



**William Ellis School, Highgate, London**

**Report on the Investigation of a  
Balcony Slab**

**Final Report - 4512**

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**London Borough of Camden**

**PROJECT:** William Ellis School, Highgate, London

**TITLE:** Report on the Investigation of a Balcony Slab

**CLIENT:** London Borough of Camden

**Report No:** 4512

**Compiled By:** S Hassan BEng (Hons)

**Reviewed By:** J Dear BEng (Hons)

**Issued on:** 8<sup>th</sup> November 2018

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#### **Appendices**

Appendix 1	Drawing (including photographs)
Appendix 2	Steel Sample Laboratory Test Certificate

## Report on the Investigation of a Balcony Slab

### 1.0 INTRODUCTION

#### 1.1. Terms of Reference

Purpose:	To determine certain construction details and material properties, as specified by the Client's Engineers (Price & Myers LLP)
Location:	William Ellis School, Highgate Road, Highgate, London, NW5 1RL
Consultants:	GB Geotechnics Ltd (GBG)
Instructed by:	Price & Myers LLP (Client's Engineers)
On behalf of:	London Borough of Camden
Date of Instruction:	8 <sup>th</sup> October 2018

#### 1.2. General

This report is the final report of this investigation. It therefore supersedes any previous reports whether written or oral, and completes all work currently ordered under this contract.

#### 1.3. Background

It is understood that William Ellis School is being refurbished and a suite of investigative works was prescribed by Price & Myers in order to determine certain construction details and material properties. The scope of works was outlined on the sketches provided within scope document *25648\_SK10\_1\_Additional Balcony Testing*.

The structure of interest is a reinforced concrete rib and hollow clay pot 1<sup>st</sup> floor balcony slab. In summary; a single concrete core sample and a single steel reinforcing bar sample were to be extracted from a rib for laboratory testing. The Client was to arrange for the rib to be reinforced/strengthened, such that a 250m long section of the rib can be sampled. There was also a requirement to position the reinforced concrete ribs within the specified survey area.

#### **1.4. Purpose of Investigation**

The purpose of the investigation was to determine certain construction details and material properties, as specified by the Client's Engineers (Price & Myers LLP).

The scope of the site investigative works is summarised below:

- Extracting a single 75mm diameter x 100mm long concrete core sample for laboratory testing to determine the density and compressive strength of the concrete.
  
- Extracting a 150mm long sample of a reinforcing bar for laboratory testing to determine the tensile strength of the steel.
  
- Surveying the soffit of the 1<sup>st</sup> floor slab area shown, using impulse radar, in order to record the position of the reinforced concrete ribs.

We had not allowed for reinstatement of the rib at the sample locations.

## 2.0 THE SURVEY

### 2.1. General

Survey Dates: 26<sup>th</sup> October 2018 – A single daytime survey session  
(1 x c.8 hours duration)

Personnel: 2-person survey team

### 2.2. Methodology

The main investigative techniques used were impulse radar surveys, intrusive inspections/breakouts, concrete core sampling and steel sampling, enabling both on site interpretation as well as laboratory testing of the samples and a more detailed analysis of the survey data off site.

#### *Impulse Radar Surveys*

Primarily used to locate embedded reinforcement within the balcony floor slab; readings were taken from a series of profiles taken at varying centres suitable for the survey, using a transducer with a centre frequency of 1.5GHz.

#### *Calibration (Radar)*

In accordance to our own quality standard, calibration of wave velocities in the surveyed materials on site are undertaken. In some instances where this calibration is not carried out, less reliable comparative methods with other surveyed materials elsewhere would be used as an alternative. These are probably accurate to about +/-5-8%, excluding the effects of varying moisture and variations in compaction.

#### *Intrusive Inspections/Breakouts*

The reinforcement within the bottom of a rib was locally exposed by use of a 110V electrical breaker, in order to expose the steel reinforcement for sampling.

### *Concrete Core Sampling*

A single concrete sample was extracted from the reinforced concrete rib as a 70mm diameter core from the location specified by Price & Myers. The sample was extracted using a diamond tip bit attached to an 110V drilling rig, with water flush used a coolant.

### *Steel Sampling*

A single steel reinforcement bar sample (150mm in length) was extracted at a location specified by Price & Myers using a 110V powered angle grinder.

## **2.3. Access, Areas Surveyed and Site Relocation**

Access to the building was arranged through Price & Myers.

All results are referenced to the layouts provided to GBG by Price & Myers and reproduced on the attached survey drawing.

## **3.0 FINDINGS**

### **3.1. Presentation of Results**

The main findings of the investigation and laboratory test results are discussed below under the headings **3.2 Structure** and **3.3 Material Sampling and Testing**.

The locations of the samples and the reinforced concrete rib positions are presented on Drawing 4512-1 in Appendix 1. A selection of photographs of interest are presented on the same drawing to help illustrate the findings of the investigation. Photographs of the samples can be found within this report. The steel sample laboratory test certificate is attached within Appendix 2.

### **3.2. Structure**

The surveyed 1<sup>st</sup> floor balcony slab was found to be of reinforced concrete rib and hollow clay pot construction, with concrete ribs spanning NE-SW between assumed load bearing masonry walls and/or lintels. It was not possible to fully survey the soffit of the balcony slab using impulse radar due to the presence of a fixed suspended ceiling, however, the slab was surveyed from the balcony deck. The reinforced concrete ribs were found to be spaced at 310 to 365mm centres within the area surveyed.

A localised breakout was carried out to the soffit of the specified rib in order to expose the steel reinforcement for sampling. The rib was found to contain 2No. 10mm diameter plain round bottom steel bars at mid-span. The concrete cover to the bars was 15mm. The rib width was measured to be approximately 90mm. Both bars were observed to be in visually good condition, displaying only light surface corrosion.

From the radar data collected from the slab deck, it was found that one of the two bars in each rib cranks up towards the supports (walls/lintels).

### 3.3. Material Sampling and Testing

#### Concrete

A single 70mm diameter concrete core sample (C1) was extracted from the balcony slab, in order to provide a specimen for laboratory inspection and testing. The core sample was extracted from the deck, through the full thickness of the slab/rib.

Upon extraction, the concrete core sample split into two, and each sub-sample was subsequently referenced as C1A (45mm in length) and C1B (60mm in length).



**Concrete Core Sample (C1) extracted from 1<sup>st</sup> Floor Deck.**

The concretes comprised of approximately 45-55% mixed-flint gravel as the coarse aggregate, which was sub-angular to sub-rounded and equant to elongate in shape. The coarse aggregate was generally well graded and evenly distributed, with a maximum nominal aggregate size of 10mm.



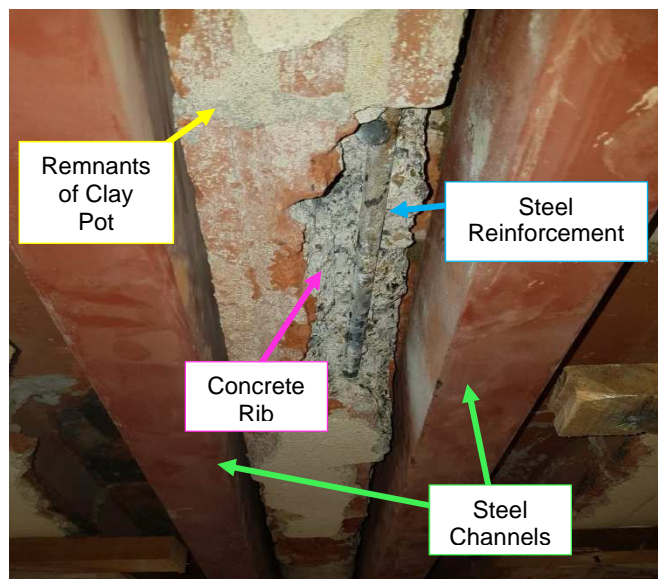
The cement pastes were generally sandy to light buff in colour and apparently of good quality and compaction, with excess voidage judged at 0.5%.

The concrete compressive strength of both core sub-samples was determined and the density of concrete sub-sample C1A was also calculated by the water displacement method. The results are presented in tabular format below.

Sample Ref.	Location	Concrete Density (kg/m <sup>3</sup> )	Core Compressive strength (MPa)
C1A	1 <sup>st</sup> Floor Slab/Rib	1810	31.6
C1B	1 <sup>st</sup> Floor Slab/Rib		29.4

### Steel

A single 10mm diameter plain round steel reinforcement bar sample (SS1) was extracted from the same reinforced concrete rib for laboratory testing to determine the yield stress and tensile strength of the steel.



Breakout to the underside of the rib showing steel reinforcement bar sample (SS1) prior to extraction.



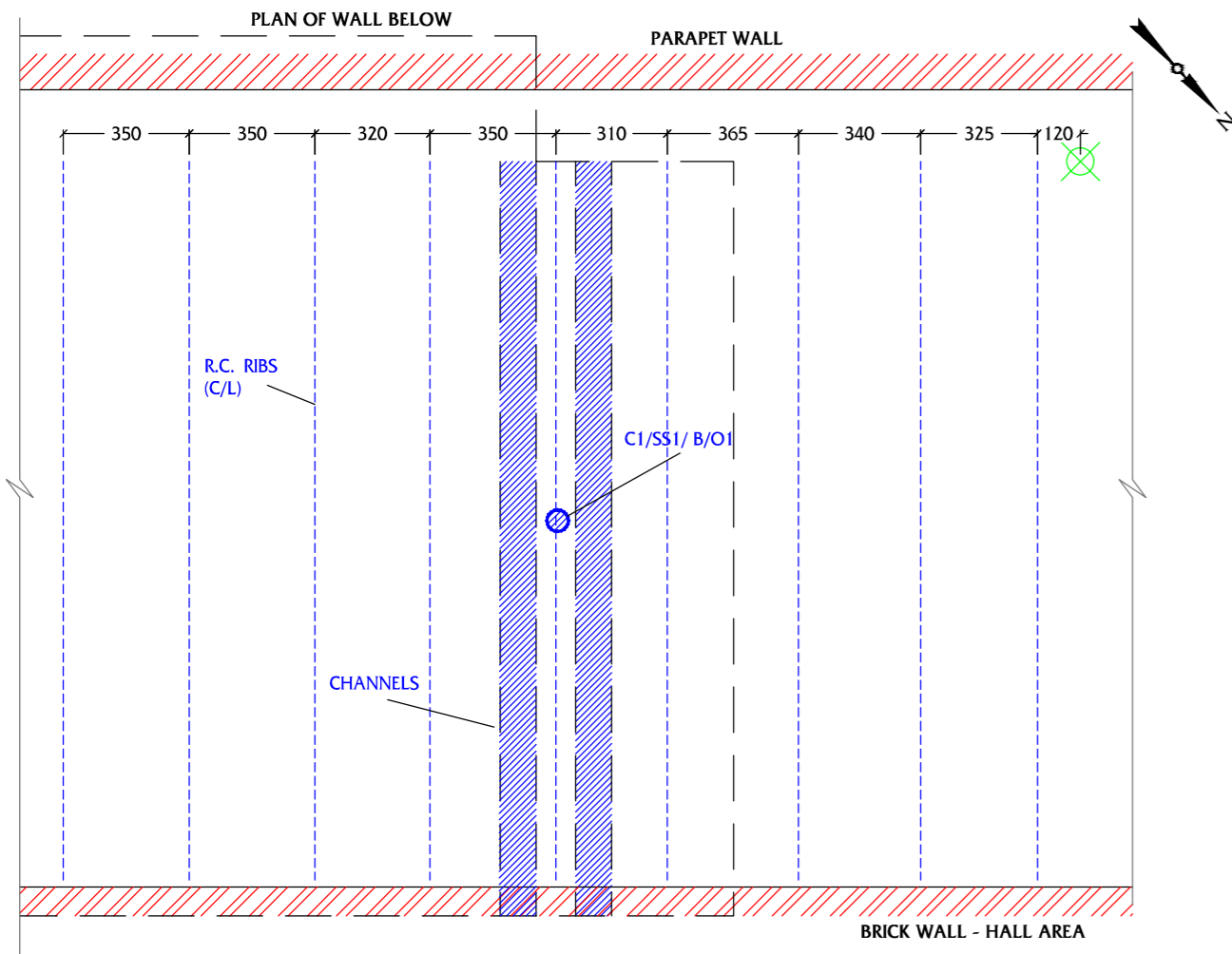
**Steel Reinforcement Sample (SS1) after extraction**

The results of these tests are summarised in the table below and presented in full within the attached laboratory test certificate in Appendix 2.

Site Ref.	Location	Yield (0.2%rp) Tensile Stress (MPa)	Maximum Stress (MPa)
SS1	1 <sup>st</sup> Floor Slab/Rib	310	487

**APPENDIX 1  
DRAWING (INCLUDING PHOTOGRAPHS)**

FIG.1 PART 1ST FLOOR BALCONY DECK PLAN SHOWING LOCATIONS OF REINFORCED CONCRETE RIBS & SAMPLES SCALE 1:20



Pl1: 1ST FLOOR BALCONY DECK ABOVE STEEL/CORE LOCATION



Pl2: STEEL SAMPLE LOCATION TO SOFFIT OF RIBS AFTER EXTRACTION

FIG.2 PART REFLECTED 1ST FLOOR SOFFIT PLAN SHOWING SAMPLE AND BREAKOUT LOCATION SCALE 1:20

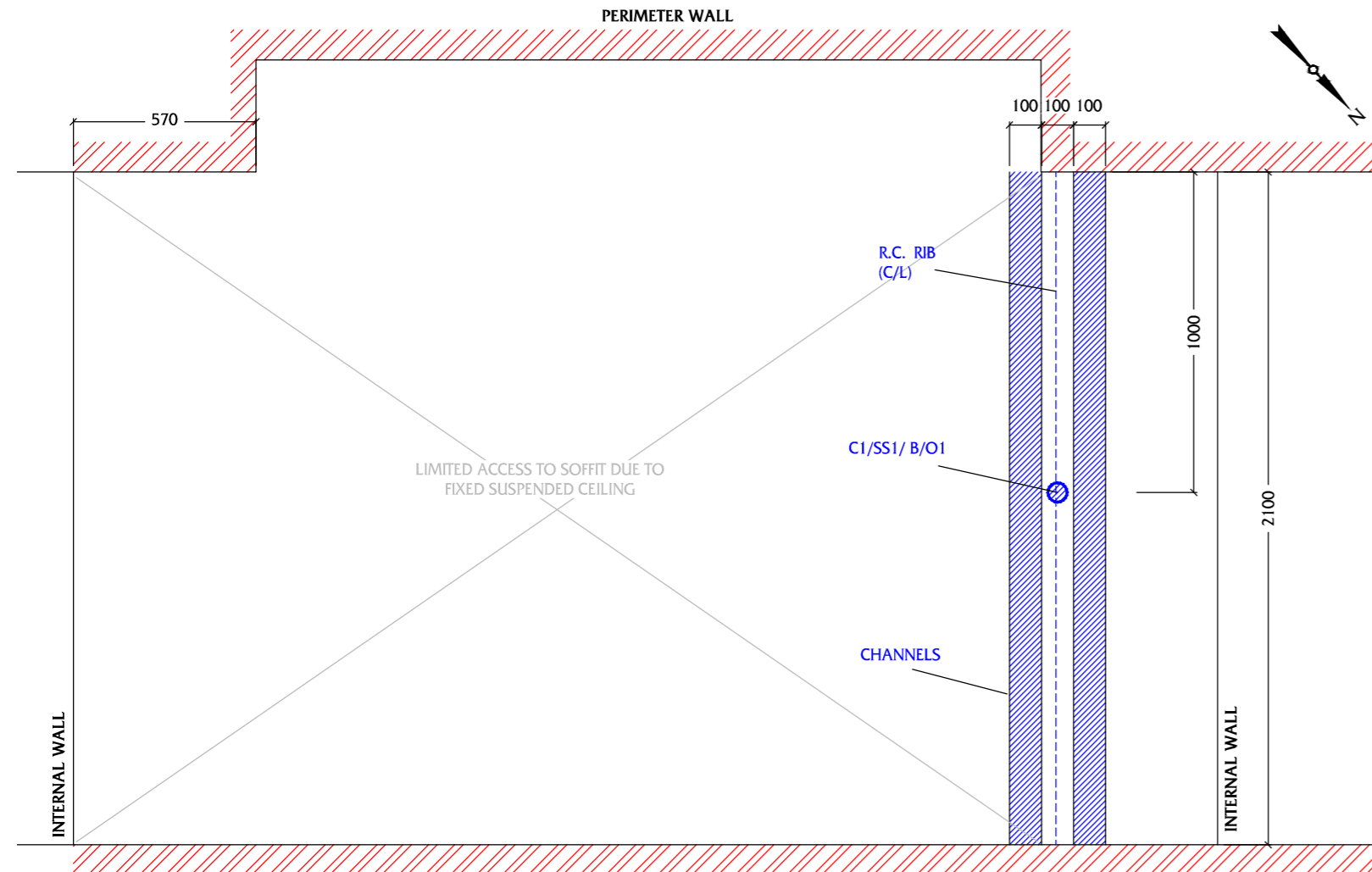
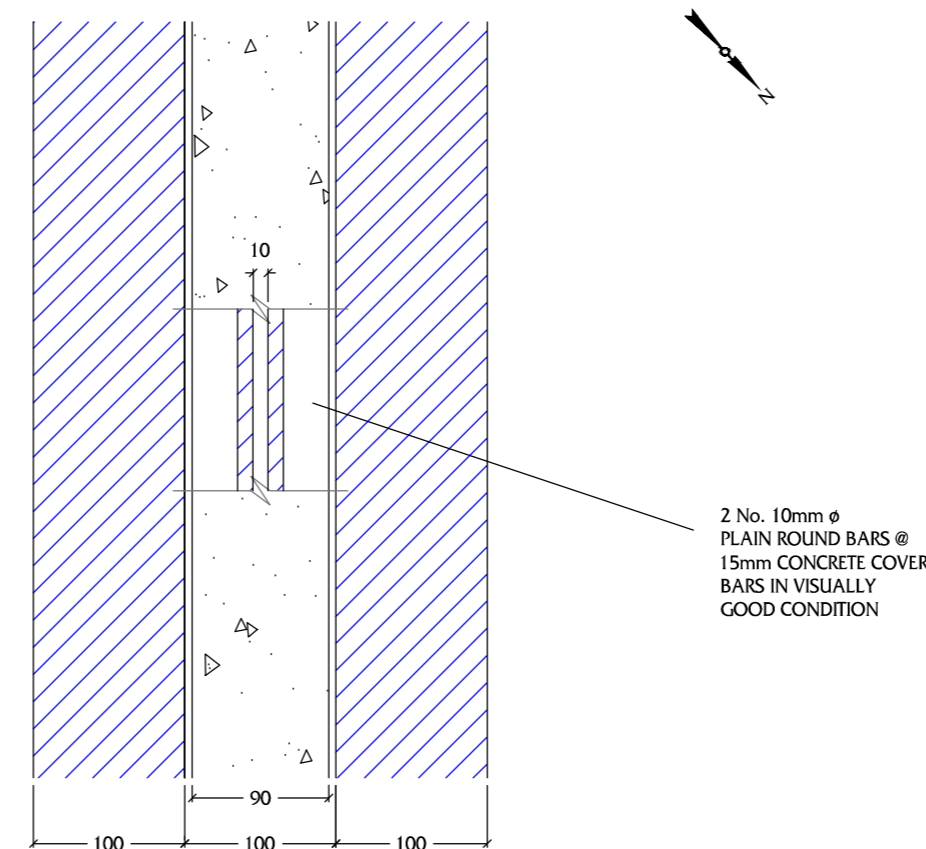
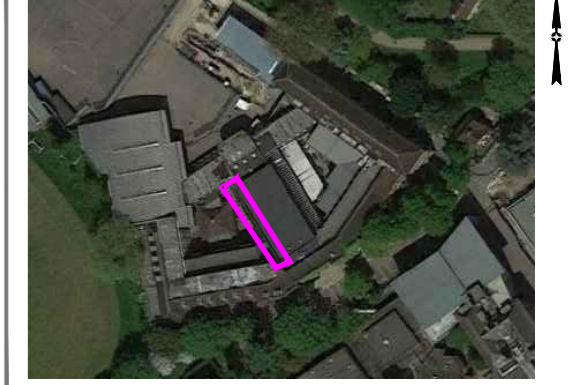


FIG.3 PART REFLECTED 1ST FLOOR SOFFIT PLAN SHOWING DETAILS OF BREAKOUT B/O1 TO SOFFIT OF RIB SCALE 1:5



LOCATION PLAN



SYMBOLS USED

- PLAN EXTENT OF BUILDING SURVEYED
  - BREAKOUT, STEEL SAMPLE & CORE LOCATION
  - C/L OF REINFORCED CONCRETE RIBS
  - GROUND FLOOR WALLS BELOW
  - ZERO DATUM
- MATERIAL TYPES**
- STEEL CHANNEL/ REINFORCEMENT
  - CONCRETE
  - BRICKWORK

PROJECT DETAILS

GBG REPORT No. 4512 ACCOMPANIES THIS DRAWING. A TOTAL OF 01 DRAWING IS INCLUDED WITH THIS REPORT, Dwg. No 4512-1.

STRUCTURE INVESTIGATED	REINFORCED CONCRETE RIB AND HOLLOW CLAY POT 1ST FLOOR BALCONY SLAB
LOCATION	WILLIAM ELLIS SCHOOL, HIGHGATE, LONDON, NWS 1RL
PURPOSE OF INVESTIGATION	TO DETERMINE CERTAIN CONSTRUCTION DETAILS AND MATERIAL PROPERTIES, AS SPECIFIED BY THE CLIENT'S ENGINEERS (PRICE & MYERS)

THIS DRAWING HAS BEEN PREPARED USING EXISTING DRAWINGS AND/OR PRINTS OF DRAWINGS AS SUPPLIED BY THE CLIENT AND SUPPLEMENTED BY MEASUREMENTS TAKEN ON SITE. ALL DIMENSIONS THEREFORE ARE TO BE CHECKED ON SITE PRIOR TO PREPARING DRAWINGS OR COMMENCING ANY WORK.

0 METRES 5

AT A SCALE OF 1:100 - ORIGINAL DWG SIZE A2 (420mm x 594mm)

REF.	REVISION	DATE

ALL ORIGINAL DRAWINGS ARE PRODUCED IN COLOUR

Project: WILLIAM ELLIS SCHOOL, HIGHGATE, LONDON

Client: LONDON BOROUGH OF CAMDEN

Title: LOCATIONS OF REINFORCED CONCRETE RIBS AND SAMPLES TO 1ST FLOOR BALCONY SLAB

Drawn: VC Date: NOV 18 Scale: AS SHOWN Dwg. No. 4512-1  
CAD: PM APP



**APPENDIX 2  
STEEL SAMPLE LABORATORY TEST CERTIFICATE**

Telephone: +44 (0) 1727 840580  
Fax: +44 (0) 1727 816700

GBG Structural Services  
Bucknalls Lane  
Garston  
Watford  
Herts  
WD25 9XX

Your Ref CX091  
Our Ref : 18/449  
Date : 01.11.18

Attention : Mr Shakir Hassan

**STEEL REINFORCING BAR SAMPLE FOR TENSILE TESTING**

Certificate Number	<b>47074/1</b>	Date of Test	01.11.18
Date of Receipt	31.10.18		
Description	10 mm Diameter Plain Round Bar		
Identified	Job Number 4512		
Test Type	Tensile (full section test specimen)		
Sample Identity	<b>SS1</b>		
Area (by weight) mm <sup>2</sup>	73.49		
Yield (0.2% <sub>r<sub>p</sub></sub> ) Stress MPa	310		
Maximum Stress MPa	487		
Gauge Length mm	50		
Elongation %	38.4		
Modulus of Elasticity GPa	231		
Mass kg/m	0.577		

Tensile test in accordance with BS EN ISO 6892-1:2016 A224




G P Grant  
Senior Mechanical Test Engineer

**End of Report**

Page 1 of 1  
(Doc29040)



Test Number.....	47074/1
File Number.....	18/449
Project No.....	TBA
Specification Id.....	Rebar
Description.....	Rebar
Test Type.....	Tensile
Test Standard.....	BS 4449
Client.....	GB Geotech
Cast No.....	Job No. 4512
Batch Reference #5.....	Sample No. SS1
Date.....	01/11/2018
Time.....	12:27:41
Machine Operator.....	GPC/MK 
Cross-Sectional Area.....	73.49 mm <sup>2</sup>
Rebar Length.....	216.5 mm
Rebar Weight.....	124.9 g
Rebar Density.....	0.00785 kg/mm <sup>2</sup> /m
Rebar Mass/Length.....	0.5769 kg/m
Rebar % Deviation.....	-6.347
Specimen Geometry.....	Rebar
Specimen Gauge Length.....	50 mm
Parallel Length.....	100 mm
Extensometer Gauge Length.....	25 mm
Maximum Load.....	35.78 kN
Ultimate Tensile Strength.....	486.861 N/mm <sup>2</sup> (35.78 kN)
Fracture Strength.....	121.919 N/mm <sup>2</sup> (8.96 kN)
Young's Modulus.....	230.7 kN/mm <sup>2</sup>
Rt(0.43%).....	306.975 N/mm <sup>2</sup> (22.56 kN)
Rp2(0.2%).....	310.241 N/mm <sup>2</sup> (22.8 kN)
Reh.....	343.442 N/mm <sup>2</sup> (25.24 kN)
Rel.....	309.697 N/mm <sup>2</sup> (22.76 kN)
Temperature.....	Ambient
% Elongation.....	38.44
Load Device.....	Load1
Load Serial No.....	.
Extr Device.....	Extr1
Extr Serial No.....	607

