



Work Area: SMM
Work Type: I&M
Originator Company: GEOCISA UK

C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer: [Redacted]

Monitoring Close-Out Report: Automated Total Station ATS 22 and 3D Targets read by ATS 22.

CRL Document Number: C435-BFK-C2-RGN-M123-51633

Supplier Document Number: N/A

Contract MDL reference C13.012

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1.0	15-01-2015	[Redacted]	[Redacted]	[Redacted]	For acceptance
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2a. Stakeholder Review Required? YES NO

Stakeholder submission required: LU RfL Purpose of submission: For no objection
 NR LO For information
 DLR Other: _____

This document has been reviewed by the following individual for coordination, compliance, integration and acceptance and is acceptable for transmission to the above stakeholder for the above stated purpose.

Sign: _____ Role: _____ Name: _____ Date: _____

Sign: _____ Role: _____ Name: _____ Date: _____

2b. Review by Stakeholder (if required):

Stakeholder Organisation	Job Title	Name	Signature	Date	Acceptance
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

compliance with their contractual obligations and does not constitute
 ds or materials developed or selected by the designer/supplier.

3. Acceptance by Crossrail:

[Redacted] eer
09/03/2016

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A. INTRODUCTION

In line with the C122 – M&W Specification KX10 – Instrumentation & Monitoring C122-OVE-Z4-RSP-CR001-00007, this close out report aims to address the following points in relation to the instrumentation defined in Section B.

- Identify movements observed by the relevant instruments;
- Relate these movements to construction activities, where applicable.
- Identify trigger breaches that may have occurred.
- Demonstrate that the rate of change of the data is either in line with the required rate or such that residual risks are minimal.
- Identify any such residual risks should there be considered to be any.
- Based on the above points, this close out reports will provide justification for the decommissioning of the instruments.

B. INSTRUMENTS

B.1 Description of the Instruments

This Close-Out Report relates the Smithfield East Market corridor, consisting of 3D Targets read by ATS 22 and 1No. Automated Total Station (ATS 22) located at Gate 8, Smithfield Market, Grand Avenue. See table 1 below with details.

ATS 22 CODE	LOCATION	COORDINATES	
		X (m)	Y (m)
C435-AT00022	Gate 8, The Smithfield Market, Grand Avenue	82191.3353	36471.1403

PRISM CODE	LOCATION	COORDINATES	
		X (m)	Y (m)
C435-RP02209	EAST MARKET - CORRIDOR	82260.6752	36513.2993
C435-RP02210	EAST MARKET - CORRIDOR	82255.9059	36510.8785
C435-RP02211	EAST MARKET - CORRIDOR	82248.7029	36507.9447
C435-RP02212	EAST MARKET - CORRIDOR	82241.7532	36503.6889
C435-RP02213	EAST MARKET - CORRIDOR	82240.8359	36503.6787
C435-RP02214	EAST MARKET - CORRIDOR	82257.0705	36511.94
C435-RP02217	EAST MARKET - CORRIDOR	82244.9899	36497.3762
C435-RP02218	EAST MARKET - CORRIDOR	82249.7143	36499.7318

Table 1: Details 3D Targets read by ATS 22 and ATS 22.

At the moment, this area monitored by these prisms should be in a Long Term basis with readings every three months, but per C435-PMI-00549 Long Term has being ceased in this area, being the last measure carried out for these devices on 13/12/2015.

These prisms read by ATS 22 and the ATS 22 itself are shown in the following documents:

Drawings:

- C122-OVE-C2-DDA-CR001_Z-31531: Asset Protection I&M Ground Surface and In-Ground Farringdon Station C435
- C122-OVE-C2-DDA-CR001_Z-31532: Asset Protection I&M Buildings Farringdon Station C435

Installation Reports:

- C435-BFK-C2-RGN-M123-50021 Installation Report: Automated Total Station Installation at Gate 8, Smithfield Market, Grand Avenue (ATS 22)
- C435-BFK-C2-RGN-M123-50067 Installation Report of 3D Targets read by ATS 22

B.2 Location of the Instruments

As you can see from the Figure 1 below, the instruments described in Section B.1 are located at Smithfield East Market. A drawing showing the location of these devices can be found in the Appendix A.

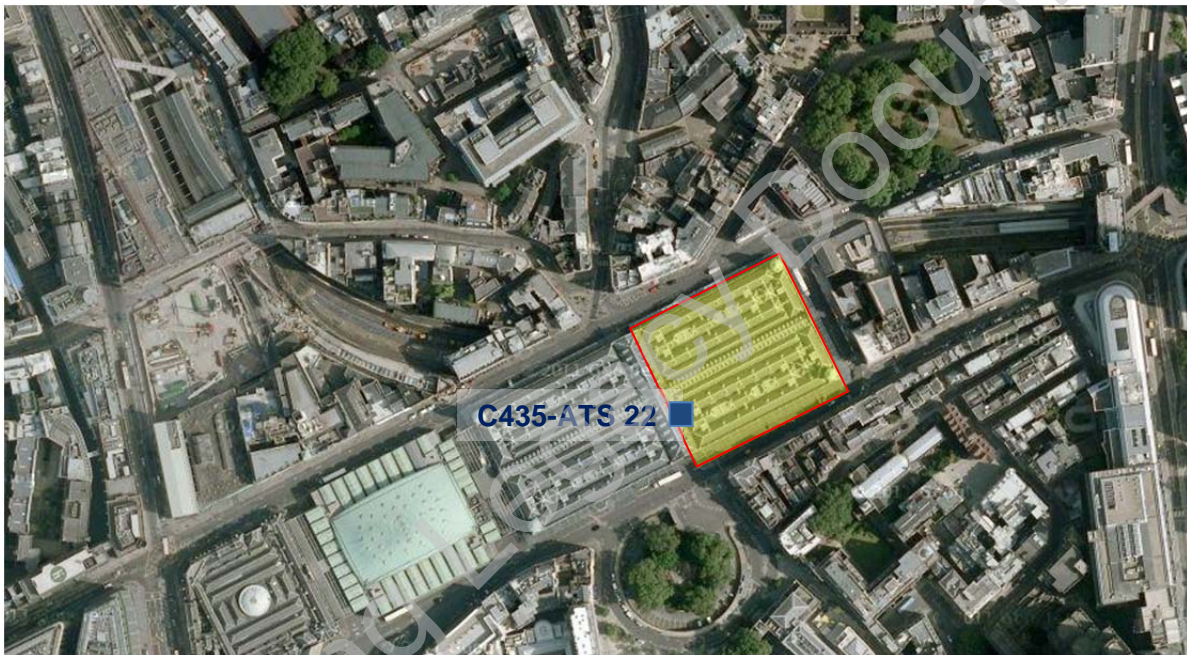


Figure 1 – Map showing the Location of ATS 22 and 3D Targets read by ATS 22.

C. MOVEMENTS

C.1 Movements Resulting from Construction Activities

C.1.1 Relevant Crossrail (BFK) Works

The construction activities associated with these instruments are related to Crossrail tunnelling works. In all cases, these comprise of the passage of a TBMs (C300) and a platform tunnel enlargement.

ACTIVITY	START DATE	END DATE
Moorgate Spur Shaft No. 1 TAM Installation	08/07/2013	20/08/2013
Moorgate Spur Shaft No. 1 Pre-Treatment works	19/08/2013	15/09/2013
Moorgate Spur Shaft No. 2 TAM Installation	01/05/2013	16/07/2013
Moorgate Spur Shaft No. 2 Pre-Treatment works	29/07/2013	02/09/2013
WB TBM passage	30/09/2013	07/10/2013
SCL-PTW enlargement	24/07/2014	06/10/2014

EB TBM passage	16/01/2014	23/01/2014
SCL-PTE enlargement	17/08/2014	18/01/2015
SCL-RTE2	18/10/2014	11/11/2014
SCL-CP6	12/11/2104	22/11/2014
SCL-CP7	23/02/2015	26/02/2015
SCL-CH2E	15/01/2015	05/03/2015
SCL-CH2 Phase2	15/05/2015	28/05/2015
SCL-ES2	04/06/2015	21/09/2015
ETH-Excavation works	26/04/2013	29/08/2014

C.1.2 Resulting Movements

- Smithfield East Market Corridor:

The monitoring data for these prisms is presented in Appendix B.

This Smithfield East Market building where the prisms are installed was affected by WB and EB TBMs, SCL PTE and PTW enlargements, RTE2, CP6, CP7, CH2E, CH2 Phase2 and ES2 tunnels. Also, this building has been affected by Compensation Grouting works carried out from Moorgate Spur Shafts No.1 and No.2 and ETH both Trapezoidal and 2 Storey Basement shafts excavation works.

During the WB TBM passage, the movement recorded by these devices was about 7mm settlement, increasing around 4mm more because of the EB TBM passage.

During the PTW stage, a settlement of 4mm was captured by these 3D Targets.

When this building was affected by RTE2 excavation works, the settlement measured by these sensors was of 4mm.

The CH2 passage caused until 5-6mm of settlement in the area.

In the last instance, this building was affected by ES2 Excavation works, recording around 6mm settlement until September 2015. From this date onwards, the area shows stable conditions, being the rate for the settlement less than 2mm per year.

No significant movement was recorded during SCL PTE, CP6, CP7 passage or ETH excavation works in this building.

About Compensation Grouting works, until 12mm heave was captured during Moorgate Spur Shaft No.1 TAM Installation and 4mm heave when the Pre-Treatment works were carried out from Moorgate Spur Shaft No.2. Additional 4mm heave was achieved before the EB TBM passage and 5mm before the SCL PTW enlargement.

C.2 Trigger Breaches

The Instrumentation and Monitoring Plan: Farringdon Station Ground Movement and Asset Protection C122-OVE-C2-RGN-M123-50013 outlines the triggers associated with the works.

In this case, part of the building is in Moorgate Spur Shafts No.1 and No.2. ZOI, so the trigger values associated to this building are:

- DEFAULT ALERT (in any direction): 10mm

No triggers have been defined for the Automated Total Stations (ATS).

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
EAST MARKET - CORRIDOR	C435-RP02209	AUTOMATIC RP	Settlement	13/12/2015 12:00	-6.1	Clear	Clear
	C435-RP02210	AUTOMATIC RP	Settlement	13/12/2015 12:00	-4.8	Clear	Clear
	C435-RP02211	AUTOMATIC RP	Settlement	13/12/2015 12:00	-2.5	Clear	Clear
	C435-RP02212	AUTOMATIC RP	Settlement	13/12/2015 12:00	-0.6	Default Alert	Clear
	C435-RP02213	AUTOMATIC RP	Settlement	13/12/2015 12:00	0	Default Alert	Clear
	C435-RP02214	AUTOMATIC RP	Settlement	13/12/2015 12:00	-5.4	Clear	Clear
	C435-RP02217	AUTOMATIC RP	Settlement	13/12/2015 12:00	3.2	Default Alert	Clear
	C435-RP02218	AUTOMATIC RP	Settlement	13/12/2015 12:00	0.4	Default Alert	Clear
	C435-RP02209	AUTOMATIC RP	Transversal	13/12/2015 12:00	0.2	Clear	Clear
	C435-RP02210	AUTOMATIC RP	Transversal	13/12/2015 12:00	-1.2	Clear	Clear
	C435-RP02211	AUTOMATIC RP	Transversal	13/12/2015 12:00	0.5	Clear	Clear
	C435-RP02212	AUTOMATIC RP	Transversal	13/12/2015 12:00	-2.3	Clear	Clear
	C435-RP02213	AUTOMATIC RP	Transversal	13/12/2015 12:00	-1.1	Clear	Clear
	C435-RP02214	AUTOMATIC RP	Transversal	13/12/2015 12:00	0	Clear	Clear
	C435-RP02217	AUTOMATIC RP	Transversal	13/12/2015 12:00	1.5	Clear	Clear
	C435-RP02218	AUTOMATIC RP	Transversal	13/12/2015 12:00	0.8	Clear	Clear
	C435-RP02209	AUTOMATIC RP	Longitudinal	13/12/2015 12:00	5.6	Clear	Clear
	C435-RP02210	AUTOMATIC RP	Longitudinal	13/12/2015 12:00	4.7	Clear	Clear
	C435-RP02211	AUTOMATIC RP	Longitudinal	13/12/2015 12:00	5.2	Clear	Clear
	C435-RP02212	AUTOMATIC RP	Longitudinal	13/12/2015 12:00	6.5	Clear	Clear
	C435-RP02213	AUTOMATIC RP	Longitudinal	13/12/2015 12:00	4.1	Clear	Clear
	C435-RP02214	AUTOMATIC RP	Longitudinal	13/12/2015 12:00	2.8	Clear	Clear
	C435-RP02217	AUTOMATIC RP	Longitudinal	13/12/2015 12:00	2.4	Clear	Clear
	C435-RP02218	AUTOMATIC RP	Longitudinal	13/12/2015 12:00	3.1	Clear	Clear

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C.3 Significant issues with the Instrumentation

3D Target C435-RP02215 was never installed, it always was the same device than C435-RP02212. For that reason it was removed from the database and not included in the Installation Report of 3D Targets read by ATS 22 C435-BFK-C2-RGN-M123-50067.

C.4 Residual Risks

The rates of residual settlement for these 3D Targets have been determined and in all cases these rates are less than 2mm/year.

D. CONCLUSIONS

Following the TBMs passages, SCL and ETH excavation works, as well as the Compensation Grouting works undertaken in this area, the maximum movement recorded by these 3D Targets read by ATS22 has been a settlement of 8mm.

On the other hand, the maximum horizontal movement in longitudinal and transversal directions has being of +6mm and +2mm for these 3D Targets, having been potentially affected by the temperature fluctuation recorded from the ATS 22 along these years, especially in transversal direction.

After the works, all devices do not show any significant movement, therefore these devices are considered stabilized.

At the moment, this area monitored by these prisms should be in a Long Term basis with readings every three months, but per C435-PMI-00549 Long Term has being ceased in this area, being the last measure carried out for these devices on 13/12/2015.



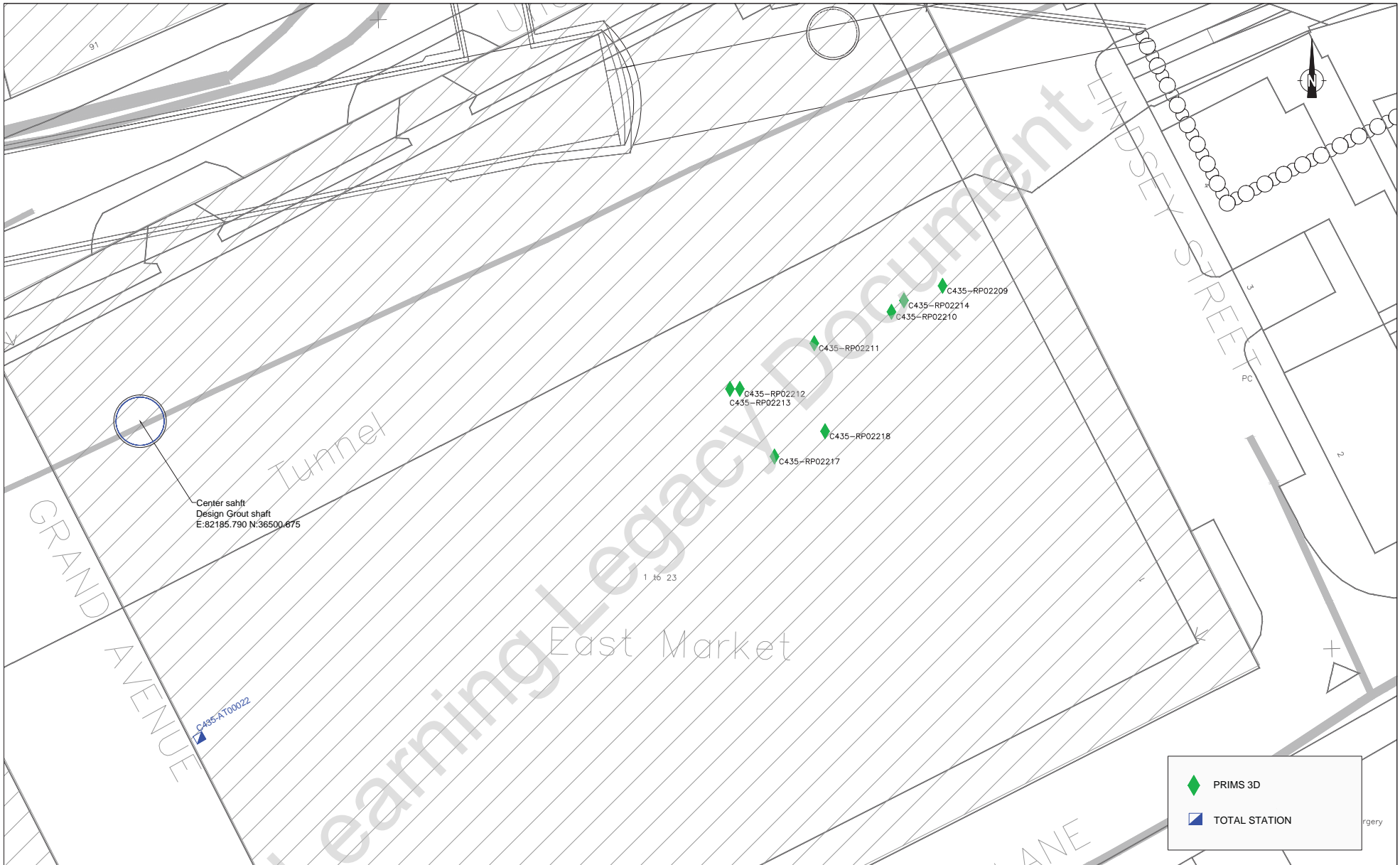
Close-Out Report – Automated Total Station ATS 22 and 3D
Targets read by ATS 22

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C435-BFK-C2-RGN-M123-51633

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Appendix A: Drawing / Photomontage



Rev.	Date	Description	By	Chkd	App	Auth
1	20-05-2013					

Notes:

Crossrail

GEOCISA UK

C/ Los Llanos de Jerez 10-12
28823- MADRID
www.geocisa.com

BFK
Barril Ferrocarril

Scale : @ A3

Contract : C435 I&M FARRINGDON

Originator : GEOCISA

Location : CROSSRAIL GENERAL

Title : 3D PRIMS ATS22

By : [Redacted]

Chk : [Redacted]

App : [Redacted]

Auth : **GEOCISA**

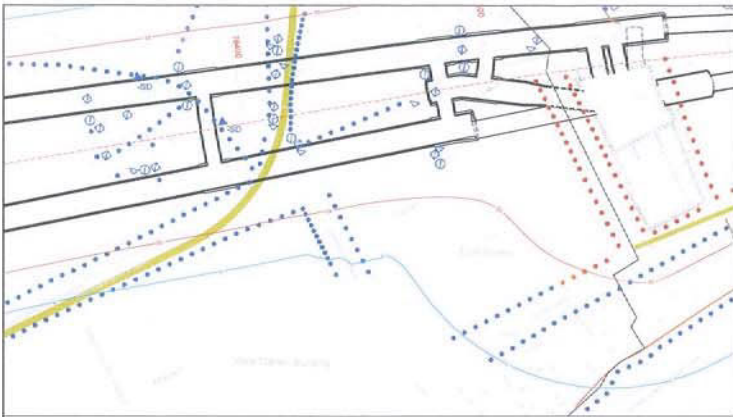
Contract : C435 I&M FARRINGDON

Location : CROSSRAIL GENERAL

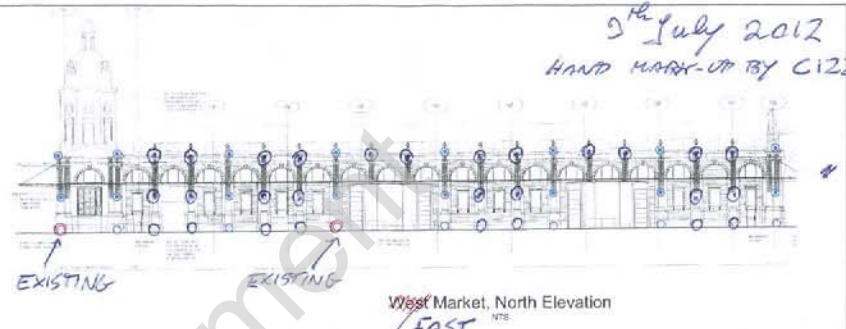
Drwg No : C435-BFK-C2-RGN-M123-50067-IR-RP-ATS22

Rev : Suit : Auth :

\$Pbby\$



- Legend**
- Parties Responsible for the installation of the I & M
- By C435
 - By Others
- Instruments and Monitors
- Automated Total Station
 - Extensometer - Rod
 - Extensometer
 - Piezometer - Vibrating Wire
 - 3D Geostic Prisms
 - Sockets - BRE Type - Structure
 - Transmitter boxes
 - Studs - Precise Ground Levelling
- Settlement Contours
- 10mm Settlement Contour
 - 100mm Settlement Contour



Plan at Street Level (Showing studs only) 1:1000

BRE Levelling Stud

Levelling stud screws into BRE socket within wall. Manually read levelling staff placed over stud.

Vibrating Wire Crackmeter

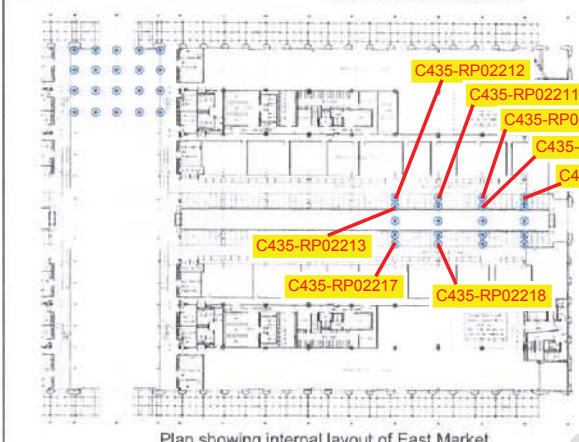
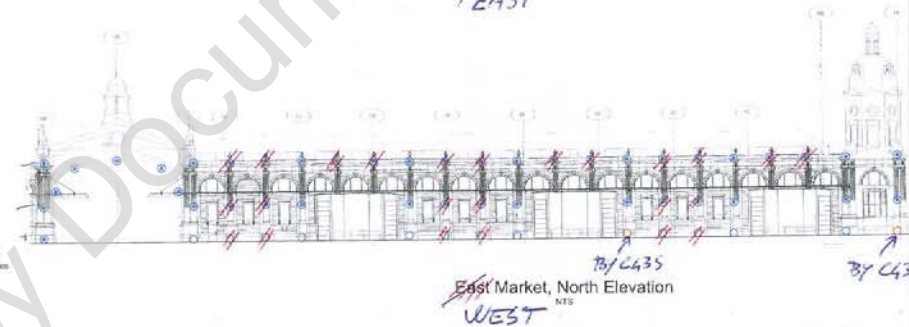
Vibrating Wire Crackmeters measure the expansion and contraction across existing cracks and joints. They are read from a transmitter box suitably positioned.

Calibrated Tell-Tale

Calibrated Tell-Tales measure displacements across cracks. A change in distance between the two fixed ends is manually read off from the crack meter using vernier or digital callipers.

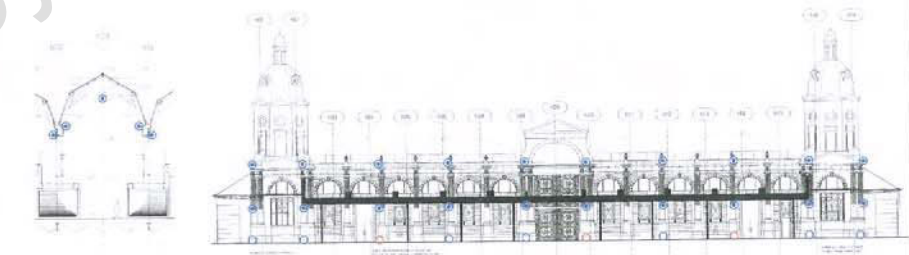
Geodetic Prism

Geodetic Prisms: Geodetic Prisms are prisms supported on brackets. They are read remotely using Automatic Total Stations fixed to structures nearby.

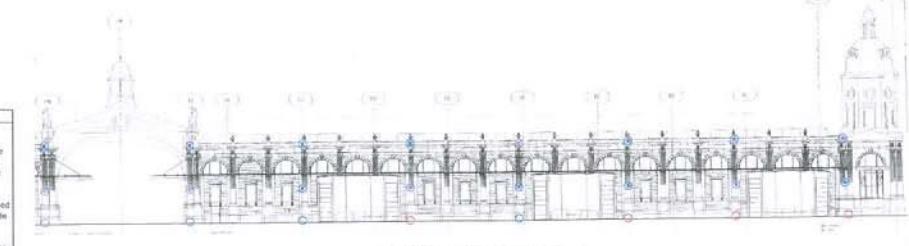


Typical Arrangement

Upper line of prisms to be clamped, no drilling or other fixing that may damage decorative finishes is allowed.



East Market - Internal elevation of Central Arch NTS



East Market East Elevation NTS

Safety, Health and Environmental Information		External monitoring, Smithfield East and West Market		Making good strategy	
<p>1. Works on this drawing should be undertaken only by an experienced and competent contractor using an approved, safe method of working.</p> <p>2. Before installing instrumentation, contractor to carry out the inspection to assess proposed positions and location-specific risks to be avoided or controlled.</p> <p>3. Hazards and risks noted below are additional to those normally associated with instrumentation and monitoring works:</p> <p>(a) Working at height - e.g. installing geostic prisms at high level on buildings.</p> <p>(b) Near railways - risk of train drivers mistaking reflective prisms for signals. Prisms to be able to avoid this risk.</p>		<p>BRE Sockets & Type Studs</p> <p>Number of Instruments: 30</p> <p>Geostic Prisms: 134</p>	<p>Fixings per instance:</p> <p>2, with transmitter box with up to 4 (TBC on site)</p>	<p>Fixing details:</p> <p>Studs are grouted into slightly recessed 10mm diameter BRE sockets, fixed into drill holes and stabilised with grout or resin. Brackets are screwed into slightly recessed self-anchoring fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise.</p> <p>Attached by screws with movable ball joints into slightly recessed self-anchoring fixings approximately 10mm in diameter, inserted into drill holes and expanded to stabilise. These are attached by a lead to a transmitter box, with screw fixings.</p> <p>Attached by screws set into the structure either side of the crack.</p>	<p>Priming studs will be removed, and recessed fixing area made good with materials to match the existing facade finish.</p> <p>Prism brackets will be removed, and recessed fixing area made good with materials to match the existing facade finish.</p> <p>Crack meters and transmitter box will be removed, and the recessed fixing areas made good with materials to match the existing facade finish.</p> <p>Instrument and screws will be removed and the finishes reinstated to match the surrounding finish in texture and colour.</p>

Internal monitoring, Smithfield Market car park, refer to drawing C122-OVE-C2-DDA-CR001_Z02542, walls under Lindsay Street, refer to drawing C122-OVE-C2-DDA-CR001_Z02546		Notes	
<p>1. The drawing provides minimum requirements for Asset Protection I&M. Any additional instrumentation required to ensure the safe and effective construction of works or for compensation grouting works shall be specified and implemented by the Contractor.</p> <p>2. Monitoring positions shown are approximate. Final locations to be determined by the Contractor depending on the 'as found' conditions at the time of installation, subject to the approval of the Project Manager.</p> <p>3. This drawings include but are not limited to the method statement for fixing internal monitoring to brick buildings (reference to be provided once approved) and with the Materials and Workmanship Specification for Instrumentation and Monitoring.</p> <p>4. Vibrating wire crackmeters, tell-tales and strain gauges to be installed at selected locations as indicated on site at the time of the installation, as indicated by the Supervisor.</p> <p>5. Prisms and BRE sockets located on the same horizontal alignment to be installed at the same level on the building facade.</p> <p>6. The facade elevations are based on South Elevation East and West Market and North and West Elevations West Market - Smithfield Central Market Refurbishment - Corporation of London - H.M Architects dated 25/03/1993.</p> <p>7. Upper rows of prisms should be clamped on the structure, no drilling or other fixing that may damage decorative features is allowed.</p>	<p>Reproduced from the Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings. T/L 100002279 2004</p>		

Contract: Eased Tunnels (Alignment and Track)

Organised by: Ove Arup & Partners Limited

Lead: Crossrail General

10 Instrumentation and Monitoring: Smithfield East and West Market buildings Plan at street level and elevations C435

Drawn: NTS@A1

Checked: C122-OVE-C2-DDA-CR001_Z-02546

Scale: 1:1000 @ A1

C122-OVE-C2-DDA-CR001_Z-02546

REPRODUCED FROM THE ARCHIVE OF THE BRITISH ARCHITECTURAL ASSOCIATION



Close-Out Report – Automated Total Station ATS 22 and 3D
Targets read by ATS 22

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C435-BFK-C2-RGN-M123-51633

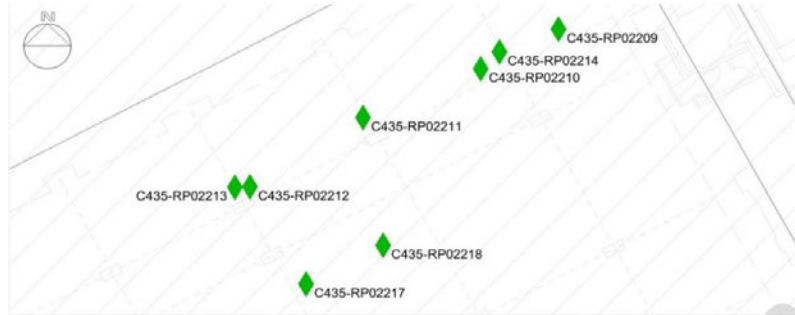
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Appendix B: Graphs

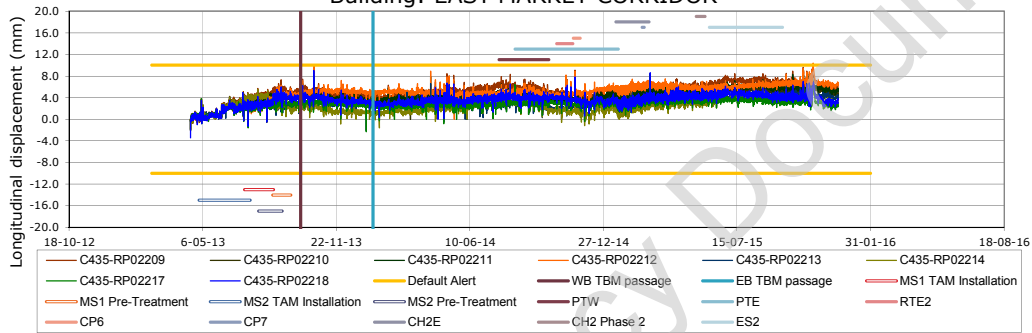


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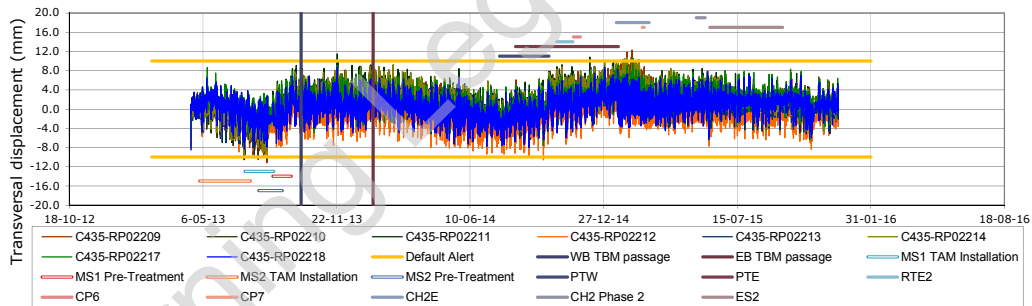
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



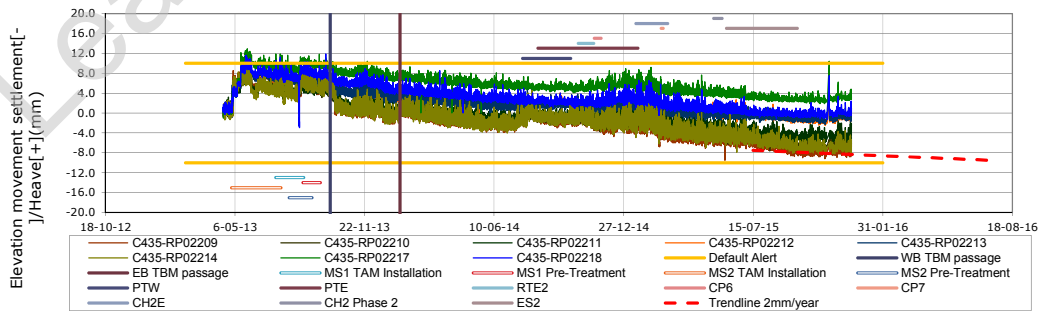
Building: EAST MARKET-CORRIDOR



Building: EAST MARKET-CORRIDOR



Building: EAST MARKET-CORRIDOR



REMARKS: