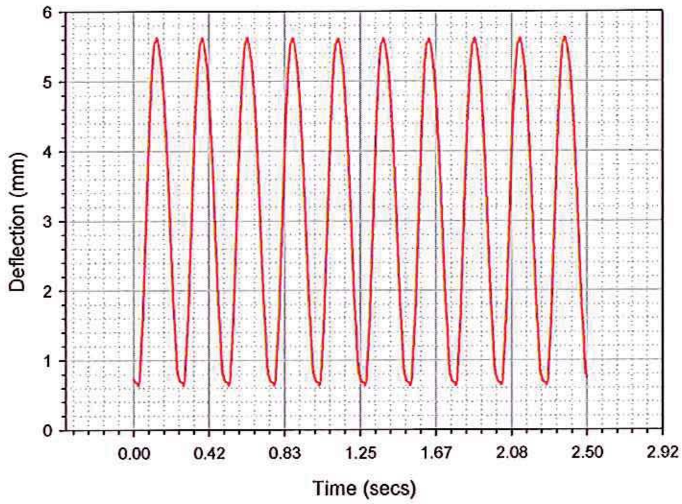


Figure 2.2.4. Vertical load v time

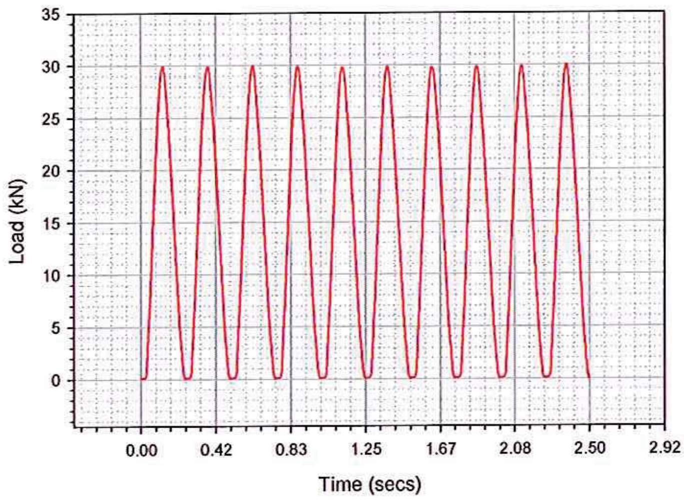


Table 2.2.5. Vertical Dynamic Stiffness Test Results

Vertical Dynamic Stiffness kN/mm	Dynamic/Static Ratio
6.17	1.27
Specification	**1.40 max**

2.3 Fastening Longitudinal Restraint Test – M&W 5.31 In Accordance with EN 13146-1: 2012

The test arrangement is shown in Figure 2.3.1

Measured results, graphs are shown in Figure 2.3.2

The test parameters and results are shown in Table 2.3.3

Method:

The test assembly was clamped firmly to a horizontal baseplate.

A load was applied longitudinally at a rate of 10 kN/minute to the rail centroid until the rail was observed to slip.

The load was rapidly reduced to zero.

Longitudinal movement of the rail was recorded during the loading cycle and for a further 2 minutes after load removal.

This test was repeated a further three times with a minimum 3 minutes between tests.

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

Figure 2.3.1. Longitudinal rail restraint test arrangement

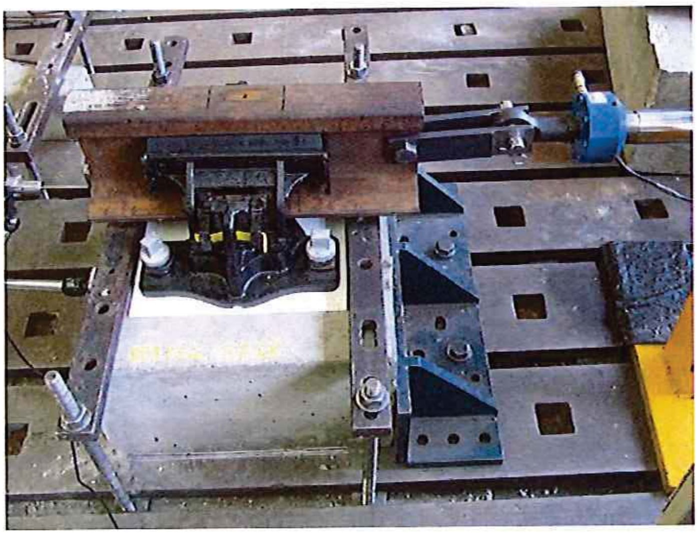


Figure 2.3.2. Longitudinal rail restraint results

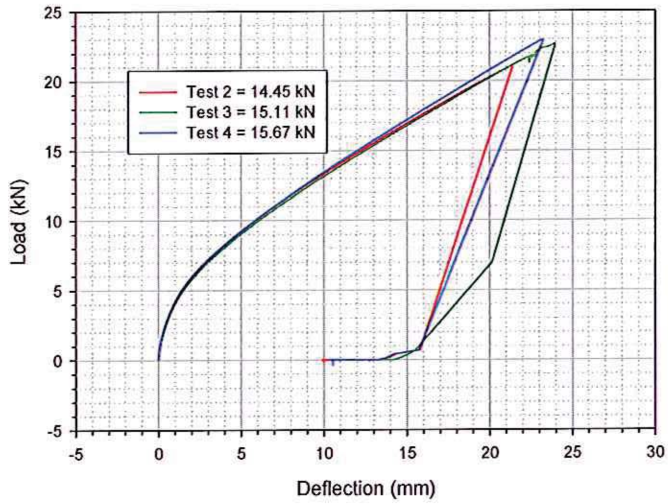


Table 2.3.3. Longitudinal Rail Restraint Test Results

Test Ref	Date of Test	Mean Restraint (kN)			
		2nd loading	3rd loading	4th loading	Mean
Rail Restraint	13/09/2013	14.45	15.11	15.67	15.07
Specification					**7 Min**

2.4 Repeated Load Test - M&W 5.29 (1 to 6)

The test arrangement is shown in Figure 2.4.1

The test parameters and results are shown in Table 2.4.2 to 2.4.8

Method:

Two short sections of rail were fastened to each assembly and clamped firmly beneath a hydraulic cylinder utilising a scissor arm oscillator to apply the repeated load. Before starting the test, the gauge measurement between the two rails was checked using a Geismar track gauge. Torque applied to all screwspikes was between 220 – 250Nm as recommended by MTR.

Prior to applying the preload and commencing the oscillations, the load was applied at a rate not exceeding 25 kN/sec up to 150 kN and then oscillated between 10 kN and 90 kN for 2000 cycles to ensure the rail was against the outside fasteners. The load was then released to 20 kN and all gauges reset to zero before applying the static preload and commencing the repeated load test. The repeated load test may generate heat in the pads and so cooling fans were used to ensure the maximum temperature did not exceed 50 °C.

Dial gauges were set to record gauge, head of rail rotation, rail foot slippage, baseplate outside edge lateral and vertical movements and head of rail vertical deflection.

A test load cycling between 10 kN and 90 kN at an angle of 26.5 degrees at a frequency of 3.15 Hz was applied according to the requirement for baseplate assemblies.

Following the repeated load test series, the gauge measurement was checked with all load removed. The rail fastening components were examined for any indications of wear or deformation. A dye penetrant test was also carried out on the baseplates. Photographs of the components are shown in Figures A.1 To A.2 2 , Appendix A

Figure 2.4.1. Repeated load test arrangement

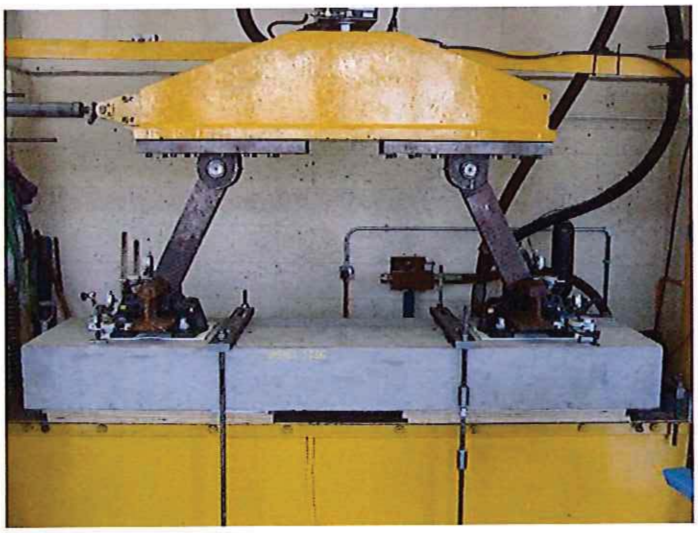


Table 2.4.2. Assembly Deflection Measurements, Assembly 1

Cycles	Rail Head Lateral (1)		Rail Head Vertical (2)		Rail Foot Lateral (3)		Rail Foot Lateral (4)		Rail Foot Lateral Average	
	Min (mm)	Max (mm)	Min (mm)	Max (mm)	Min (mm)	Max (mm)	Min (mm)	Max (mm)	Min (mm)	Max (mm)
1000	-0.24	0.20	-3.08	2.69	0.01	0.61	0.08	0.67	0.05	0.64
500000	-0.24	0.20	-4.57	0.05	0.02	0.80	-0.14	0.60	-0.06	0.70
1000000	-0.33	-0.16	-4.56	0.06	0.53	1.43	0.69	1.55	0.61	1.49
1500000	-0.29	-0.13	-4.53	0.15	0.54	1.46	0.65	1.56	0.60	1.51
2000000	-0.27	0.11	-4.57	0.19	0.57	1.49	0.49	1.43	0.53	1.46
2500000	-0.30	-0.16	-4.61	0.15	0.57	1.51	0.49	1.43	0.53	1.46
3000000	-0.30	-0.17	-4.60	0.16	0.60	1.51	0.50	1.40	0.55	1.46
Test End 20kN		-0.24		-0.93		0.61		0.53		0.57

Table 2.4.3. Assembly Deflection Measurements, Assembly 1

Cycles	Baseplate Vertical (5)		Baseplate Lateral (6)	
	Min (mm)	Max (mm)	Min (mm)	Max (mm)
1000	0.00	-0.18	0.00	0.07
500000	0.00	-0.16	0.00	0.06
1000000	0.00	-0.20	0.00	0.05
1500000	0.00	-0.20	0.00	0.05
2000000	-0.05	-0.20	0.00	0.05
2500000	-0.05	-0.20	0.00	0.05
3000000	-0.05	-0.20	0.00	0.05
Test End 20kN		-0.04		-0.02

Table 2.4.4. Assembly Deflection Measurements, Assembly 2

Cycles	Rail Head Lateral (1)		Rail Head Vertical (2)		Rail Foot Lateral (3)		Rail Foot Lateral (4)		Rail Foot Lateral Average	
	Min (mm)	Max (mm)	Min (mm)	Max (mm)	Min (mm)	Max (mm)	Min (mm)	Max (mm)	Min (mm)	Max (mm)
1000	-0.13	-0.01	-4.51	0.69	0.01	1.04	0.14	1.08	0.08	1.06
500000	-1.23	-1.07	-5.12	0.15	0.01	1.18	0.39	1.48	0.20	1.33
1000000	-1.21	-1.11	-5.05	0.04	-0.16	1.00	0.57	1.03	0.22	1.02
1500000	-1.16	-1.07	-4.85	0.06	-0.16	0.98	0.59	1.03	0.22	1.01
2000000	-1.19	-1.37	-4.70	0.09	0.24	1.55	0.74	1.38	0.49	1.47
2500000	-1.37	-1.20	-4.71	0.09	0.24	1.59	0.75	1.40	0.50	1.50
3000000	-1.38	-1.20	-4.64	0.08	0.24	1.60	0.40	1.44	0.32	1.52
Test End 20kN		-0.61		-0.93		0.61		0.53		0.57

Table 2.4.5. Assembly Deflection Measurements, Assembly 2

Cycles	Baseplate Vertical (5)		Baseplate Lateral (6)	
	Min (mm)	Max (mm)	Min (mm)	Max (mm)
1000	0.00	-0.20	0.00	0.10
500000	0.00	-0.20	0.00	0.09
1000000	0.30	0.45	0.00	0.05
1500000	0.30	0.45	0.00	0.06
2000000	0.30	0.45	0.00	0.05
2500000	-0.30	0.45	0.00	0.05
3000000	0.30	0.45	0.00	0.05
Test End 20kN		0.46		-0.02

Table 2.4.6. Track Gauge

Track Gauge	Track Gauge (mm)			
	Pre Repeated Load	Post Repeated Load	Change	Specification
	1431.5	1433.0	1.5	<3.0

Table 2.4.7. Rail Roll and Rail Foot Slippage

Parameter	Assembly 1	Assembly 2	Specification
Maximum Rail Head Rotation	0.33	1.38	**4.0 max**
Maximum Rail Foot Slippage	0.57	0.57	**1.0 max**

2.5 Corrosion testing of the baseplate protective coating – ISO 9227:2012

One PANDROL Brand baseplate, type 11280, supplied with a Powercron 6000CX coating, was corrosion tested to ISO 9227: 2012.
An assessment of the coatings corrosion resistance was made in accordance with ISO 4628-3: 2003.
The coating had a rusting index (Ri) value Ri5 after approximately 309 hours of testing, having a maximum of 60% surface corrosion staining..
Photograph of the baseplate at end of test is shown in Figure 2.5.1 below.

Figure 2.5.1. Coated baseplate after approximately 309 hours of testing

2.6 Electrical Insulation Test – M&W 5.30

The test arrangement is shown in Figures 2.6.1 and 2.6.2.

The test parameters and results are shown in Table 2.6.3

Method:

The concrete block and rail assemblies were immersed in a tank of distilled water for a period of 6 hours.

Following the soak period, the sleeper was removed from the water. Within one hour of removal from the water, a 10 volt D.C potential was then applied across the two rails for a period of 15 minutes during which the current flow was measured. The sleeper resistance was then calculated.

Figure 2.6.1. Electrical test arrangement. Sleeper in water

Figure 2.6.2. Electrical test arrangement. Resistance measurement

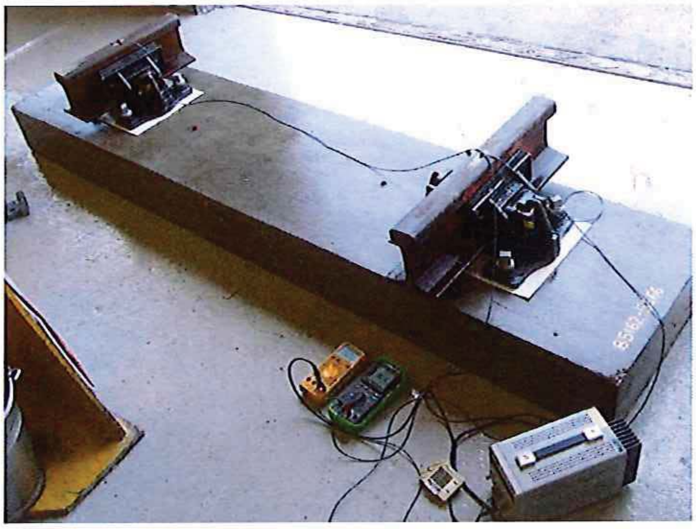


Table 2.6.3. Electrical Resistance Results

Sleeper Resistance	1,000,000 Ω
Specification	20,000 Ω min

3. DISCUSSION

All of the test arrangements and consequent results were monitored/assessed by Trevor Yeoman and Simon Marshall, representatives from Hong Kong MTRC UK.

The assembly conformed with the specification in all tests and a summary of the results is shown below :-

Average vertical static stiffness of the assembly between 0 kN and 30 kN: 4.85 kN/mm. The maximum permitted: 6 kN/mm.

Average vertical dynamic stiffness of the assembly between 0 kN and 30 kN: 6.17 kN/mm, giving a dynamic/static ratio: 1.27. The maximum permitted ratio: 1.40.

Following the Repeated Load Test all components were inspected and found to be in good condition. There was no failure of any component during the test.

Maximum lateral deflection of rail head recorded during combined vertical and lateral load test: 0.65 mm. The maximum permitted: 1.20 mm.

Longitudinal restraint per fastener: 15.07 kN. Minimum requirement: 7 kN

The track gauge increased by 1.5 mm during the repeated load test. Maximum permitted: 3 mm.

Maximum rail head rotation recorded during the repeated load test: 0.33 mm and 1.38 mm. Maximum permitted: 4 mm

Maximum rail foot slippage measured after the repeated load test: 0.57 mm and 0.57 mm. Maximum permitted: 1 mm

Electrical insulation measured: 1,000,000 Ω. Minimum requirement: 20,000 Ω.

The baseplate gave the coating a Corrosivity Category of C3 with a Medium durability rating in accordance with ISO 12944-6.

4. CONCLUSION

The PANDROL VANGUARD assembly complied with the specification supplied for Hong Kong SIL/KTE Contract 913/1020, in all respects.

End of Report