AtkinsRéalis

Stage 2 Structural Assessment Report

Mayo County Council

January 2025

N58 STRADE RIVER BRIDGE REHABILITATION WORKS

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Comhairle Contae Mhaigh Eo
Mayo County Council

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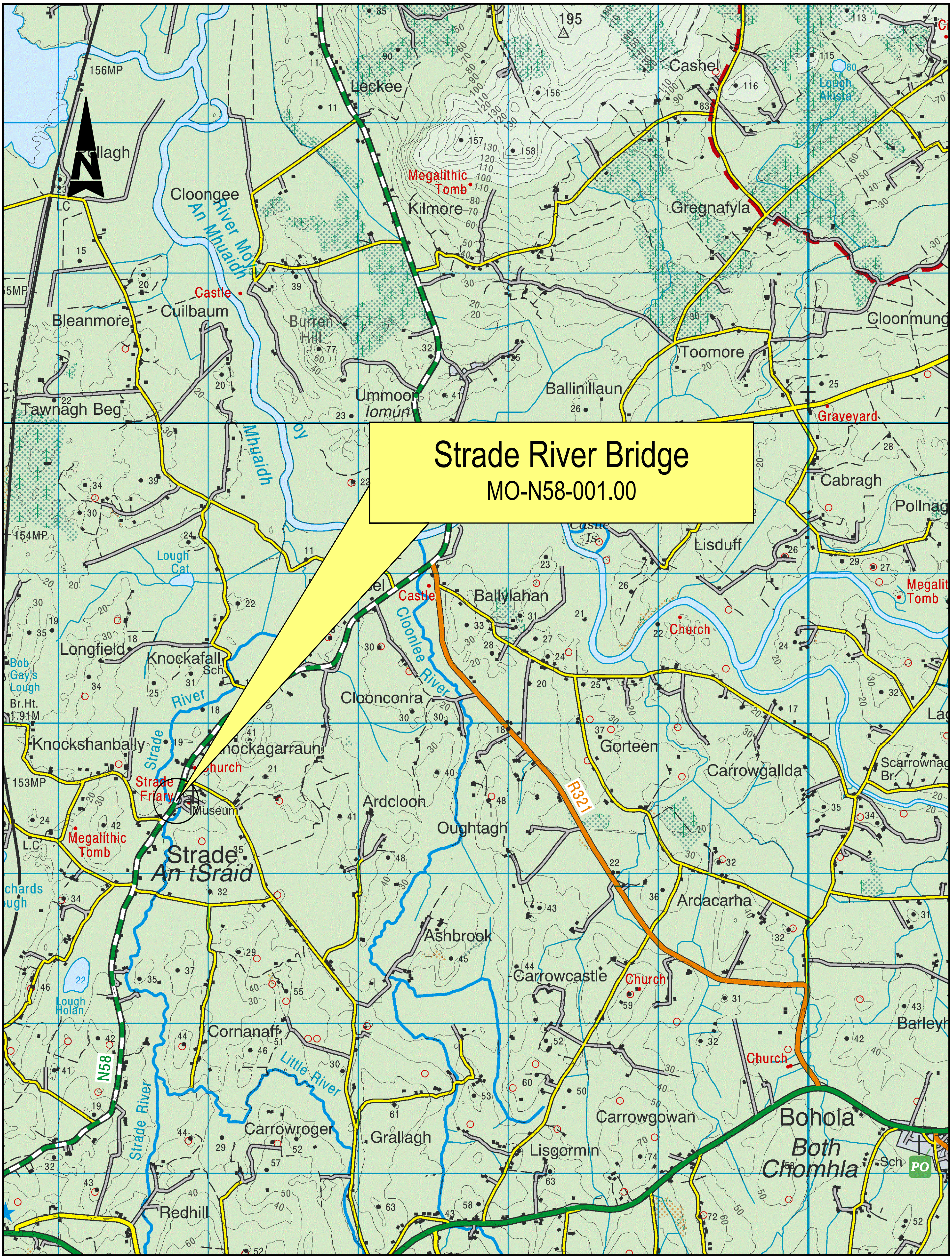


Task Order No.315- Mayo Bridge Assessments

AtkinsRéalis

Contents

1. Introduction

AtkinsRéalis were appointed by Mayo County Council for Eirspan Task Order 315 – Mayo Bridge Assessments and Strengthening 2023, comprising the assessment and rehabilitation of 10no. bridges on the national road network throughout County Mayo. 7no. structures required structural assessment to determine the condition of the structures and their load-carrying capacity for HA, HB and SV loading. The assessment of the structures was undertaken in accordance with TII Publications *AM-STR-06056 Stage 1 Structural Assessment of Road Structures* and *AM-STR-06057 Stage 2 Structural Assessment of Sub-Standard Road Structures.*

The assessment of MO-N58-001.00 Strade River Bridge comprised the Stage 2 assessment of the 2no. span filler beam slab structure.

1.1 Background information covering the origins for the need for the structural assessment

The need for the Stage 2 structural assessment was outlined in the recommendations of the 2012 Stage 1 assessment report, refer to Appendix A of this report for the Stage 1 Assessment Report. The Stage 1 Assessment determined a bending capacity of 18t and a shear capacity of 40t for the structure but less than 3t capacity for bond with the low concrete strength and area of steel found to be the cause of low structural capacity.

1.2 Previous reports and their recommendations

The following table outlines the previous reports, with the 2012 Stage 1 assessment report recommending that a Stage 2 assessment be undertaken to the structure. The 2024 Principal Inspection report found the structure to be in poor condition due to the spalling and delamination to the deck slab soffit.

Table 1-1 Previous Reports

Document Reference	Document Title
-	Strade River Bridge Stage 1 Assessment Report (May 2012)
-	MO-N58-001.00 Strade River Bridge PI Report (May 2024)

2. Executive Summary

MO-N58-001.00 Strade River Bridge carries the N58 National Secondary Road over the Strade River in Co. Mayo. The structure comprises a two span filler beam deck structure with the filler beam deck slab comprising railway girders encased in concrete and supported on a mass concrete pier and abutments. The structure has skew span lengths of 3.82m and 3.79m for the south and north spans respectively with an overall structure length of 8.6m. The structure has a skew of 26 degrees. The overall width out-to-out of the structure is 10.3m.

The assessment of the structure comprised the Stage 2 assessment of the 2no. span filler beam slab structure. The need for the Stage 2 structural assessment was outlined in the recommendations of the Stage 1 assessment report completed by Atkins in May 2012. The Stage 1 Assessment determined a bending capacity of 18t and a shear capacity of 40t for the structure but less than 3t capacity for bond with the low concrete strength and area of steel found to be the cause of low structural capacity.

A visual inspection for the Stage 2 assessment was undertaken by Atkins in July 2024 with the structure in poor overall condition due to the extensive spalling and delamination noted to the deck soffit. Structural investigations were also undertaken to the structure by Triur Construction Ltd. in July 2024 to confirm the parameters for the Stage 2 assessment.

The initial assessment of the filler beam deck slab was carried out using the strip analysis method as per *AM-STR-06026* and *AM-STR-06037* followed by a grillage analysis as per *AM-STR-06057*. The assessment live loading comprised 40t HA loading in accordance with TII Publication *AM-STR-06026*. Abnormal loading considered as part of the assessment comprised SV196 loading in accordance with TII Publication *AM-STR-06048 The Assessment of Road Bridges and Structures for the Effects of Abnormal and Exceptional Abnormal Load Vehicles using SV and SOV Load Models* and 45 Units HB loading in accordance with *AM-STR-06030 Loads for Highway Bridges*.

The initial strip analysis showed a bending capacity of 3t HA loading alone, with no capacity for HB and SV loading. The filler beam was found unsuitable for composite action as it failed under the bond stress check, resulting in a bond capacity of less than 3t GVW.

The grillage analysis determined a reduction in the assessment load effects due to the transverse distributions of loads, which resulted in a bending capacity of 40t GVW for the structure when considering composite action. The bond capacity of the section limits the slab capacity to 7.5t however.

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Assessed Capacity (ALL)	HB Capacity	SV Capacity
MO-N58-001.00	Strade Bridge	Filler Beam	2	3.79m(north) 3.82m(south)	7.5t	Fails HB30 units	Fails SV80

Based on the findings of the assessment the structure is determined to have a reduced load capacity due to bond failure between the concrete and steel beams with the significant delamination and spalling visible to the deck slab soffit providing evidence of the issue. As a result no further assessment measures are deemed required for the structure as they are not likely to increase the bond capacity to 40t loading due to the low compressive strength values found for the concrete in the soffit of the structure.

The deck slab is therefore recommended to be removed and a new deck installed across the structure, in either a single or two span structural arrangement.

Although there are extensive defects to the deck soffit as there is no evidence of failure or excess deformation of the slab a load restriction is not recommended at this time. Monitoring of the structure should be taken annually however to check for any further evidence of deformation or failure of the deck. Regular term maintenance should also be undertaken to the structure to maintain its condition in the interim.

3. Structure Description

3.1 General description of structure

MO-N58-001.00 Strade River Bridge carries the N58 National Secondary Road over the Strade River in Co. Mayo. The structure comprises a two span filler beam deck structure with the filler beam deck slab comprising railway girders encased in concrete and supported on mass concrete piers and abutments.

The structure has square spans of 3.44m and 3.42m and skew spans of 3.82m and 3.79m for the south and north spans respectively. The overall square length of the structure is 7.59m with a skew length of 8.6m. The structure has a skew of 26 degrees.

The overall kerb-to-kerb width on the bridge is 6.90m with the carriageway measuring 5.70m wide. Concrete verges are provided across the structure measuring 1.1m and 1.7m wide respectively with concrete parapets also provided measuring 900mm and 750mm high respectively. The overall width out-to-out of the structure is 10.3m square to the carriageway with a skewed width of 11.4m.

3.2 Span arrangements

The structure comprises 2no. spans measuring as follows:
South Span = 3.82m (square 3.42m)
North Span = 3.79m (square 3.44m)

3.3 Foundation Type

Unknown.

3.4 Substructure

The substructure comprises mass concrete abutments, pier and wing walls.

3.5 Superstructure

The superstructure comprises a filler beam deck slab formed by railway girders. The average thickness of the filler beam deck slab is 310mm.

3.6 Articulation arrangements, joints and bearings

The spans are separated by a transverse joint across the central pier with the support conditions considered as simply supported for the purpose of assessment.

3.7 Parapet

The parapets are of mass concrete construction with heights of 750mm and 900mm. The parapets have a thickness of 290mm.

3.8 Materials

The superstructure is comprised of steel railway girders and secondary reinforcement encased in concrete and the substructure comprises mass concrete.

3.9 Changes to Material Properties

The Stage 1 investigation report found the estimated worst credible concrete strength of the deck slab to be 13.3 N/mm^2. Further concrete strength testing undertaken as part of the Stage 2 assessment determined an increased concrete strength of 18.9 N/mm^2, accredited to a lower void % found in the core samples.

4. Stage 1 Structural Assessment Summary

4.1 Date of assessment

31st May 2012.

4.2 Assessing organisation

Atkins.

4.3 Review of testing undertaken as part of Stage 1 Assessment

The testing undertaken as part of the Stage 1 assessment comprised the following:

- 1no. trial pit was excavated over the filler beam deck to establish the internal thickness of the slab and the depth of the fill.
- Covermeter survey at 4 different locations at the soffit of the RC beam and slab to identify the reinforcing bar spacing, arrangement and orientation.
- 2no. concrete breakouts at the base of the slab to determine articulation details
- 3no. concrete cores drilled from the deck soffit of each span for the compressive strength testing of the concrete.

4.4 Review of the results of the Stage 1 Structural Assessment

Stage 1 assessment was carried out for filler beam structure in accordance with UK Highways Agency Design Manual for Roads and Bridges (BD21/01, BD44/95 & BD44/96). The structure was assessed using the strip method for HA loading, single axle and single wheel loads in accordance with BD21/01 and the methods outlined in BD44/95. Each span was assessed separately.

The live load capacity of both spans was 7.5 tonnes Gross Vehicle Weight (GVW) for bending and 40 tonnes for shear. An additional check carried out on the bond also indicated the capacity of the structure of less than 3 tonnes assessment loading for both spans.

As the adequacy of the structures in bending for 40t live loading was 60% for span 1 and 73% for span 2 using the strip method, a grillage analysis was carried out, which increased the load capacity of the structure in bending to 18 tonnes assessment loading for Span 1 and to 40 tonnes for Span 2. The variation in capacity was due to the variation in concrete strengths found in both spans.

The structure was also assessed for 45 units of HB live loading as per BD37/01. The results indicated that the structure had a HB rating of 30HB units for bending and 45HB units for shear, while for bond the structure had less than 30HB units capacity.

4.5 Extent to which the structure failed the assessment

The filler beam deck was found to have a sufficient capacity of 40t for span 2 and have a reduced capacity of 18t in bending for span 1 due to the decreased concrete strength found. Both spans had sufficient capacity of 40t in shear but had less than 3t capacity in bond.

4.6 Detailed commentary on the significance of all of the original assumptions made during the stage 1 assessment in terms of the assessed capacity of the structure

A condition factor of 0.9 was assumed for both spans of the structure based on the condition of the structure at the time of assessment with water seepage and calcite staining evident. The shear at supports was assumed to be carried by the steel sections only with a 40t capacity in shear determined for the structure. The loadings on the slab were assumed to be dispersed in both the longitudinal and transverse direction, increasing the capacity of the slab in the grillage analysis. A varying concrete strength was assumed for both spans which resulted in different assessment capacities.

4.7 Mode of failure

The mode of failure for the filler beam slab was identified as bond failure and bending for the south span.

4.8 Details of any strengthening works undertaken as a result of the assessment

There were no known structural strengthening works undertaken as a result of the Stage 1 assessment.

4.9 Description of any changes to the load effects or assessment resistance since the original assessment

An increased worst credible concrete strength of 18.9 N/mm^2 has been determined by the Stage 2 structural investigations.

4.10 Results of any monitoring or inspections undertaken

Regular Principal Inspections have been undertaken on the structure since the Stage 1 assessment with the condition of the deck further deteriorating since the assessment. The most recent Principal Inspection found the deck to be in poor condition. See the most recent inspection report dated May 2024 in Appendix A of this report.

Crack pips were installed to the north abutment and the north span deck soffit as part of the 2023 Principal Inspection to the structure. No change has occurred to the pip measurements since installation. Refer to Section 5.1 for further details.

4.11 The assessed capacity

The Stage 1 Assessment of the structure determined a capacity of 18t assessment loading for bending, 40t assessment loading for shear and less than 3 tonnes assessment loading for bond.

5. Stage 2 Structural Assessment Inspection Summary

5.1 Detailed description of the findings of the visual inspection

The Inspection of the structure was undertaken in June 2024. Photographs from the inspection are provided in Appendix H of this report. The condition of the structure is outlined below.

Bridge Surface

The bridge surface is in good condition apart cracking evident to the carriageway on the northwest approach. See Photograph H-1 to view the surface looking south and see Photograph H-2 to view the cracking to the northwest approach.

Expansion Joints

Not applicable.

Footways

The footways are in good condition apart from vegetation debris. See Photograph H-3 for the east footway and see Photograph H-4 for the west footway.

Parapets

The parapets are in good overall condition. See Photograph H-5 and H-6 for views of the east and west parapets, respectively.

Embankments

The embankments are in good condition apart from vegetation growth at both elevations to be cut back during routine maintenance. See Photograph H-7 to view the northwest embankment and Photograph H-8 for the southeast embankment.

Wing/Spandrel walls

The wing walls are in good condition apart from vegetation growth. See Photograph H-9 for a view of the southwest wing wall.

Abutments

The abutments are in good condition apart from algae and calcite staining evident. A 0.6mm crack is evident to the west side of the north abutment with previously installed (2023) crack pips measuring 25.91mm. The cause of the crack is unconfirmed with no signs of differential settlement to the structure and may be a shrinkage crack from the construction stage linked to the mass concrete nature of the abutments. The crack was reported in the 2012 PI with no significant deterioration since.

See Photograph H-10 for the south abutment and see Photograph H-11 for the north abutment.

Pier

The pier is in good condition apart from algae and calcite staining evident. Minor honeycombing evident to the east side upstream of the pier. Cracking sealed with calcite is evident to the north face of the pier. See Photograph H-12 and H-13 for a view of the northeast and south faces. See Photograph H-14 to view the cracking to the north face of the pier sealed with calcite.

Bearings

Not applicable.

Deck

The deck is in poor condition with multiple areas of spalling noted with exposed filler beams evident. Extensive delamination is noted throughout both spans which is concentrated below each beam location, with water seepage and calcite staining evident. Refer to the defect plan in Appendix C.

Previously installed crack pips (2023 PI) are located on a 0.5mm wide longitudinal crack in the north span, approximately 5m from the west elevation and measured 25.56mm at the time of inspection. The widespread cracking is attributed to the low bond capacity between the concrete and steel girders found by the assessment, resulting in the cracking and delamination of the concrete at each girder bottom flange.

See Photograph H-15 and H-16 for a general view of the north and south spans. See Photograph H-17 and H-18 for a view of cracking sealed with calcite and the exposed filler beam to the south span. See Photograph H-19 for a view of cracking sealed with calcite, water staining and spalling to the north span and Photograph H-20 for a view of the exposed filler beam at the north span.

Beams

Included in deck component above.

Riverbed

The riverbed is in good condition with a 600mm high raised concrete apron provided under the south span of the structure to direct flow through the north span. See Photograph H-21.

Overall Structure

The structure is in poor condition due to the defects to the deck slab soffit. See Photograph H-22 for the west elevation of the structure and Photograph H-23 for the east elevation of the structure.

5.2 Identification and justification of the condition factor used in the assessment calculations for each structural element

The condition factor for the reinforced concrete slab was taken as 0.8 for assessment purposes due to the delamination to the concrete soffit and areas of spalling with exposed filler beams. The condition factor decreased from 0.9 used in the previous Stage 1 assessment due to deterioration in the deck soffit with additional cracking, delamination and spalling noted.

5.3 Detailed description of the testing undertaken

The testing undertaken to the structure for the Stage 2 assessment by Triur Construction Ltd. in July 2024 comprised the following:

- 2no. concrete cores and strength testing to both spans(4no. total)
- 4no. pilot holes to confirm deck thickness
- 4no. areas of breakout to areas of the steel beams for condition survey (2no. internal 2no. external beams)
- Delamination survey to both spans
- Durability testing to 6no. areas (2no. top, 2no. fascias, 2no. soffits)
- Waterproofing pull off testing
- Covermeter & GPR survey to 1no. areas of abutments and pier with breakouts (3no. areas total)
- 2no. pilot holes to confirm abutment thickness
- Durability testing to 2no. areas of each substructure element (6no. total)

For further information on the structural investigations undertaken refer to Appendix E of this report.

5.4 Results of all testing undertaken

The trial pit to the concrete verge found a total depth of fill of 420mm with no waterproofing present on the deck slab. The pilot hole cores drilled through the deck varied from 300mm and 320 mm in depth. The steel beams encased in the deck slab comprised a 125mm high railway girder at 600mm spacing with 23x13mm transverse bars at 600mm spacing between the girders. The concrete strength of the slab varied between 18.9 N/mm2 and 57.10 N/mm2.

For further information on the structural investigations results refer to Appendix E of this report.

5.5 Summary of safety partial factors used in the assessment

For the concrete, the values of γ_m is taken as 1.2 considering worst credible strengths which is taken from Table 4A (4.3.3.3.) of AM-STR-06031. For structural steel the γ_m is taken as 1.05.

The partial safety factors taken from *AM-STR-06030 Appendix A* are represented below in Table 5-1. Refer to Appendix G calculations for more details.

Table 5-1 - Partial Safety Factors for Assessment

Loading	γ_{f3} for ULS	γ_{fL} for ULS
Dead Load	1.1	1.15
Super Imposed Dead Load	1.1	1.75
Soil Fill	1.1	1.2
Type HA Loading	1.1	1.5
Type HB Loading	1.1	1.3
SV Loading	1.1	1.1

5.6 Summary of all material properties used in the assessment

Fill Material: (Structural fill)
Unit weight of fill = 22kN/m^3
Angle of Friction, phi = 30^o

Road Surfacing:
Unit Weight = 24kN/m^3

Filler beam concrete slab:
The estimated worst credible concrete strength of the concrete deck slab is taken as 18.9 N/mm^2. This is based on compression testing data of concrete core samples and is derived in accordance with *AM-STR-06031*. In the absence of test data on the characteristic yield strength of the structural steel sections, it was assumed as 230 N/mm^2 as per AM-STR-06026 Cl 4.3.

6. Assessment Method

6.1 Summary of analysis methodology undertaken as part of Stage 1 Structural Assessment

Assessment of the Filler Beam deck was carried out in accordance with the NRA Stage 1 Assessment Methodology Report (Revision C) and the methods outlined in the UK Highways Agency Design Manual for Roads and Bridges (BD21/01, BD44/95 & BA44/96). The structure was assessed using the strip method for HA loading, single axle and single wheel loads in accordance with BD21/01 and the methods outlined in BD44/95. A grillage analysis was also subsequently undertaken as part of the Stage 1 Assessment.

6.2 Detailed description of method of analysis undertaken for Stage 2 analysis including justification as to how this has led to an increase in the assessed capacity for the superstructure, substructure and foundations

The initial assessment of the filler beam deck slab was carried out using the strip analysis method as per *AM-STR-06026* and *AM-STR-06037* followed by a grillage analysis as per *AM-STR-06057*. A refined grillage analysis including transverse distribution and enhanced material properties from the structural investigations was used for the Stage 2 analysis. Using Midas Civil the main longitudinal members were defined as line elements and assigned composite section properties, which produced improved results compared to the stage 1 analysis.

The assessment live loading comprised 40t HA loading in accordance with TII Publication *AM-STR-06026*. Abnormal loading considered as part of the assessment comprised SV196 loading in accordance with TII Publication *AM-STR-06048 The Assessment of Road Bridges and Structures for the Effects of Abnormal and Exceptional Abnormal Load Vehicles using SV and SOV Load Models* and 45 Units HB loading in accordance with *AM-STR-06030 Loads for Highway Bridges*.

An increase in the bending capacity of the structure from the Stage 1 assessment when considering composite action was found due to the increase in the worst credible concrete strength as determined by the structural investigations. However, the check on the bond between the beams and the concrete slab to enable composite action found a reduced capacity for the structure of 7.5t.

6.3 Description of the model and software used for the analysis

The filler beam concrete slab was analysed with a grillage model using MIDAS Civil software. The grillage model was created with main longitudinal beams modelled as composite steel sections and transverse dummy elements for transverse distribution.

The diagram of the model and the model inputs are shown in Appendix F of this report.

6.4 Assessment live loading

Assessment live loading comprised 40t HA loading in accordance with TII Publication *AM-STR-06026*.

6.5 Abnormal loading

Abnormal loading considered as part of the assessment comprised SV196 loading in accordance with TII Publication *AM-STR-06048 The Assessment of Road Bridges and Structures for the Effects of Abnormal and Exceptional Abnormal Load Vehicles using SV and SOV Load Models* and 45 Units HB loading in accordance with *AM-STR-06030 Loads for Highway Bridges*.

6.6 Additional loading requirements

Dead and superimposed dead loads were applied to the structure based on the information gathered during the site investigation works and the inspection for assessment.

7. Assessment Commentary

7.1 Assumptions made during the Stage 2 Structural Assessment

The section property and capacity calculations of the composite steel beams were calculated in accordance with *BS 5400 Part 3:2000*. A condition factor of 0.8 was applied due to the delamination and spalling of the concrete deck soffit in both spans. As the year of construction and yield strength of the steel beams is unknown, a minimum yield strength of 230N/mm^2 was assumed for structural steel as per *AM-STR-06026 Cl 4.3*. The worst credible strength of concrete for the superstructure was taken as 18.9 N/mm^2 based on the findings of the structural investigations. Transverse distribution has been assumed across the deck based on structural investigations confirming the presence of transverse reinforcement in the slab. The dispersion of traffic loading through the fill was not considered due to the shallow depth of fill over the structure.

7.2 Significance of these assumptions in relation to the overall capacity of the structure or element

The filler beam structure is found to have sufficient loading for 40t HA loading when considering full composite action however the capacity is reduced due to bond failure in the section which prevents full composite action from occurring.

8. Assessment Results

The initial strip analysis undertaken for the Stage 2 assessment showed a bending capacity of 3t HA loading, with no capacity for HB and SV loading. The filler beam was found unsuitable for composite action as it failed under the bond stress check, resulting in a bond capacity of less than 3t GVW.

The bridge was also assessed using grillage analysis for live load capacity of 40t HA, combined HA+HB45, HB45, and SV196 loading with the results shown in Table 8-1 below as per the guidance from *AM-STR-06057*. The detailed calculations for each load case are provided in Appendix G of this report.

Table 8-1 – Grillage Assessment results for Filler beam slab

Element	Load Effect	R_{A^*}	S_{D^*}	S_{HA40t^*}	$S_{HA+HB45^*}$	S_{HB45^*}	S_{SV196^*}	R_A^*/S_A^*
Filler beam concrete slab	Moment near Support (Sagging) (kNm)	**73**	5	12	20	14	18	3.64
	Max. Sagging Moment (kNm)	**73**	17	56	84	75	66	0.87
	Max. Shear (kN)	**101**	53	85	146	121	110	0.69
	Bond Capacity	7.5t			< HB 30 units		< SV 80	

Where

R_A^*	=	Assessment Resistance (flexure, shear etc.)
S_D^*	=	Assessment load effects due to dead and superimposed dead loads
S_{HA}^*	=	Assessment load effect due to the associated Type HA loading and Permanent loads (ULS)
S_{HA+HB}^*	=	Assessment load effect due to the Combined Type HA+HB loading and Permanent loads (ULS)
S_{HB}^*	=	Load effect due to HB loading and Permanent loads (ULS)
S_{SV}^*	=	Load effect due to Special Vehicle loading and Permanent loads (ULS)
S_A^*	=	Assessment load effects (Maximum of ULS Combination)
R_A^*/S_A^*	=	Structural Assessment Factor (shown for the critical case from the ULS cases)

The grillage analysis determined a reduction in the assessment load effects due to the transverse distributions of loads, which resulted in a bending capacity of 40t GVW for the structure when considering composite action. The bond capacity of the section limits the slab capacity to 7.5t however.

The assessment summary is provided in the Table 8-2 below.

Table 8-2 - Assessment summary for Structure

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Assessed Capacity (ALL)	HB Capacity	SV Capacity
MO-N58-001.00	Strade Bridge	Filler Beam	2	3.82m / 3.79m	7.5t	Fails HB30 units	Fails SV80

9. Recommendations

Based on the findings of the assessment the structure is determined to have a reduced load capacity due to bond failure between the concrete and steel beams with the significant delamination and spalling visible to the deck slab soffit providing evidence of the issue. As a result no further assessment measures are deemed required for the structure as they are not likely to increase the bond capacity to 40t loading due to the low compressive strength values found for the concrete in the soffit of the structure. The deck slab is therefore recommended to be either strengthened or replaced.

Due to the extensive defects to the soffit of the structure and the presence of railway girders acting as primary structural members the strengthening of the structure is not recommended. A full deck replacement is instead recommended with the existing deck slab removed and a new deck installed across the structure, in either a single or two span arrangement.

Although there are extensive defects to the deck soffit as there is no evidence of failure or excess deformation of the slab a load restriction is not recommended at this time. Monitoring of the structure should be taken annually however to check for any further evidence of deformation or failure of the deck. Regular term maintenance should also be undertaken to the structure to maintain its condition in the interim.

Appendices

Appendices

Appendix A. Archive Information about the Structure

MO-N58-001.00 Strade River Bridge

Maintaining Agent.....: 23 MO - Mayo
Road..................: Bellavary - Foxford, County Mayo
Side of road..........: 0
Region................: 1 Connacht\Ulster
Struct. reg. no.......: 1155

Year of construction..................:
Year of reconstruction................:
Primary passage Overbridge/Underbridge: U
Dir. of chainage on primary road......: N
Access equipment needed...............: 0 Nothing

Data collected: Date ....: 15 May 2024
Inspector Initials....: CS
Checker Initials......: CP

MO-N58-001.00 Strade River Bridge

Geographical position (ITM):

Easting: 525752.652 Northing: 797496.734

Geometry:

Number of spans..............:	2
Min span length...........(m):	3.79
Max span length...........(m):	3.79
Overall length............(m):	8.70
Width out-to-out..........(m):	10.30
Width of median...........(m):	0.00
Width of footway left.....(m):	1.67
Width of footway right....(m):	1.09
Width of carriageway......(m):	5.70
Width kerb-to-kerb........(m):	6.90
Width of approach.........(m):	5.70
Area.....................(m2):	89.61
Minimum Parapet Height....(m):	0.88
Width of Soft Verge Left..(m):	0.00
Width of Soft Verge Right.(m):	0
Approach Skew 1.........(deg):	15.00
Approach Skew 2.........(deg):	15.00
Bridge curved...........(Y/N):	N
Skew....................(deg):	30

Span Lengths:

Span 1...(m):	3.79	Span 6...(m):		Span 11..(m):	
Span 2...(m):	3.79	Span 7...(m):		Span 12..(m):	
Span 3...(m):		Span 8...(m):		Span 13..(m):	
Span 4...(m):		Span 9...(m):		Span 14..(m):	
Span 5...(m):		Span 10..(m):			

MO-N58-001.00 Strade River Bridge

Superstructure, principal type:

Standard design ....(Y/N):	Y	
Design of cross section.............:	10	Slab
Design of elevation.................:	40	Frame, constant cross section
Material of primary members.........:	42	Composite steel & concrete

Superstructure, secondary type (if applicable):

Standard design ....(Y/N):	N	
Design of cross section.............:	91	Not applicable
Design of elevation.................:	91	Not applicable
Material of primary members.........:	91	Not applicable

Superstructure, tertiary type (if applicable):

Standard design ....(Y/N):	N	
Design of cross section.............:	91	Not applicable
Design of elevation.................:	91	Not applicable
Material of primary members.........:	91	Not applicable

Substructure:

Abutment:	Type......................:	10	Abutm. wall, integ. wing walls
	Material..................:	21	Reinforced concrete
	Foundation................:	92	Unknown
Pier:	Type......................:	10	Solid wall
	Material..................:	21	Reinforced concrete
	Foundation................:	92	Unknown

MO-N58-001.00 Strade River Bridge

Details:

Type of parapet.....................:	30	Concrete cast in situ
Type of safety barrier.............:	0	No guard rail
Type of wearing surface............:	23	Hot rolled asphalt
Type of expansion joint............:	91	Not applicable
Type of fixed bearings on support...:	91	Not applicable
Type of free bearings on support....:	91	Not applicable
Type of fixed bearings on girders...:	91	Not applicable
Type of free bearings on girders....:	91	Not applicable

Obstacle:

Type of passage.....................:	31	River
Passage id..........................:		RIVER
Passage name........................:		Strade River
Road side...........................:		

Vertical Clearance:

Primary passage.................(m):	L:	LM:	RM:	R:
Secondary passage...............(m):	L: 2.33	LM: 2.33	RM: 2.33	R: 2.33

Miscellaneous:

Design Load..........................:		
Load Distribution....................:	2	Distribution in 1 direction
Technical Standards..................:	0	Unknown standard
Assessed Capacity Normal.............:	7	18T GVW
Assessed Capacity Abnormal...........:	32	30 Units HB
Weight Restriction...................:	1	N/A
Owner:	23	Mayo County Council
Maintaining Agent....................:	23	Mayo County Council
Inspection Consultant................:	96	Atkins
Designer/Consultant..................:	92	Unknown
Technical installations..............:	2	Other electrical installation
	4	Water supply pipeline

MO-N58-001.00 Strade River Bridge

Remarks:

The deck slab comprises a composite filler beam slab construction.
The vertical clearance at the north span is 2.33m and the south span is 1.65m.

The skew span is 3.79m and the square span is 3.44m for both spans.
Technical installations over the structure include a water main and overhead ESB.
The 2012 Stage 1 Report gives a capacity of 18 tonnes in bending however this reduces to less than 3 tonnes when bond stress is considered.

Chronological Overview

Date	Activity	1 Br	2 Ex	3 Fo	4 Pa	5 Em	6 Wi	7 Ab	8 Pi	9 Be	10 De	11 Be	12 Ri	13 Ot	14 St
01 Jan 2012	Assessment	Stage 1 / 18T GVW / Y													
Remarks: Bending Mid-Span															
14 Aug 2012	Principal inspection	0	-	2	1	0	0	1	1	-	2	-	0	-	2
18 Aug 2017	Principal inspection	2	-	-	1	0	0	1	1	-	1	-	1	-	1
09 Mar 2022	Principal inspection	1	-	0	0	1	0	1	1	-	2	-	1	-	2
29 May 2023	Principal inspection	1	-	1	1	1	1	2	1	-	3	1	1	-	3
15 May 2024	Principal inspection	1	-	0	0	1	1	2	1	-	3	-	0	-	3

MO-N58-001.00 Strade River Bridge

Principal Inspection:

Date.................................:	15 May 2024
Team Leader Name.....................:	Curtis Swanepoel
Initials.............................:	CS
Weather..............................:	Sunny
Temperature..................(deg. C):	14
Traffic:Annual Average Daily Traffic.:	6274
Percentage, light vehicles...:	96
Percentage, heavy vehicles...:	4
Year for next Principal Inspection...:	2025

Remark:

AADT Information sourced from TII Traffic Counter Data from 'TMU N58 010.0 N' in year 2023, based on 100% coverage.

MO-N58-001.00 Strade River Bridge

No	Component Repair work Damage description Type of damage	Con rtg	Mtn req	Spe Ins	Repair Work T P	Qty	Year	Cost	Pho tos
1	**Bridge surface** The bridge surface is in good condition overall, see P1.1 for a view north. There is cracking evident to the carriageway at the northwest corner to be sealed during routine maintenance, see P1.2.	1	Y	N					2
2	**Expansion joints**	-		N					0
3	**Footways/median** The rubbing strips are both in good condition, see P3.1 for a view of the eastern rubbing strip.	0	N	N					1
4	**Parapets/Safety barrier** The parapets are in good condition, see P4.1 for a view of the western parapet.	0	N	N					1
5	**Embankments/Revetments** The embankments are in a good condition apart from vegetation growth that should be cut back from all the embankments during RM, see P5.1 for a view of the southeast embankment.	1	Y	N					1
6	**Wing/Spandrel/Retaining Walls** The wing walls are in good condition, see P6.1 for a view of the northeast wing wall. There is a previous repair evident to the northwest wing wall, see P6.2.	1	N	N					2
7	**Abutments**	2	N	N					2

MO-N58-001.00 Strade River Bridge

No	Component Repair work Damage description Type of damage	Con rtg	Mtn req	Spe Ins	Repair Work T P	Qty	Year	Cost	Pho tos
	E : Injection of cracks Both abutments are in a fair condition, see P7.1 for view of the southern abutment. The previously reported crack to the west side of the northern abutment remains 0.6mm wide, see P7.2. The previously installed crack pips have a measurement of 25.91mm (The previous base reading 23.1mm is confirmed to be incorrect with 25.91mm the new base reading). The crack should be injection repaired. Cracking of concrete				E	1	2026	500	
8	**Piers** The pier is in a good overall condition, see P8.1 for view of the south face of the pier looking east. There is minor honeycombing to the east side upstream of the pier which requires no action, see P8.2. There is a crack sealed with calcite on the concrete protection to the north face of the pier, see P8.3.	1	N	N					3

MO-N58-001.00 Strade River Bridge

No	**Component** **Repair work** **Damage description** **Type of damage**	**Con rtg**	**Mtn req**	**Spe Ins**	**Repair Work** **T P**	**Qty**	**Year**	**Cost**	**Pho tos**
9	**Bearings**	-		N					0
10	**Deck/slab/arch barrel**	3	N	N					6
	A : Concrete repair (without reinforcement)				A	6	2025	3210	

The deck is in a poor condition, see P10.1 for view of the southern span deck looking east with areas of spalling evident below the filler beams. There is spalling with exposed beams in the northern span also, see P10.2. See P10.3 for closer view of large spalling to the south span deck. All areas of spalling should be repaired. There are longitudinal cracks that are self healed with calcite on the east and west side of the deck under the headwalls of the northern span. There are also longitudinal cracks that are self healed with calcite on the east side of the southern span, see P10.4.
There is a 0.5mm wide longitudinal crack in the northern span located 5.35m from the western elevation. Previously installed crack pips have a reading of 25.56mm (The previous base reading of 23.4mm is confirmed to be incorrect, with 25.56mm the new base reading), see P10.5.
All cracks appear to be replicating the behaviour of spalling of the exposed beams with widespread delamination identified.
The 2012 Stage 1 Assessment report indicated that the structure is substandard due to failure of bond stress checks in the deck. The spalling and delamination of concrete noted above is consistent with debonding of the concrete to the soffit of the steel beams. Otherwise there was no deformation or transverse cracking in the deck that would suggest failure in bending/shear. The condition of the deck does not appear to have deteriorated further since the last PI.

MO-N58-001.00 Strade River Bridge

Spalling								
11 Beams/girders/transverse beams	-		N					0
12 Riverbed	0	N	N					1
The riverbed is in good condition, see P12.1 for a view downstream east.								
13 Other elements	-		N					0
14 Structure in general	3	Y	N					2
The structure is in a fair condition with cracking to the northern abutment and spalling and delamination to the southern and northern deck slabs with exposed beams evident. Routine Maintenance is also required. See P14.1 and P14.2 for views of the western and eastern elevations respectively. The inspection of the structure has been undertaken in accordance with the requirements of TII AM-STR-06039 (BD 79) outside of the normal PI schedule due to the 2012 Stage 1 Assessment Report finding the structure to have a reduced load capacity due to failure of the bond stress checks between the filler beams and surrounding concrete.								
Total Cost:							**3710**	

MO-N58-001.00 Strade River Bridge

Component No.	1	Bridge surface

The bridge surface is in good condition overall, see P1.1 for a view north. There is cracking evident to the carriageway at the northwest corner to be sealed during routine maintenance, see P1.2.

Condition/Mainten. 1 / Y

MO-N58-001.00 Strade River Bridge

Component No.	**1**	**Bridge surface**

The bridge surface is in good condition overall, see P1.1 for a view north. There is cracking evident to the carriageway at the northwest corner to be sealed during routine maintenance, see P1.2.

Condition/Mainten. 1 / Y

MO-N58-001.00 Strade River Bridge

Component No. 3 Footways/median
The rubbing strips are both in good condition, see P3.1 for a view of the eastern rubbing strip.
Condition/Mainten. 0 / N

MO-N58-001.00 Strade River Bridge

Component No.	**4**	**Parapets/Safety barrier**
The parapets are in good condition, see P4.1 for a view of the western parapet.		
Condition/Mainten.	0 / N	

MO-N58-001.00 Strade River Bridge

Component No.	5	Embankments/Revetments

The embankments are in a good condition apart from vegetation growth that should be cut back from all the embankments during RM, see P5.1 for a view of the southeast embankment.

Condition/Mainten. 1 / Y

MO-N58-001.00 Strade River Bridge

Component No.	6	Wing/Spandrel/Retaining Walls

The wing walls are in good condition, see P6.1 for a view of the northeast wing wall. There is a previous repair evident to the northwest wing wall, see P6.2.

Condition/Mainten. 1 / N

MO-N58-001.00 Strade River Bridge

Component No.	**6**	**Wing/Spandrel/Retaining Walls**

The wing walls are in good condition, see P6.1 for a view of the northeast wing wall. There is a previous repair evident to the northwest wing wall, see P6.2.

Condition/Mainten. 1 / N

MO-N58-001.00 Strade River Bridge

Component No.	7	Abutments

Both abutments are in a fair condition, see P7.1 for view of the southern abutment. The previously reported crack to the west side of the northern abutment remains 0.6mm wide, see P7.2. The previously installed crack pips have a measurement of 25.91mm (The previous base reading 23.1mm is confirmed to be incorrect with 25.91mm the new base reading). The crack should be injection repaired.

Condition/Mainten. 2 / N

MO-N58-001.00 Strade River Bridge

Component No. 7 Abutments
Both abutments are in a fair condition, see P7.1 for view of the southern abutment. The previously reported crack to the west side of the northern abutment remains 0.6mm wide, see P7.2. The previously installed crack pips have a measurement of 25.91mm (The previous base reading 23.1mm is confirmed to be incorrect with 25.91mm the new base reading). The crack should be injection repaired.
Condition/Mainten. 2 / N

P7.2

MO-N58-001.00 Strade River Bridge

Component No.	**8**	**Piers**

The pier is in a good overall condition, see P8.1 for view of the south face of the pier looking east. There is minor honeycombing to the east side upstream of the pier which requires no action, see P8.2. There is a crack sealed with calcite on the concrete protection to the north face of the pier, see P8.3.

Condition/Mainten. 1 / N

MO-N58-001.00 Strade River Bridge

Component No.	**8**	**Piers**

The pier is in a good overall condition, see P8.1 for view of the south face of the pier looking east. There is minor honeycombing to the east side upstream of the pier which requires no action, see P8.2. There is a crack sealed with calcite on the concrete protection to the north face of the pier, see P8.3.

Condition/Mainten. 1 / N

MO-N58-001.00 Strade River Bridge

Component No. 8 Piers
The pier is in a good overall condition, see P8.1 for view of the south face of the pier looking east. There is minor honeycombing to the east side upstream of the pier which requires no action, see P8.2. There is a crack sealed with calcite on the concrete protection to the north face of the pier, see P8.3. Condition/Mainten. 1 / N

MO-N58-001.00 Strade River Bridge

Component No. 10 Deck/slab/arch barrel
The deck is in a poor condition, see P10.1 for view of the southern span deck looking east with areas of spalling evident below the filler beams. There is spalling with exposed beams in the northern span also, see P10.2. See P10.3 for closer view of large spalling to the south span deck. All areas of spalling should be repaired. There are longitudinal cracks that are self healed with calcite on the east and west side of the deck under the headwalls of the northern span. There are also longitudinal cracks that are self healed with calcite on the east side of the southern span, see P10.4. There is a 0.5mm wide longitudinal crack in the northern span located 5.35m from the western elevation. Previously installed crack pips have a reading of 25.56mm (The previous base reading of 23.4mm is confirmed to be incorrect, with 25.56mm the new base reading), see P10.5. All cracks appear to be replicating the behaviour of spalling of the exposed beams with widespread delamination identified. The 2012 Stage 1 Assessment report indicated that the structure is substandard due to failure of bond stress checks in the deck. The spalling and delamination of concrete noted above is consistent with debonding of the concrete to the soffit of the steel beams. Otherwise there was no deformation or transverse cracking in the deck that would suggest failure in bending/shear. The condition of the deck does not appear to have deteriorated further since the last PI. Condition/Mainten. 3 / N

MO-N58-001.00 Strade River Bridge

MO-N58-001.00 Strade River Bridge

Component No. 10 Deck/slab/arch barrel
The deck is in a poor condition, see P10.1 for view of the southern span deck looking east with areas of spalling evident below the filler beams. There is spalling with exposed beams in the northern span also, see P10.2. See P10.3 for closer view of large spalling to the south span deck. All areas of spalling should be repaired. There are longitudinal cracks that are self healed with calcite on the east and west side of the deck under the headwalls of the northern span. There are also longitudinal cracks that are self healed with calcite on the east side of the southern span, see P10.4. There is a 0.5mm wide longitudinal crack in the northern span located 5.35m from the western elevation. Previously installed crack pips have a reading of 25.56mm (The previous base reading of 23.4mm is confirmed to be incorrect, with 25.56mm the new base reading), see P10.5. All cracks appear to be replicating the behaviour of spalling of the exposed beams with widespread delamination identified. The 2012 Stage 1 Assessment report indicated that the structure is substandard due to failure of bond stress checks in the deck. The spalling and delamination of concrete noted above is consistent with debonding of the concrete to the soffit of the steel beams. Otherwise there was no deformation or transverse cracking in the deck that would suggest failure in bending/shear. The condition of the deck does not appear to have deteriorated further since the last PI.
Condition/Mainten. 3 / N


P10.2
15/05/2024

MO-N58-001.00 Strade River Bridge

Component No. 10 Deck/slab/arch barrel
The deck is in a poor condition, see P10.1 for view of the southern span deck looking east with areas of spalling evident below the filler beams. There is spalling with exposed beams in the northern span also, see P10.2. See P10.3 for closer view of large spalling to the south span deck. All areas of spalling should be repaired. There are longitudinal cracks that are self healed with calcite on the east and west side of the deck under the headwalls of the northern span. There are also longitudinal cracks that are self healed with calcite on the east side of the southern span, see P10.4. There is a 0.5mm wide longitudinal crack in the northern span located 5.35m from the western elevation. Previously installed crack pips have a reading of 25.56mm (The previous base reading of 23.4mm is confirmed to be incorrect, with 25.56mm the new base reading), see P10.5. All cracks appear to be replicating the behaviour of spalling of the exposed beams with widespread delamination identified. The 2012 Stage 1 Assessment report indicated that the structure is substandard due to failure of bond stress checks in the deck. The spalling and delamination of concrete noted above is consistent with debonding of the concrete to the soffit of the steel beams. Otherwise there was no deformation or transverse cracking in the deck that would suggest failure in bending/shear. The condition of the deck does not appear to have deteriorated further since the last PI.
Condition/Mainten. 3 / N

MO-N58-001.00 Strade River Bridge

MO-N58-001.00 Strade River Bridge

Component No. 10 Deck/slab/arch barrel
The deck is in a poor condition, see P10.1 for view of the southern span deck looking east with areas of spalling evident below the filler beams. There is spalling with exposed beams in the northern span also, see P10.2. See P10.3 for closer view of large spalling to the south span deck. All areas of spalling should be repaired. There are longitudinal cracks that are self healed with calcite on the east and west side of the deck under the headwalls of the northern span. There are also longitudinal cracks that are self healed with calcite on the east side of the southern span, see P10.4. There is a 0.5mm wide longitudinal crack in the northern span located 5.35m from the western elevation. Previously installed crack pips have a reading of 25.56mm (The previous base reading of 23.4mm is confirmed to be incorrect, with 25.56mm the new base reading), see P10.5. All cracks appear to be replicating the behaviour of spalling of the exposed beams with widespread delamination identified. The 2012 Stage 1 Assessment report indicated that the structure is substandard due to failure of bond stress checks in the deck. The spalling and delamination of concrete noted above is consistent with debonding of the concrete to the soffit of the steel beams. Otherwise there was no deformation or transverse cracking in the deck that would suggest failure in bending/shear. The condition of the deck does not appear to have deteriorated further since the last PI.
Condition/Mainten. 3 / N


P10.4
15/05/2024

MO-N58-001.00 Strade River Bridge

Component No. 10 Deck/slab/arch barrel
The deck is in a poor condition, see P10.1 for view of the southern span deck looking east with areas of spalling evident below the filler beams. There is spalling with exposed beams in the northern span also, see P10.2. See P10.3 for closer view of large spalling to the south span deck. All areas of spalling should be repaired. There are longitudinal cracks that are self healed with calcite on the east and west side of the deck under the headwalls of the northern span. There are also longitudinal cracks that are self healed with calcite on the east side of the southern span, see P10.4. There is a 0.5mm wide longitudinal crack in the northern span located 5.35m from the western elevation. Previously installed crack pips have a reading of 25.56mm (The previous base reading of 23.4mm is confirmed to be incorrect, with 25.56mm the new base reading), see P10.5. All cracks appear to be replicating the behaviour of spalling of the exposed beams with widespread delamination identified. The 2012 Stage 1 Assessment report indicated that the structure is substandard due to failure of bond stress checks in the deck. The spalling and delamination of concrete noted above is consistent with debonding of the concrete to the soffit of the steel beams. Otherwise there was no deformation or transverse cracking in the deck that would suggest failure in bending/shear. The condition of the deck does not appear to have deteriorated further since the last PI. Condition/Mainten. 3 / N

MO-N58-001.00 Strade River Bridge

MO-N58-001.00 Strade River Bridge

Component No.	**10**	**Deck/slab/arch barrel**

The deck is in a poor condition, see P10.1 for view of the southern span deck looking east with areas of spalling evident below the filler beams. There is spalling with exposed beams in the northern span also, see P10.2. See P10.3 for closer view of large spalling to the south span deck. All areas of spalling should be repaired. There are longitudinal cracks that are self healed with calcite on the east and west side of the deck under the headwalls of the northern span. There are also longitudinal cracks that are self healed with calcite on the east side of the southern span, see P10.4.
There is a 0.5mm wide longitudinal crack in the northern span located 5.35m from the western elevation. Previously installed crack pips have a reading of 25.56mm (The previous base reading of 23.4mm is confirmed to be incorrect, with 25.56mm the new base reading), see P10.5. All cracks appear to be replicating the behaviour of spalling of the exposed beams with widespread delamination identified.
The 2012 Stage 1 Assessment report indicated that the structure is substandard due to failure of bond stress checks in the deck. The spalling and delamination of concrete noted above is consistent with debonding of the concrete to the soffit of the steel beams. Otherwise there was no deformation or transverse cracking in the deck that would suggest failure in bending/shear. The condition of the deck does not appear to have deteriorated further since the last PI.

Condition/Mainten. 3 / N

MO-N58-001.00 Strade River Bridge

MO-N58-001.00 Strade River Bridge

Component No.	**12**	**Riverbed**
The riverbed is in good condition, see P12.1 for a view downstream east.		
Condition/Mainten.	0 / N	

MO-N58-001.00 Strade River Bridge

Component No.	14	Structure in general

The structure is in a fair condition with cracking to the northern abutment and spalling and delamination to the southern and northern deck slabs with exposed beams evident. Routine Maintenance is also required. See P14.1 and P14.2 for views of the western and eastern elevations respectively.
The inspection of the structure has been undertaken in accordance with the requirements of TII AM-STR-06039 (BD 79) outside of the normal PI schedule due to the 2012 Stage 1 Assessment Report finding the structure to have a reduced load capacity due to failure of the bond stress checks between the filler beams and surrounding concrete.

Condition/Mainten. 3 / Y

MO-N58-001.00 Strade River Bridge

Component No. 14 Structure in general
The structure is in a fair condition with cracking to the northern abutment and spalling and delamination to the southern and northern deck slabs with exposed beams evident. Routine Maintenance is also required. See P14.1 and P14.2 for views of the western and eastern elevations respectively. The inspection of the structure has been undertaken in accordance with the requirements of TII AM-STR-06039 (BD 79) outside of the normal PI schedule due to the 2012 Stage 1 Assessment Report finding the structure to have a reduced load capacity due to failure of the bond stress checks between the filler beams and surrounding concrete.
Condition/Mainten. 3 / Y

NRA
National Roads Authority
An tÚdarás um Bóithre Náisiúnta

ATKINS

STRADE RIVER BRIDGE

STRUCTURE ID: MO-N58-001.00

STAGE I ASSESSMENT REPORT

Revision 0

May 2012

EIRSPAN BRIDGE MANAGEMENT SYSTEM

TASK ORDER NO. 213 : STAGE 1 STRUCTURAL ASSESSMENTS OF BRIDGES IN DONEGAL, SLIGO, MAYO AND GALWAY

STRADE RIVER BRIDGE

STRUCTURE ID: MO-N58-001.00

STAGE 1 ASSESSMENT REPORT

Notice

Document History

PROJECT NO.: 3044			DOCUMENT REF: DG-TO213-69 Local Reference: 3044/30/32/321			
Revision	Purpose and Description	Originated	Checked	Reviewed	Authorised	Date
0	NRA Approval	S. Counihan	C. Maunsell	P. Garg	M. Jennings	31.05.12

CONTENTS

APPENDICES

Executive Summary

Strade River Bridge, MO-N58-001.00 carries the N58 national secondary road across the Strade River in County Mayo. This bridge is a two span Filler Beam deck structure with skew spans of 3.81m and 3.79m, and square spans of 3.56m and 3.34m.

Assessment of this structure was carried out in accordance with the NRA Stage 1 Assessment Methodology Report (Revision C) and the methods outlined in the UK Highways Agency Design Manual for Roads and Bridges (BD21/01, BD44/95 & BA44/96 for the RC Slab). A summary of Stage 1 Assessment Results is presented in the following table.

Structure ID	Structure Name	Structure Type	No of Spans	Skew Span Lengths (m)	Assessed Capacity	HB Rating
MO-N58-001.00	Strade River Bridge	Filler Beam	2	Span 1: 3.81	18t Bending 40t Shear <3t Bond	30HB Bending 45HB Shear <30HB Bond
				Span 2: 3.79	40t Bending 40t Shear <3t Bond	30HB Bending 45HB Shear <30HB Bond

Table 1.0: Structure Assessment Summary Results

A site investigation was carried out by Stanger Testing Services Limited for this structure to establish the concrete slab thickness, concrete strength and layout and cover to the filler beams.

The Stage 1 Assessment of the filler beam deck structure indicated that both spans could withstand 7.5 tonnes assessment in bending and 40 tonnes in shear, however the bond load capacity was less than 3 tonnes for both spans. As the adequacy of the structures in bending for 40t live loading was 60% for span 1 and 73% for span 2 using the strip method, a grillage analysis was carried out, which increased the load capacity of the structures in bending to 18 tonnes assessment loading for Span 1 and to 40 tonnes for Span 2.

A low concrete strength and low area of steel components are the main causes of the low carrying capacity of the structure.

The following works are recommended for the structure:

(i) Stage 2 Assessment of the filler beam deck in the form of Plastic Analysis or Finite Element Method and subsequent strengthening using FRP plates or similar;

(ii) The grass verges on both sides of the carriageway should be replaced with paved/raised verges and the entire structure should be waterproofed (such as impermeable layer should be placed under the pavement);

(iii) Both parapets should be upgraded to meet current standards.

It is recommended that the structure be inspected in year 2012, as per the Principal Inspection Report dated 1st October, 2008.


MO-N58-001.00
Strade River Bridge
Lough Cullin
Loch Cuilinn
FOXFORD
Béal Easa
Strade
An tSráid
Bellavary
Béal Átha Bhearaigh

1.0 Introduction

Atkins was appointed by the National Roads Authority in August 2011 to carry out the structural assessment of 136 bridges in Donegal, Sligo, Mayo and Galway as part of Task Order 213.

Strade River Bridge MO-N58-001.00, which is located in County Mayo and carries the N58 across the Strade River, is a part of this Task Order. The co-ordinates of the structure are:

Latitude Y: 297482.729 Longitude X: 125785.401

The most recent Principal Inspection of this structure was carried out on 1st October, 2008. An Inspection for Assessment was carried out by Atkins on 18th December, 2011.

The layout of the Assessment Report follows the layout as described in Section 7 of the NRA Stage 1 Assessment Methodology Report, Rev C.

2.0 Description of Structure

Strade River Bridge is a two span Filler Beam deck structure with skew spans of 3.81m and 3.79m, and square spans of 3.56m and 3.34m.

The structure carries the N58 national secondary route across the Strade River. The overall width of the structure from outside of the west parapet to the outside of the east parapet is 10.17m (skew length 11.54m).

3.0 Visual Inspection of structure

General:

The visual inspection was carried out in dry weather from the river, inside the structure and from the carriageway over the bridge. Photos are given in Appendix B. Eastern and western elevations of the structure are shown in photos 1 & 2. The structure was on a straight alignment.

Surfacing:

The surfacing of the 5.62m wide carriageway was noted to be in good condition, apart from minor wear. There were no obvious signs of rutting or ponding over the main carriageway. Road markings were showing signs of wear (Ref. photo 3, 4 & 5).

Footways/verges:

There were no footways on this structure. There were 0.42m wide hard strips on both sides of the carriageway. Additionally, there was a 1.80m wide grassed verge on the west side of the structure and a 1.45m wide grassed verge on the east side (Ref. photo 6 & 7).

Parapet walls / Headwalls:

There were concrete parapets and spandrel walls on both sides of the structure.

The western parapet was 980mm high and the eastern parapet was 930mm high. Both parapets were 230mm thick. Both parapets were in good condition. Cracks to both parapets as outlined in the previous Principal Inspection Report have been repaired and the ivy growth removed (Ref. photo 6 & 7).

Both head walls were in good condition and there was no defects recorded (Ref. photo 8 & 9).

Deck:

The thickness of the Filler Beam deck was 340mm. The deck slab was noted to be in good condition, apart from some minor water seepage, calcite staining and stalactites in span 1 at the eastern end. There was also water seepage noted under span 2 at the western end (Ref. photo 10 & 11). The cracks identified in the previous principal inspection have been repaired and were not detected at the time of inspection.

Abutments / Pier:

There were concrete abutments on both sides of the structure. The abutments were noted to be in good condition, apart from honeycombing noted to both components (Ref. photo 12 & 13). There was 210mm wide x 230mm high scour protection on the southern abutment and the south face of the pier. There was also 210mm wide x 770mm high scour protection on the abutment and north face of the pier. The pier was in good condition apart from honeycombing to the east cut water as outlined in the previous inspection. The ivy growth has been removed from the west face of the pier (Ref. photo 14).

River Bed:

The riverbed was in good condition. The river bed in span 1 had a raised 540mm thick concrete apron and was dry at the time of inspection (Ref. photo 15 to 18).

4.0 Site Investigation Results

Stanger Testing Services Limited carried out the intrusive site investigations at this structure.

As part of the site investigations, a trial pit was excavated over the Filler Beam deck to establish the internal thickness of the slab and the depth of the fill. The site investigation also showed that the deck was waterproofed.

Four covermeter scans were carried out to the soffit of the RC beam and slab deck to establish the beam spacing, arrangement and orientation. Additionally, 2 no. breakouts were performed at the base of the slab to determine the articulation.

3 no. cores were extracted from the deck soffit of each span. The cores were then sent for laboratory compression testing.

For full details and results of the site investigation, refer to Appendix C for Site Investigation Report.

5.0 Assessment of Structure

Assessment of Filler Beam Deck Structure:

Assessment of this Filler Beam Deck structure was carried out in accordance with the NRA Stage 1 Assessment Methodology Report (Revision C) and the methods outlined in the UK Highways Agency Design Manual for Roads and Bridges (BD21/01, BD44/95 & BA44/96). The structure was assessed using the strip method for HA loading, single axle and single wheel loads in accordance with BD21/01 and the methods outlined in BD44/95. Due to water seepage, a condition factor of 0.9 was assumed for both spans of the Filler Beam Deck. Both spans were assessed separately.

As per the Stage 1 assessment, the live load capacity of both spans was 7.5 tonnes Gross Vehicle Weight (GVW) for bending and 40 tonnes for shear. An additional check carried out on the bond also indicated the capacity of the structure of less than 3 tonnes assessment loading for both spans. The results are summarised in Table 5.1a & 5.1b.

Assessment Live Load Capacity			
	HA UDL & KEL	**Single Axle Load**	**Single Wheel Load**
Bending	40t	7.5t	7.5t
Shear	40t	40t	40t
Bond	<3t	-	-
Hence Overall Rating of **<3t**			

Table 5.1a Assessed RC Slab Load Capacity – Span 1

Assessment Live Load Capacity			
	HA UDL & KEL	**Single Axle Load**	**Single Wheel Load**
Bending	40t	7.5t	7.5t
Shear	40t	40t	40t
Bond	<3t	-	-
Hence Overall Rating of **<3t**			

Table 5.1b Assessed RC Slab Load Capacity – Span 2

Using strip method analysis, the adequacy of the structure in bending was only 60% for span 1 and 73% for span 2 for 40t single wheel loading. Hence, a grillage analysis was carried out for the structure, which increased the bending load capacity of the structure to 18 tonnes assessment loading for span 1 and to 40 tonnes assessment loading for span 2. The results are summarised in Table 5.2a & 5.2b.

Live Load Capacity – Grillage Analysis	
Bending	18 t
Shear	40 t
Bond	<3 t
Hence Overall Rating of **<3 t**	

Table 5.2a Assessed Grillage Analysis Load Capacity – Span 1

Live Load Capacity – Grillage Analysis	
Bending	40 t
Shear	40 t
Bond	<3 t
Hence Overall Rating of **<3 t**	

Table 5.2b Assessed Grillage Analysis Load Capacity – Span 2

The structure was also assessed for 45 units of HB live loading in accordance with NRA Design Manual for Roads and Bridges BD37/01. As per Stage 1 Assessment, the HB rating of both spans was found to be 30HB units for bending, 45HB units for shear and less than 30HB units for bond. The results are summarised in Table 5.3a & 5.3b.

HB Live Load Capacity	
Bending	30 HB
Shear	45 HB
Bond	<30 HB
Hence Overall Rating of **<30 HB**	

Table 5.3a Assessed HB Load Capacity – Span 1

HB Live Load Capacity	
Bending	30 HB
Shear	45 HB
Bond	<30 HB
Hence Overall Rating of **<30 HB**	

Table 5.3b Assessed HB Load Capacity – Span 2

Abutments and Pier:

A qualitative assessment was carried out for the substructure. The abutments and pier were in good condition and not showing any signs of distress apart from those mentioned in Section 3 of the report, which however were not considered to be structurally significant. Hence, the components were considered satisfactory in accordance with BD21/01 & BA 16/97.

Headwalls

The headwalls were assessed qualitatively. Both headwalls were found to be in good condition with no signs of structural defects. Hence, the headwalls were considered satisfactory.

Parapets

The western parapet was 980mm high and the eastern parapet was 930mm high. Both parapets were 230mm thick.

These parapets heights are substandard for a National Road as per clause 4.5 of NRA BD52/07.

Additionally, both parapets are inadequate for normal containment level with an impact speed of 80kph as per figure 4 of BS6779: Part 4.

Hence, it is advised that both parapets should be upgraded to meet current standards.

6.0 Conclusions

The Stage 1 Assessment of the structure in its present condition indicates that both spans of the Filler Beam Deck structure have a live load capacity of 7.5 tonnes assessment loading for bending, 40 tonnes assessment loading for shear and less than 3 tonnes assessment loading for bond. As the adequacy of the structures in bending for 40t live loading was 60% for span 1 and 73% for span 2 using the strip method, a grillage analysis was carried out, which increased the load capacity of the structure in bending to 18 tonnes assessment loading for Span 1 and to 40 tonnes for Span 2.

The Stage 1 Assessment also indicated that the structure had a HB rating of 30HB units for bending and 45HB units for shear, while for bond the structure could not achieve even 30HB units.

The structure was noted to be in good condition and not showing any signs of structural defects. The main causes of low carrying capacity of the structure were low concrete strength and low area of steel components.

It is considered likely that Stage 2 Assessment of the Filler Beam Deck would increase the assessment load capacity of the structure, but may not increase it to 40 tonnes assessment loading.

7.0 Recommendations

The following works are recommended for the structure:

(i) Stage 2 Assessment of the filler beam deck in the form of Plastic Analysis or Finite Element Method and subsequent strengthening using FRP plates or similar;

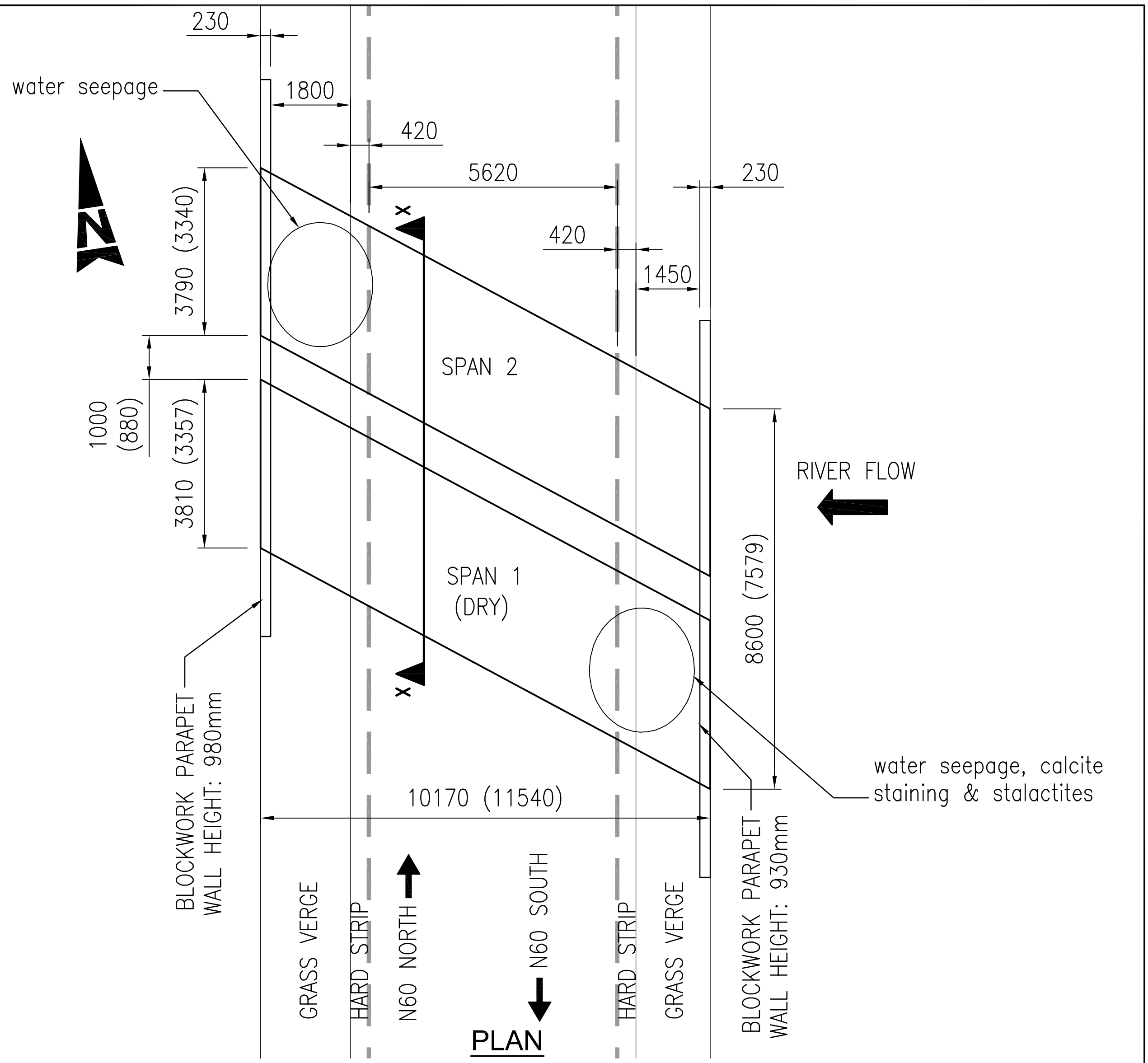
(ii) The grass verges on both sides of the carriageway should be replaced with paved/raised verges and the entire structure should be waterproofed (such as an impermeable layer should be placed under the pavement);

(iii) Both parapets should be upgraded to meet current standards.

It is recommended that the structure be inspected in year 2012, as per the Principal Inspection Report dated 1st October, 2008.

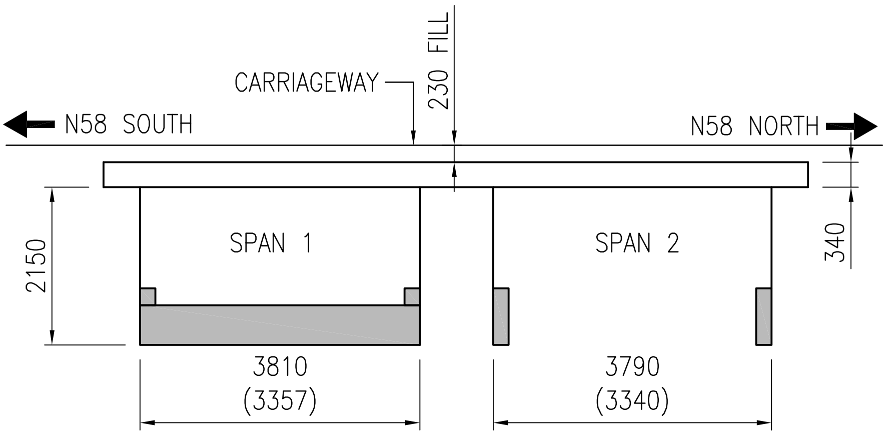
Appendix A

Sketches



PLAN

SCALE 1:150



LONGITUDINAL SECTION X-X

SCALE 1:100

DO NOT SCALE

A4

ATKINS™

Atkins Consultants Limited ©

Atkins House, 150–155 Airside Business Park, Swords Co. Dublin Tel: (+353) 01 890 9000 Fax: (+353) 01 890 9001

Unit 2B, 2200 Cork Airport Business Park, Cork Co. Cork Tel: (+353) 021 429 0300 Fax: (+353) 021 429 0360

Client: NRA National Roads Authority — An tÚdarás um Bóithre Náisiúnta

Project: EIRSPAN BRIDGE MANAGEMENT SYSTEM TASK ORDER No. 213 STAGE I STRUCTURAL ASSESSMENTS OF BRIDGES IN DONEGAL, SLIGO, MAYO AND GALWAY

Title: Strade River Bridge MO-N58-001.00

Original Scale	Designed/Drawn	Checked	Authorised
AS SHOWN	SC	CP	PG
	Date 12/10/11	Date 12/10/11	Date 12/10/11

Status	Drawing Number	Rev
A	MO-N58-001.00	A

File: Z:\3044 Eirspan Task Order 213\60 Drawings\61 AutoCAD\3044 Eirspan Task Order 213 Mayo N58.dwg
Date: May 18, 2012 – 4:15pm Plotted by: ispeiwok

Appendix B

Photographs

Photo 1. General view - Eastern elevation

Photo 2. General view - Western elevation

Photo 3. Northern Departure (Increasing Chainage)

Photo 4. Southern Departure (Decreasing Chainage)

Photo 5. Road surface

Photo 6. Western parapet

Photo 7. Eastern parapet

Photo 8. Eastern Headwall

Photo 9. Western Headwall

Photo 10. Span 1 soffit – water seepage & calcite staining

Photo 11. Span 2 soffit – water seepage

Photo 12. Southern abutment

Photo 13. Northern abutment

Photo 14. North face of pier

Photo 15. View through span 1

Photo 16. View through span 2

Photo 17. Upstream channel view

Photo 18. Downstream Channel View

Appendix C

Site Investigation Results

Stanger

WS ATKINS IRELAND LTD.

STRADE RIVER BRIDGE
MO-N58-001.00
ISSUE DATE:
24TH JANUARY 2012

REVISION NO. 1

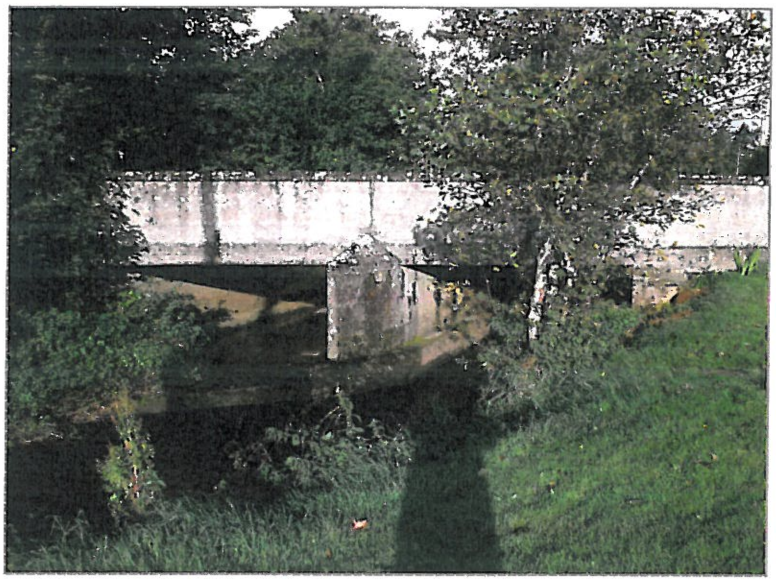
LMS/8623 – Strade River Bridge
WS Atkins Ireland Limited
Unit 2B 2200 Cork Airport Business Park, Cork, Ireland

Stanger
Stanger Testing Services Limited
Cambuslang Laboratory
Bogleshole Road Cambuslang
Glasgow G72 7DD
Telephone (0141) 641 3623
Fax (0141) 641 927

Revision No. : 1
Our Ref : LMS/8623
Issue Date : 24th January 2012

WS Atkins Ireland Limited
Atkins House
150-155 Airside Business Park
Swords
Co. Dublin

REPORT ON THE INVESTIGATION OF BRIDGE: STRADE RIVER BRIDGE MAP REF 69 STRUCTURE I.D: MO-N58-001.00 STRUCTURE FORM: SLAB, SLAB



Prepared by : James Maddison B.Eng (Hons)
Engineer

Approved by : P/ Billy Johnstone B.Eng (Hons)
Manager/Engineer

CONTENTS

1. INTRODUCTION

Stanger Testing Services Ltd. were instructed by WS Atkins Ireland Ltd. on behalf of The National Roads Authority to carry out an investigation under task order 213 stage of Strade River bridge .

The object of the investigation was to determine the following;

1). Core strength of various elements
2). Typical reinforcement and cover to concrete elements
3). Articulation of the slab
4). Type and presence of water proofing
5). Depth of slab
6). Beam dimensions
7). Depth of fill over slab

2. SITE WORKS

Stanger Testing Services carried out the investigation on the 1ST December 2011.
All traffic management was in accordance with Chapter 8 of the Traffic Signs Manual 2009. Prior to hand excavating trial pits, the area was scanned for services using a cat scan. Wet drilling techniques were used to extract core samples. Each core was logged, photographed and individually numbered prior to being sealed in a sample bag for return to the laboratory for testing. A Hilti Ferrocan was used to determine the cover and the reinforcement layout a small breakout was performed at main and secondary steel to confirm the results of the Ferroscan. A breakout was performed at the base of the slab to determine the articulation. All core holes and breakout were repaired using a fast setting concrete repair material. Trial pits were reinstated and compacted in layers not exceeding 100mm and stabilized with cement.

3. RESULTS

A) Concrete Cores

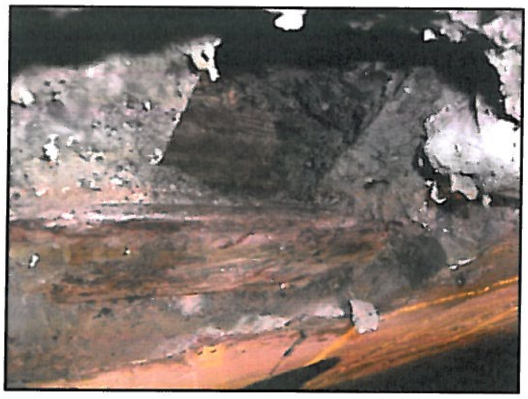
Core No.	Location	Compressive Strength (N/mm^2)	As Received Density (kg/m^3)
C1	**Soffit span 1**	**30.9**	**2380**
C2	**Soffit span 1**	**27.4**	**2360**
C3	**Soffit span 1**	**32.1**	**2390**
C4	**Soffit span 2**	**32.6**	**2430**
C5	**Soffit span 2**	**38.1**	**2420**
C6A	**Soffit span 2**	**28.5**	**2380**
C6B	**Soffit span 2**	**13.5**	**2320**

B) Cover Meter

Location: Soffit Span 1, Mid Span 1.8x1.8m (See Scan FB 011622)

Horizontal: Steel Beams Running From Abutment To Abutment (Slight Skew)
Beam Size: 125x125mm
Spacing: 600mm
Cover: 70mm

Vertical: Secondary Steel Running Parallel To Abutment (Slight Skew) Between Beams
Bar Size: 28x14mm Rectangular Bar
Spacing: 140mm
Cover: 60mm



Location: Soffit Span 1, Near Abutment 1.0x1.0m (See Scan FB 011626)

Horizontal: Steel Beams Running From Abutment To Abutment (Slight Skew)
Beam Size: 125x125mm
Spacing: 600mm
Cover: 70mm

Vertical: Secondary Steel Running Parallel To Abutment (Slight Skew) Between Beams
Bar Size: 28x14mm Rectangular Bar
Spacing: 140mm
Cover: 60mm

Location: Soffit Span 2, Mid Span 1.8x1.8m (See Scan FB 011621)

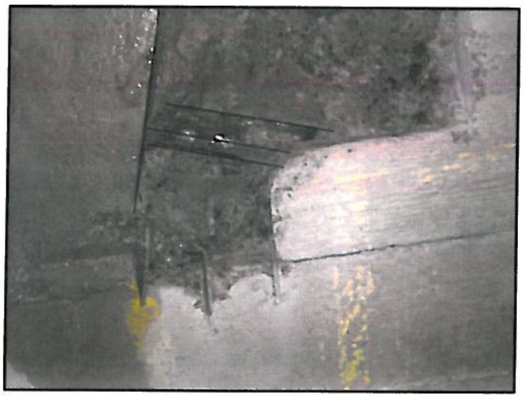
Horizontal: Steel Beams Running From Abutment To Abutment (Slight Skew)
Beam Size: 125x125mm
Spacing: 600mm
Cover: 60mm

Vertical: Secondary Steel Running Parallel To Abutment (Slight Skew) Between Beams
Bar Size: 28x14mm Rectangular Bar
Spacing: 140mm
Cover: 70mm

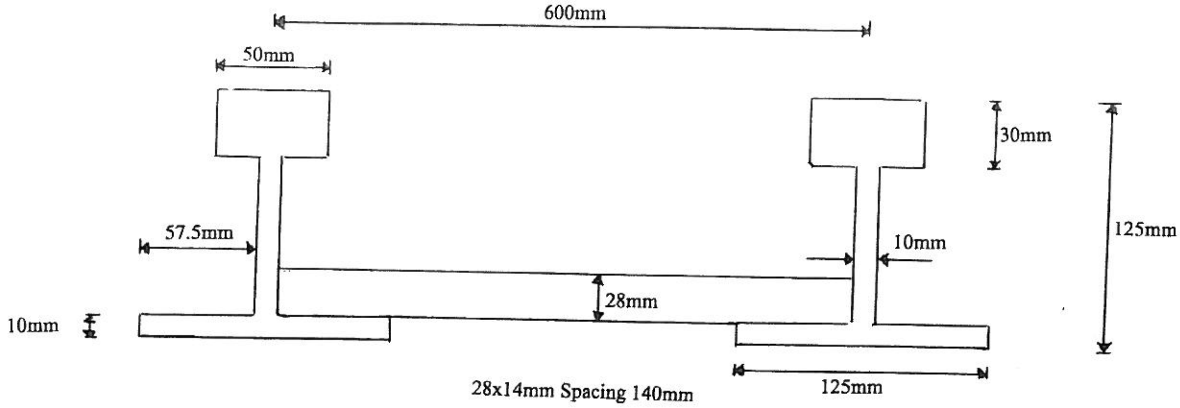
Location: Soffit Span 2, Near Abutment 1.0x1.0m (See Scan FB 011620)

Horizontal: Steel Beams Running From Abutment To Abutment (Slight Skew)
Beam Size: 125x125mm
Spacing: 600mm
Cover: 60mm

Vertical: Secondary Steel Running Parallel To Abutment (Slight Skew) Between Beams
Bar Size: 28x14mm Rectangular Bar
Spacing: 140mm
Cover: 70mm

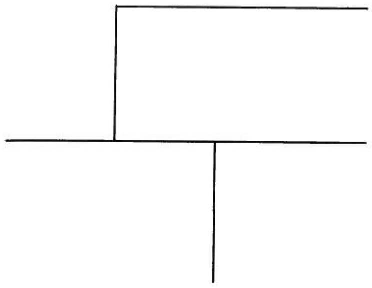


Strade River Bridge

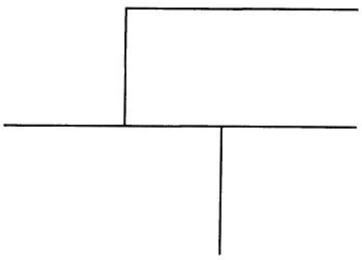


C) Articulation –

Location: Span No 1 (See Scan FB 11624)
None Found



Location: Span No 2 (See Scan FB 11619)
None Found



D) Trial Pit –
Location: Above Middle Pier In Verge 500mm From Parapet.
Note: Slab Is Not Continuous Over The Pier.

0.0 – 0.10 Topsoil
0.10 – 0.21 Granular Fill
0.21 – 0.23 Blacktop 10mm
0.23 – 0.57 Concrete

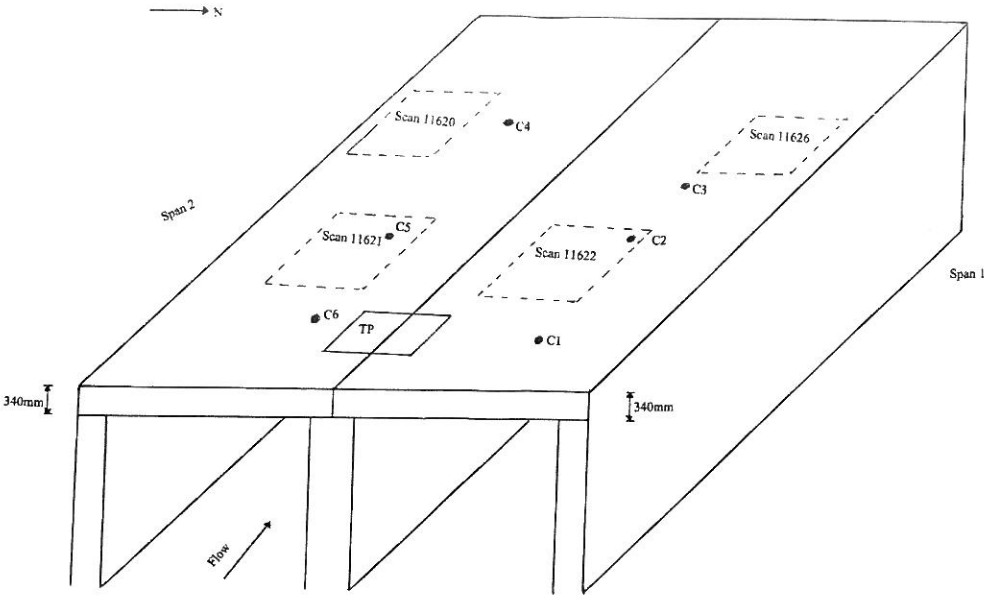
4. QUALITY STATEMENT

We can confirm that in preparing this report we have exercised all reasonable skill and care.

APPENDIX A

LOCATION PLAN

Strade River Bridge



APPENDIX B

CORE LOGS & COMP STRENGTH CERTIFICATES

Stanger

Your Ref :
Our Ref : LMS/8623
Date : 21 December 2011

W.S Atkins Ireland Limited
Atkins House
150-155 Airside Business Park
Swords
Co.Dublin

CERTIFICATE OF TEST FOR COMPRESSIVE STRENGTH OF CONCRETE CORES TO BS EN 12504-1 : 2009

Contract	:	Strade River Bridge
Designation	:	C1
Core Location	:	Soffit Span 1
Date Cored	:	01/12/2011
Date Cast	:	Not Stated
Date Received	:	12/12/2011
Sample Ref.	:	C1
GRN	:	23960
Cored By	:	Stanger Testing Services Ltd.
Estimated Maximum Aggregate Size	:	40mm
Max & Min Length as Received (mm)	:	160/150
Coring Direction	:	Vertical Up
Mean Diameter (mm)	:	92
Mean Length before End Preparation (mm)	:	90
Length/Diameter Ratio of Prepared Specimen (mm)	:	1.033
Position Relative to Total Length (mm)	:	20mm from top of core
Average Length after End Preparation (mm)	:	95
Method of End Preparation	:	Sulphur Sand
Density as Received (kg/m^3)	:	2380
Method	:	Water Displacement
Date of Test	:	16/12/2011
Age at Test Date	:	N/A
Time Stored in Water before Test (days)	:	1 Day
Surface Moisture at Test	:	Moist
Maximum Load at Failure (kN)	:	205.7
Appearance at Failure	:	Normal
Size, Position and Spacing of Reinforcement Bars	:	Not Applicable
Compressive Strength (N/mm^2)	:	30.9
Estimated In-Situ Cube Strength (N/mm^2)	:	31.3

Remarks:

Compaction	:	Good
Voids (%)	:	1
Honeycombing	:	None
Cracks	:	None
Aggregate Distribution	:	Even

N.B.: Please be advised that all samples (if not destroyed during the testing process) will be disposed of 7 days from the date of issue of this report unless we received written instruction to retain them, in which case charges may apply.

Laurie Murphy	Allan Reid	Billy Johnstone	James Maddison
Technical Director	**Laboratory Supervisor**	**Manager/Engineer**	**Engineer**

Stanger Testing Services Limited
Cambuslang Laboratory Bogleshole Road Cambuslang Glasgow G72 7DD Dundee Telephone (01382) 535272
Telephone (0141) 641 3623 Fax (0141) 641 9279 Fax (01382) 530899
Email: stangertesting@aol.com

UKAS TESTING 0251 Group

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 1

DATE CORED: 01/12/2011

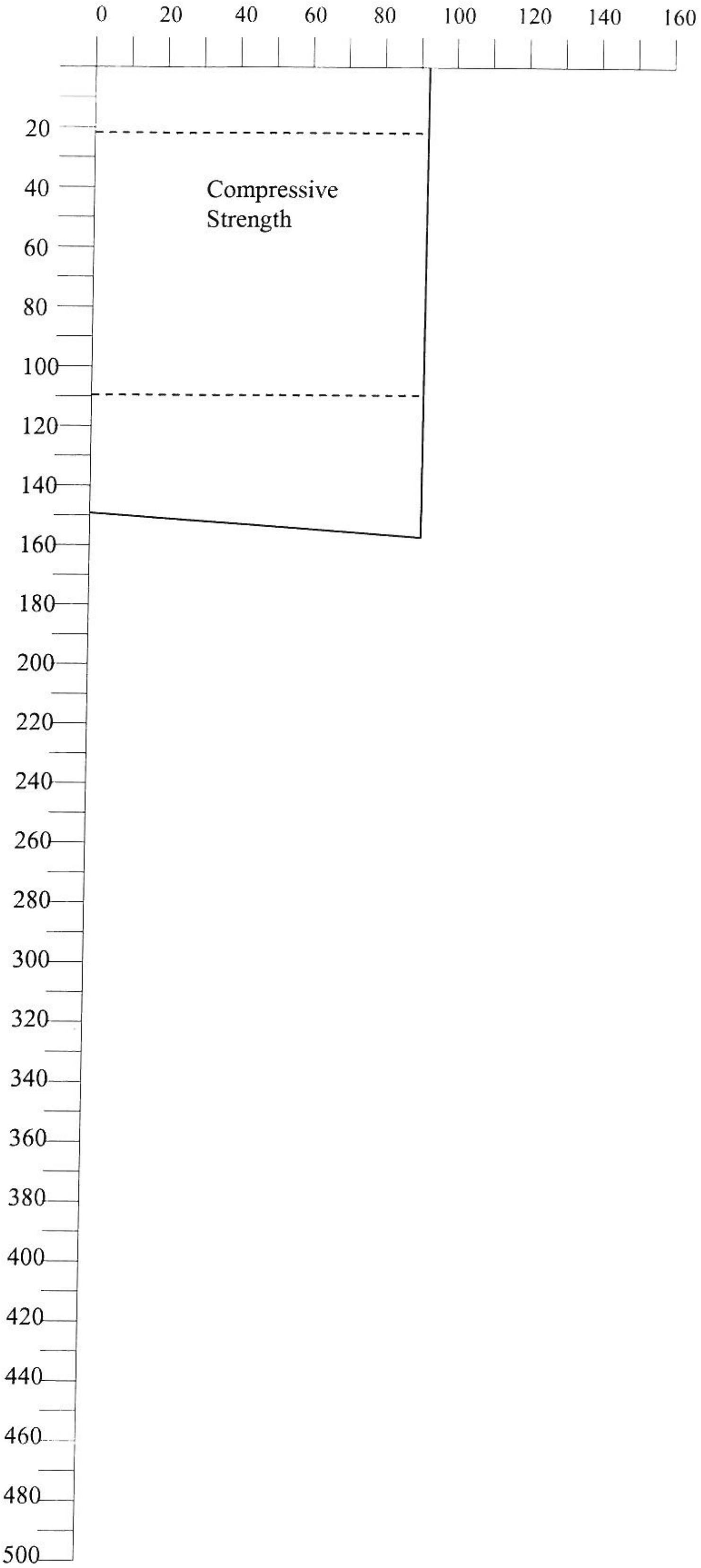
CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C1

PHOTOGRAPH: Yes

GRN: 23960



Aggregate Distribution	:	Even
Nominal Maximum Size	:	40mm
Compaction Remarks:		
Compaction	:	Good
Excess Voidage	:	1.0%
Honeycombing	:	None
Cracks	:	None
No of pieces	:	1
Type of Aggregate	:	Crushed Rock
Shape of Aggregate	:	Angular
Presence of Microcracking	:	N/A
Max/Min Length (mm)	:	150/160
Diameter (mm)	:	92mm
Depth of Carbonation	:	<1mm
Render	:	None
Repairs	:	None
Reinforcing Bars	:	None
No: N/A	Diameter:	N/A
Orientation of core With respect to structure	:	Vertical Up

Checked by : S.Lilley

Date : 16/12/2011

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 1

DATE CORED: 01/12/2011

CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C1

PHOTOGRAPH: Yes

GRN: 23960

Stanger

Your Ref :
Our Ref : LMS/8623
Date : 21 December 2011

W.S Atkins Ireland Limited
Atkins House
150-155 Airside Business Park
Swords
Co.Dublin

CERTIFICATE OF TEST FOR COMPRESSIVE STRENGTH OF CONCRETE CORES TO BS EN 12504-1 : 2009

Contract	:	Strade River Bridge
Designation	:	C2
Core Location	:	Soffit Span 1
Date Cored	:	01/12/2011
Date Cast	:	Not Stated
Date Received	:	12/12/2011
Sample Ref.	:	C2
GRN	:	23960
Cored By	:	Stanger Testing Services Ltd.
Estimated Maximum Aggregate Size	:	40mm
Max & Min Length as Received (mm)	:	140/120
Coring Direction	:	Vertical Up
Mean Diameter (mm)	:	92
Mean Length before End Preparation (mm)	:	92
Length/Diameter Ratio of Prepared Specimen (mm)	:	1.054
Position Relative to Total Length (mm)	:	20mm from top of core
Average Length after End Preparation (mm)	:	97
Method of End Preparation	:	Sulphur Sand
Density as Received (kg/m^3)	:	2360
Method	:	Water Displacement
Date of Test	:	16/12/2011
Age at Test Date	:	N/A
Time Stored in Water before Test (days)	:	1 Day
Surface Moisture at Test	:	Moist
Maximum Load at Failure (kN)	:	185.0
Appearance at Failure	:	Normal
Size, Position and Spacing of Reinforcement Bars	:	Not Applicable
Compressive Strength (N/mm^2)	:	27.4
Estimated In-Situ Cube Strength (N/mm^2)	:	28.0

Remarks:

Compaction	:	Fair
Voids (%)	:	1.0
Honeycombing	:	None
Cracks	:	None
Aggregate Distribution	:	Even

N.B.: Please be advised that all samples (if not destroyed during the testing process) will be disposed of 7 days from the date of issue of this report unless we received written instruction to retain them, in which case charges may apply.

Laurie Murphy	Allan Reid	Billy Johnstone	James Maddison
Technical Director	**Laboratory Supervisor**	**Manager/Engineer**	**Engineer**

Stanger Testing Services Limited
Cambuslang Laboratory Bogleshole Road Cambuslang Glasgow G72 7DD
Telephone (0141) 641 3623 Fax (0141) 641 9279
Email: stangertesting@aol.com
Dundee Telephone (01382) 535272
Fax (01382) 530899

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 1

DATE CORED: 01/12/2011

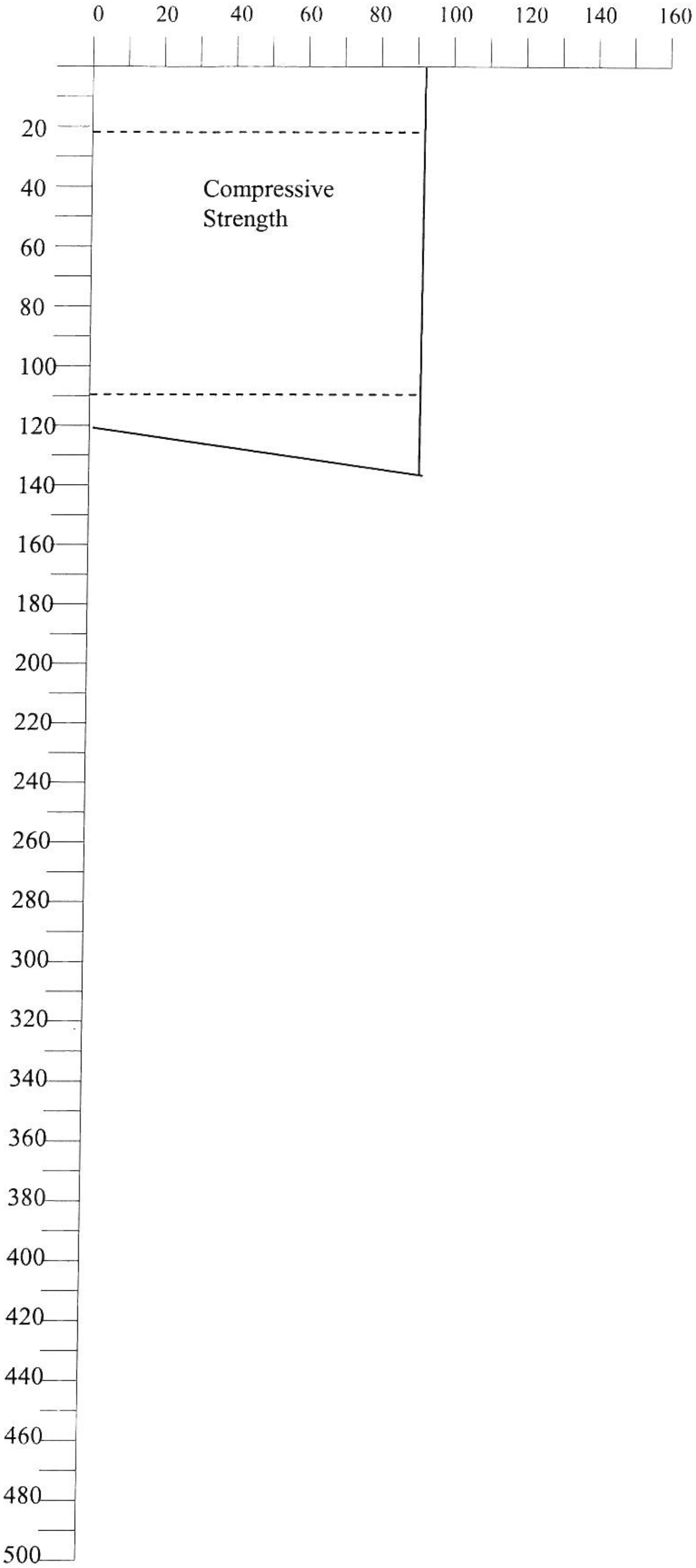
CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C2

PHOTOGRAPH: Yes

GRN: 23960



Aggregate Distribution	:	Even
Nominal Maximum Size	:	20mm
Compaction Remarks:		
Compaction	:	Fair
Excess Voidage	:	1.5%
Honeycombing	:	None
Cracks	:	None
No of pieces	:	1
Type of Aggregate	:	Crushed Rock
Shape of Aggregate	:	Angular
Presence of Microcracking	:	N/A
Max/Min Length (mm)	:	140/120
Diameter (mm)	:	92mm
Depth of Carbonation	:	<1mm
Render	:	None
Repairs	:	None
Reinforcing Bars	:	None
No: N/A	Diameter:	N/A
Orientation of core With respect to structure	:	Vertical Up

Checked by : S.Lilley

Date : 16/12/2011

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 1

DATE CORED: 01/12/2011

CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C2

PHOTOGRAPH: Yes

GRN: 23960

Stanger

Your Ref :
Our Ref : LMS/8623
Date : 21 December 2011

W.S Atkins Ireland Limited
Atkins House
150-155 Airside Business Park
Swords
Co.Dublin

CERTIFICATE OF TEST FOR COMPRESSIVE STRENGTH OF CONCRETE CORES TO BS EN 12504-1 : 2009

Contract	:	Strade River Bridge
Designation	:	C3
Core Location	:	Soffit Span 1
Date Cored	:	01/12/2011
Date Cast	:	Not Stated
Date Received	:	12/12/2011
Sample Ref.	:	C3
GRN	:	23960
Cored By	:	Stanger Testing Services Ltd.
Estimated Maximum Aggregate Size	:	40mm
Max & Min Length as Received (mm)	:	180/170
Coring Direction	:	Vertical Up
Mean Diameter (mm)	:	92
Mean Length before End Preparation (mm)	:	85
Length/Diameter Ratio of Prepared Specimen (mm)	:	0.99
Position Relative to Total Length (mm)	:	20mm from top of core
Average Length after End Preparation (mm)	:	91
Method of End Preparation	:	Sulphur Sand
Density as Received (kg/m^3)	:	2390
Method	:	Water Displacement
Date of Test	:	16/12/2011
Age at Test Date	:	N/A
Time Stored in Water before Test (days)	:	1 Day
Surface Moisture at Test	:	Moist
Maximum Load at Failure (kN)	:	213.3
Appearance at Failure	:	Normal
Size, Position and Spacing of Reinforcement Bars	:	Not Applicable
Compressive Strength (N/mm^2)	:	32.1
Estimated In-Situ Cube Strength (N/mm^2)	:	31.7

Remarks:

Compaction	:	Fair
Voids (%)	:	1.5
Honeycombing	:	None
Cracks	:	None
Aggregate Distribution	:	Even

N.B.: Please be advised that all samples (if not destroyed during the testing process) will be disposed of 7 days from the date of issue of this report unless we received written instruction to retain them, in which case charges may apply.

Laurie Murphy	Allan Reid	Billy Johnstone	James Maddison
Technical Director	**Laboratory Supervisor**	**Manager/Engineer**	**Engineer**

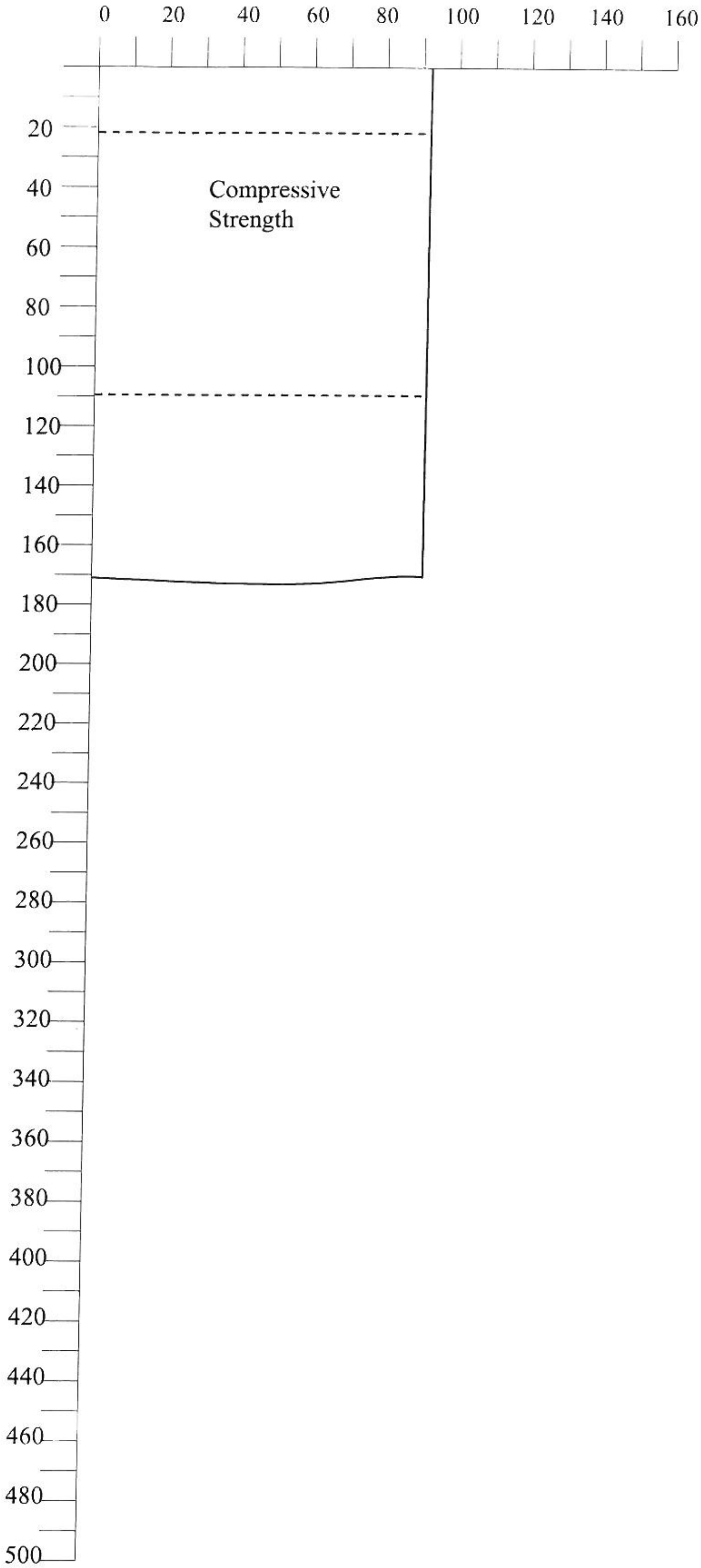
Stanger Testing Services Limited
Cambuslang Laboratory Bogleshole Road Cambuslang Glasgow G72 7DD   Dundee Telephone (01382) 535272
Telephone (0141) 641 3623   Fax (0141) 641 9279   Fax (01382) 530899
Email: stangertesting@aol.com

CONCRETE CORE LOG

CLIENT:	W.S Atkins Ireland Limited	FILE REF:	8623
STRUCTURE:	Strade River Bridge	LOCATION:	Soffit Span 1

DATE CORED: 01/12/2011 CORED BY: Stanger DATE REC'D: 12/12/2011

CORE MARK/No: C3 PHOTOGRAPH: Yes GRN: 23960



Aggregate Distribution	:	Even
Nominal Maximum Size	:	20mm
Compaction Remarks:		
Compaction	:	Fair
Excess Voidage	:	1.5%
Honeycombing	:	None
Cracks	:	None
No of pieces	:	1
Type of Aggregate	:	Crushed Rock
Shape of Aggregate	:	Angular
Presence of Microcracking:		N/A
Max/Min Length (mm)	:	180/170
Diameter (mm)	:	92mm
Depth of Carbonation	:	<1mm
Render	:	None
Repairs	:	None
Reinforcing Bars	:	None
No: N/A	Diameter:	N/A
Orientation of core With respect to structure	:	Vertical Up

Checked by : S.Lilley

Date : 16/12/2011

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 1

DATE CORED: 01/12/2011

CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C3

PHOTOGRAPH: Yes

GRN: 23960

Stanger

Your Ref :
Our Ref : LMS/8623
Date : 21 December 2011

W.S Atkins Ireland Limited
Atkins House
150-155 Airside Business Park
Swords
Co.Dublin

CERTIFICATE OF TEST FOR COMPRESSIVE STRENGTH OF CONCRETE CORES TO BS EN 12504-1 : 2009

Contract	:	Strade River Bridge
Designation	:	C4
Core Location	:	Soffit Span 2
Date Cored	:	01/12/2011
Date Cast	:	Not Stated
Date Received	:	12/12/2011
Sample Ref.	:	C4
GRN	:	23960
Cored By	:	Stanger Testing Services Ltd.
Estimated Maximum Aggregate Size	:	20mm
Max & Min Length as Received (mm)	:	225/225
Coring Direction	:	Vertical Up
Mean Diameter (mm)	:	92
Mean Length before End Preparation (mm)	:	93
Length/Diameter Ratio of Prepared Specimen (mm)	:	1.065
Position Relative to Total Length (mm)	:	30mm from top of core
Average Length after End Preparation (mm)	:	98
Method of End Preparation	:	Sulphur Sand
Density as Received (kg/m^3)	:	2430
Method	:	Water Displacement
Date of Test	:	16/12/2011
Age at Test Date	:	N/A
Time Stored in Water before Test (days)	:	1 Day
Surface Moisture at Test	:	Moist
Maximum Load at Failure (kN)	:	217.0
Appearance at Failure	:	Normal
Size, Position and Spacing of Reinforcement Bars	:	Not Applicable
Compressive Strength (N/mm^2)	:	32.6
Estimated In-Situ Cube Strength (N/mm^2)	:	33.5

Remarks:

Compaction	:	Good
Voids (%)	:	1
Honeycombing	:	None
Cracks	:	None
Aggregate Distribution	:	Even

N.B.: Please be advised that all samples (if not destroyed during the testing process) will be disposed of 7 days from the date of issue of this report unless we received written instruction to retain them, in which case charges may apply.

Laurie Murphy	Allan Reid	Billy Johnstone	James Maddison
Technical Director	**Laboratory Supervisor**	**Manager/Engineer**	**Engineer**

Stanger Testing Services Limited
Cambuslang Laboratory Bogleshole Road Cambuslang Glasgow G72 7DD
Telephone (0141) 641 3623 Fax (0141) 641 9279
Email: stangertesting@aol.com
Dundee Telephone (01382) 535272
Fax (01382) 530899

UKAS TESTING 0251 Group

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 2

DATE CORED: 01/12/2011

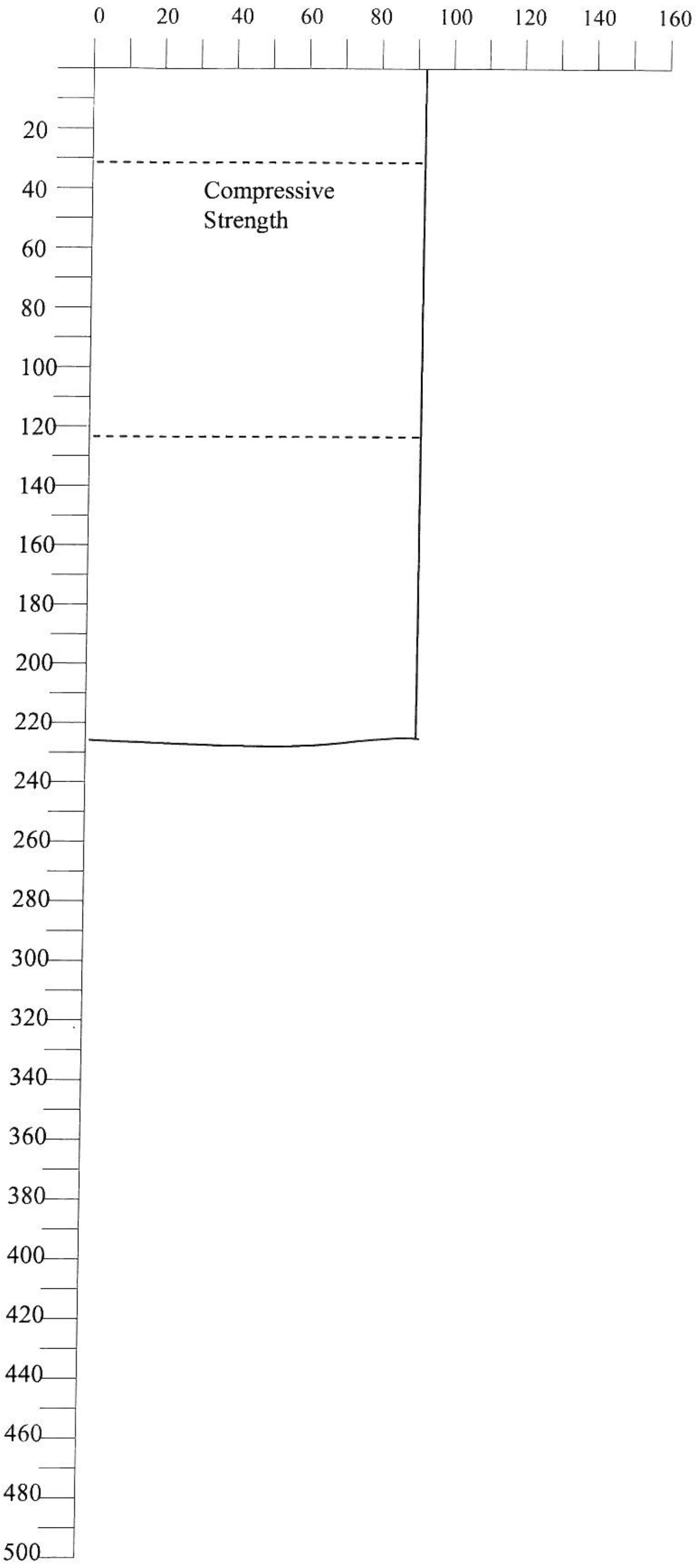
CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C4

PHOTOGRAPH: Yes

GRN: 23960



Aggregate Distribution	:	Even
Nominal Maximum Size	:	20mm
Compaction Remarks:		
Compaction	:	Good
Excess Voidage	:	1.0%
Honeycombing	:	None
Cracks	:	None
No of pieces	:	1
Type of Aggregate	:	Crushed Rock
Shape of Aggregate	:	Angular
Presence of Microcracking:		N/A
Max/Min Length (mm)	:	225/225
Diameter (mm)	:	92mm
Depth of Carbonation	:	<1mm
Render	:	None
Repairs	:	None
Reinforcing Bars	:	None
No: N/A	Diameter:	N/A
Orientation of core With respect to structure	:	Vertical Up

Checked by : S.Lilley

Date : 16/12/2011

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 2

DATE CORED: 01/12/2011

CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C4

PHOTOGRAPH: Yes

GRN: 23960

Stanger

Your Ref :
Our Ref : LMS/8623
Date : 21 December 2011

W.S Atkins Ireland Limited
Atkins House
150-155 Airside Business Park
Swords
Co.Dublin

CERTIFICATE OF TEST FOR COMPRESSIVE STRENGTH OF CONCRETE CORES TO BS EN 12504-1 : 2009

Contract	:	Strade River Bridge
Designation	:	C5
Core Location	:	Soffit Span 2
Date Cored	:	01/12/2011
Date Cast	:	Not Stated
Date Received	:	12/12/2011
Sample Ref.	:	C5
GRN	:	23960
Cored By	:	Stanger Testing Services Ltd.
Estimated Maximum Aggregate Size	:	40mm
Max & Min Length as Received (mm)	:	135/125
Coring Direction	:	Vertical Up
Mean Diameter (mm)	:	92
Mean Length before End Preparation (mm)	:	94
Length/Diameter Ratio of Prepared Specimen (mm)	:	1.076
Position Relative to Total Length (mm)	:	20mm from top of core
Average Length after End Preparation (mm)	:	99
Method of End Preparation	:	Sulphur Sand
Density as Received (kg/m^3)	:	2420
Method	:	Water Displacement
Date of Test	:	16/12/2011
Age at Test Date	:	N/A
Time Stored in Water before Test (days)	:	1 Day
Surface Moisture at Test	:	Moist
Maximum Load at Failure (kN)	:	253.0
Appearance at Failure	:	Normal
Size, Position and Spacing of Reinforcement Bars	:	Not Applicable
Compressive Strength (N/mm^2)	:	38.1
Estimated In-Situ Cube Strength (N/mm^2)	:	39.2

Remarks:

Compaction	:	Good
Voids (%)	:	1
Honeycombing	:	None
Cracks	:	None
Aggregate Distribution	:	Even

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Laurie Murphy
Technical Director

Allan Reid
Laboratory Supervisor

Billy Johnstone
Manager/Engineer

James Maddison
Engineer

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Dundee Telephone (01382) 535272
Fax (01382) 530899

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 2

DATE CORED: 01/12/2011

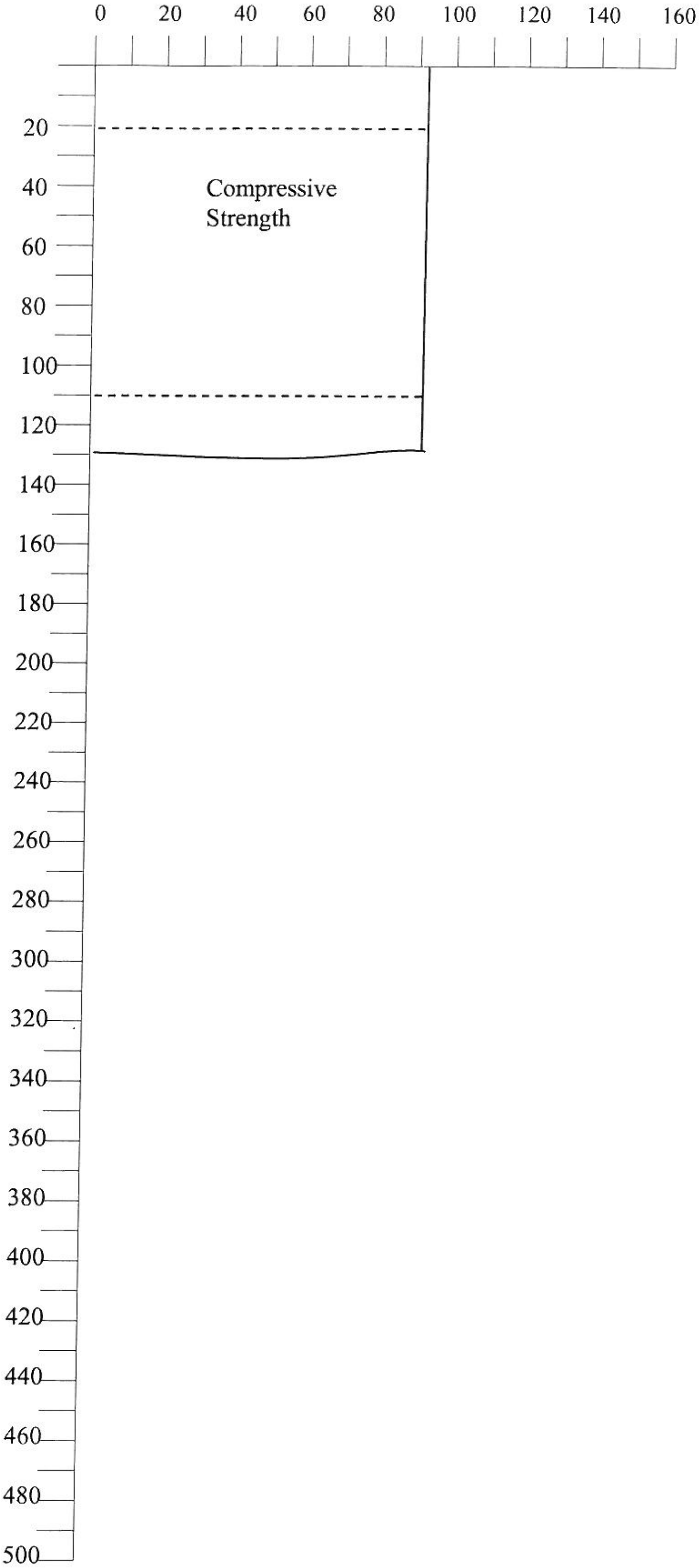
CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C5

PHOTOGRAPH: Yes

GRN: 23960



Aggregate Distribution	:	Even
Nominal Maximum Size	:	40mm
Compaction Remarks:		
Compaction	:	Good
Excess Voidage	:	1.0%
Honeycombing	:	None
Cracks	:	None
No of pieces	:	1
Type of Aggregate	:	Crushed Rock
Shape of Aggregate	:	Angular
Presence of Microcracking	:	N/A
Max/Min Length (mm)	:	125/135
Diameter (mm)	:	92mm
Depth of Carbonation	:	<1mm
Render	:	None
Repairs	:	None
Reinforcing Bars	:	None
No: N/A	Diameter:	N/A
Orientation of core With respect to structure	:	Vertical Up

Checked by : S.Lilley

Date : 16/12/2011

CONCRETE CORE LOG

CLIENT:	W.S Atkins Ireland Limited	FILE REF:	8623
STRUCTURE:	Strade River Bridge	LOCATION:	Soffit Span 2

DATE CORED: 01/12/2011 CORED BY: Stanger DATE REC'D: 12/12/2011

CORE MARK/No: C5 PHOTOGRAPH: Yes GRN: 23960

Stanger

Your Ref :
Our Ref : LMS/8623
Date : 21 December 2011

W.S Atkins Ireland Limited
Atkins House
150-155 Airside Business Park
Swords
Co.Dublin

CERTIFICATE OF TEST FOR COMPRESSIVE STRENGTH OF CONCRETE CORES
TO BS EN 12504-1 : 2009

Contract	:	Strade River Bridge
Designation	:	C6A
Core Location	:	Soffit Span 2
Date Cored	:	01/12/2011
Date Cast	:	Not Stated
Date Received	:	12/12/2011
Sample Ref.	:	C6A
GRN	:	23960
Cored By	:	Stanger Testing Services Ltd.
Estimated Maximum Aggregate Size	:	20mm
Max & Min Length as Received (mm)	:	340/340
Coring Direction	:	Vertical Down
Mean Diameter (mm)	:	92
Mean Length before End Preparation (mm)	:	85
Length/Diameter Ratio of Prepared Specimen (mm)	:	0.98
Position Relative to Total Length (mm)	:	20mm from top of core
Average Length after End Preparation (mm)	:	90
Method of End Preparation	:	Sulphur Sand
Density as Received (kg/m^3)	:	2440
Method	:	Water Displacement
Date of Test	:	16/12/2011
Age at Test Date	:	N/A
Time Stored in Water before Test (days)	:	1 Day
Surface Moisture at Test	:	Moist
Maximum Load at Failure (kN)	:	189.6
Appearance at Failure	:	Normal
Size, Position and Spacing of Reinforcement Bars	:	Not Applicable
Compressive Strength (N/mm^2)	:	28.5
Estimated In-Situ Cube Strength (N/mm^2)	:	28.3

Remarks:

Compaction	:	Good
Voids (%)	:	1.5
Honeycombing	:	None
Cracks	:	None
Aggregate Distribution	:	Even

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Laurie Murphy	Allan Reid	Billy Johnstone	James Maddison
Technical Director	**Laboratory Supervisor**	**Manager/Engineer**	**Engineer**

Stanger

Your Ref	:	
Our Ref	:	LMS/8623
Date	:	21 December 2011

W.S Atkins Ireland Limited
Atkins House
150-155 Airside Business Park
Swords
Co.Dublin

CERTIFICATE OF TEST FOR COMPRESSIVE STRENGTH OF CONCRETE CORES TO BS EN 12504-1 : 2009

Contract	:	Strade River Bridge
Designation	:	C6B
Core Location	:	Soffit Span 2
Date Cored	:	01/12/2011
Date Cast	:	Not Stated
Date Received	:	12/12/2011
Sample Ref.	:	C6B
GRN	:	23960
Cored By	:	Stanger Testing Services Ltd.
Estimated Maximum Aggregate Size	:	20mm
Max & Min Length as Received (mm)	:	340
Coring Direction	:	Vertical Up
Mean Diameter (mm)	:	92
Mean Length before End Preparation (mm)	:	85
Length/Diameter Ratio of Prepared Specimen (mm)	:	0.99
Position Relative to Total Length (mm)	:	220mm from top of core
Average Length after End Preparation (mm)	:	91
Method of End Preparation	:	Sulphur Sand
Density as Received (kg/m^3)	:	2320
Method	:	Water Displacement
Date of Test	:	16/12/2011
Age at Test Date	:	N/A
Time Stored in Water before Test (days)	:	1 Day
Surface Moisture at Test	:	Moist
Maximum Load at Failure (kN)	:	89.8
Appearance at Failure	:	Normal
Size, Position and Spacing of Reinforcement Bars	:	Not Applicable
Compressive Strength (N/mm^2)	:	13.5
Estimated In-Situ Cube Strength (N/mm^2)	:	13.3

Remarks:

Compaction	:	Good
Voids (%)	:	2.0
Honeycombing	:	None
Cracks	:	None
Aggregate Distribution	:	Even

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Technical Director	**Laboratory Supervisor**	**Manager/Engineer**	**Engineer**

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Dundee Telephone (01382) 535272
Fax (01382) 530899

CONCRETE CORE LOG

CLIENT: W.S Atkins Ireland Limited

FILE REF: 8623

STRUCTURE: Strade River Bridge

LOCATION: Soffit Span 2

DATE CORED: 01/12/2011

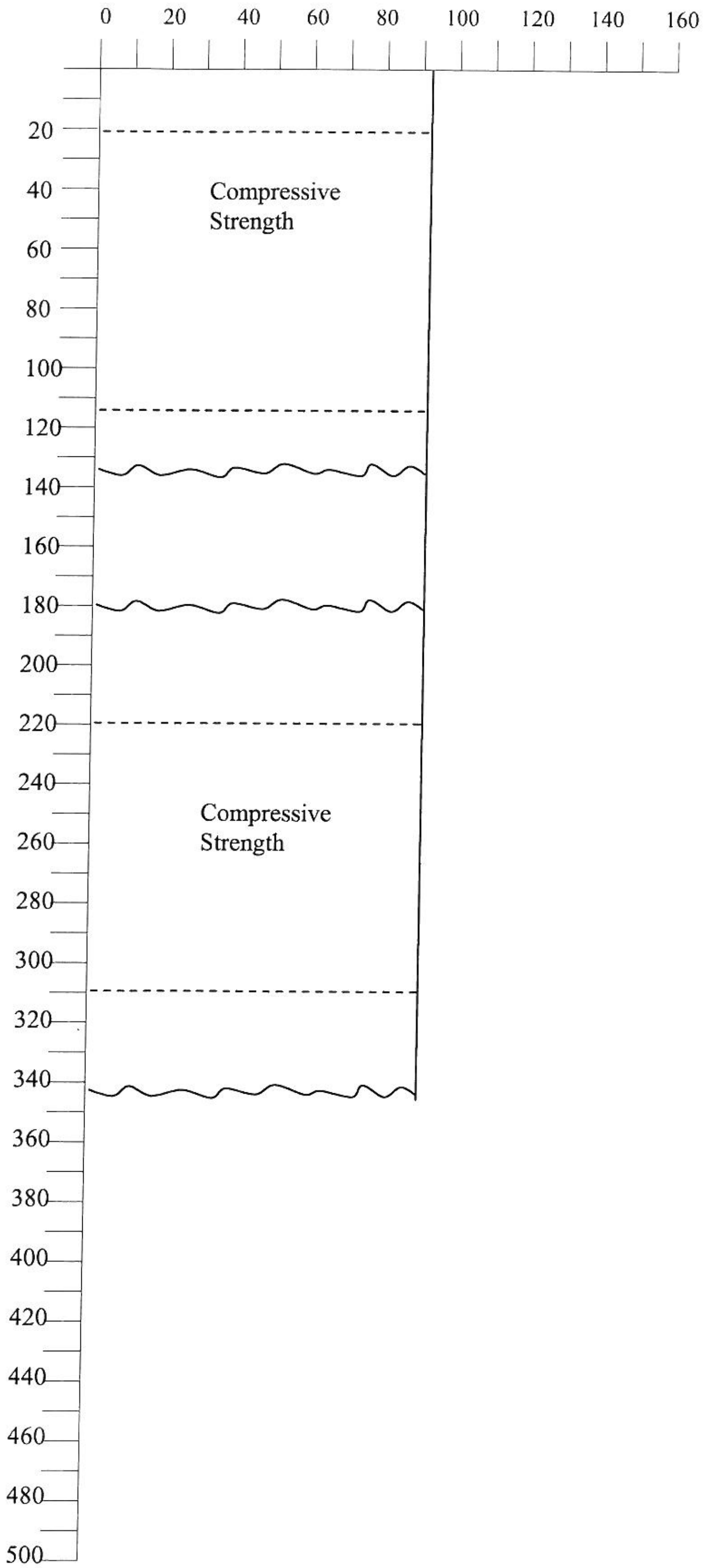
CORED BY: Stanger

DATE REC'D: 12/12/2011

CORE MARK/No: C6

PHOTOGRAPH: Yes

GRN: 23960



Aggregate Distribution	:	Even
Nominal Maximum Size	:	20mm
Compaction Remarks:		
Compaction	:	Good
Excess Voidage	:	1.5%
Honeycombing	:	None
Cracks	:	None
No of pieces	:	3
Type of Aggregate	:	Crushed Rock
Shape of Aggregate	:	Angular
Presence of Microcracking	:	N/A
Max/Min Length (mm)	:	340/340
Diameter (mm)	:	92mm
Depth of Carbonation	:	<1mm
Render	:	None
Repairs	:	None
Reinforcing Bars	:	None
No: N/A	Diameter:	N/A
Orientation of core With respect to structure	:	Vertical Up

Checked by : S.Lilley

Date : 16/12/2011

CONCRETE CORE LOG

CLIENT:	W.S Atkins Ireland Limited	FILE REF:	8623
STRUCTURE:	Strade River Bridge	LOCATION:	Soffit Span 2

DATE CORED: 01/12/2011 CORED BY: Stanger DATE REC'D: 12/12/2011

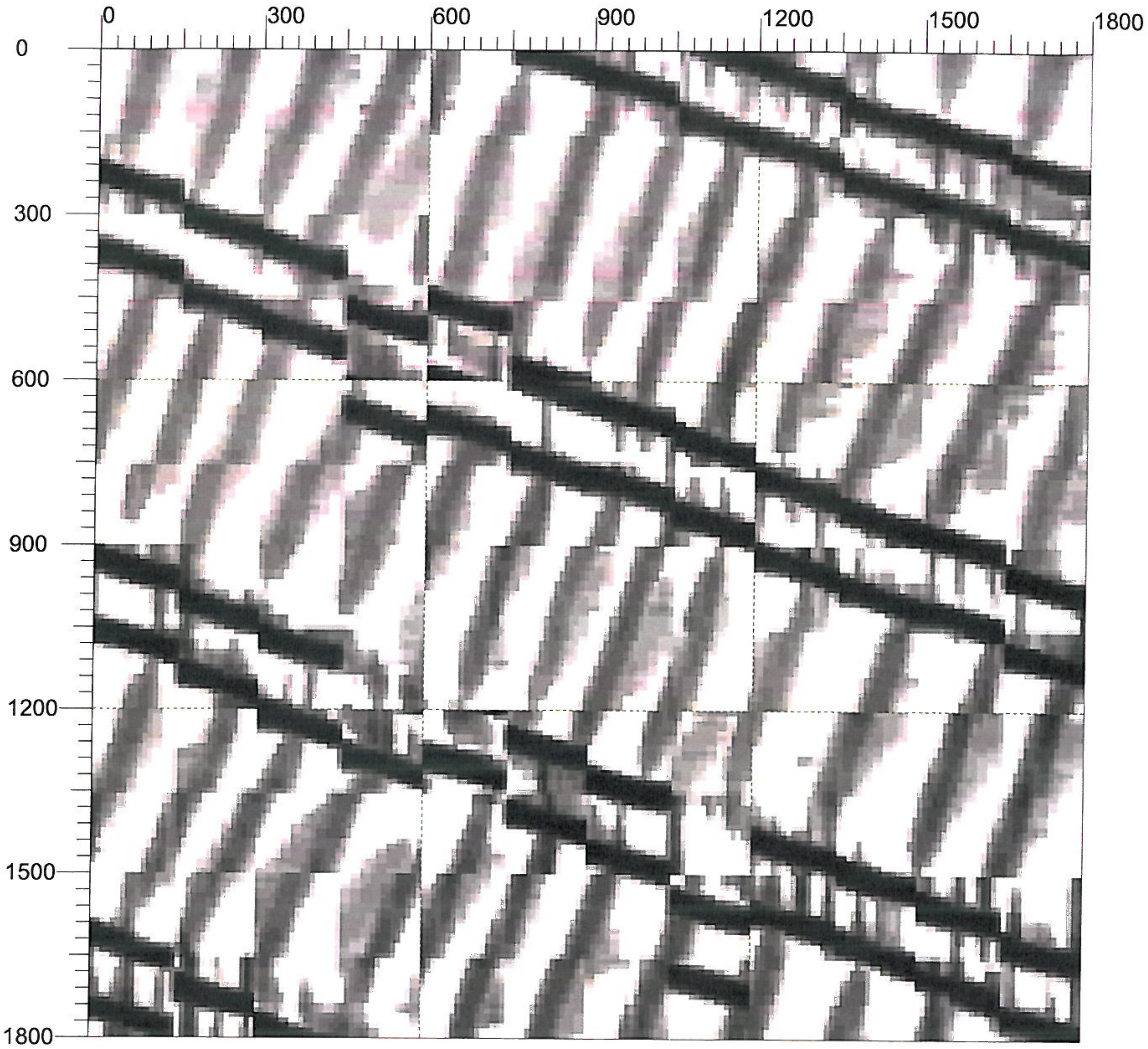
CORE MARK/No: C6 PHOTOGRAPH: Yes GRN: 23960

APPENDIX C

FERROSCANS

Blockscan: FB011622.XFF

Date / Time: 2011-11-30 13:14:45 SSN: 04310005 [mm]



Customer: W.S Atkins

Location: Soffit Span No 1, Mid Span 1.8x1.8m Operator: B.Johnstone

Comment:

Horizontal: Steel Beams Running From Abutment To Abutment (Slight Skew)
Beam Size: 125x125mm
Spacing: 600mm
Cover: 70mm

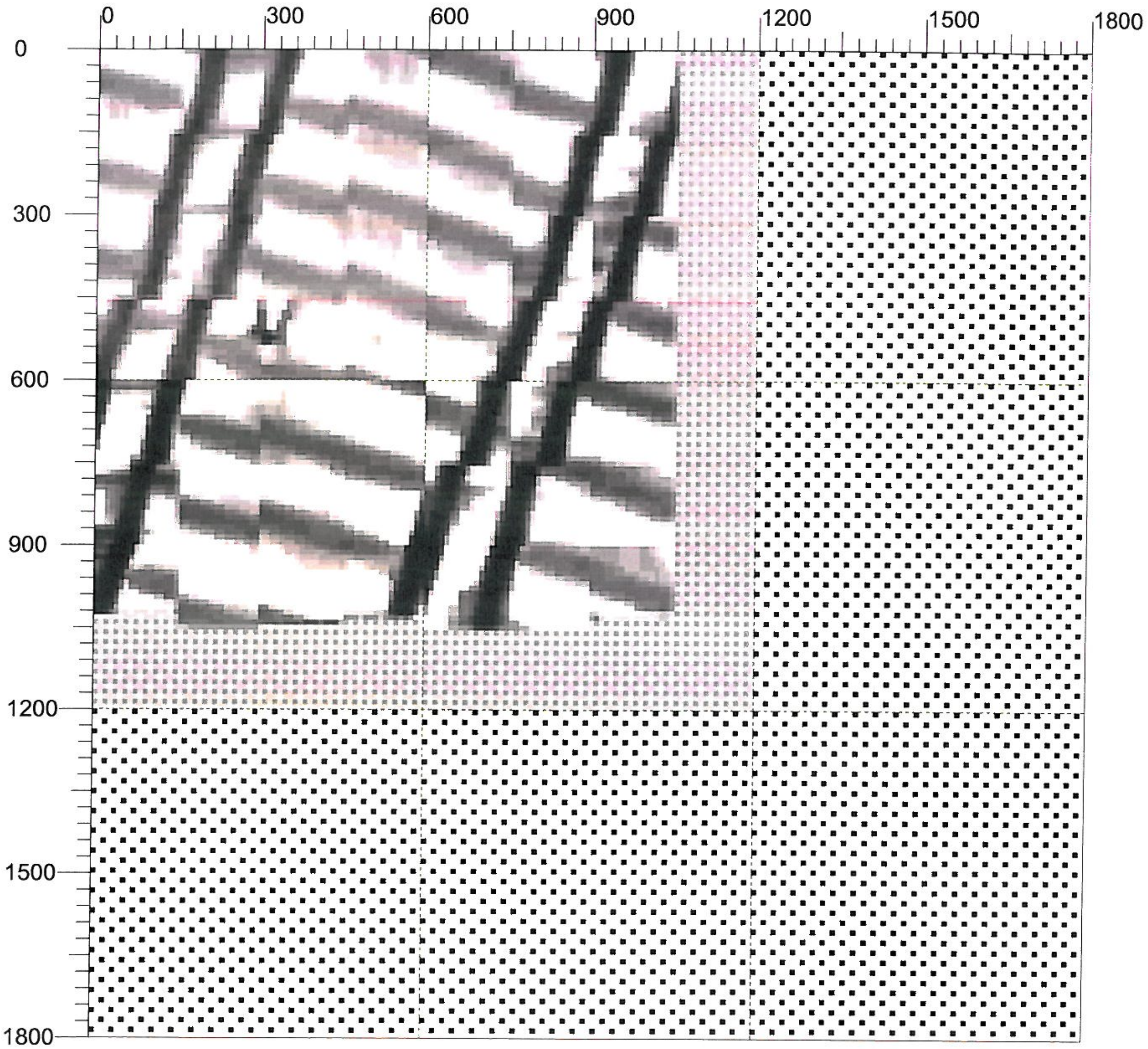
Vertical: Secondary Steel Running Parallel To Abutment (Slight Skew) Between Beams
Bar Size: 28x14mm Rectangular Bar
Spacing: 140mm
Cover: 60mm

File Storage: Z:\PROJEC~1\IRELAN~1\STRADE~1\Prj00003\FB011622.XFF

Project:

Blockscan: FB011626.XFF

Date / Time: 2011-11-30 14:58:30 SSN: 04310005 [mm]



Customer: W.S Atkins

Location: Soffit Span No 1 Near Abutment 1.0x1.0merator: B.Johnstone

Comment:

Horizontal: Steel Beams Running From Abutment To Abutment (Slight Skew)
Beam Size: 125x125mm
Spacing: 600mm
Cover: 70mm

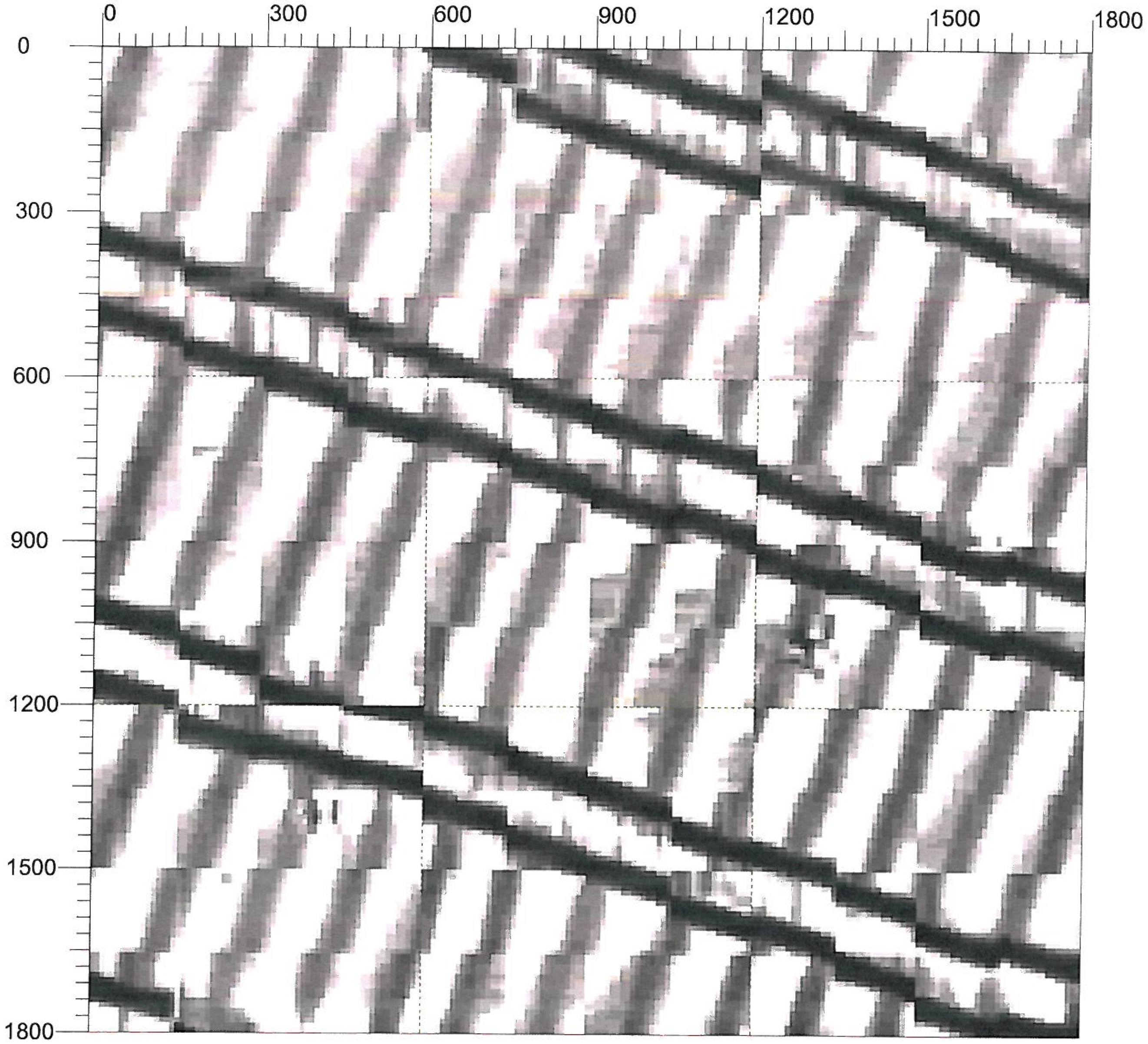
Vertical: Secondary Steel Running Parallel To Abutment (Slight Skew) Between Beams
Bar Size: 28x14mm Rectangular Bar
Spacing: 140mm
Cover: 60mm

File Storage: Z:\scott\11111\MON580~1\Prj00003\FB011626.XFF

Project:

Blockscan: FB011621.XFF

Date / Time: 2011-11-30 12:27:51 SSN: 04310005 [mm]



Customer: W.S Atkins

Location: Soffit Span No 2, Mid Span 1.8x1.8m Operator: B.Johnstone

Comment:

Horizontal: Steel Beams Running From Abutment To Abutment (Slight Skew)
Beam Size: 125x125mm
Spacing: 600mm
Cover: 60mm

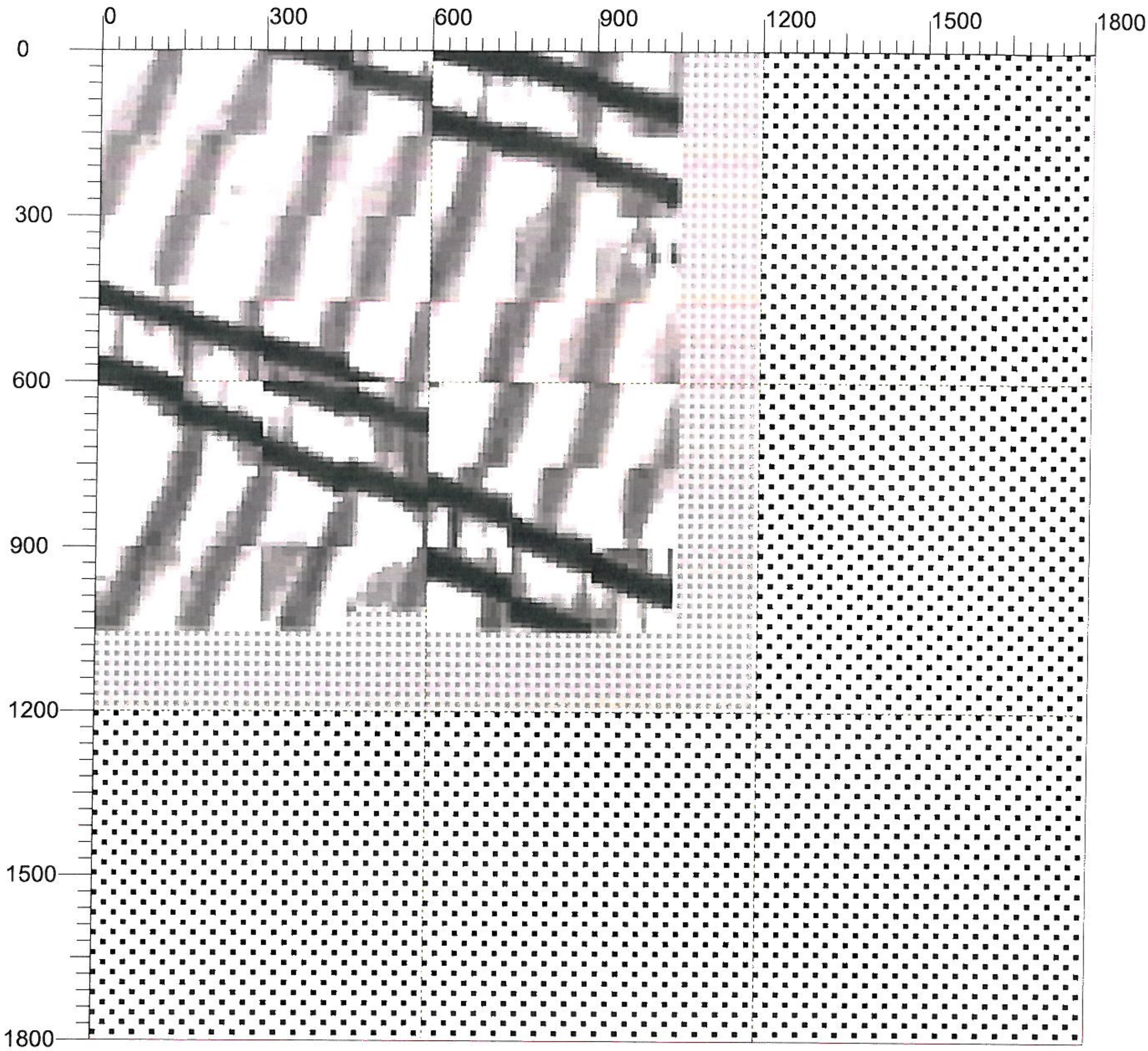
Vertical: Secondary Steel Running Parallel To Abutment (Slight Skew) Between Beams
Bar Size: 28x14mm Rectangular Bar
Spacing: 140mm
Cover: 70mm

File Storage: Z:\scott\11111\MON580~1\Prj00003\FB011621.XFF

Project:

Blockscan: FB011620.XFF

Date / Time: 2011-11-30 12:13:15 SSN: 04310005 [mm]



Customer: W.S Atkins

Location: Soffit Span No 2 Near Abtument 1.0x1.0merator: B.Johnstone

Comment:

Horizontal: Steel Beams Running From Abutment To Abutment (Slight Skew)
Beam Size: 125x125mm
Spacing: 600mm
Cover: 60mm

Vertical: Secondary Steel Running Parallel To Abutment (Slight Skew) Between Beams
Bar Size: 28x14mm Rectangular Bar
Spacing: 140mm
Cover: 70mm

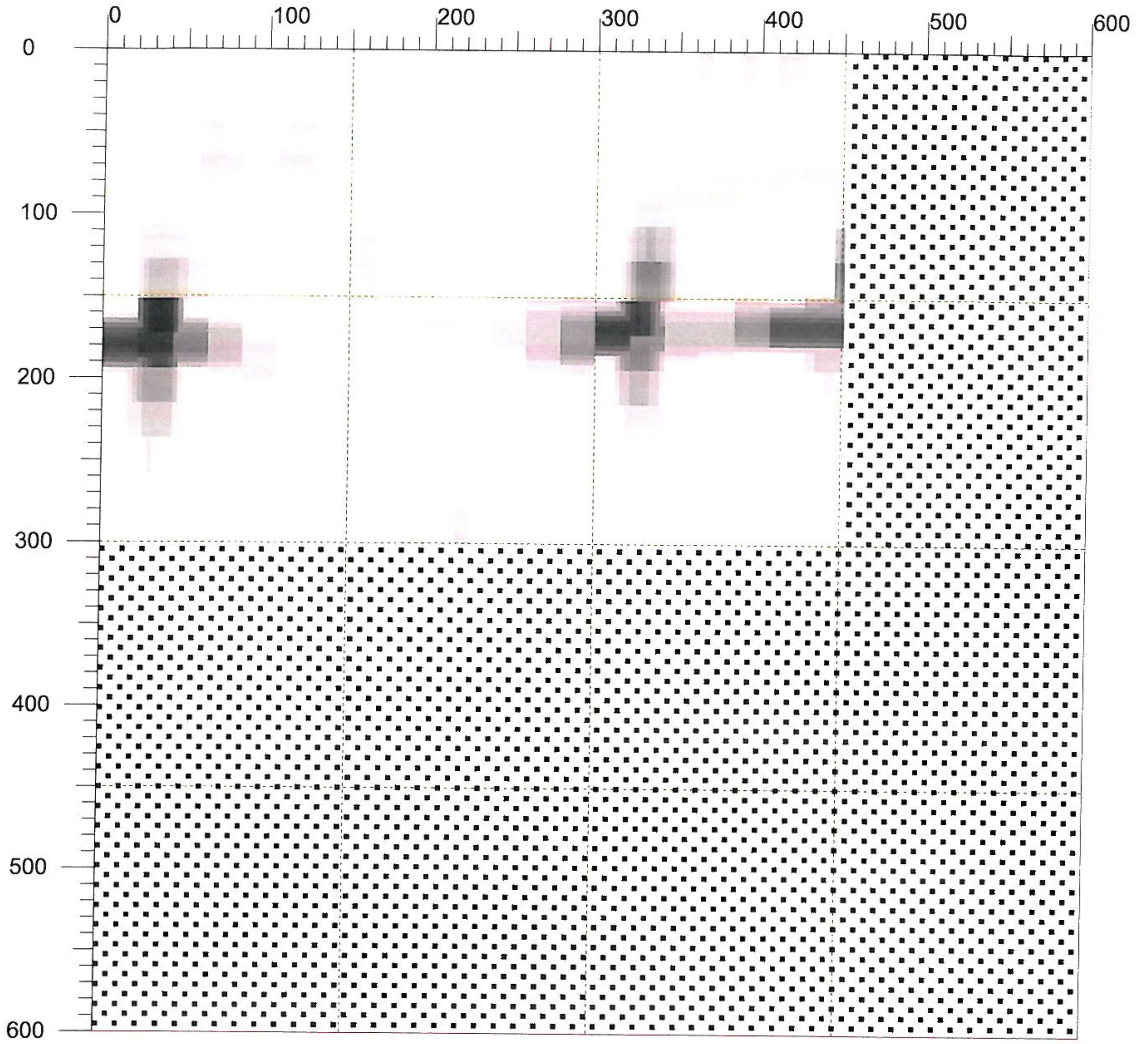
File Storage: Z:\scott\11111\MON580~1\Prj00003\FB011620.XFF

Project:

Imagescan: FS011624.XFF

Date / Time: 2011-11-30 14:17:29

SSN: 04310005 [mm]



Customer: W.S Atkins

Location: Span No 1

Operator: B.Johnstone

Comment:

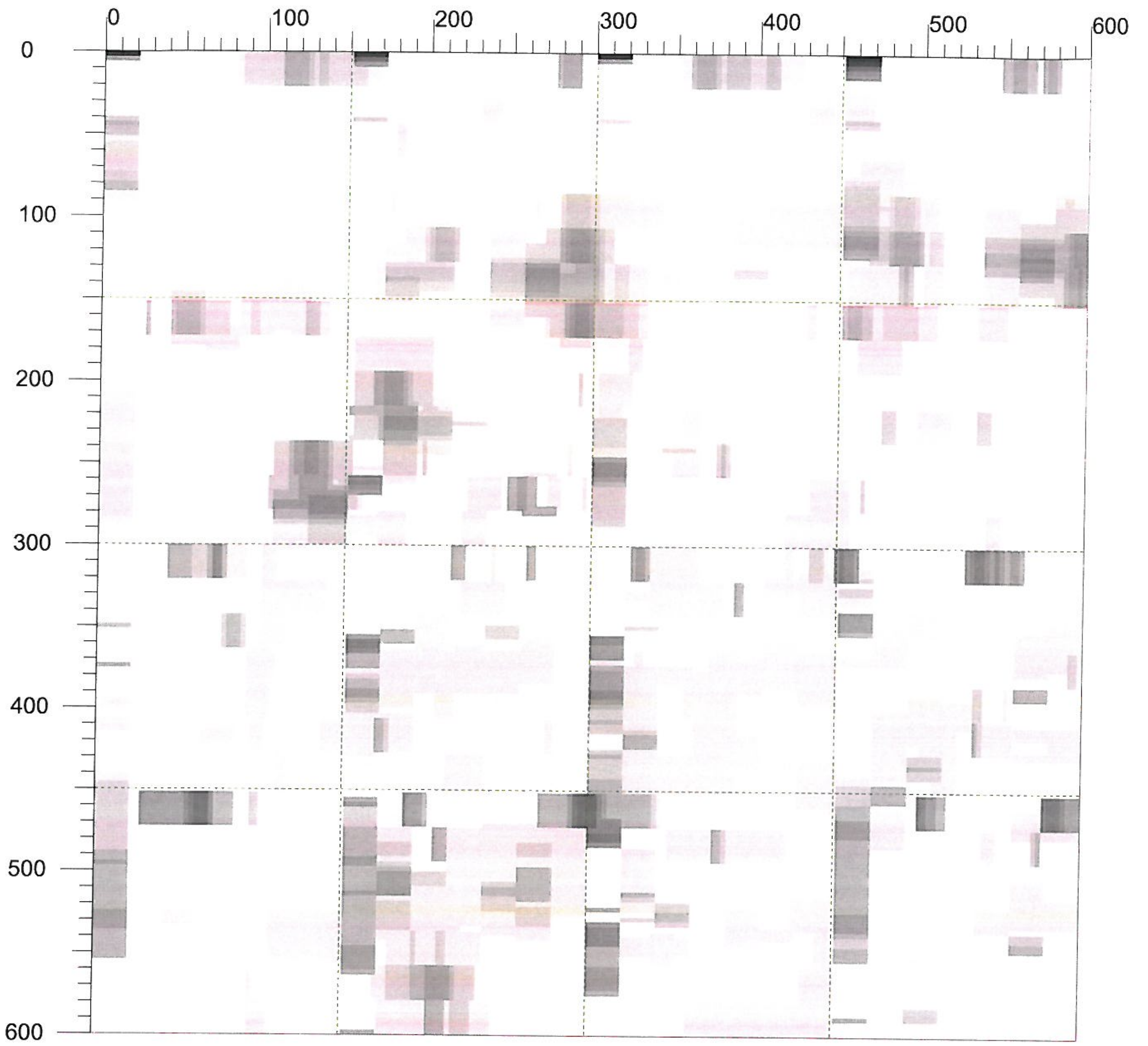
None Found

File Storage: Z:\scott\11111\MON580~1\Prj00003\FS011624.XFF

Project:

Imagescan: FS011619.XFF

Date / Time: 2011-11-30 11:29:52 SSN: 04310005 [mm]



Customer: W.S Atkins

Location: Span No 2 Operator: B.Johnstone

Comment:

None Found

File Storage: Z:\scott\11111\MON580~1\Prj00003\FS011619.XFF

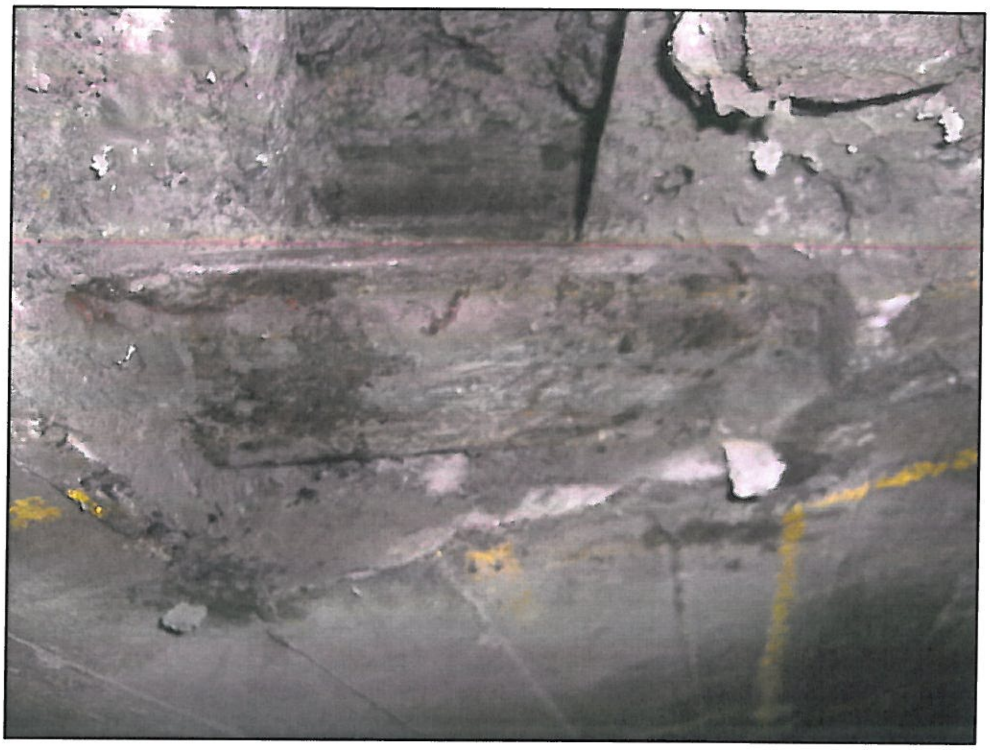
Project:

APPENDIX D

PLATE PAGES

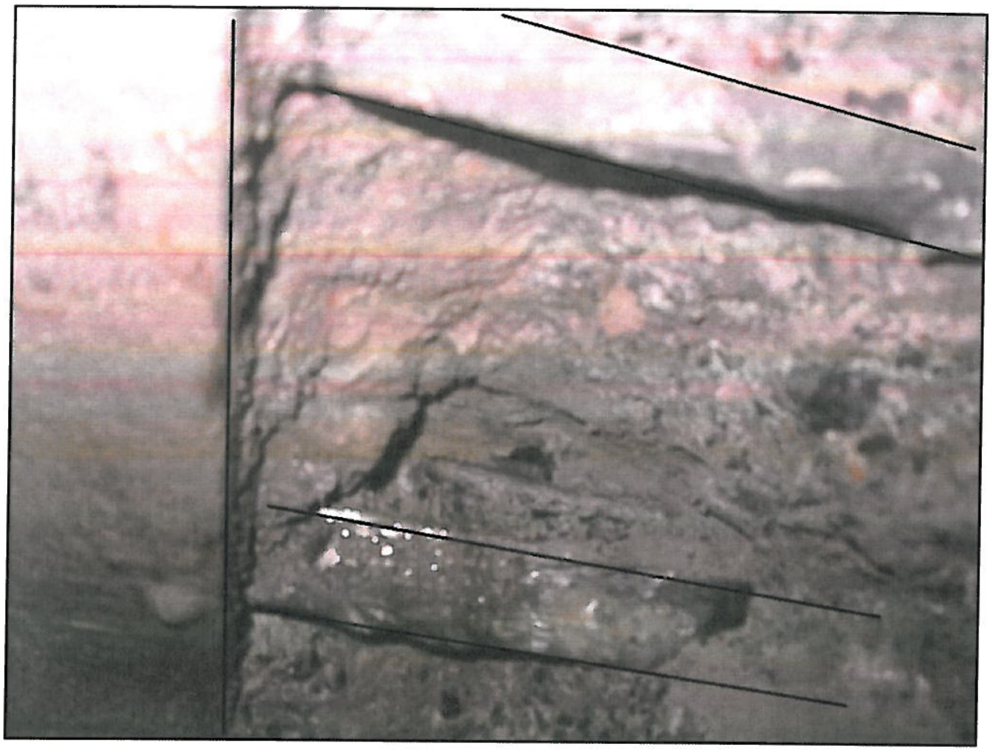
Beam

Beam

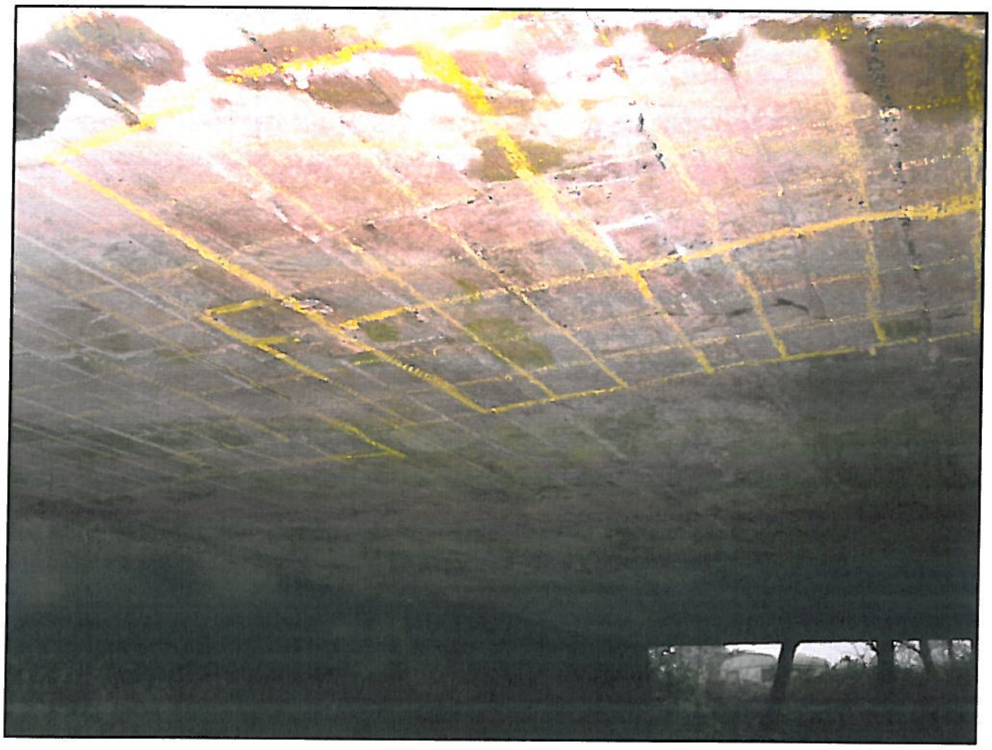


Beam

Beam



Beam



Scan Location

Appendix D

Calculations

ASSESSMENT SUMMARY: **Filler Beam - Span 1 (South)**

	HA UDL & KEL	Single Axle	Single Wheel	HB	Punching Shear
Moment	40t	18t	18t	<30HB	-
Shear	40t	<40t	<40t	<45HB	0
Bond	<3t	-	-	<30HB	-

CALCULATION OF REBAR SPACING

MID SPAN

App. C1 /SI Report

Spacing (mm)	MAIN BEAM
	600
Average beam spacing	600

Depth of beam 125 mm
Bottom Cover 60 mm

NEAR SUPPORT

App. C1 /SI Report

Spacing (mm)	MAIN BEAM
	600
Average rebar spacing	600

Depth of beam 125 mm
Bottom Cover 60 mm

Ref	Calculations	Output

CALCULATION OF WORST CREDIBLE STRENGTH

Input a maximum of 11 Core samples

App.C2
SI Report

LOCATION	CORE REFERENCE	ESTIMATED IN-SITU CUBE STRENGTH N/mm^2 (f_c)	(fc - MEAN)^2
	C4	33.5	23.36
	C5	39.2	110.95
	C6b	13.3	236.13
			-
			-
			-
			-
			-
			-
			-
	TOTAL	86	370.44667
	No of cores	**3**	
	MEAN	**28.67**	
	Standard Deviation	**13.61**	

WCS will be calculated using 2 different methods:

1) LOCATION : Using equation from BA 44/96 with n = total number of core samples

Note - only use this for cores taken at the location of interest

n = 3

From BA 44/90, WCS = (Total fc*(100-(20/n^0.5)))/100n

WCS = **25.4 N/mm^2**

2) LOWEST CORE STRENGTH :

Lowest core strength = 13.3 N/mm2

WCS = **13.3 N/mm^2**

Using the above results and engineering judgement,
the proposed WCS = 13.3 N/mm^2

SAGGING - SECTION PROPERTIES (Using BS 5400 Part 3;2000) for composite section

		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	Panel Length (mm)	Section depth mm
Slab	Slab	600	340		13.3	23.6		125
Haunch		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	NA	
	Haunch	0	0		0	0	NA	
Girder		Width (mm)	Depth (mm)		f_y (MPa)	E (GPa)		m
	Top Flange	50	30		230	205.0		8.69
	Web	10	85		230	205.0		
	Bottom Flange	125	10		230	205.0		
	Bottom Cover		60	mm				

e) Plastic Section Properties

Condition factor for RC Filler | - | 0.9

nb if NA lies below the web this doesn't work

Stress in concrete = $0.4*f_{cu}$

Stress in steel = σ_y/γ_m γ_m = 1.05

	Depth (mm)	Width (mm)	Area (mm^2)	Stress (Nmm^{-2})	Force (kN)	Force above NA (kN)	Force below NA (kN)	y above NA (mm)	y below NA (mm)
Slab*	155	600	93000	5	495	495	-	91	-
Haunch	0	0	0	0	0	0	-	0	-
Top Flange	30	50	1500	219	329	147	182	7	8
Web	85	10	850	219	186	0	186	-17	59
Bottom Flange	10	125	1250	219	274	-	274	-	107

*Concrete above beam only taken in properties

NA lies in Top Flange

Depth of Neutral Axis From Top Slab

Concrete $M_{plastic}$ = 45 **kNm**
Single Beam $M_{plastic}$ = 38 **kNm**

	Depth (mm)
Slab	0.0
Haunch	0.0
Top Flange	168.4
Web	0.0

m= 0.0

Depth of Plastic NA = **168.4** 171.6

f) Compactness Check

Ref						(Compact?)
9.3.7.2	If m < 0.5	Check web depth is less than	$(34t_w/m)*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If m > 0.5	Check web depth is less than	$(374t_w/(13m-1))*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If web fully in tension section is compact					yes

Section is Compact

SAGGING - PLASTIC CHECKS (Using BS 5400 Part 3;2000)

2. ULS Bending Capacity of Section

$M_{plastic}$ = 88 kNm

$M_{pe\ (unfactored)}$ = 92 kNm

$M_D = M_{pe}$ / 1.05 x 1.1 = 72 kNm (Also Adjusted by condition factor)

3/9.9.2.2 **3. ULS Pure Shear Capacity of Section**

Depth of panel = d_{we} = 85 mm

Aspect Ratio = $\varphi = a/d_{we}$ = 1.000

b_{fe} (top flange) = 0 | b_{fe} (bottom flan = 0

m_{fw} (top flange) = $\sigma_{yf}b_{fe}t_f^2/(2d_{we}^2t_w\sigma_{yw})$ = 0.1557 | m_{fw}(bot) = $\sigma_{yf}b_{fe}t_f^2/(2d_{we}^2t_w\sigma_{yw})$ 0.0433

Minimum value of m_{fw} for use in shear calcs. = 0.0433 | $\lambda = (d_{we}/t_w)x(\sigma_{yw}/355)^{1/2}$ = 6.8

$\tau_y = \sigma_{yw}/\sqrt{3}$ = 132.79

3/Fig12-18 τ_l/τ_y for m_{fw} of 0.0433 = 1.300 τ_l = 172.58

τ_l/τ_y for m_{fw} of 0.000 = 1.300 τ_l = 172.58

3/9.9.2.2 $V_D = (d_w t_w x\tau_l) / (\gamma_m\gamma_{f3})$ = 114.3 kN When m_{fw} = 0.1557 (Adjusted by condition factor)

V_R = "" = 114.3 kN When m_{fw} = 0.0000 (Adjusted by condition factor)

SAGGING - SECTION PROPERTIES (Using BS 5400 Part 3;2000) for Steel Section (IGNORING CONCRETE)

Slab		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	Panel Length (mm)	Section depth mm
	Slab	600	125		13.3	23.591		125
Haunch		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	*NA*	
	Haunch	0	0		0	0	*NA*	
Girder		Width (mm)	Depth (mm)		f_y (MPa)	E (GPa)		
	Top Flange	50	30		230	205		
	Web	10	85		230	205		
	Bottom Flange	125	10		230	205		
	Bottom Cover		60	mm				

Condition factor for RC Filler | - | 0.9

e) Plastic Section Properties

nb if NA lies below the web this doesn't work

Stress in concrete = $0.4 \cdot f_{cu}$

Stress in steel = σ_y/γ_m γ_m = 1.05

	Depth (mm)	Width (mm)	Area (mm^2)	Stress (Nmm^{-2})	Force (kN)	Force above NA (kN)	Force below NA (kN)	y above NA (mm)	y below NA (mm)
Slab*	-60	600	-36000	5	-192	-192	-	74	-
Haunch	0	0	0	0	0	0	-	0	-
Top Flange	30	50	1500	219	329	329	0	89	-74
Web	85	10	850	219	186	161	25	37	6
Bottom Flange	10	125	1250	219	274	-	274	-	16

*Concrete above beam only taken in properties

NA lies in Web

Depth of Neutral Axis From Top Slab

	Depth (mm)
Slab	0.0
Haunch	0.0
Top Flange	0.0
Web	43.7

Concrete $M_{plastic}$ = -14 **kNm**

Single Beam $M_{plastic}$ = 36 **kNm**

m= 0.9

Depth of Plastic NA = 43.7

f) Compactness Check

Ref						(Compact?)
9.3.7.2	If m < 0.5	Check web depth is less than	$(34t_w/m)*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If m > 0.5	Check web depth is less than	$(374t_w/(13m-1))*(355/\sigma_{yw})$^0.5	452.2410439	mm	yes
	If web fully in tension section is compact					n/a

Section is Compact

SAGGING - PLASTIC CHECKS (Using BS 5400 Part 3;2000)

2. ULS Bending Capacity of Section

$M_{plastic}$ = 26 kNm

$M_{pe\ (unfactored)}$ = 27 kNm

$M_D = M_{pe}$ / 1.05 x 1.1 = 21 kNm (Also Adjusted by condition factor)

Ref	Calculations	Output
BD21/01		

Slab Details :

Filler Beam - Span 1 (South)

Depth of slab	(mm)	340
Clear Span	(m)	**3.36**
Effective Span	(m)	3.64
Slab width	(mm)	**600**
Depth of fill above RC Slab	(mm)	**230**
Condition factor for RC Slab	-	**0.90**

Cl 5.3.1.1 of BD44/95 (Ref)

water seepage, localised calcite staining & stalactites

SI Report (Ref)

Material Details :

Main Tension Steel	**Beam Depth**	(mm)	125
	Spacing	(mm)	**600**
	As	(mm2)	4433
Concrete cover to tension steel		(mm)	60
Secondary reinforcement dia		(mm)	0
Is tension steel the outer layer of rebar?		Y/N	**Y**
effective depth	d	(mm)	280
Concrete Density		kN/m3	**23.9**
Surfacing Density		kN/m3	**23.0**
Fill Density		kN/m3	**20.0**
Concrete WCS Strength	WCS, fcu		13
Steel Characteristic Strength	fy	(N/mm2)	230
Material Factor for Concrete	Ymc		1.20
Material Factor for Steel	Yms		1.05

Page 2 Cl. 4.4 of BD21 Table 4A of BD44/95 (Ref)

Calculation of Moment Capacity of Section at Mid Span :

=>	xu	(mm)	168.4
M. Capacity	M_C	**(kNm/m)**	72

Filler Beam Moment Capacity 71.7 kNm

Calculation of Shear Capacity of Section near supports :

Shear checked at 2 locations (i) a_v = d from face of support (with shear enhancement if applicable)
(ii) a_v = 2d from face of support (without shear enhancement)

$100As/b_wd$	-	-	2.6
Depth Factor	ξ_s	-	1.18
Material FOS for Concrete in Shear	Ymc		1.15
Ultimate shear stress	vc	(N/mm2)	0.677
Shear link diameter	dia.	mm	**0**
No. Legs	-		**0**
Shear link spacing	sv	mm	**0**
Asv	Asv	mm2	0.0
S. capacity section	-	kN/m	114
S. capacity links	-	kN/m	0
S.Capacity at av = 2d	V_{C1}	**kN/m**	114
Shear enhancement allowed?	Y/N	**-**	**Y**
S.Capacity at av = d	V_{C2}	**kN/m**	114

Table 4A of BD44/95 (Ref)

Slab Shear Capacity
At 2d 114.3 kN/m
At d 114.3 kN/m

Assumed shear carried by steel sections only

Ref	Calculations	Output

Filler Beam - Span 1 (South)

Calculation of Moment due to Permanent Loads at Mid Span &

Calculation of Shear due to Permanent Loads near supports:

Ref						
	Self weight	Load	(kN/m2)	5.1		
Table 3.1/ BD21		Yfl		1.15		
Cl.3. 1/ BD21 &		Yf3		1.0		
Cl. 4.2.3/ BD 44		M_{sw}	(kNm/m)	**9.7**	SLS Shear (kN)	
		Vsw	(kN/m)	**10.7**	9.3	
	Surfacing	Load	(kN/m2)	1.4		
Table 3.1/ BD21		Yfl		1.75		
Cl.3. 1/ BD21 &		Yf3		1.0		
Cl. 4.2.3/ BD 44		M_s	(kNm/m)	**4.0**		
		Vs	(kN/m)	**4.4**	2.5	
	Fill	Load	(kN/m2)	1.6		
Table 3.1/ BD21		Yfl		1.20		
Cl.3. 1/ BD21 &		Yf3		1.0		
Cl. 4.2.3/ BD 44		M_{fill}	(kNm/m)	**3.1**		
		V_{fill1}	(kN/m)	**3**	2.8	
	Hence, Capacity Available for LL, M_{CLL}		(kNm/m)	**55**	14.7	kN

Available Capacity for LL

Moment
54.9 kNm

Distance (x) from support to face of support		(mm)	140
Shear at support	V_{LLsup}	(kN/m)	19
Shear at av_1 = 2d	$V_{LLav1 = 2d}$	(kN/m)	11
Shear at av_2 = d	$V_{LLav2 = d}$	(kN/m)	14
Hence, Capacity Available for LL, $V_{CLL= 2d}$		(kNm/m)	**103**
Hence, Capacity Available for LL, $V_{CLL= d}$		(kNm/m)	**100**

Shear
At 2d **102.9 kN/m**
At d **100.1 kN/m**

Traffic Flows & Surface Condition

Ref			
	Annual Average Daily Traffic (Ref P I Report)		4147
	Percentage of heavy vehicles		5%
Cl. 5.21/ BD 21	Annual average hourly HGV flow (AAHHGVF)		9
	Traffic Flow Cl.5.2.2 of BD 21	L/M/H	Medium
	Condition of road surfacing (Good/ Poor)		Good
	Therefore Bridge Category		**Mg**
Figure 5.6	Factor **K** for 40 tonne loading		0.79

Bridge Category
Mg

HA + KEL and Equiv. 40 t Assessment Loading

Ref						
Cl. 5.18/ BD21	HA Loading	UDL	(kN/m)	141.4		
		KEL	(kN)	120.0		
	Lane Factor			1.0		
Cl 5.23/ BD 21	Adjustment Factor	AF		1.46		
	Therefore, Equivalent 40 t loading	UDL	(kN/m2)	**30.60**		
		KEL	(kN/m)	**25.97**		
		Yfl		1.50		
		Yf3		1.0		
	Moment Due 40 tonne loading	M_{LL}	(kNm)	**67**	SLS shear	
	Shear due to 40t at support	V_{LLsup}	(kN/m)	**73**	49	kN
	Shear due to 40t av = 2d	$V_{av = 2d}$	(kN/m)	**51**		
	Shear due to 40t av = d	$V_{LLav = d}$	(kN/m)	**60**		

Ref			
Cl 5.27/ BD 21	Factor C for Moment at midspan	**0.65**	
	Loading Capacity Moment at midspan	**40t**	as per Figure 5.6
	Factor C for Shear at 3*d	**1.11**	
	Factor C for Shear at d	**1.56**	
	Loading Capacity Shear	**40t**	as per Figure 5.6

(HA + KEL Eqv.)
Moment Capacity
40t

Shear Capacity
40t

Check bond stress at support where shear is maximum

Ref				Bond Stress (N/mm2)	Permissble Stress (N/mm2)
Ref page 10	SLS Shear at support Dead Load	kN	14.66	1.63	0.7
	SLS Shear at support Live Load	kN	49.00		

Is bond stress okay? Y/N	N	
Load Capacity where bond stress exceeded	**<3t**	Assuming no contribution from Concrete
Adequacy Factor for Bond Stress	13%	
Adequacy Factor for Moment at Midspan	82%	
Adequacy Factor for Shear	140%	

Bond Capacity
<3t

40 t Adequacy
82%

Single Axle Load

Ref: Table 5.3.1 of BD21

Filler Beam - Span 1 (South)			Moment Check	Shear Check	Adequacy for 40t
Assessment Loading		(Tonne)	7.5	40.0	40.0
Nominal Single Axle Load		(kN)	86	170	170
Wheel Contact Area		(m)	0.198	0.278	0.278
Minimum Distance Possible from edge of slab to centre line of first wheel in width direction	on left side	(m)	0.58	0.58	0.58
	on right side	(m)	10.96	10.96	10.96
Dispersion for one axle, in transvesre direction		beff	1.53	1.69	1.69
Dispersion for two axle, in transverse direction		b'eff	2.99	3.23	3.23
Dispersion in longitudinal direction		b_L	0.43	0.51	0.51
=> Load for one axle (P)		kN	86.0	170.0	170.0
Load for two axle (P')		kN	172	340	340
$w = P/b_{eff}\,b_L$ assuming load dispersed long. & transversely		kN/m^2	131.5	198.1	198.1
$w' = P'/b'_{eff}\,b_L$ assuming load dispersed long. & transversely		kN/m^2	134.3	206.9	206.9
	Yfl		1.50	1.50	1.50
	Yf3		1.0	1.0	1.0
Moment due to one axle	M_{LL}	(kNm)	**72**	**-**	**128**
Moment due to two axles	M_{LL}	(kNm)	**74**	**-**	**133**
Adequacy Factor			74%	-	41%
=>Loading Capacity (Moment)			**<7.5t**	-	-
Shear Due due to one axle at support				**140.4**	**140.4**
Shear Due due to two axles at support				**146.7**	**146.7**
Shear due to one axle at av = d	$V_{LLav = d}$	(kN/m)	-	**129**	**129**
Shear due to two axle at av = d	$V_{LLav = d}$	(kN/m)	-	**135**	**135**
Adequacy Factor			-	74%	74%
=>Loading Capacity (Shear) (av = d)			-	**<40t**	**-**
Shear due to one axle at av = 2d	$V_{av = 2d}$	(kN/m)	-	**117**	**117**
Shear due to two axles av = 2d	$V_{av = 2d}$	(kN/m)	-	**122**	**122**
Adequacy Factor				84%	84%
=>Loading Capacity (Shear)(av = 2d)			-	**<40t**	**-**

Single Axle Load
Moment Capacity
<7.5t
Shear Capacity
<40t
40 t Adequacy
41%

Single Wheel Load

Ref: Table 5.3.1 of BD21

			Moment Check	Shear Check	Adequacy for 40t
Assessment Loading		(Tonne)	7.5	40.0	40.0
Nominal Single Wheel Load		(kN)	43	86	86
Wheel Contact Area		(m)	0.198	0.280	0.280
Minimum Distance Possible from edge of slab to centre line of first wheel	on left side	(m)	0.58	0.58	0.58
	on right side	(m)	10.96	10.96	10.96
Dispersion for Wheel Load		beff	0.76	0.85	0.85
$w = P/b_{eff}^2$ assuming load dispersed long. & transversely		kN/m^2	**73.6**	**120.0**	**120.0**
	Yfl		1.50	1.50	1.50
	Yf3		1.0	1.0	1.0
Moment Due Single Wheel Load	M_{LL}	(kNm)	**68.7**	**-**	**122.6**
Adequacy Factor			80%	-	45%
=>Loading Capacity (Moment)			**<7.5t**	**-**	**-**
Shear Due Single Wheel Load	V_{LL}	(kN)	-	**134.7**	**134.7**
Shear due to 40t av = d	$V_{LLav = d}$	(kN)	-	**123.0**	**123.0**
Adequacy Factor				81%	81%
=>Loading Capacity (Shear) (av = d)				**<40t**	**-**
Shear due to 40t av = 2d	$V_{av = 2d}$	(kN)	-	**111.2**	**111.2**
Adequacy Factor				93%	93%
=>Loading Capacity (Shear)(av = 2d)				**<40t**	**-**

Grillage Required Y/N **Y**

As Adequecy factor is only 41% for 40 tonnes loading, a grillage analyis was carried out.

Single Wheel Load
Moment Capacity
<7.5t
Shear Capacity
<40t
40 t Adequacy
45%

Grillage Analysis Output due to 40t load

Ref: Refer page 4 of Grillage O/p

	Moment (kNm/m)	
Applied 40 t (factored for ULS)	56.8	
'LL Capacity of the section	54.9	
Live Load Capacity Factor, C	**0.76**	
Hence, Live Load Capacity	**18t**	
Adequacy Factor for 40t:	**97%**	

Moment of 94.7 kNm is for 1m, 56.8kNm moment is for 0.6m

Grillage Results
Structure Capacity
18t
40 t Adequacy
97%

ATKINS	Project	NRA Eirspan Task Order 213			Job ref 3044	
	Part of Structure MO-N58-001.00	Assessment using BD21/01 RC Slabs			Calc sheet no. 8	rev 0
	Drawing Ref MO-N58-001.00	Calc By CP		Date 13-Feb-12	Check by PG	Date 14-Feb-12
Ref	Calculations				Output	

HB Load

Ref: Table 5.3.1 of BD21

			Moment	Shear
Assessment Loading		HB	30.0	45.0
Nominal Single Axle Load		(kN)	300	450
Wheel Contact Area		(m)	0.261	0.320
Minimum Distance Possible from edge of slab to centre line of first wheel	on left side	(m)	0.58	0.58
	on right side	(m)	10.96	10.96
Dispersion for HB Axle		beff	0.83	0.89
=> Load for HB axle		kN	75.0	112.5
		kN/m	**90.6**	**126.9**
	Yfl		1.50	Moment Factor as per Influence Line
	Yf3		1.0	

				Moment Factor as per Influence Line
Moment Capacity Check				
Position of first axle from left support centre line		**x1**	1.07	0.5
Hence, distance of other axle from left support		x2	2.9	0.4
		x3	0.0	0.0
		x4	0.0	0.0
Moment Due to HB Load	M_{LL}	(kNm)	**75**	
Adequacy Factor			73%	
=>Loading Capacity (Moment)			**<30HB**	

		for shear at d	for shear at 2d	Shear Factor at d	Shear Factor at 2d
Shear Capacity Check					
Position of first axle from left support centre line	**x1**	0.42	0.70	0.88	0.8
Hence, distance of other axle from left support	x2	2.2	2.5	0.07	0.1
	x3	0.000	0.0	0.00	0.0
Shear Due HB Loading	x4	0.000	0.0	0.00	0.0

Shear at av = d	$V_{LLav = d}$	(kN/m)	**109**
Adequacy Factor			91%
=>Loading Capacity (Shear) (av = d)			**<45HB**
Shear at av = 2d	$V_{av = 2d}$	(kN/m)	**109**
Adequacy Factor			94%
=>Loading Capacity (Shear)(av = 2d)			**<45HB**

HB Load

Moment Capacity
<30HB

Shear Capacity
<45HB

Ref Page 13&14

Check Bond Stress

Moment Capacity for non composite section = <30HB — Assuming no contribution from Concrete

Adequacy Factor for 45HB 26%

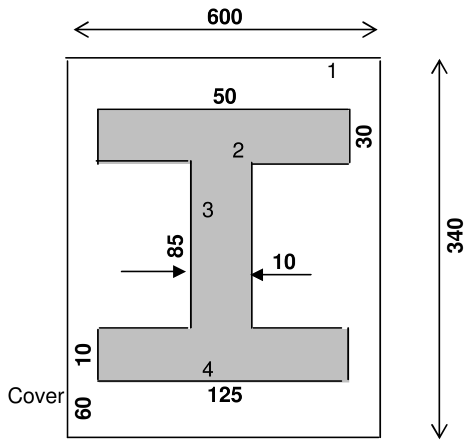
Bond Capacity
<30HB

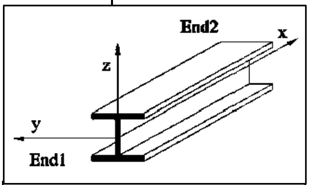
ATKINS	Project: NRA Eirspan Task Order 213			Job ref: 3044	
	Part of Structure: Section Properties MO-N58-001.00			Calc sheet no. 9	rev 0
	Drawing Ref: MO-N58-001.00	Calc By: CP	Date: 13-02-12	Check by: PG	Date: 13-02-12

Ref	Calculations	Output

Section Properties

Composite Section Properties





Axes used in Calculations to coincide with Superstress Axes

Idealised Section Short Term

fcu = 13.3

Ec = (20 + 0.27f_{cu}) = 24

Es = 205 **m** = Es / Ec = **8.69**

	Sr No.	b	h	No.	E_s/E_c	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	340	1	1.00	204000	170	34680000	5.896E+09	1.965E+09	Concrete
Top Flange	2	50	30	1	8.69	13034.6	170	2215887.4	376700860	112500	Steel
Web	3	10	85	1	8.69	7386.29	112.5	830957.78	93482750	511770.83	Steel
Bot Flange	4	125	10	1	8.69	10862.2	65	706042.56	45892766	10416.667	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					235283	517.5	38432888	6.412E+09	1.966E+09	

$Y_{CG} = \frac{\Sigma\ Ay}{\Sigma\ A}$ for bottom $= \frac{38432887.8}{235283.116} =$ 163.35 mm

$I_{CG} = Iyy - (\Sigma A \times y_{CG}^2)$

$Iyy = (\Sigma I_{self} + \Sigma Ay^2)$

$I_{CG} = (\Sigma I_{self} + \Sigma Ay^2) - (\Sigma A \times y_{CG}^2)$

$= ($ 2E+09 + 6.4E+09 $) - ($ 235283 $) \times ($ 163.347 $^2)$

$=$ 2.1E+09 mm4

Idealised Section Long Term

Es = 205 **m** = Es / Ec = **17.38**

	Sr No.	b	h	No.	E_s/E_c	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	340	1	1.00	204000	170	34680000	5.896E+09	1.965E+09	Concrete
Top Flange	2	50	30	1	17.38	26069.3	170	4431774.8	753401721	112500	Steel
Web	3	10	85	1	17.38	14772.6	112.5	1661915.6	186965501	511770.83	Steel
Bot Flange	4	125	10	1	17.38	21724.4	65	1412085.1	91785533	10416.667	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					266566	517.5	42185776	6.928E+09	1.966E+09	

$Y_{CG} = \frac{\Sigma\ Ay}{\Sigma\ A}$ for bottom $= \frac{42185775.5}{266566.233} =$ 158.26 mm

$I_{CG} = Iyy - (\Sigma A \times y_{CG}^2)$

$Iyy = (\Sigma I_{self} + \Sigma Ay^2)$

$I_{CG} = (\Sigma I_{self} + \Sigma Ay^2) - (\Sigma A \times y_{CG}^2)$

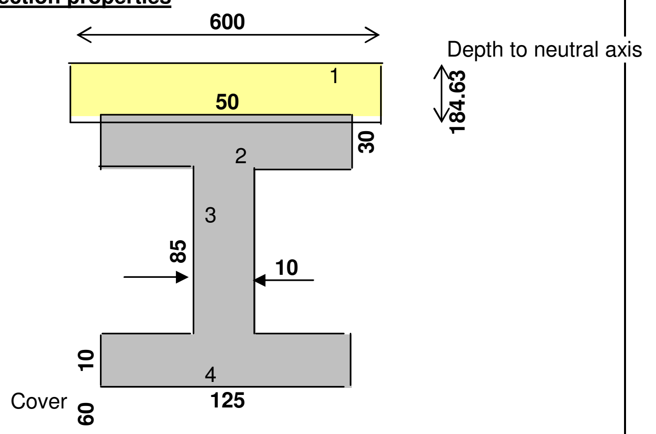
$= ($ 2E+09 + 6.9E+09 $) - ($ 266566 $) \times ($ 158.256 $^2)$

$=$ 2.217E+09 mm4

Ref	Calculations	Output

Section Properties

Cracked Section properties



Idealised Section Short Term

fcu = 13.3

$E_c = (20 + 0.27 f_{cu}) =$ 24

Es = 205 **m** = Es / Ec = **8.69**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	184.63	1	1.00	110778	247.685	27438064	6.796E+09	314686364	Concrete
Top Flange	2	50	30	1	8.69	13034.6	170	2215887.4	376700860	112500	Steel
Web	3	10	85	1	8.69	7386.29	112.5	830957.78	93482750	511770.83	Steel
Bot Flange	4	125	10	1	8.69	10862.2	65	706042.56	45892766	10416.667	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					142061	595.185	31190951	7.312E+09	315321051	

$Y_{CG} = \frac{\Sigma\ Ay}{\Sigma\ A}$ for bottom $= \frac{31190951.4}{142061.211} =$ 219.56 mm

$I_{CG} = Iyy - (\Sigma A \times y_{CG}^2)$

$Iyy = (\Sigma I_{self} + \Sigma Ay^2)$

$I_{CG} = (\Sigma I_{self} + \Sigma Ay^2) - (\Sigma A \times y_{CG}^2)$

$= (3.2E+08 + 7.3E+09) - (142061) \times (219.56^2)$

= 7.79E+08 mm4

Idealised Section Long Term

Es = 205 **m** = Es / Ec = **17.38**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	184.63	1	1.00	110778	247.685	27438064	6.796E+09	314686364	Concrete
Top Flange	2	50	30	1	17.38	26069.3	170	4431774.8	753401721	112500	Steel
Web	3	10	85	1	17.38	14772.6	112.5	1661915.6	186965501	511770.83	Steel
Bot Flange	4	125	10	1	17.38	21724.4	65	1412085.1	91785533	10416.667	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					173344	595.185	34943839	7.828E+09	315321051	

$Y_{CG} = \frac{\Sigma\ Ay}{\Sigma\ A}$ for bottom $= \frac{34943839.1}{173344.327} =$ 201.59 mm

$I_{CG} = Iyy - (\Sigma A \times y_{CG}^2)$

$Iyy = (\Sigma I_{self} + \Sigma Ay^2)$

$I_{CG} = (\Sigma I_{self} + \Sigma Ay^2) - (\Sigma A \times y_{CG}^2)$

$= (3.2E+08 + 7.8E+09) - (173344) \times (201.586^2)$

= 1.10E+09 mm4

Check bond stress of section

Dimensions in mm

Allowable f_{cu}=	13.3	b=	600
γ_{mc}=	1.05	d_c=	340
Allowable f_{st}=	230	d_s=	125
γ_{ms}=	1.05	A_{st}=	1500
γ_{f3}=	1.1	t_{ft}=	30
Bottom Cover=	60	t_{fb}=	10
		A_{sb}=	1250
		t_w=	10

Short Term Ec (BD 44/95 cl. 4.3.2.1)

$Ec = (20 + 0.27f_{cu}) = 24$

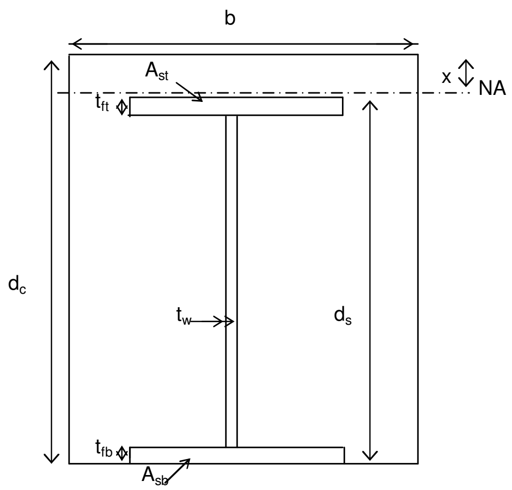
Es = 205 **m** = Es / Ec = **8.69**

Long Term Ec (BD 44/95 cl. 4.3.2.1)

Twice Short Term **m** = **17.38**

Allowable Conc stress = $0.75f_{cu}/\gamma_{mc}\gamma_{f3}$ = **8.636**

Allowable steel stress = $f_{st}/\gamma_{ms}\gamma_{f3}$ = **199.134**



Uncracked Section for Grillage Analysis

	Short Term	Long Term Ec	
m =	8.69	17.38	
x =	184.63	195.83	mm
Area of section (concrete units) =	235283.12	266566.23	mm^2
Area of section (steel units) =	27075.92	15337.96	mm^2
I_{NA} (concrete units)=	2.10E+09	2.22E+09	mm^4
I_{NA} (steel units)=	2.72E+08	1.55E+08	mm^4

Cracked Section

	Short Term	Long Term Ec	
m =	8.69	17.38	
x =	153.27	161.20	mm
Area of concrete in compression =	91962.82	96717.02	mm^2
Centroid of conc. in comp.(from NA) =	76.64	80.60	mm
I_{NA} (cracked section)=	7.79E+08	1.10E+09	mm^4
$A * y / I_{NA}$ =	0.00905	0.00709	/mm

BD61/10 Cl 8.5.1: *"The bond may be assumed to be developed uniformly only over both sides of the web and the upper surface of the top and bottom flanges of the steel beam where there is complete encasement and over both sides of the web and the upper surface of the top flange of the steel beam where the beam soffit is exposed."*

Hence, as cover to soffit of bottom flange is 60mm, Ls = 335 mm

ATKINS	Project	NRA Eirspan Task Order 213			Job ref 3044.00	
	Part of Structure	Filler Beam Capacity			Calc sheet 12	Rev 0
	MO-N58-001.00					
	Drawing ref.	Calc by CP	Date 2012-02-13		Check by PG	Date 2012-02-14

Ref	Calculations	Ouptut

Check for Max Shear (at support) 40t

Serviceability Loads (F)

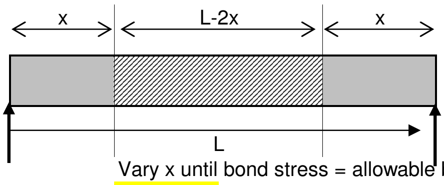
Shear at support	kN
Dead Load	14.66
Live Load	49.00

	Live Load	Dead Load	
'l Shear Force = FAy/I_{NA}	443.24	103.99	N/mm
Bond stress =	1.323	0.310	N/mm^2
Total bond stress =		1.634	N/mm^2
Allowable bond stress at SLS =		0.700	N/mm^2

Result: Section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check capacity of section unsuitable for composite action

Find distance x such that bond stress due to combined Dead Load and Live Load = 0.7N/mm2



Legend:

bond stress <0.7N/mm2 suitable for composite action

bond stress >0.7N/mm2 unsuitable for composite action

Vary x until bond stress = allowable bond stress

Try x = **1.75** m (Max x = L/2 = 1.82 m)

Okay Hint:Use Goalseek

Serviceability Loads (F)

Shear at location x	kN
Dead Load	**0.60**
Live Load	**9.49**

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	85.82	4.28	N/mm
Bond stress using =	0.256	0.013	N/mm^2
Total bond stress=		**0.269**	N/mm^2
Allowable bond stress at SLS =		**0.700**	N/mm^2

Result: Bond stress okay

Check corresponding moment capacity at x

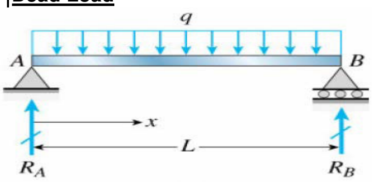
Factor **K** for 40 tonne loading	0.79	
Moment Capacity of steel section	25.58	kNm
Moment Capacity of composite section	38.41	kNm

ULS Moment at x	kNm
Dead Load	16.82
Available capacity for live load	8.76
Live Load	66.77

Factor C for Moment	0.10	
Loading Capacity Moment	**<3t**	as per Figure 5.6
Adequacy Factor	0.13	

Output: **(HA + KEL Eqv.)** **Moment Capacity** **<3t**

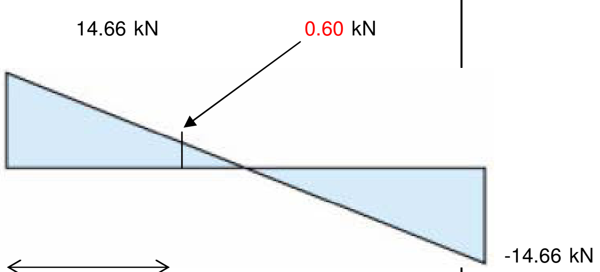
Dead Load

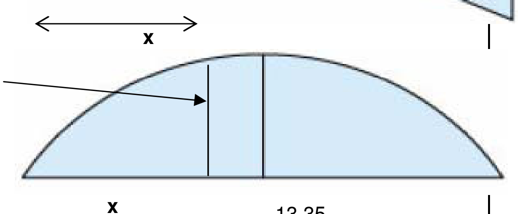


q	8.06	kN/m
L	3.64	m
x	**1.75**	m

unfactored

RA=RB =	14.66 kN
Vx	0.60 kN
Vmax	14.66 kN
Mx	13.32 kNm
Mmax	13.35 kNm

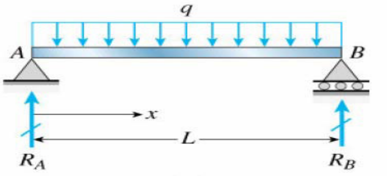


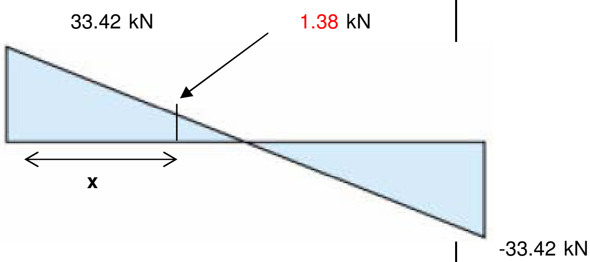


ATKINS	**Project** NRA Eirspan Task Order 213			Job ref 3044	
	Part of Structure Filler Beam Capacity MO-N58-001.00			Calc sheet 13	Rev 0.00
	Drawing ref.	Calc by CP	Date 2012-02-13	Check by PG	Date 2012-02-14

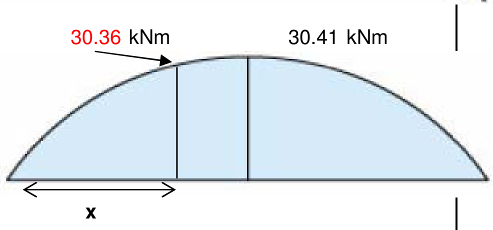
Ref	Calculations	Ouptut

HA UDL Live Load



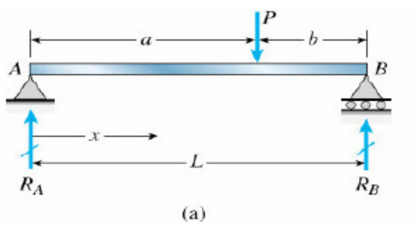


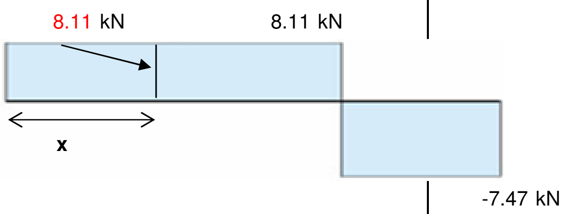
q	18.36	kN/section
L	3.64	m
x	1.75	m



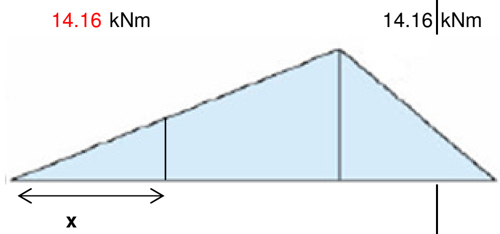
RA=RB = 33.42 kN
Vx 1.38 kN
Vmax 33.42 kN
Mx 30.36 kNm
Mmax 30.41 kNm

HA KEL Live Load





P	15.58	kN
L	3.64	m
a	1.75	
b	1.89	
x	1.75	m



RA 8.11 kN
RB 7.47 kN
Vx 8.11 kN
Vmax 15.58 kN (P at support)
Mx 14.16 kNm
Mmax 14.16 kNm
Mmax P at centre 14.18 kNm

Combined Continuos + Point Load

	per m width	ULS (Yf3=1.5)
Combined Moment Mx	44.51 kNm	66.77
Combined Shear Vx	9.49 kN	14.23

		ULS (Yf3=1.5)
Max M	44.59 kNm	66.88 kNm
Max V	49.00 kN	73.50 kN

HB Live Load

Check for Max Shear (at support) 45HB

Serviceability Loads (F)

Shear at support	kN
Dead Load	14.66
Live Load	72.98

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	660.13	103.99	N/mm
Bond stress using=	1.971	0.310	N/mm^2
Total bond stress using =	2.281		N/mm^2
Allowable bond stress at SLS =	0.700		N/mm^2

Result: Bond Stress (2.28) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check section at x

45HB Loading Vary x until bond stress = allowable bond stress

Try x = **1.55** m Load **45.00** HB

reduce x Hint:Use Goalseek

Serviceability Loads (F)

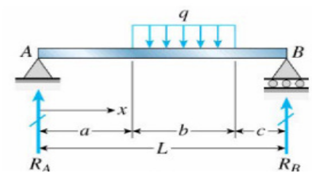
Shear at location x	kN
Dead Load	**2.14**
Live Load	**8.22**

Check for Shear at x - 45HB

Note: If bottom flange is exposed use L_{S1} otherwise use L_{S2}

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	74	15.19	N/mm
Bond stress=	0.222	0.045	N/mm^2
Total bond stress=	**0.267**		N/mm^2
Allowable bond stress at SLS = 0.7	**0.700**		N/mm^2

Result: Bond stress okay using Ls2



beff = 0.83 m

Suggested values for x (beff/2) 0.41 m

Live Load at x

q	90.59	kN/section
a	1.14	m
b	0.83	m
c	1.67	m
L	3.64	m
x	1.55	m

			ULS	
RA	42.98	kN		
RB	32.02	kN		
Vx	5.48	kN	8.22	kN
Vmax	42.98	kN	64.47	kN
Mx	59.03	kNm	88.55	kNm
Mmax	59.20	kNm	88.80	kNm

Dead Load at x

q	8.06	kN/m
L	3.64	m
x	**1.55**	m

unfactored

RA=RB =	14.66	kN
Vx	2.14	kN
Vmax	14.66	kN
Mx	13.06	kNm
Mmax	13.35	kNm

Check corresponding moment capacity at x

ULS Moment at x	kNm
Dead Load	15.02
Available capacity for live load	23.39
45HB Live Load	88.80

Adequacy 0.26 Fail

Moment Capacity <45HB

Check for Max Shear (at support) 30HB

Serviceability Loads (F)

Shear at support	kN
Dead Load	14.66
Live Load	48.65

Note: If bottom flange is exposed use L_{S1} otherwise use L_{S2}

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	440.08	103.99	N/mm
Bond stress=	1.314	0.310	N/mm^2
Total bond stress=	1.624		N/mm^2
Allowable bond stress at SLS =	0.700		N/mm^2

Result: Bond Stress (1.62) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check section at x 30HB

Vary x until bond stress = allowable bond stress

Loading Try x = **1.55** m Load **30** HB

reduce x Hint:Use Goalseek

Serviceability Loads (F)

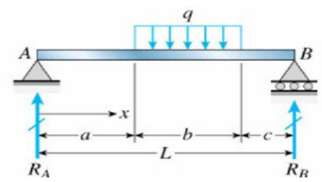
Shear at location x	kN
Dead Load	**2.14**
Live Load	**8.22**

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	74	15.19	N/mm
Bond stress=	0.222	0.045	N/mm^2
Total bond stress=	**0.267**		N/mm^2
Allowable bond stress at SLS = 0.7	**0.700**		N/mm^2

Result: Bond stress okay using Ls2

Use Composite Section

Live Load at x



beff = 0.83 m

q	90.59	kN/section
a	1.14	m
b	0.83	m
c	1.67	m
L	3.64	m
x	1.55	m

			ULS	
RA	42.98	kN		
RB	32.02	kN		
Vx	5.48	kN	8.22	kN
Vmax	42.98	kN	64.47	kN
Mx	59.03	kNm	88.55	kNm
Mmax	59.20	kNm	88.80	kNm

Dead Load at x

q	8.06	kN/m	unfactored
L	3.64	m	
x	**1.55**	m	

RA=RB =	14.66	kN
Vx	2.14	kN
Vmax	14.66	kN
Mx	13.06	kNm
Mmax	13.35	kNm

ULS Moment at x		kNm	
	Dead Load	15.02	
Available capacity for live load		23.39	Adequacy
30HB	Live Load	88.80	0.26 Fail

Moment Capacity <30HB

ATKINS	Project: NRA Eirspan Task Order 213				Job ref: 3044
	Part of Structure: MO-N58-001.00				Calc sheet no. 1, rev 0
	Drawing Ref: MO-N58-001.00	Calc By: CP	Date: 13-Feb-12	Check by: PG	Date: 14-Feb-12

Ref	Calculations	Output

ASSESSMENT SUMMARY: Filler Beam Span 2 (North)

	HA UDL & KEL	Single Axle	Single Wheel	HB	Punching Shear
Moment	40t	40t	40t	30HB	-
Shear	40t	40t	40t	45HB	0
Bond	<3t	-	-	<30HB	-

CALCULATION OF REBAR SPACING

MID SPAN

App. C1 /SI Report

Spacing (mm)	MAIN BEAM
	600
Average beam spacing	600

Depth of beam 125 mm
Bottom Cover 70 mm

NEAR SUPPORT

App. C1 /SI Report

Spacing (mm)	MAIN BEAM
	600
Average rebar spacing	600

Depth of beam 125 mm
Bottom Cover 70 mm

ATKINS	Project	NRA Eirspan Task Order 213		Job ref 3044	
	Part of Structure MO-N58-001.00			**Calc sheet no.** 2	**rev** 0
	Drawing Ref MO-N58-001.00	**Calc By** CP	**Date** 13-Feb-12	**Check by** PG	**Date** 14-Feb-12

Ref	Calculations	Output

CALCULATION OF WORST CREDIBLE STRENGTH

Input a maximum of 11 Core samples

App.C2
SI Report

LOCATION	CORE REFERENCE	ESTIMATED IN-SITU CUBE STRENGTH N/mm^2 (f_c)	(fc - MEAN)^2
	C1	31.3	0.93
	C2	28.0	5.44
	C3	31.7	1.87
			-
			-
			-
			-
			-
			-
			-
	TOTAL	91	8.2466667
	No of cores	**3**	
	MEAN	**30.33**	
	Standard Deviation	**2.03**	

WCS will be calculated using 2 different methods:

1) LOCATION : Using equation from BA 44/96 with n = total number of core samples

Note - only use this for cores taken at the location of interest

n = 3

From BA 44/90, WCS = (Total fc*(100-(20/n^0.5)))/100n

WCS = **26.8 N/mm^2**

2) LOWEST CORE STRENGTH :

Lowest core strength = 28.0 N/mm2

WCS = **28.0 N/mm^2**

Using the above results and engineering judgement,
the proposed WCS = 26.8 N/mm^2

SAGGING - SECTION PROPERTIES (Using BS 5400 Part 3;2000) for composite section

Slab		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	Panel Length (mm)	Section depth mm
	Slab	600	340		26.8	27.2		50
Haunch		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	*NA*	
	Haunch	0	0		0	0	*NA*	
Girder		Width (mm)	Depth (mm)		f_y (MPa)	E (GPa)		*m*
	Top Flange	50	30		230	205.0		*7.52*
	Web	85	10		230	205.0		
	Bottom Flange	125	10		230	205.0		
	Bottom Cover		70	mm				

e) Plastic Section Properties

Condition factor for RC Filler | - | 0.9

nb if NA lies below the web this doesn't work

Stress in concrete = $0.4 f_{cu}$

Stress in steel = σ_y/γ_m γ_m = 1.05

	Depth (mm)	Width (mm)	Area (mm^2)	Stress (Nmm^{-2})	Force (kN)	Force above NA (kN)	Force below NA (kN)	y above NA (mm)	y below NA (mm)
Slab*	220	600	132000	11	1417	789	-	61	-
Haunch	0	0	0	0	0	0	-	0	-
Top Flange	30	50	1500	219	329	0	329	-98	113
Web	10	85	850	219	186	0	186	-128	133
Bottom Flange	10	125	1250	219	274	-	274	-	143

*Concrete above beam only taken in properties

NA lies in Slab

Depth of Neutral Axis From Top Slab

Concrete $M_{plastic}$ = 48 **kNm**

Single Beam $M_{plastic}$ = 91 **kNm**

	Depth (mm)
Slab	122.5
Haunch	0.0
Top Flange	0.0
Web	0.0

m= 0.0

Depth of Plastic NA = 122.5 217.5

f) Compactness Check

Ref						(Compact?)
9.3.7.2	If m < 0.5	Check web depth is less than	$(34t_w/m)*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If m > 0.5	Check web depth is less than	$(374t_w/(13m-1))*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If web fully in tension section is compact					yes

Section is Compact

SAGGING - PLASTIC CHECKS (Using BS 5400 Part 3;2000)

2. ULS Bending Capacity of Section

$M_{plastic}$ = 149 kNm

$M_{pe\ (unfactored)}$ = 156 kNm

$M_D = M_{pe}$ / 1.05 x 1.1 = 122 kNm (Also Adjusted by condition factor)

3/9.9.2.2 **3. ULS Pure Shear Capacity of Section**

Depth of panel = d_{we} = 10 mm

Aspect Ratio = $\varphi = a/d_{we}$ = 1.000

b_{fe} (top flange) = 0 | b_{fe} (bottom flan = 0

m_{fw} (top flange) = $\sigma_{yf}b_{fe}t_f^2/(2d_{we}^2t_w\sigma_{yw})$ = 1.3235 | m_{fw}(bot) = $\sigma_{yf}b_{fe}t_f^2/(2d_{we}^2t_w\sigma_{yw})$ 0.3676

Minimum value of m_{fw} for use in shear calcs. = 0.3676 | $\lambda = (d_{we}/t_w)x(\sigma_{yw}/355)^{1/2}$ = 0.1

$\tau_y = \sigma_{yw}/\sqrt{3}$ = 132.79

3/Fig12-18 τ_l/τ_y for m_{fw} of 0.3676 = 3.547 τ_l = 471.02

τ_l/τ_y for m_{fw} of 0.000 = 3.547 τ_l = 471.02

3/9.9.2.2 $V_D = (d_w t_w x\tau_l) / (\gamma_m\gamma_{f3})$ = 312.0 kN When m_{fw} = 1.3235 (Adjusted by condition factor)

V_R = "" = 312.0 kN When m_{fw} = 0.0000 (Adjusted by condition factor)

SAGGING - SECTION PROPERTIES (Using BS 5400 Part 3;2000) for Steel Section (IGNORING CONCRETE)

Slab		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	Panel Length (mm)	Section depth mm
	Slab	600	50		26.8307417	27.24430026		50
Haunch		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	*NA*	
	Haunch	0	0		0	0	*NA*	
Girder		Width (mm)	Depth (mm)		f_y (MPa)	E (GPa)		
	Top Flange	50	30		230	205		
	Web	85	10		230	205		
	Bottom Flange	125	10		230	205		
	Bottom Cover		70	mm				

Condition factor for RC Filler | - | 0.9

e) Plastic Section Properties

nb if NA lies below the web this doesn't work

Stress in concrete = $0.4*f_{cu}$

Stress in steel = σ_y/γ_m γ_m = 1.05

	Depth (mm)	Width (mm)	Area (mm^2)	Stress (Nmm^{-2})	Force (kN)	Force above NA (kN)	Force below NA (kN)	y above NA (mm)	y below NA (mm)
Slab*	-70	600	-42000	11	-451	-451	-	35	-
Haunch	0	0	0	0	0	0	-	0	-
Top Flange	30	50	1500	219	329	329	0	55	-40
Web	10	85	850	219	186	186	0	35	-30
Bottom Flange	10	125	1250	219	274	-	274	-	-25

*Concrete above beam only taken in properties

NA lies in Below Web

Depth of Neutral Axis From Top Slab

	Depth (mm)
Slab	0.0
Haunch	0.0
Top Flange	0.0
Web	0.0

Concrete $M_{plastic}$ = -16 **kNm**

Single Beam $M_{plastic}$ = 16 **kNm**

m= 4.0

Depth of Plastic NA = 0.0

f) Compactness Check

						(Compact?)
9.3.7.2	If m < 0.5	Check web depth is less than	$(34t_w/m)*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If m > 0.5	Check web depth is less than	$(374t_w/(13m-1))*(355/\sigma_{yw})$^0.5	774.40939	mm	yes
	If web fully in tension section is compact					n/a

Section is Compact

SAGGING - PLASTIC CHECKS (Using BS 5400 Part 3;2000)

2. ULS Bending Capacity of Section

$M_{plastic}$ = 2 kNm

$M_{pe\ (unfactored)}$ = 2 kNm

$M_D = M_{pe}$ / 1.05 x 1.1 = 2 kNm (Also Adjusted by condition factor)

ATKINS	Project	NRA Eirspan Task Order 213			Job ref 3044	
	Part of Structure MO-N58-001.00	Assessment using BD21/01 Filler Beam			**Calc sheet no.** 5	**rev** 0
	Drawing Ref MO-N58-001.00	**Calc By** CP		**Date** 13-Feb-12	**Check by** PG	**Date** 14-Feb-12
Ref	Calculations				Output	

BD21/01

Slab Details : Filler Beam Span 2 (North)

Depth of slab	(mm)	340
Clear Span	(m)	3.34
Effective Span	(m)	3.61
Slab width	(mm)	600
Depth of fill above RC Slab	(mm)	230
Condition factor for RC Slab	-	0.90

Cl 5.3.1.1 of BD44/95

water seepage

SI Report

Material Details :

Main Tension Steel	**Beam Depth**	(mm)	50
	Spacing	(mm)	600
	As	(mm2)	4433
Concrete cover to tension steel		(mm)	70
Secondary reinforcement dia		(mm)	0
Is tension steel the outer layer of rebar?		Y/N	Y
effective depth	d	(mm)	270
Concrete Density		kN/m3	23.8
Surfacing Density		kN/m3	23.0
Fill Density		kN/m3	20.0
Concrete WCS Strength	WCS, fcu		27
Steel Characteristic Strength	fy	(N/mm2)	230
Material Factor for Concrete	Ymc		1.20
Material Factor for Steel	Yms		1.05

Page 2
Cl. 4.4 of BD21
Table 4A of BD44/95

Calculation of Moment Capacity of Section at Mid Span :

=>	xu	(mm)	122.5
M. Capacity	**M_C**	**(kNm/m)**	122

Filler Beam Moment Capacity
121.9 kNm

Calculation of Shear Capacity of Section near supports :

Shear checked at 2 locations (i) a_v = d from face of support (with shear enhancement if applicable)
(ii) a_v = 2d from face of support (without shear enhancement)

$100As/b_wd$	-	-	2.7
Depth Factor	ξ_s	-	1.19
Material FOS for Concrete in Shear	Ymc		1.15
Ultimate shear stress	vc	(N/mm2)	0.864
Shear link diameter	dia.	mm	0
No. Legs	-		0
Shear link spacing	sv	mm	0
Asv	Asv	mm2	0.0
S. capacity section	-	kN/m	312
S. capacity links	-	kN/m	0
S.Capacity at av = 2d	**V_{C1}**	**kN/m**	312
Shear enhancement allowed?	Y/N	**-**	Y
S.Capacity at av = d	**V_{C2}**	**kN/m**	312

Table 4A of BD44/95

Slab Shear Capacity
At 2d 312.0 kN/m
At d 312.0 kN/m

Assumed shear carried by steel sections only

Filler Beam Span 2 (North)

Calculation of Moment due to Permanent Loads at Mid Span &

Calculation of Shear due to Permanent Loads near supports:

Ref					SLS Shear (kN)	Output
Table 3.1/ BD21 Cl.3. 1/ BD21 & Cl. 4.2.3/ BD 44	Self weight	Load	(kN/m2)	5.1		
		Yfl		1.15		
		Yf3		1.0		
		M_{sw}	(kNm/m)	**9.5**		
		Vsw	(kN/m)	**10.6**	9.2	
Table 3.1/ BD21 Cl.3. 1/ BD21 & Cl. 4.2.3/ BD 44	Surfacing	Load	(kN/m2)	1.4		
		Yfl		1.75		
		Yf3		1.0		
		M_s	(kNm/m)	**3.9**		
		Vs	(kN/m)	**4.4**	2.5	
Table 3.1/ BD21 Cl.3. 1/ BD21 & Cl. 4.2.3/ BD 44	Fill	Load	(kN/m2)	1.6		
		Yfl		1.20		**Available Capacity for LL**
		Yf3		1.0		
		M_{fill}	(kNm/m)	**3.0**		
		V_{fill1}	(kN/m)	**3**	2.8	**Moment**
	Hence, Capacity Available for LL, M_{CLL}		(kNm/m)	**105**	14.5 kN	**105.4 kNm**

				Output
Distance (x) from support to face of support		(mm)	135	
Shear at support	V_{LLsup}	(kN/m)	18	
Shear at av_1 = 2d	$V_{LLav1 = 2d}$	(kN/m)	11	
Shear at av_2 = d	$V_{LLav2 = d}$	(kN/m)	14	**Shear**
Hence, Capacity Available for LL, $V_{CLL= 2d}$		(kNm/m)	**301**	At 2d **300.5 kN/m**
Hence, Capacity Available for LL, $V_{CLL= d}$		(kNm/m)	**298**	At d **297.8 kN/m**

Traffic Flows & Surface Condition

Ref				Output
	Annual Average Daily Traffic (Ref P I Report)		**4147**	
	Percentage of heavy vehicles		**5%**	
Cl. 5.21/ BD 21	Annual average hourly HGV flow (AAHHGVF)		9	
	Traffic Flow Cl.5.2.2 of BD 21	L/M/H	Medium	
	Condition of road surfacing (Good/ Poor)		**Good**	**Bridge Category**
	Therefore Bridge Category		**Mg**	**Mg**
Figure 5.6	Factor **K** for 40 tonne loading		**0.79**	

HA + KEL and Equiv. 40 t Assessment Loading

Ref					SLS shear
Cl. 5.18/ BD21	HA Loading	UDL	(kN/m)	142.2	
		KEL	(kN)	120.0	
	Lane Factor			1.0	
Cl 5.23/ BD 21	Adjustment Factor	AF		1.46	
	Therefore, Equivalent 40 t loading	UDL	(kN/m2)	**30.77**	
		KEL	(kN/m)	**25.97**	
		Yfl		1.50	
		Yf3		1.0	
	Moment Due 40 tonne loading	M_{LL}	(kNm)	**66**	
	Shear due to 40t at support	V_{LLsup}	(kN/m)	**73**	49 kN
	Shear due to 40t av = 2d	$V_{av = 2d}$	(kN/m)	**51**	
	Shear due to 40t av = d	$V_{LLav = d}$	(kN/m)	**60**	

Ref				Output
				(HA + KEL Eqv.)
Cl 5.27/ BD 21	Factor C for Moment at midspan	**1.26**		**Moment Capacity**
	Loading Capacity Moment at midspan	**40t**	as per Figure 5.6	**40t**
	Factor C for Shear at 3*d	**3.24**		
	Factor C for Shear at d	**4.60**		**Shear Capacity**
	Loading Capacity Shear	**40t**	as per Figure 5.6	**40t**

Check bond stress at support where shear is maximum

Ref				Bond Stress (N/mm2)	Permissble Stress (N/mm2)
Ref page 11	SLS Shear at support Dead Load	kN	14.50	4.71	0.7
	SLS Shear at support Live Load	kN	48.91		

			Output
Is bond stress okay? Y/N	N		**Bond Capacity**
Load Capacity where bond stress exceeded	**<3t**	Assuming no contribution from Concrete	**<3t**
Adequacy Factor for Bond Stress	0%		
Adequacy Factor for Moment at Midspan	159%		**40 t Adequacy**
Adequacy Factor for Shear	410%		**159%**

ATKINS	Project	NRA Eirspan Task Order 213		Job ref 3044	
	Part of Structure MO-N58-001.00	Assessment using BD21/01 RC Slabs		Calc sheet no. 7	rev 0
	Drawing Ref MO-N58-001.00	Calc By CP	Date 13-Feb-12	Check by PG	Date 14-Feb-12
Ref	Calculations			Output	

Single Axle Load

Filler Beam Span 2 (North)

Ref: Table 5.3.1 of BD21

			Moment Check	Shear Check	Adequacy for 40t
Assessment Loading		(Tonne)	7.5	40.0	40.0
Nominal Single Axle Load		(kN)	86	170	170
Wheel Contact Area		(m)	0.198	0.278	0.278
Minimum Distance Possible from edge of slab to centre line of first wheel in width direction	on left side	(m)	0.58	0.58	0.58
	on right side	(m)	10.96	10.96	10.96
Dispersion for one axle, in transvesre direction		beff	1.35	1.51	1.51
Dispersion for two axle, in transverse direction		b'eff	2.69	2.96	2.96
Dispersion in longitudinal direction		b_L	0.43	0.51	0.51
=> Load for one axle (P)		kN	86.0	170.0	170.0
Load for two axle (P')		kN	172	340	340
w = $P/b_{eff}\,b_L$ assuming load dispersed long. & transversely		kN/m^2	149.5	222.2	222.2
w' = $P'/b'_{eff}\,b_L$ assuming load dispersed long. & transversely		kN/m^2	149.5	226.2	226.2
	Yfl		1.50	1.50	1.50
	Yf3		1.0	1.0	1.0
Moment due to one axle	M_{LL}	(kNm)	81	-	142
Moment due to two axles	M_{LL}	(kNm)	81	-	145
Adequacy Factor			129%	-	73%
=>Loading Capacity (Moment)			7.5t	-	-
Shear Due due to one axle at support				157.4	157.4
Shear Due due to two axles at support				160.2	160.2
Shear due to one axle at av = d	$V_{LLav = d}$	(kN/m)	-	145	145
Shear due to two axle at av = d	$V_{LLav = d}$	(kN/m)	-	147	147
Adequacy Factor			-	202%	202%
=>Loading Capacity (Shear) (av = d)			-	40t	-
Shear due to one axle at av = 2d	$V_{av = 2d}$	(kN/m)	-	132	132
Shear due to two axles av = 2d	$V_{av = 2d}$	(kN/m)	-	134	134
Adequacy Factor				223%	223%
=>Loading Capacity (Shear)(av = 2d)			-	40t	-

Single Axle Load

Moment Capacity
7.5t

Shear Capacity
40t

40 t Adequacy
73%

Single Wheel Load

Ref: Table 5.3.1 of BD21

			Moment Check	Shear Check	Adequacy for 40t
Assessment Loading		(Tonne)	7.5	40.0	40.0
Nominal Single Wheel Load		(kN)	43	86	86
Wheel Contact Area		(m)	0.198	0.280	0.280
Minimum Distance Possible from edge of slab to centre line of first wheel	on left side	(m)	0.58	0.58	0.58
	on right side	(m)	10.96	10.96	10.96
Dispersion for Wheel Load		beff	0.67	0.75	0.75
w = P/b_{eff}^2 assuming load dispersed long. & transversely		kN/m^2	95.0	151.1	151.1
	Yfl		1.50	1.50	1.50
	Yf3		1.0	1.0	1.0
Moment Due Single Wheel Load	M_{LL}	(kNm)	78.5	-	138.2
Adequacy Factor			134%	-	76%
=>Loading Capacity (Moment)			7.5t	-	-
Shear Due Single Wheel Load	V_{LL}	(kN)	-	153.1	153.1
Shear due to 40t av = d	$V_{LLav = d}$	(kN)	-	140.3	140.3
Adequacy Factor				212%	212%
=>Loading Capacity (Shear) (av = d)				40t	-
Shear due to 40t av = 2d	$V_{av = 2d}$	(kN)	-	127.5	127.5
Adequacy Factor				236%	236%
=>Loading Capacity (Shear)(av = 2d)				40t	-

Single Wheel Load

Moment Capacity
7.5t

Shear Capacity
40t

40 t Adequacy
76%

Grillage Required Y/N **Y**

As Adequecy factor is only 73% for 40 tonnes loading, a grillage analyis was carried out.

Grillage Analysis Output due to HA loading & Single Axle load

Ref: Refer page 4 of Grillage O/p

	Moment (kNm/m)
Applied 40 t (factored for ULS)	56.8
'LL Capacity of the section	105.4
Live Load Capacity Factor, C	1.46
Hence, Live Load Capacity	40t
Adequacy Factor for 40t:	185%

Moment of 94.7 kNm is for 1m, 56.8kNm moment is for 0.6m

Grillage Results

Structure Capacity
40t

40 t Adequacy
185%

Ref	Calculations	Output

HB Load

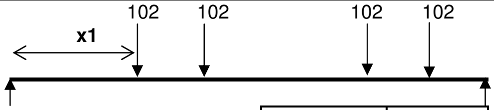


Table 5.3.1 of BD21

			Moment	Shear
Assessment Loading		HB	30.0	45.0
Nominal Single Axle Load		(kN)	300	450
Wheel Contact Area		(m)	0.261	0.320
Minimum Distance Possible from edge of slab to centre line of first wheel	on left side	(m)	0.58	0.58
	on right side	(m)	10.96	10.96
Dispersion for HB Axle		beff	0.74	0.79
=> Load for HB axle		kN	75.0	112.5
		kN/m	101.9	141.6
	Yfl		1.50	
	Yf3		1.0	

				Moment Factor as per Influence Line
Moment Capacity Check				
Position of first axle from left support centre line		x1	1.07	0.5
Hence, distance of other axle from left support		x2	2.9	0.4
		x3	0.0	0.0
		x4	0.0	0.0
Moment Due to HB Load	M_{LL}	(kNm)	83	
Adequacy Factor			127%	
=>Loading Capacity (Moment)			30HB	

			for shear at d	for shear at 2d	Shear Factor at d	Shear Factor at 2d
Shear Capacity Check						
Position of first axle from left support centre line		x1	0.41	0.68	0.89	0.8
Hence, distance of other axle from left support		x2	2.2	2.5	0.07	0.1
		x3	0.000	0.0	0.00	0.0
Shear Due HB Loading		x4	0.000	0.0	0.00	0.0
Shear at av = d	$V_{LLav = d}$	(kN/m)	123			
Adequacy Factor			243%			
=>Loading Capacity (Shear) (av = d)			45HB			
Shear at av = 2d	$V_{av = 2d}$	(kN/m)	123			
Adequacy Factor			245%			
=>Loading Capacity (Shear)(av = 2d)			45HB			

Output: **HB Load**

Moment Capacity
30HB

Shear Capacity
45HB

Ref Page 14&15

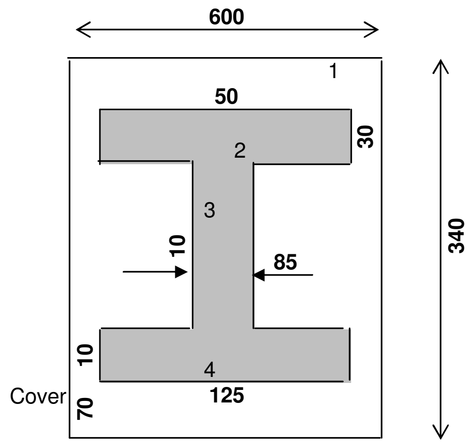
Check Bond Stress

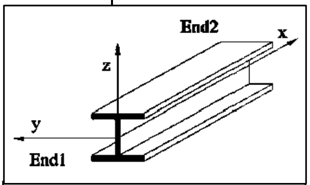
Moment Capacity for non composite section	=	<30HB	Assuming no contribution from Concrete
Adequacy Factor for 45HB		-14%	

Output: **Bond Capacity**
<30HB

Section Properties

Composite Section Properties





Axes used in Calculations to coincide with Superstress Axes

Idealised Section Short Term fcu = 26.8307

Ec = (20 + 0.27f_{cu}) = 27

Es = 205 **m** = Es / Ec = **7.52**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	340	1	1.00	204000	170	34680000	5.896E+09	1.965E+09	Concrete
Top Flange	2	50	30	1	7.52	11286.8	105	1185110.3	124436578	112500	Steel
Web	3	85	10	1	7.52	6395.83	85	543645.82	46209895	7083.3333	Steel
Bot Flange	4	125	10	1	7.52	9405.64	75	705422.78	52906708	10416.667	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					231088	435	37114179	6.119E+09	1.965E+09	

$Y_{CG} = \frac{\Sigma\ Ay}{\Sigma\ A}$ for bottom $= \frac{37114178.9}{231088.235} =$ 160.61 mm

$I_{CG} = Iyy - (\ \Sigma A \ \ x\ y_{CG}^2\ )$

$Iyy = (\ \Sigma\ I_{self} + \Sigma\ Ay^2\ )$

$I_{CG} = (\ \Sigma\ I_{self} + \Sigma\ Ay^2\ ) - (\ \Sigma\ A \ x\ y_{CG}^2\ )$

= (2E+09 + 6.1E+09)-(231088)x(160.606 ^{2})

= 2.124E+09 mm4

Idealised Section Long Term

Es = 205 **m** = Es / Ec = **15.05**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	340	1	1.00	204000	170	34680000	5.896E+09	1.965E+09	Concrete
Top Flange	2	50	30	1	15.05	22573.5	105	2370220.5	248873156	112500	Steel
Web	3	85	10	1	15.05	12791.7	85	1087291.6	92419790	7083.3333	Steel
Bot Flange	4	125	10	1	15.05	18811.3	75	1410845.6	105813417	10416.667	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					258176	435	39548358	6.343E+09	1.965E+09	

$Y_{CG} = \frac{\Sigma\ Ay}{\Sigma\ A}$ for bottom $= \frac{39548357.7}{258176.469} =$ 153.18 mm

$I_{CG} = Iyy - (\ \Sigma A \ \ x\ y_{CG}^2\ )$

$Iyy = (\ \Sigma\ I_{self} + \Sigma\ Ay^2\ )$

$I_{CG} = (\ \Sigma\ I_{self} + \Sigma\ Ay^2\ ) - (\ \Sigma\ A \ x\ y_{CG}^2\ )$

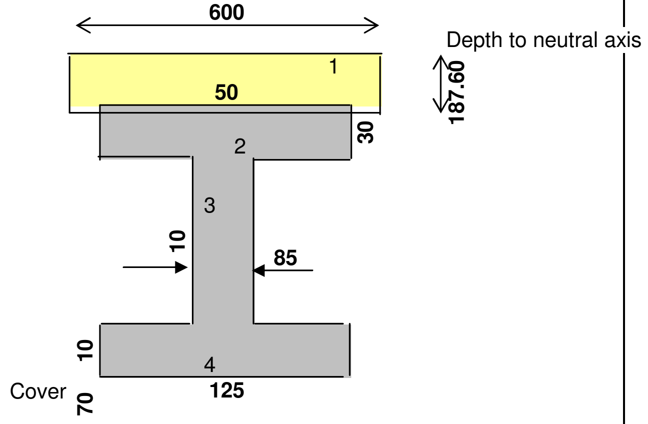
= (2E+09 + 6.3E+09)-(258176)x(153.183 ^{2})

= 2.25E+09 mm4

Ref	Calculations	Output

Section Properties

Cracked Section properties



Idealised Section Short Term

fcu = 26.8307

Ec = $(20 + 0.27f_{cu})$ = 27

Es = 205 **m** = Es / Ec = **7.52**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	187.599	1	1.00	112560	246.2	27712210	6.823E+09	330113917	Concrete
Top Flange	2	50	30	1	7.52	11286.8	105	1185110.3	124436578	112500	Steel
Web	3	85	10	1	7.52	6395.83	85	543645.82	46209895	7083.3333	Steel
Bot Flange	4	125	10	1	7.52	9405.64	75	705422.78	52906708	10416.667	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					139648	511.2	30146389	7.046E+09	330243917	

Y_{CG} = $\frac{\Sigma\ Ay}{\Sigma\ A}$ for bottom = $\frac{30146389.4}{139647.831}$ = 215.87 mm

I_{CG} = Iyy -(Σ A x y_{CG}^2)

Iyy = (Σ I_{self} + Σ Ay^2)

I_{CG} = (Σ I_{self} + Σ Ay^2)-(Σ A x y_{CG}^2)

= (3.3E+08 + 7E+09)-(139648)x(215.874 ^{2})

= 8.69E+08 mm4

Idealised Section Long Term

Es = 205 **m** = Es / Ec = **15.05**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	187.599	1	1.00	112560	246.2	27712210	6.823E+09	330113917	Concrete
Top Flange	2	50	30	1	15.05	22573.5	105	2370220.5	248873156	112500	Steel
Web	3	85	10	1	15.05	12791.7	85	1087291.6	92419790	7083.3333	Steel
Bot Flange	4	125	10	1	15.05	18811.3	75	1410845.6	105813417	10416.667	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					166736	511.2	32580568	7.27E+09	330243917	

Y_{CG} = $\frac{\Sigma\ Ay}{\Sigma\ A}$ for bottom = $\frac{32580568.2}{166736.066}$ = 195.40 mm

I_{CG} = Iyy -(Σ A x y_{CG}^2)

Iyy = (Σ I_{self} + Σ Ay^2)

I_{CG} = (Σ I_{self} + Σ Ay^2)-(Σ A x y_{CG}^2)

= (3.3E+08 + 7.3E+09)-(166736)x(195.402 ^{2})

= 1.23E+09 mm4

Check bond stress of section

Dimensions in mm

Allowable f_{cu}=	26.83074	b=	600
γ_{mc}=	1.05	d_c=	340
Allowable f_{st}=	230	d_s=	50
γ_{ms}=	1.05	A_{st}=	1500
γ_{f3}=	1.1	t_{ft}=	30
Bottom Cover=	70	t_{fb}=	10
		A_{sb}=	1250
		t_w=	85

Short Term Ec (BD 44/95 cl. 4.3.2.1)

Ec = (20 + 0.27f_{cu}) = 27

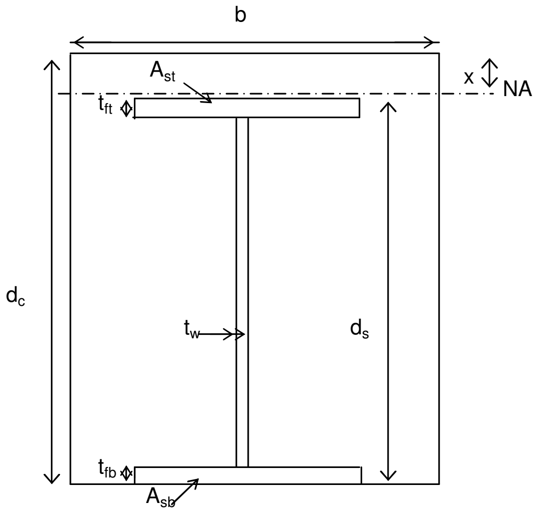
Es = 205 **m** = Es / Ec = **7.52**

Long Term Ec (BD 44/95 cl. 4.3.2.1)

Twice Short Term **m** = **15.05**

Allowable Conc stress = $0.75f_{cu}/\gamma_{mc}\gamma_{f3}$ = **17.423**

Allowable steel stress = $f_{st}/\gamma_{ms}\gamma_{f3}$ = **199.134**



Uncracked Section for Grillage Analysis

	Short Term	Long Term Ec	
m =	7.52	15.05	
x =	187.60	201.51	mm
Area of section (concrete units) =	231088.23	258176.47	mm^2
Area of section (steel units) =	30711.40	17155.70	mm^2
I_{NA} (concrete units)=	2.12E+09	2.25E+09	mm^4
I_{NA} (steel units)=	3.34E+08	1.95E+08	mm^4

Cracked Section

	Short Term	Long Term Ec	
m =	7.52	15.05	
x =	157.33	168.64	mm
Area of concrete in compression =	94399.88	101183.60	mm^2
Centroid of conc. in comp.(from NA) =	78.67	84.32	mm
I_{NA} (cracked section)=	8.69E+08	1.23E+09	mm^4
A * y / I_{NA} =	0.00855	0.00692	/mm

BD61/10 Cl 8.5.1: *"The bond may be assumed to be developed uniformly only over both sides of the web and the upper surface of the top and bottom flanges of the steel beam where there is complete encasement and over both sides of the web and the upper surface of the top flange of the steel beam where the beam soffit is exposed."*

Hence, as cover to soffit of bottom flange is 70mm, Ls = 110 mm

Check for Max Shear (at support) 40t

Serviceability Loads (F)

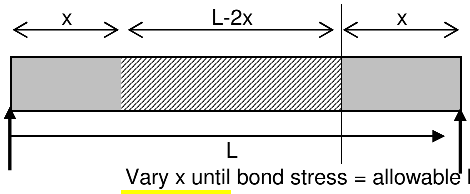
Shear at support	kN
Dead Load	14.50
Live Load	48.91

	Live Load	Dead Load	
l Shear Force = FAy/I_{NA}	418.09	100.24	N/mm
Bond stress =	3.801	0.911	N/mm^2
Total bond stress =		4.712	N/mm^2
Allowable bond stress at SLS =		0.700	N/mm^2

Result: Section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check capacity of section unsuitable for composite action

Find distance x such that bond stress due to combined Dead Load and Live Load = 0.7N/mm2



Legend:

bond stress <0.7N/mm2 suitable for composite action

bond stress >0.7N/mm2 unsuitable for composite action

Vary x until bond stress = allowable bond stress

Try x = **1.76** m (Max x = L/2 = 1.805 m)

Okay Hint:Use Goalseek

Serviceability Loads (F)

Shear at location x	kN
Dead Load	**0.33**
Live Load	**8.74**

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	74.69	2.31	N/mm
Bond stress using =	0.679	0.021	N/mm^2
Total bond stress=	**0.700**		N/mm^2
Allowable bond stress at SLS =	**0.700**		N/mm^2

Result: Bond stress okay

Check corresponding moment capacity at x

Factor **K** for 40 tonne loading	0.79	
Moment Capacity of steel section	1.97	kNm
Moment Capacity of composite section	90.61	kNm

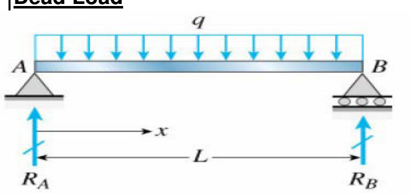
ULS Moment at x	kNm
Dead Load	16.51
Available capacity for live load	-14.55
Live Load	66.18

Factor C for Moment	-0.17
Loading Capacity Moment	<3t
Adequacy Factor	-0.22

as per Figure 5.6

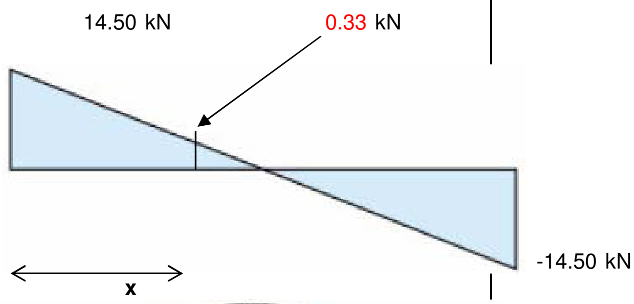
(HA + KEL Eqv.)
Moment Capacity
<3t

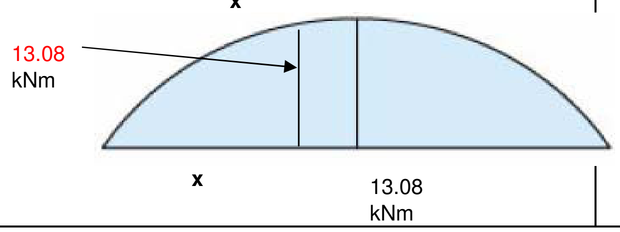
Dead Load



q	8.03	kN/m	unfactored
L	3.61	m	
x	**1.76**	m	

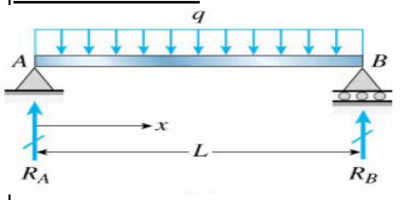
RA=RB =	14.50	kN
Vx	0.33	kN
Vmax	14.50	kN
Mx	13.08	kNm
Mmax	13.08	kNm

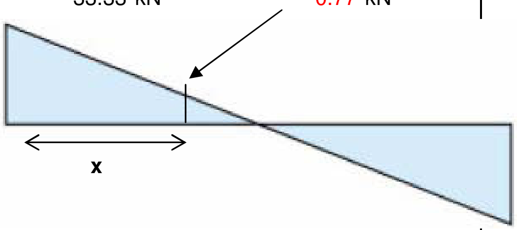




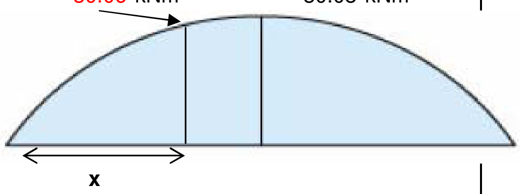
Ref		Project NRA Eirspan Task Order 213			Job ref 3044	
	ATKINS	**Part of Structure** Filler Beam Capacity MO-N58-001.00			Calc sheet 13	Rev 0.00
		Drawing ref.	Calc by CP	Date 2012-02-13	Check by PG	Date 2012-02-14
Ref	Calculations				Ouptut	

HA UDL Live Load



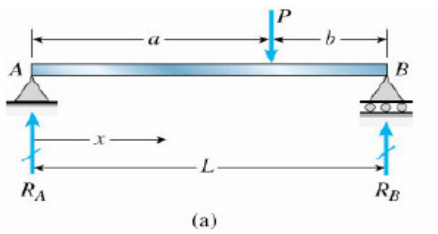


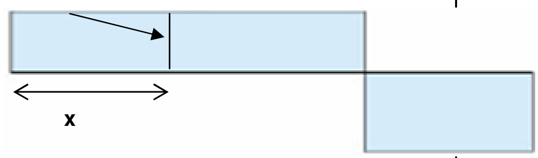
q	18.46	kN/section
L	3.61	m
x	1.76	m



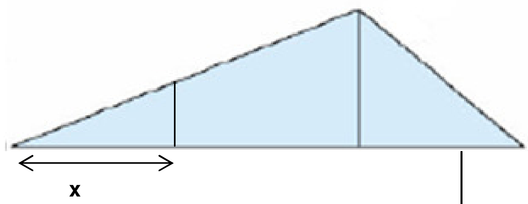
RA=RB = 33.33 kN
Vx 0.77 kN
Vmax 33.33 kN
Mx 30.06 kNm
Mmax 30.08 kNm

HA KEL Live Load





P	15.58	kN
L	3.61	m
a	1.76	
b	1.85	
x	1.76	m



RA 7.97 kN
RB 7.61 kN
Vx 7.97 kN
Vmax 15.58 kN (P at support)
Mx 14.06 kNm
Mmax 14.06 kNm
Mmax P at centre 14.06 kNm

Combined Continuos + Point Load

	per m width	ULS (Yf3=1.5)
Combined Moment Mx	44.12 kNm	66.18
Combined Shear Vx	8.74 kN	13.11

		ULS (Yf3=1.5)
Max M	44.14 kNm	66.21 kNm
Max V	48.91 kN	73.36 kN

	ATKINS	**Project** NRA Eirspan Task Order 213			Job ref 3044.00	
		Part of Structure Filler Beam Capacity MO-N58-001.00			Calc sheet 14	Rev 0.00
		Drawing ref.	Calc by CP	Date 2012-02-13	Check by PG	Date 2012-02-14
Ref	Calculations				Ouptut	

HB Live Load

Check for Max Shear (at support) 45HB

Serviceability Loads (F)

Shear at support	kN
Dead Load	14.50
Live Load	81.73

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	698.69	100.24	N/mm
Bond stress using=	6.352	0.911	N/mm^2
Total bond stress using =	7.263		N/mm^2
Allowable bond stress at SLS =	0.700		N/mm^2

Result: Bond Stress (7.26) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check section at x

45HB Loading Vary x until bond stress = allowable bond stress

Try x = **1.57** m Load **45.00** HB

reduce x Hint:Use Goalseek

Serviceability Loads (F)

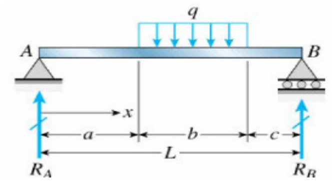
Shear at location x	kN
Dead Load	**1.92**
Live Load	**7.45**

Check for Shear at x - 45HB

Note: If bottom flange is exposed use L_{S1} otherwise use L_{S2}

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	64	13.28	N/mm
Bond stress=	0.579	0.121	N/mm^2
Total bond stress=	**0.700**		N/mm^2
Allowable bond stress at SLS = 0.7	**0.700**		N/mm^2

Result: Bond Stress (0.7) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action at this location (see BD 61/10 Clause 8.5.1)



beff = 0.74 m

Suggested values for x (beff/2) 0.37 m

Live Load at x

q	101.90	kN/section
a	1.20	m
b	0.74	m
c	1.68	m
L	3.61	m
x	1.57	m

			ULS	
RA	42.47	kN		
RB	32.53	kN		
Vx	4.97	kN	7.45	kN
Vmax	42.47	kN	63.70	kN
Mx	59.60	kNm	89.40	kNm
Mmax	59.72	kNm	89.58	kNm

Dead Load at x

q	8.03	kN/m
L	3.61	m
x	**1.57**	m

unfactored

RA=RB =	14.50	kN
Vx	1.92	kN
Vmax	14.50	kN
Mx	12.85	kNm
Mmax	13.08	kNm

Check corresponding moment capacity at x

ULS Moment at x	kNm		
Dead Load	14.78		
Available capacity for live load	-12.81	Adequacy	
45HB Live Load	89.58	-0.14	Fail

Moment Capacity <45HB

Check for Max Shear (at support) 30HB

Serviceability Loads (F)

Shear at support	kN
Dead Load	14.50
Live Load	54.49

Note: If bottom flange is exposed use L_{S1} otherwise use L_{S2}

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	465.79	100.24	N/mm
Bond stress=	4.234	0.911	N/mm^2
Total bond stress=		5.146	N/mm^2
Allowable bond stress at SLS =		0.700	N/mm^2

Result: Bond Stress (5.15) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check section at x 30HB

Vary x until bond stress = allowable bond stress

Loading Try x = 1.57 m Load 30 HB

reduce x Hint:Use Goalseek

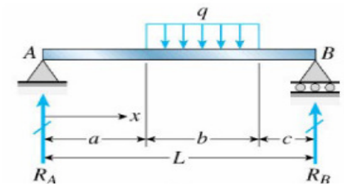
Serviceability Loads (F)

Shear at location x	kN
Dead Load	**1.92**
Live Load	**7.45**

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	64	13.28	N/mm
Bond stress=	0.579	0.121	N/mm^2
Total bond stress=		**0.700**	N/mm^2
Allowable bond stress at SLS = 0.7		**0.700**	N/mm^2

Result: Bond Stress (0.7) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Live Load at x



beff = 0.74 m

q	101.90	kN/section
a	1.20	m
b	0.74	m
c	1.68	m
L	3.61	m
x	1.57	m

			ULS	
RA	42.47	kN		
RB	32.53	kN		
Vx	4.97	kN	7.45	kN
Vmax	42.47	kN	63.70	kN
Mx	59.60	kNm	89.40	kNm
Mmax	59.72	kNm	89.58	kNm

Dead Load at x

q	8.03	kN/m
L	3.61	m
x	**1.57**	m

unfactored

RA=RB =	14.50	kN
Vx	1.92	kN
Vmax	14.50	kN
Mx	12.85	kNm
Mmax	13.08	kNm

	ULS Moment at x	kNm	
	Dead Load	14.78	
Available capacity for live load		-12.81	Adequacy
30HB	Live Load	89.58	-0.14 Fail

Moment Capacity <30HB

Job Name :Eirspan TO213

Structure Type = Grillage
No of joints = 60
No of members = 103

Analysis Settings

Analysis method = Linear Elastic

Material Types

Data last edited at 15:38 on 9/5/12

Units : E(kN/mm2) G(kN/mm2) CTE(/deg C) Density(kN/m3)

Type no	E CTE	G Density	Name
1	31.0 1.2e-5	11.6 24.0	Concrete

Supports

Data last edited at 15:45 on 9/5/12

Joint No	DZ (kN/m)	RX (kN.m/deg)	RY (kN.m/deg)
1	Rigid	Rigid	Free
6	Rigid	Rigid	Free
7	Rigid	Rigid	Free
12	Rigid	Rigid	Free
13	Rigid	Rigid	Free
18	Rigid	Rigid	Free
19	Rigid	Rigid	Free
24	Rigid	Rigid	Free
25	Rigid	Rigid	Free
30	Rigid	Rigid	Free
31	Rigid	Rigid	Free
36	Rigid	Rigid	Free
37	Rigid	Rigid	Free
42	Rigid	Rigid	Free
43	Rigid	Rigid	Free
48	Rigid	Rigid	Free
49	Rigid	Rigid	Free
54	Rigid	Rigid	Free
55	Rigid	Rigid	Free
60	Rigid	Rigid	Free
61	Rigid	Rigid	Free
66	Rigid	Rigid	Free
67	Rigid	Rigid	Free
72	Rigid	Rigid	Free

Sections

Data last edited at 15:43 on 9/5/12

Section 1 : 1000mm slab : Rectangle

	Dy = 1000.0 mm	Dz = 340.0 mm
	Tz = 0.0 mm	Ty = 0.0 mm
	Cy = n/a	Cz = 0.0 mm
Ax = 3400.00 cm2	Ay = n/a	Az = 2833.33 cm2
Ix = 1029815.29 cm4	Iy = 327533.33 cm4	Iz = n/a

Section 2 : Support : Rectangle

	Dy = 640.0 mm	Dz = 340.0 mm
	Tz = 0.0 mm	Ty = 0.0 mm
	Cy = n/a	Cz = 0.0 mm
Ax = 2176.00 cm2	Ay = n/a	Az = 1813.33 cm2
Ix = 559717.50 cm4	Iy = 209621.33 cm4	Iz = n/a

Loadcase titles

Data last edited at 10:32 on 10/5/12

Loadcase No	Reference	Title
1	B1	HL:ALP: My at End2 : Member 69: LV 40t

CURRENT : Minimum Member end forces

Loadcases : B1

Analysed at 10:32 hrs on 10/5/12

Member	Joint	Torque (kN.m)	Bending Moment (kN.m)	Shear Force (kN)
38	61	**-5.361 B1**	-2.092h	80.654
126	66	5.946	**-2.312 B1**	-93.367
126	66	5.946	-2.312h	**-93.367 B1**

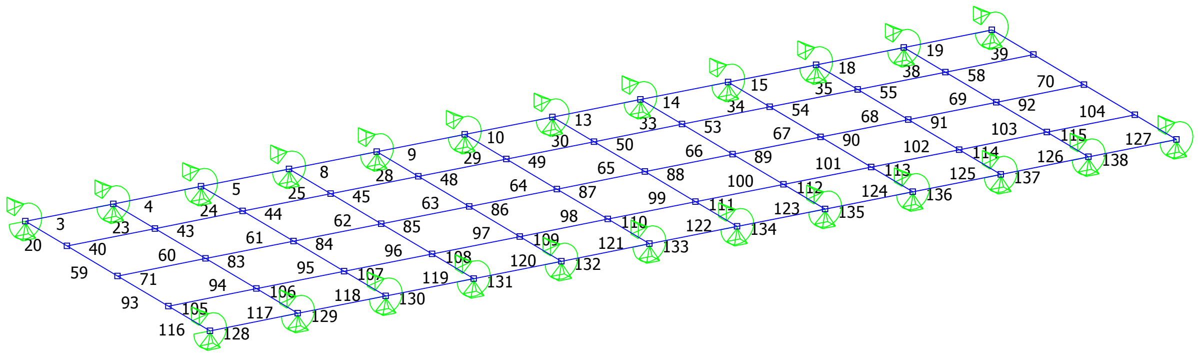
CURRENT : Maximum Member end forces

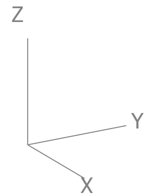
Loadcases : B1

Analysed at 10:32 hrs on 10/5/12

Member	Joint	Torque (kN.m)	Bending Moment (kN.m)	Shear Force (kN)
126	66	**5.946 B1**	-2.312h	-93.367
69	64	-1.644	**95.101 B1**	20.637
38	61	-5.361	-2.092h	**80.654 B1**

SCALES
Structure 1:74

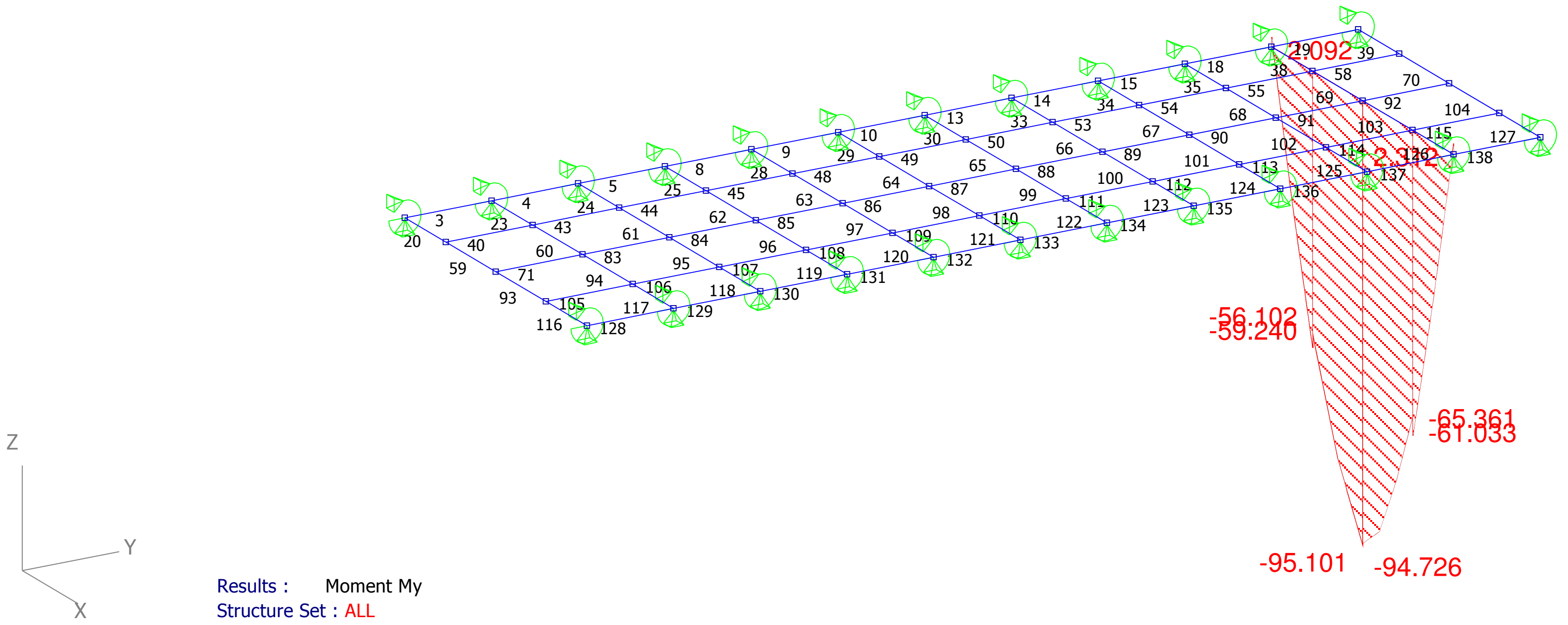




Structure Set : ALL

SCALES

Structure 1:74
Moments 1 mm = 1.500 kN.m



Results : Moment My
Structure Set : ALL
Loadcases : B1

Appendix E

Sub-Standard Structure Summary

APPENDIX E: SUB-STANDARD STRUCTURE SUMMARY

Structure Name: **Strade River Bridge**
Structure Ref. No.: **MO-N58-001.00**

Assessment/Stage Review	Stage 1 Assessment	Stage 2 Assessment		
Date: Report Reference: Assessed Capacity: Sub-Standard Status:	21/05/2012 DG-TO213-69 Span 1: Bending 18t, Shear 40t, Bond <3t Span 2: Bending 40t, Shear 40t, Bond <3t Provisionally Sub-Standard			
Interim Measures Date: Feasibility Assessment Is the Structure an Immediate Structure or a Low Risk Provisionally Sub-Standard Structure?	21/05/2012 Low Risk Provisionally Sub-Standard			
Is the Structure Monitoring appropriate?	Monitoring of the substructure is not appropriate.			
Interim Measures Date: Proposal: Recommendation:	21/05/2012 Stage 2 Assessment of the structure and subsequent strengthening of the structure, if required.			
Interim Measures Date: Approval: Approval/Rejection:				
Actions Implementation Date : Details/Ref : Provisional finish date for monitoring : Removal Date :				
Additional Notes				

Appendix F

Interim Measures Feasibility Assessment

APPENDIX F: INTERIM MEASURES FEASIBILITY ASSESSMENT FOR BRIDGES

1. GENERAL DETAILS

1.1 Structure name and assessment reference:
Structure Ref No: MO-N58-001.00

1.2 Location, route and county/area:
Strade River Bridge, N58, County Mayo

Latitude Y: 297482.729 Longitude X: 125785.401

1.3 Assessing Organisation:
ATKINS
Assessed by: CM
Checked by: PG
Assessment date: 21/05/2012

1.4 Structure type, form, span, skew:
Two Span Filler Beam Deck Structure, Skew Spans 3.81m & 3.79, Skew 28°.

1.5 Obstacle crossed and facility carried:
Carries the N58 National Secondary Route across the Strade River.

1.6 Estimated cost of permanent strengthening/replacement works:
Not applicable.

2. ASSESSMENT PROGRESS

2.1 Level of assessment reached:
Stage 1 Assessment

2.2 Assessed capacity:
Span 1: 18 t (Bending), 40t (Shear) & <3t (Bond)
Span 2: 40 t (Bending), 40t (Shear) & <3t (Bond)

2.3 Date of assessment:
21/05/2012

2.4 Assessment Report reference:
3044/30/32/DG-TO-213-69

2.5 Provisionally Sub-standard or Sub-standard?
Provisionally Sub-standard

2.6 Description of anticipated mode of failure, including its progressions from local overstress to global collapse mechanism.
Failure mode of the RC slab structure is likely to be due to bond stress between the steel components and the concrete.

2.7 Description of distress (if present):
No structural defects present.

3. CONSIDERATION OF RISK POSED BY STRUCTURE IN CURRENT STATE

3.1 Discussion

The Stage 1 Assessment indicated that both spans of the structure had a capacity of 7.5 tonnes assessment loading for bending, 40 tonnes for shear and less than 3 tonnes for bond. As the adequacy of the structures in bending for 40t live loading was 60% for span 1 and 73% for span 2 using the strip method, a grillage analysis was carried out, which increased the load capacity of the structures in bending to 18 tonnes assessment loading for Span 1 and to 40 tonnes for Span 2. The Stage 1 Assessment also indicated that the structure failed for 30 Units of HB loading in bond.

The structure was noted to be in good condition and not showing any signs of structural defects. The main causes of low carrying capacity of the structure were low concrete strength and low area of steel reinforcement components.

It is considered likely that Stage 2 Assessment of the structure would increase the assessment load capacity of the structure, but may not increase it to 40 tonnes assessment loading. Hence, based on the results of Stage 2 Assessment, the structure should be strengthened, if necessary.

3.2 Is the structure an Immediate Risk Structure?

No, the structure is not an immediate risk structure.

3.3 Is the structure a Low Risk Provisionally Sub-standard Structure?

Yes, the structure is a Low Risk Provisionally Sub-standard Structure.

4. APPROPRIATENESS OF MONITORING

4.1 Discussion

The structure was not showing any signs of structural defects. Hence, it is considered that the monitoring of the substructure is not appropriate.

4.2 Is the structure monitoring appropriate?

No, the structure is not monitoring appropriate.

5. OPTIONS FOR LOAD MITIGATION INTERIM MEASURES

Load mitigation measures are not required at this stage

6. OPTIONS FOR MONITORING INTERIM MEASURES

Monitoring interim measures are not required at this stage.

7. RECOMMENDED OPTIONS FOR INTERIM MEASURES

7.1 Recommended Load Mitigation Interim Measures:

Load mitigation measures are not required at this stage.

7.2 Recommended Monitoring Interim Measures:

Monitoring interim measures are not required at this stage.

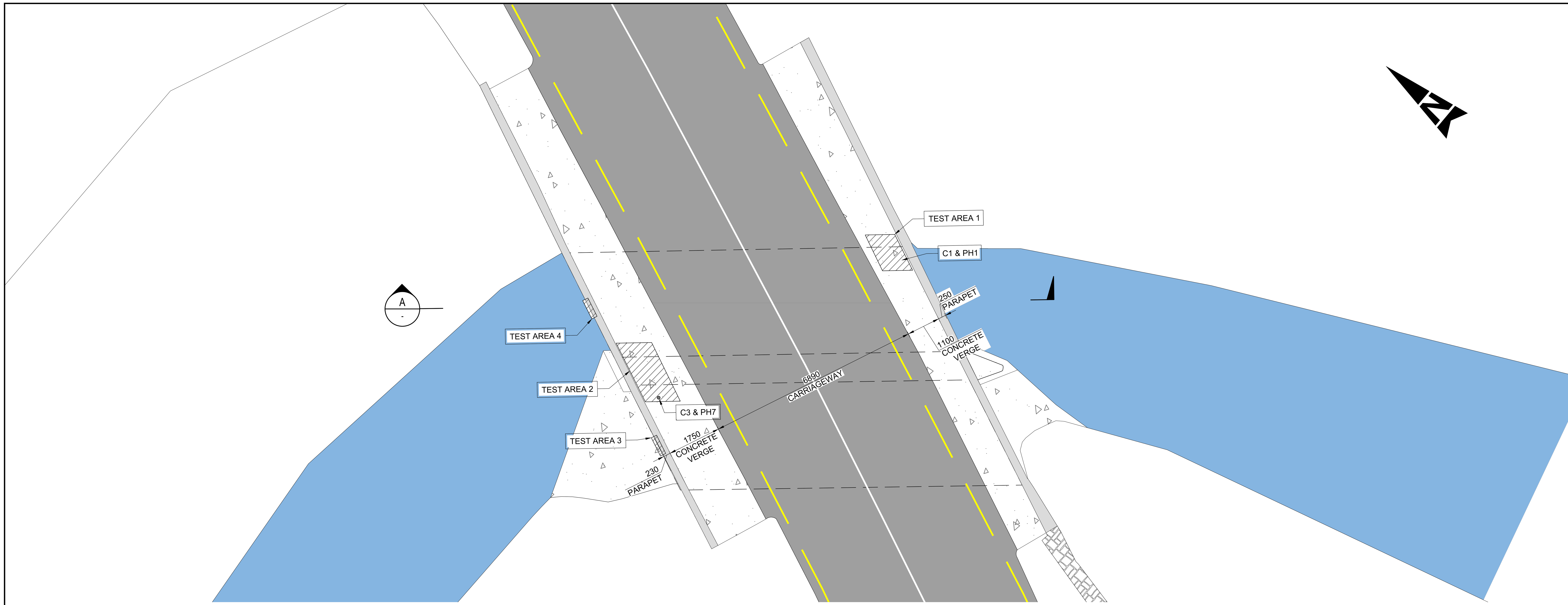
Appendix B. Results of Additional Literature Search

No additional material found.

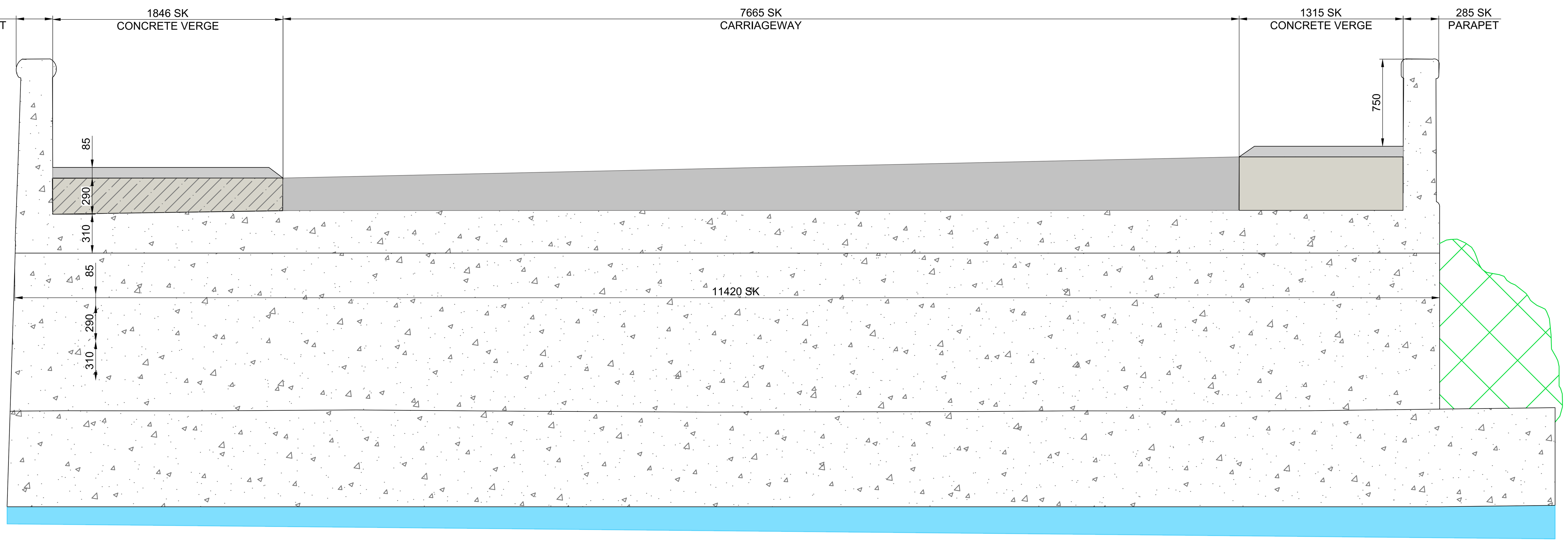
Appendix C. General Arrangement Drawings

A1

DO NOT SCALE



PLAN
Scale at A1 1:75
Scale at A3 1:150



SECTION A
Scale at A1 1:25
Scale at A3 1:50

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

Risk Level		
	X	Atkins Base Line - Low Risk
		Atkins Sensitive - Medium Risk
		Atkins Private - High Risk
		Client Critical - Already Marked

TII Bonneagar Iompair Éireann Transport Infrastructure Ireland

Donegal NRDO Oifig Deartha Náisiúnta Dhún na nGall

Rev	Description	By	Date	Chk'd	Rev'd	Auth
P0	ISSUED FOR REVIEW	SOC	08.24	POS	MG	MJ

AtkinsRéalis

Atkins House, 150-155 Airside Business Park, Swords, Co. Dublin Tel (+353) 01 810 8000 Fax (+353) 01 810 8001

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1st Floor Technology House Parkmore Technology Park, Galway Tel (+353) 091 786 050 Fax (+353) 091 779 830

Client: Comhairle Contae Mhaigh Eo Mayo County Council

Project: TO315 - MAYO BRIDGE ASSESSMENTS AND STRENGTHENING 2023

Purpose: PRELIMINARY ISSUE

Title: Strade River Bridge MO-N58-001.00 PLAN AND CROSS SECTION

Original Scale	Drawn	Checked	Reviewed	Authorised
As Shown	SOC Date 30.08.24	POS Date 30.08.24	MG Date 30.08.24	MJ Date 30.08.24

Status	Drawing Number	Rev
S0	0088572-ATK-02-XX-DR-CE-900201	P0

File: 0088572-ATK-02-XX-DR-CE-900201 to 0202.dwg Plotted by: SOConnor Date: Oct 22, 2024 - 2:19pm

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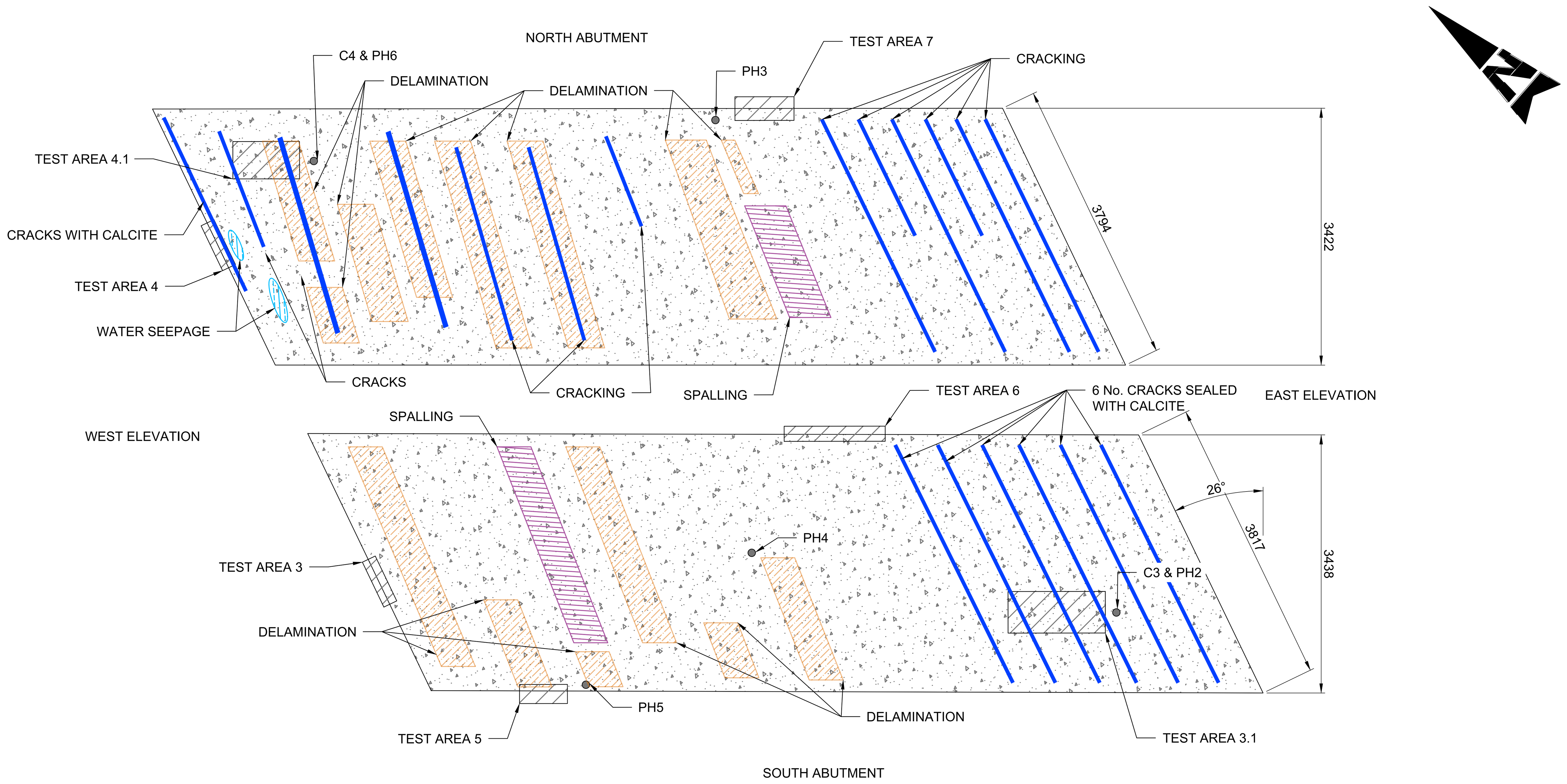
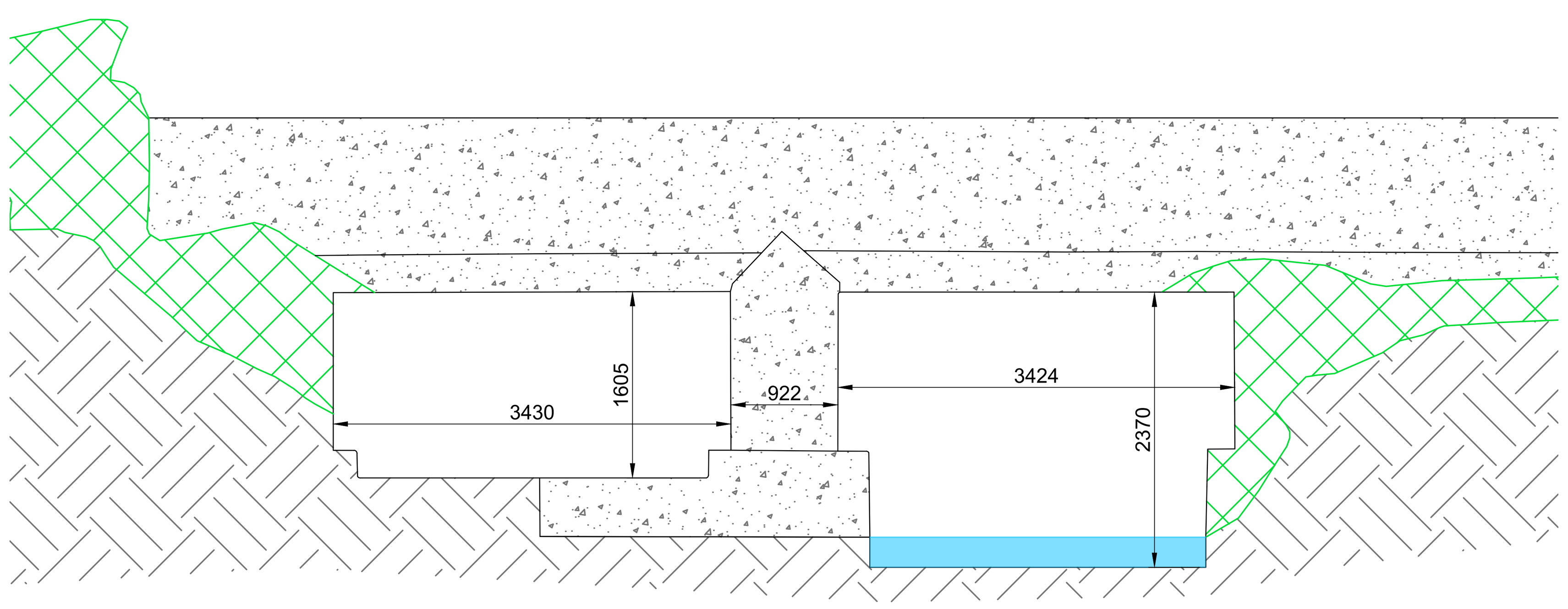


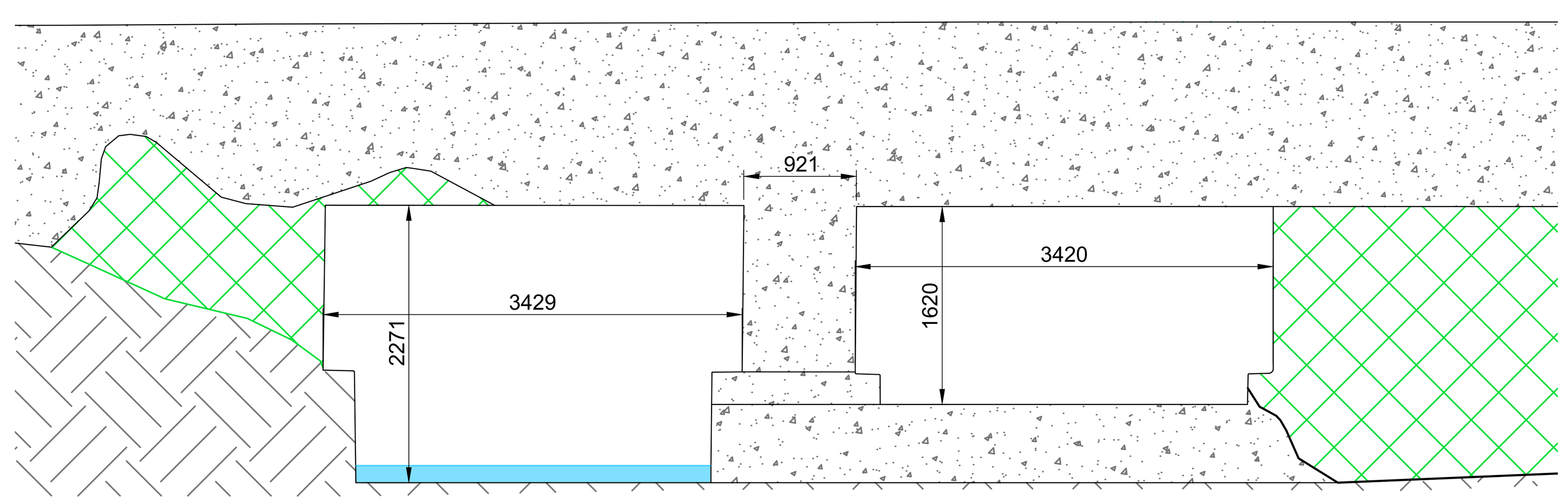
DEFECT PLAN

Scale at A1 1:50
Scale at A3 1:100



EAST ELEVATION

Scale at A1 1:50
Scale at A3 1:100



WEST ELEVATION

Scale at A1 1:50
Scale at A3 1:100

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

A1

DO NOT SCALE

Risk Level		
	X	Atkins Base Line - Low Risk
		Atkins Sensitive - Medium Risk
		Atkins Private - High Risk
		Client Critical - Already Marked

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Oifig Deichnid Náisiúnta
Dhún na nGall

Rev	Description	By	Date	Chk'd	Rev'd	Auth
P0	ISSUED FOR REVIEW	SOC	08.24	POS	MG	MJ

AtkinsRéalis

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Fax (+353) 021 429 0360

1st Floor Technology House Parkmore Technology Park, Galway
Tel (+353) 091 786 050
Fax (+353) 091 779 830

Client: Comhairle Contae Mhaigh Eo
Mayo County Council

Project: TO315 - MAYO BRIDGE ASSESSMENTS AND STRENGTHENING 2023

Purpose: PRELIMINARY ISSUE

Title: Strade River Bridge
MO-N58-001.00
ELEVATIONS AND DEFECT LAYOUT PLAN

Original Scale	Drawn	Checked	Reviewed	Authorised
1:50	SOC	POS	MG	MJ
	Date 30.08.24	Date 30.08.24	Date 30.08.24	Date 30.08.24

Status	Drawing Number	Rev
S0	0088572-ATK-02-XX-DR-CE-900202	P0

File: 0088572-ATK-02-XX-DR-CE-900201 to 0202.dwg Plotted by: SOConnor
Date: Oct 22, 2024 - 2:19pm

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Appendix D. Structural Condition Drawing

Refer to Appendix C for General Arrangement Drawings with the defect locations sketch included.

Appendix E. Copy of Materials Testing Report

TRIUR CONSTRUCTION LTD.

Structural Investigation Report

MO-N58-001.00 - STRUCTURAL INVESTIGATION REPORT – [REV 1]

12TH December 2024

PREPARED FOR

Comhairle Contae Mhaigh Eo
Mayo County Council

TII
Bonneagar Iompair Éireann
Transport Infrastructure Ireland

CONTENTS

1. INTRODUCTION

TRIUR Construction LTD carried out structural investigation works on Strade River Bridge (MO-N58-001.00) from the 8th to the 12th of July 2024
The Scope of the work included the following:
The site works were to consist of the following:

- Mobilization and site set up
- Installation of traffic management measures (traffic lights)
- Excavation of 2no. trial pits in the concrete verges for depth of fill and deck exposure. One trial pit was excavated above the Northeastern abutment support while the second trial pit was excavated above the western pier support.
- Coring of 4x samples for strength testing of deck soffit (2no. in each span).
- The drilling of pilot holes in both the deck and the abutments, as required.
- Expose the deck slab and cleaning of the deck surface in adhesion test area.
- Carry out waterproofing adhesion test in Test Area 1
- Delamination survey to both spans
- Ferroscan and Concrete breakout of Test area 1-7.
- Chloride, cement content and carbonation samples obtained for BHP to lab test.
- Half-cell potential and Resistivity testing conducted by BHP.
- Detailed sketches made of breakout areas to include reinforcement sizing, location, spacing and cover.
- Reinstatement of the breakout and coring areas using PLANITOP RASA AND RIPARA R4 cementitious mortar.
- Reinstatement of any road openings as per *Guidelines for Managing Openings in Public Roads (Guidelines on the Opening, Backfilling and Reinstatement of Openings in Public Roads) Second Edition Rev 1 (2017).*
- Preparation of a detailed factual report on the investigation work undertaken at each bridge, i.e. one no. report required per bridge
- Removal of traffic management measures
- Demobilization
- The Bridge was reinstated on the 15th July 2024
- A detailed sketch was prepared, see below.
- A digital photographic record was carried out throughout the investigation works, see below.

2. GENERAL DESCRIPTION OF STRUCTURE

The Strade River Bridge is a 2 span filler beam bridge. Each span is approx. 3.8m in length with a width of 11m.The Strade River predominantly flows in the northern span while the southern span consists of an elevated concrete floor which at the time of testing was above the river water level and completely dry. It carries the N58 national secondary road over the Strade Rriver which flows from east to west.

Location

Strade River Bridge
Co-ordinates: 53.921444, -9.130361 MO-N58-001.00, Strade

3. INVESTIGATION WORKS

- The excavation of the Trial pits above the deck comprised of the breakout and removal of 2no. concrete rubbing strip located on the eastern and western verges. A layer of mesh and fill was also removed from each trial pit until the deck was exposed. Test area 1 (TA1) was located over the northeastern abutment while Test area 2 (TA2) was located over the western pier. No waterproofing layer was found above the concrete deck. No services or ducting were located in each respective trial pit.
- The excavation of a Trial pit (Test Area 01), located above the northeastern abutment to expose the RC slab for depth of fill and deck exposure. In this Trial Pit, a Covermeter and GPR survey was conducted to an area of the deck surface followed by concrete breakout to confirm cover and sizing of reinforcement members. The material covering this RC slab was observed to be 804 over layed with a concrete rubbing strip. A concrete core (C1) was also extracted for strength testing along with a pilot hole to obtain deck thickness. Durability testing was carried out by BHP.

- The excavation of a Trial pit (Test Area 02), located above the western end of the bridge pier to expose the RC slab for depth of fill and deck exposure. In this Trial Pit, a Covermeter and GPR survey was conducted to an area of the deck surface. No Steel was found on the deck side of the slab. A concrete core (C2) was also extracted for strength testing. A 25mm diameter pilot hole was drilled through the deck to obtain a value for the depth of the slab in this location. Durability testing was carried out by BHP.
- The investigation of Test Area 03, located in the the centre of the southern span on the western fascia. The area was scanned for reinforcement, samples acquired for testing and broken out to expose reinforcement.
- The investigation of Test area 3.1 located on the southeastern corner of the soffit of the southern span. In this area, a Concrete core (C3) was extracted for strength testing. A pilot hole was drilled to obtain measurements for deck thickness. A scan and breakout of the soffit in this area was undertaken to expose internal reinforcement.
- The investigation of Test Area 04, was located at the centre of the northern span on the western fascia. The area was scanned for reinforcement, samples acquired for testing and broken out to expose reinforcement.
- The investigation of Test area 4.1 located on the northwestern corner of the soffit on the Northern span. In this area, a Concrete core (C4) was extracted for strength testing. A pilot hole was drilled to obtain measurements for deck thickness. A scan and breakout of the soffit in this area was undertaken to expose internal reinforcement.
- The investigation of Test Area 05 located in the southern abutment approx. 3 meters from the the western edge. In this area, a Covermenter and GPR survey was conducted. 2no. durability tests were also conducted. This was followed by the drilling of a pilot hole to obtain the abutment thickness.
- The investigation of Test Area 06 located on the southern face of the pier at the midpoint. In this area, a Covermenter and GPR survey was conducted. 2no. durability tests were also conducted.
- The investigation of Test Area 07 located in the northern abutment approx. 3 meters from the eastern edge. In this area, a Covermenter and GPR survey was conducted. 2no. durability tests were also conducted. This was followed by the drilling of a pilot hole to obtain the abutment thickness.
- Adhesion pull off test on the deck top surface in Test Area 1 to determine the suitability of deck to a spray applied deck waterproofing system.
- Reinforcement was found via breakouts in both the deck and in the soffit. Both longitudinal and transverse members were located and exposed on the deck and the soffit. The longitudinal reinforcement consisted of asymmetrical I-beams wherein the top flange was found to be narrower and thicker than the bottom flange. The transverse support consisted of smaller rectangular length of steel located close to the soffit. No conncection observed between the traverse reinforcement and the beams. Placed rebar detail.
- A delamination survey of both the southern and northern soffits was conducted. In the southern span, significant delamination was found across the whole width of the bridge. The areas where delamination had occurred were generally in the area covering each section of longitudinal reinforcement. The delamination ran in the direction of the longitudinal reinforcement while being consistent with the longitudinal reinforcement spacing.

  In the northern span, delamination was present in the midsection of the bridge between 5m and 7.5m in from the eastern facia. There was evidence to suggest that this northern span had previously experienced delamination and been repaired.

4. INVESTIGATION RESULTS

TEST AREA 1	mm
DeckTrial hole (east)	
cover of fill	420
cover on longitudinal bars	148
cover on transverse bars	124
Longitudinal bar sizing	125mm high rail
Transverse bar sizing	23x13mm bar
pilot hole 1	300
pilot hole 2	315
pilot hole 3	320
pilot hole 4	300
Core 1 – Area 1 – Deck	18.9 N/mm2
Core 2 – Area 1 – Deck	21.1 N/mm2

TEST AREA 2	mm
DeckTrial hole (west)	
cover of fill	315
cover on longitudinal bars	n/a
cover on transverse bars	n/a
Longitudinal bar sizing	n/a
Transverse bar sizing	n/a
No reinforcement found above rail girders	

TEST AREA 3	mm
FACIA (south west)	
side cover on Web	129
cover on bottom flange	32
side cover bottom flange	68
side cover on top flange	105

TEST AREA 3.1	mm
soffit (south east)	
cover of fill	n/a
cover on longitudinal bars	34
cover on transverse bars	59
Longitudinal bar sizing	125 high rail
Transverse bar sizing	23x13mm bar
Core 3 – Area 3.1 – Soffit 1	49.6 N/mm2

TEST AREA 4	mm
FACIA (north west)	
side cover on Web	132
cover on bottom flange	37
side cover bottom flange	80
side cover on top flange	104
Core 4 – Area 4.1 – Soffit 2	57.1 N/mm2

TEST AREA 4.1	mm
soffit (north west)	
cover of fill	n/a
cover on longitudinal bars	47
cover on transverse bars	51
Longitudinal bar sizing	125 high rail
Transverse bar sizing	23x13mm bar

TEST AREA 5	mm
Southern Abutment	
pilot hole	740
cover on longitudinal bars	n/a
cover on transverse bars	n/a
Longitudinal bar sizing	n/a
Transverse bar sizing	n/a
No reinforcement found	

TEST AREA 6	mm
Pier mid support (south west side)	
pilot hole	n/a
cover on longitudinal bars	n/a
cover on transverse bars	n/a
Longitudinal bar sizing	n/a
Transverse bar sizing	n/a
No reinforcement found	

TEST AREA 7	mm
Northern Abutment	
pilot hole	890
cover on longitudinal bars	n/a
cover on transverse bars	n/a
Longitudinal bar sizing	n/a
Transverse bar sizing	n/a
No reinforcement found	

5.DETAILED SKETCHES

Plan of works area – Test Area locations – see Appendix 1 for more details.

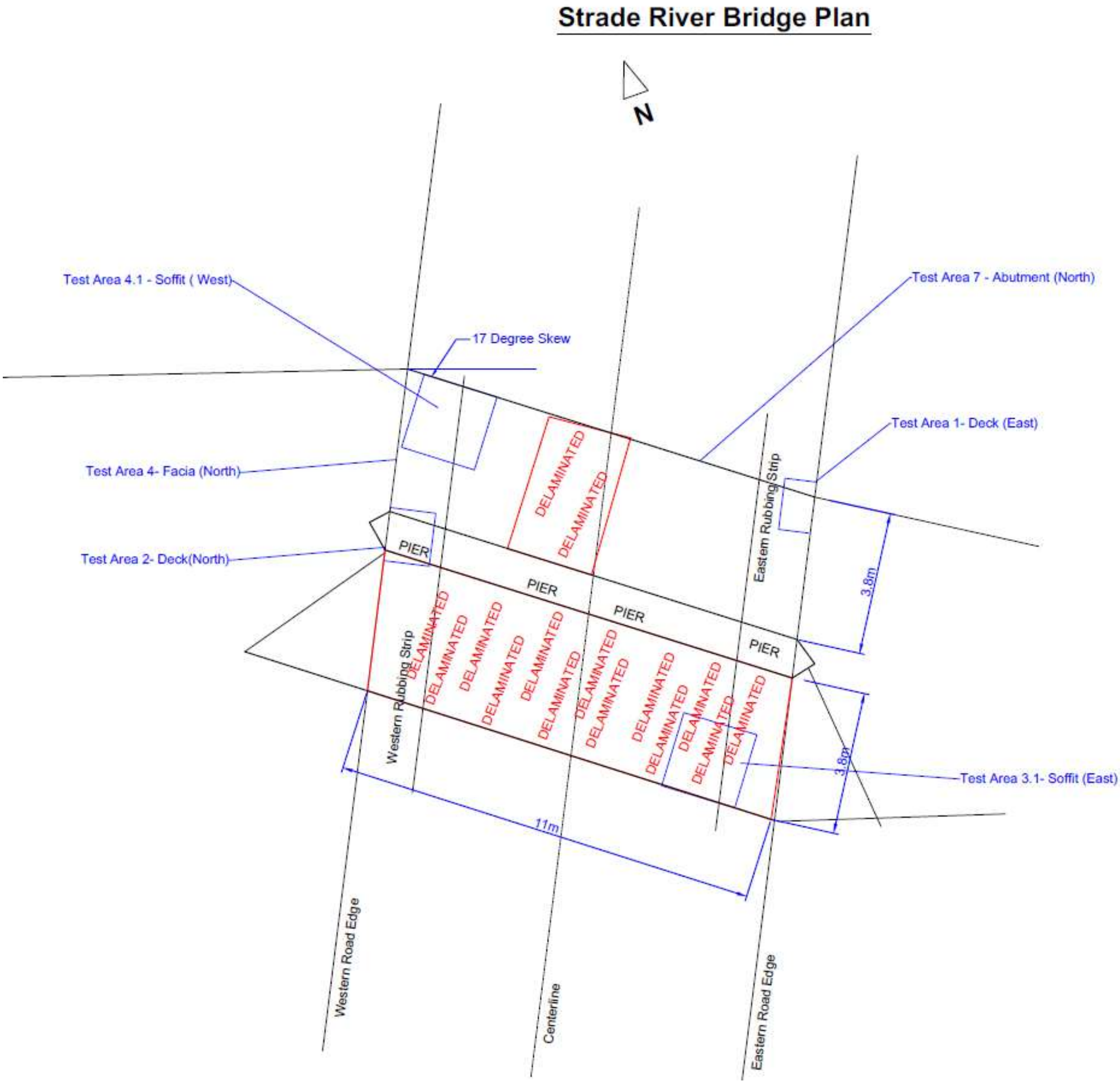


Figure 1: Strade Bridge Plan

Test area 1

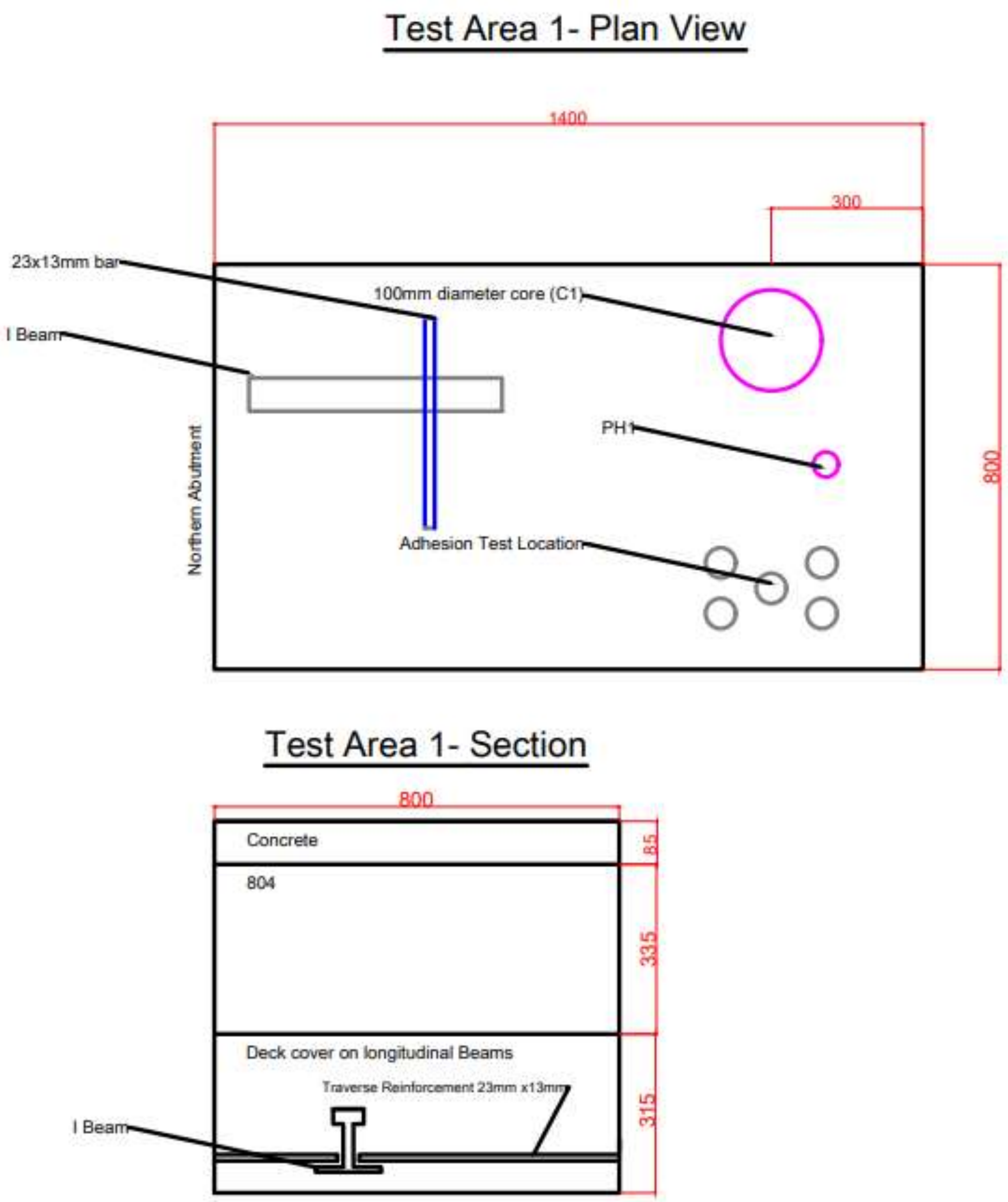


Figure 2: Test area 1 drawing

Test area 2

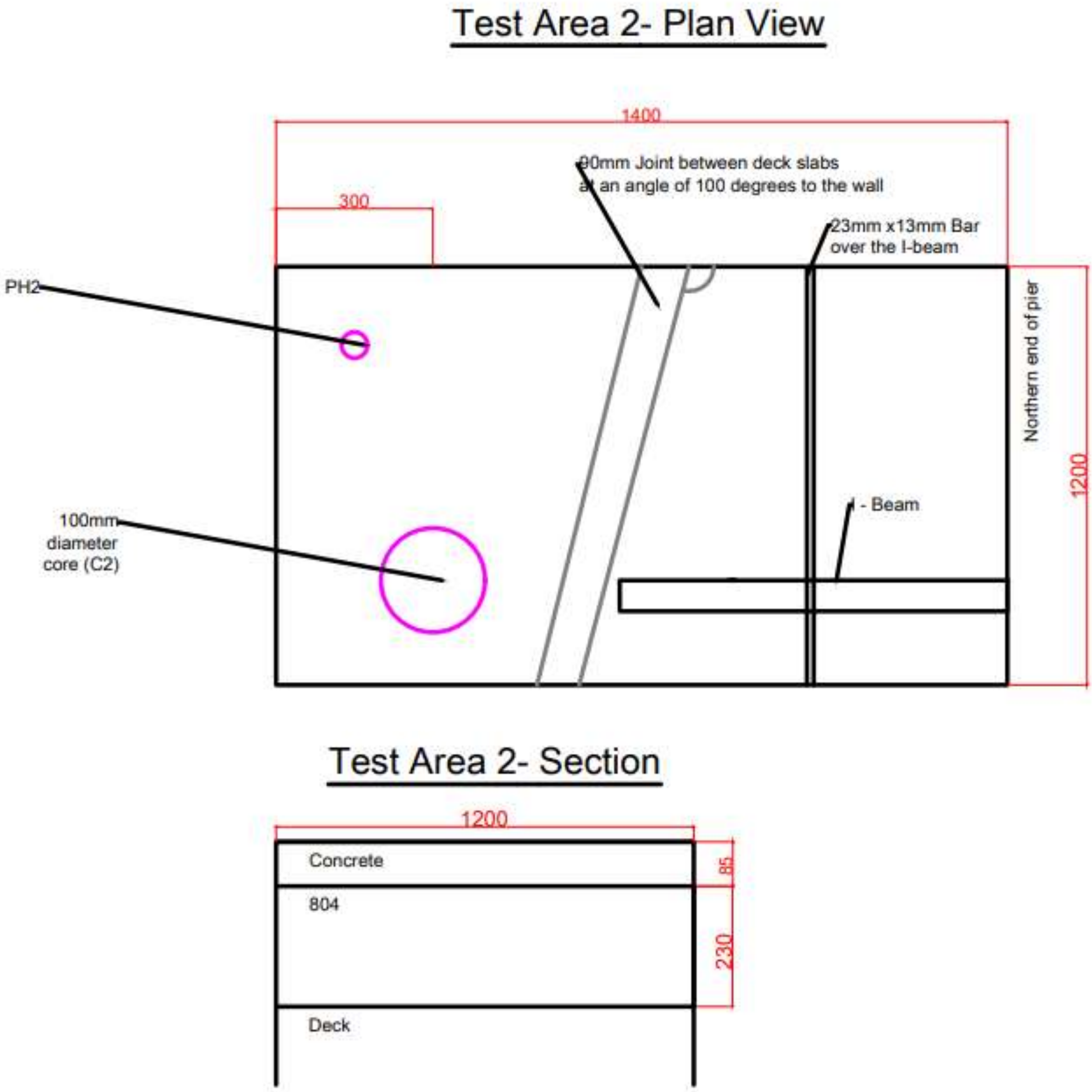


Figure 3: Test area 2 drawing

Test area 3

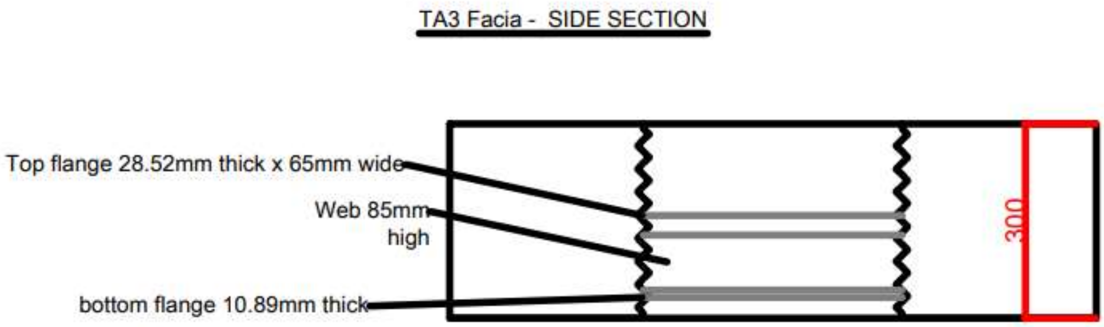


Figure 4:Facia side section

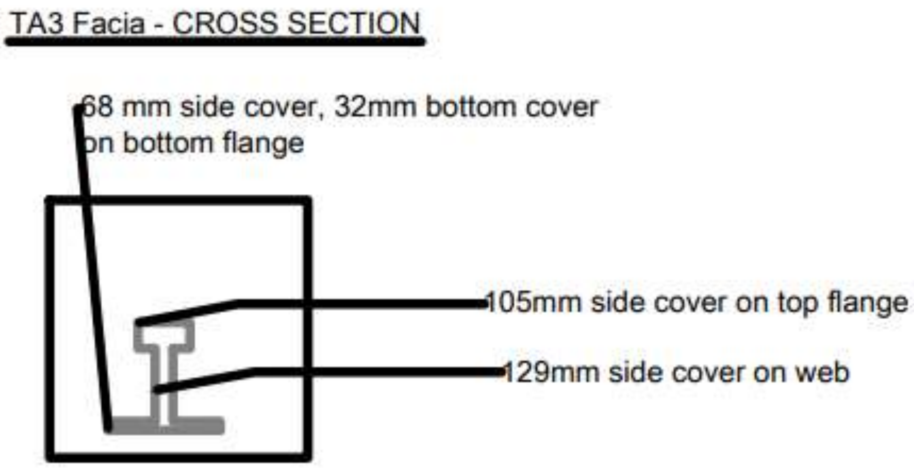


Figure 5: TP3 Facia cross section

TA3 Beam dimensions (mm)

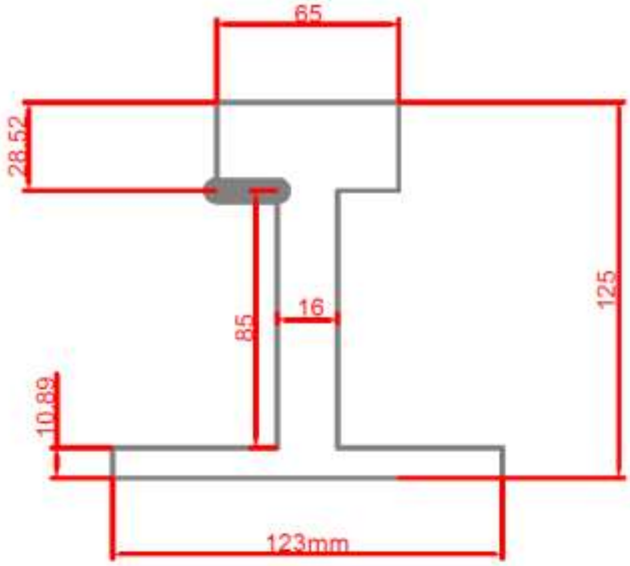


Figure 6 : External Beam Dimensions

Test area 3.1

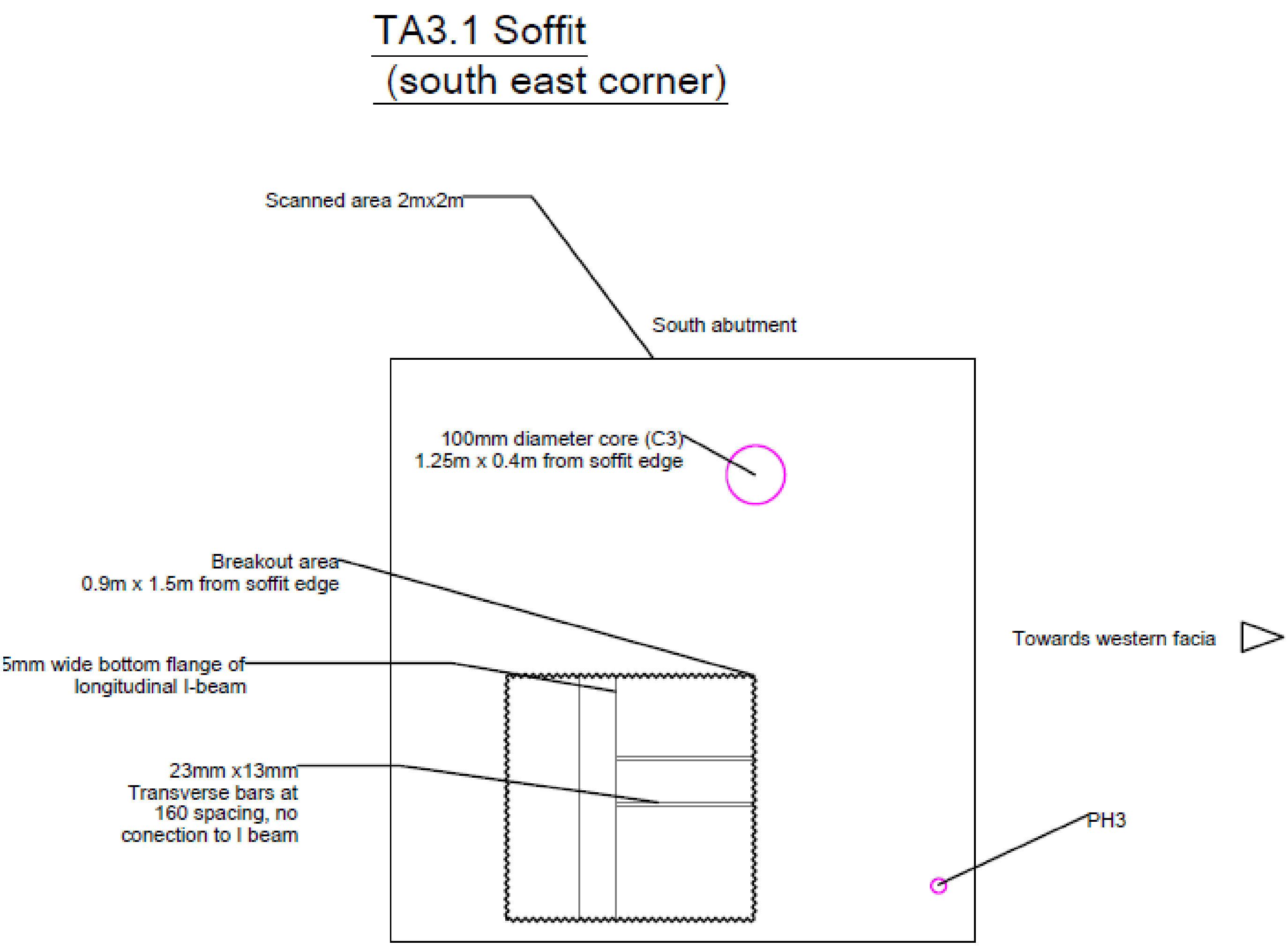


Figure 7: Test area 3.1 Soffit

Test area 4

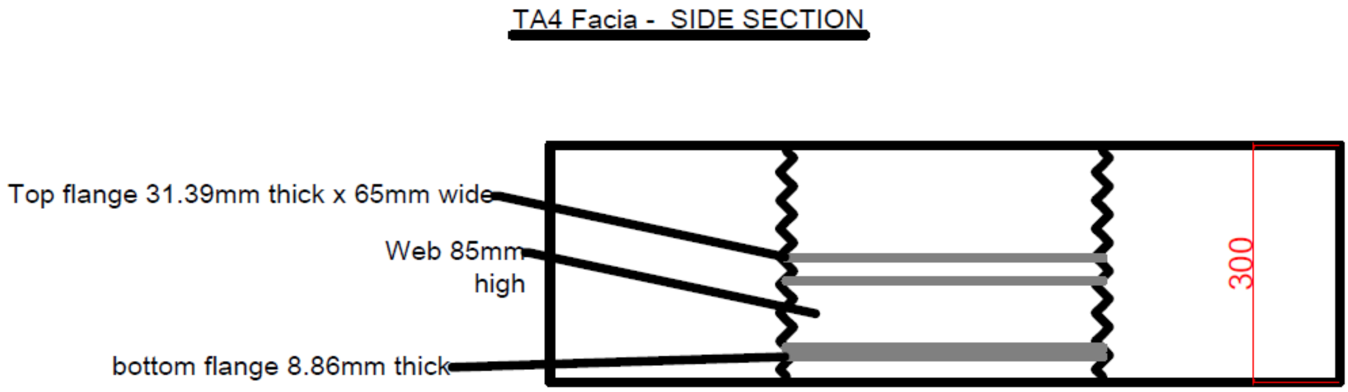


Figure 8:TA4 Facia - Side Section

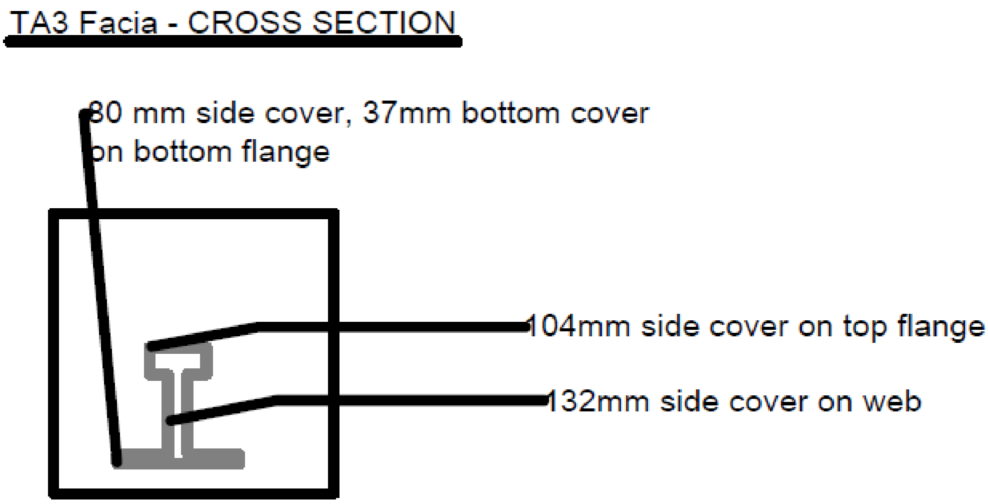


Figure 9 : TA4 Facia - Cross Section

TA4 Beam dimensions (mm)

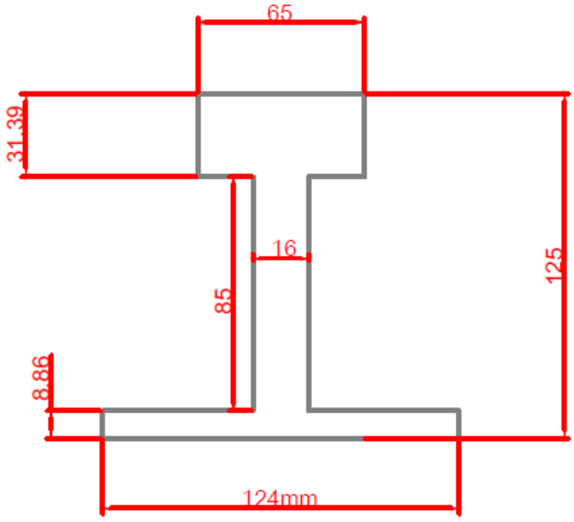


Figure 10: TA4 Beam Dimensions

Test area 4.1

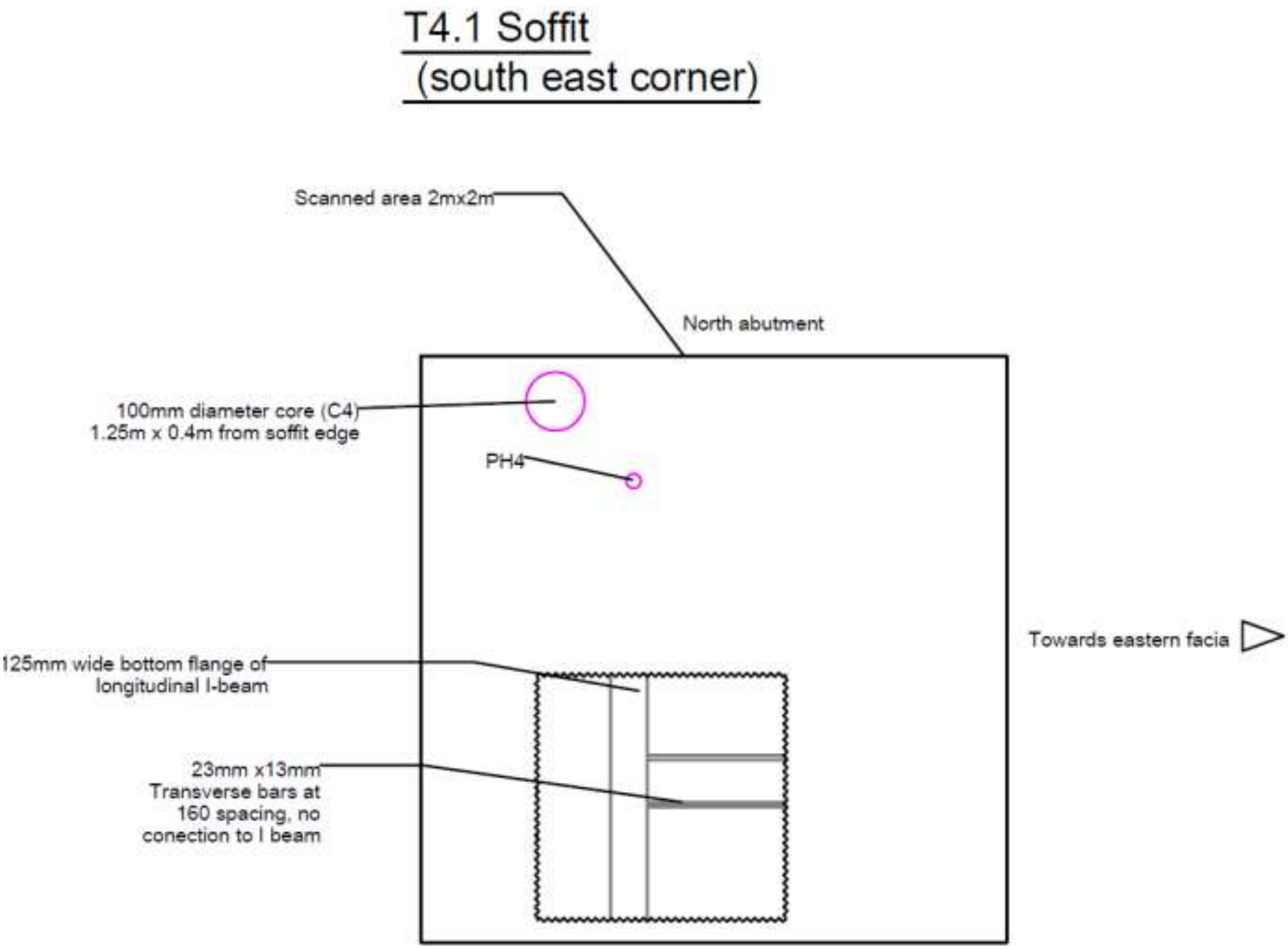
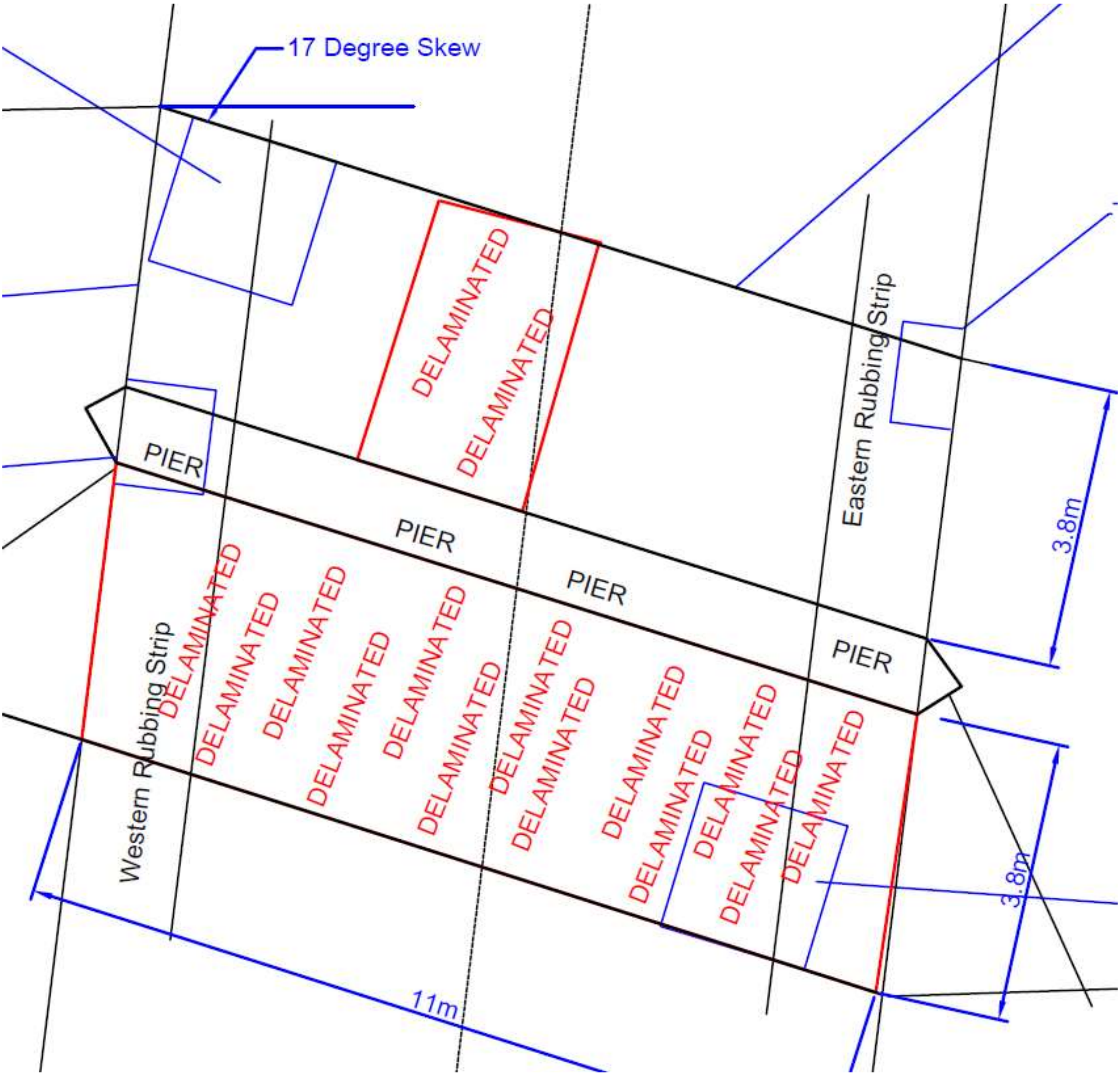


Figure 11: Test Area 4.1

Delamination – shown in Red



6.REINSTATEMENT DETAIL

- Rubbing strip cutouts were backfilled with UGM A and infilled with 35N 10mm agg

- Fosroc Renderoc HB45 was used to carry out concrete repairs to breakouts.

7.PHOTO REPORT

General bridge overview

TEST AREA 1

Figure 12: Test area 1 containing pilot hole, core sample hole and breakout.

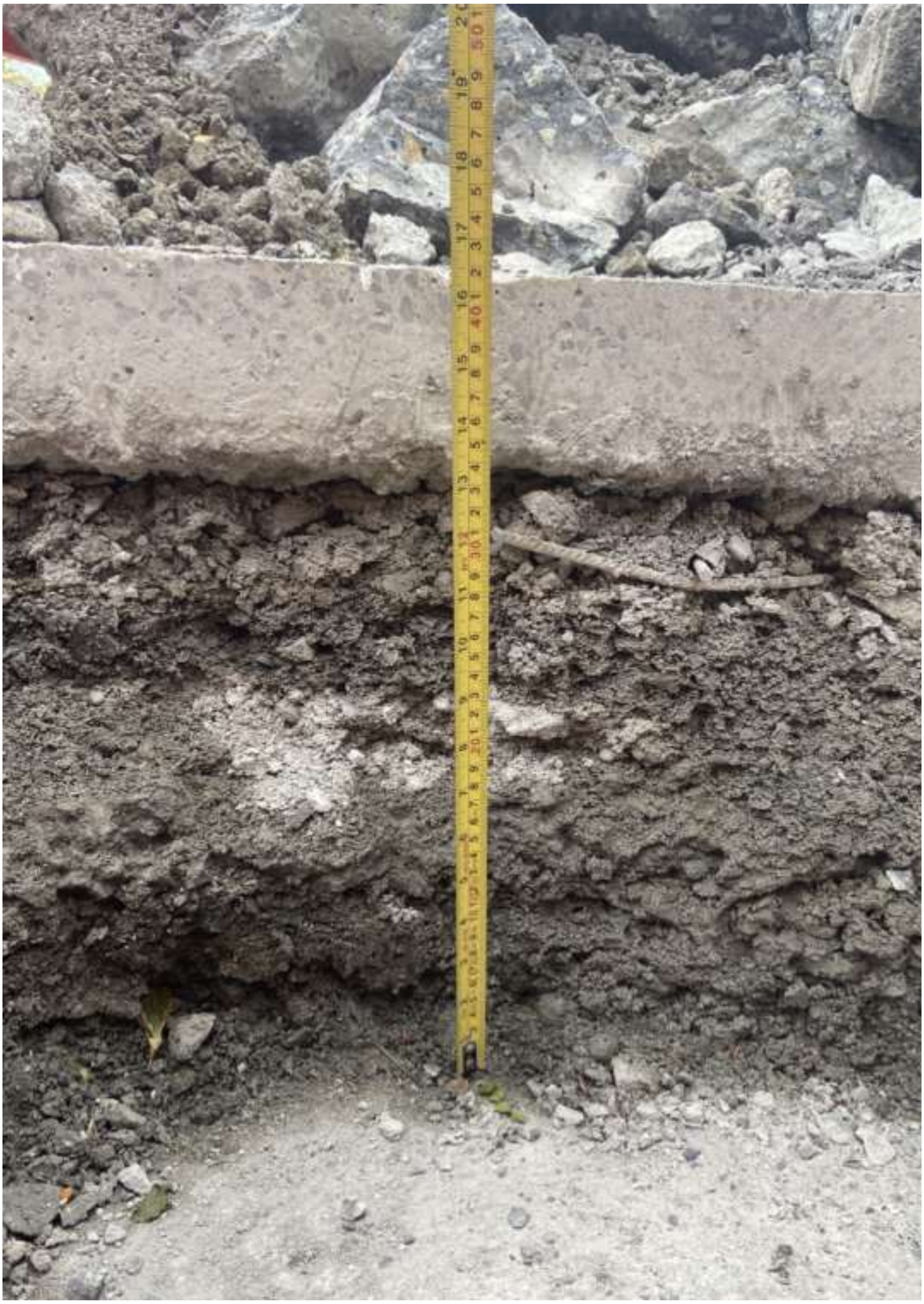


Figure 13: Trial Pit layers

Figure 14: Deck cover on longitudinal steel

Figure 15: Concrete core hole (C1)

Figure 16: Adhesion testing

Test Area 2

Figure 17: Trial pit on western edge

Figure 18: Trial pit layers

Figure 19: 90mm cutout in deck surface

Test area 3

Figure 20: Breakout of external beam

Figure 21: Wide angle view of test area including drill holes for dust samples

Figure 22: Half cell potential testing

Figure 23: Carbonation test sample extracted to the left of breakout

Test Area 3.1

Figure 24: Core hole from C3

Figure 25: Measurement of longitudinal beam flange

Figure 26: Transverse steel members running perpindicular to longitudinal members at 160mm spacing

Figure 27: Longitudinal cover was 39mm, Transverse cover wad 54mm


Figure 28: Delamination survey showed significant delamination underneath longitudinal sections on south arch

Figure 29: Further delamination on south arch

Figure 30: Exposed beams due to delamination of concrete cover

Figure 31: Delamination denoted by white x chalk marks

Test Area 4

Figure 32: Half cell potential testing of TP04

Figure 33: Resistivity testing of TP04

Figure 34: Breakout at test area 4 exposing external beam

Test Area 4.1

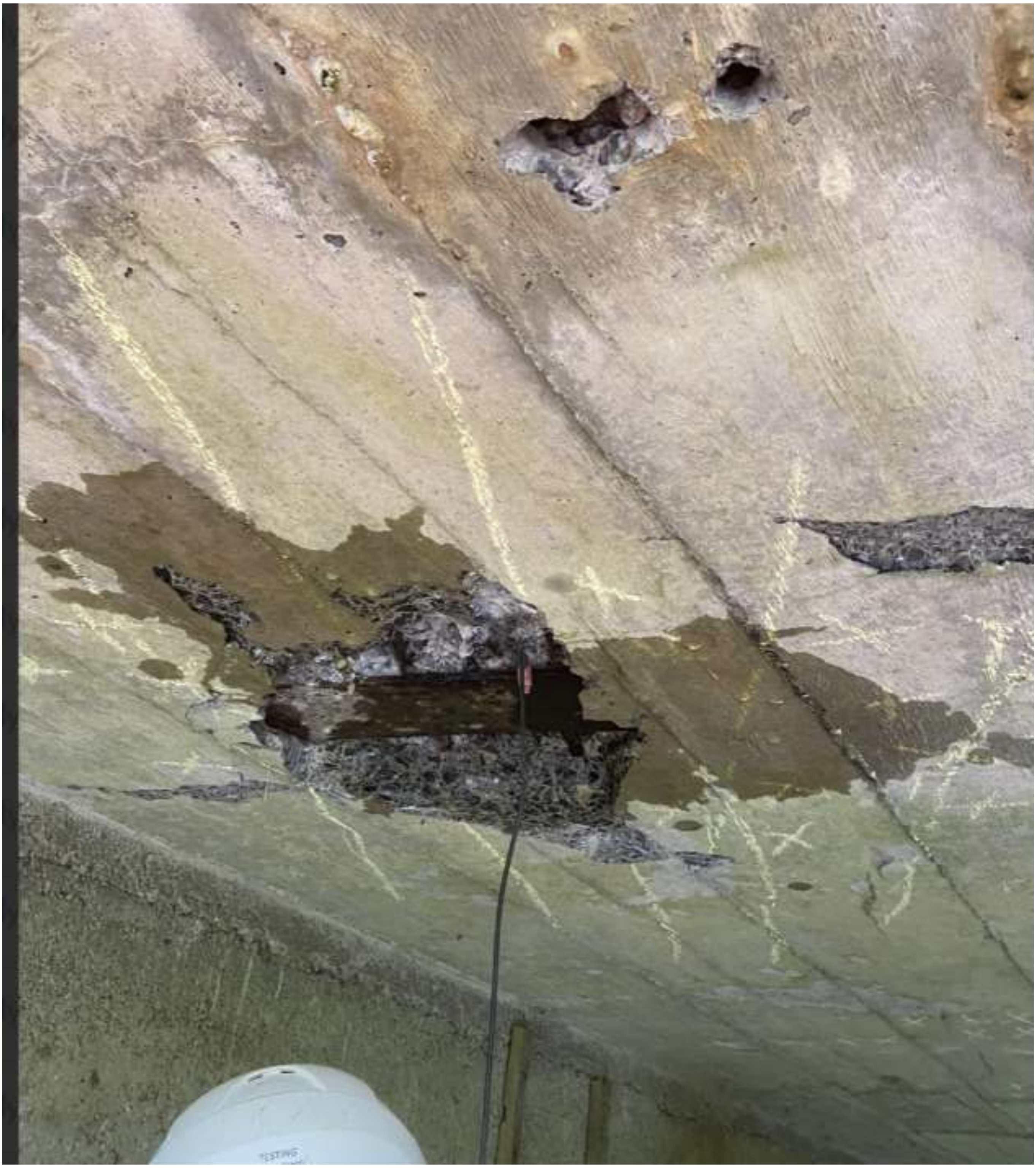


Figure 35: Breakout of internal beam showing transverse spacing marked via GPR

Figure 36: Half cell potential testing

Figure 37: Delamination found in northern arch

Figure 38: Delamination survey in Northern arch wide angle view

Figure 39: Core hole C4

Figure 40: Longitudinal bottom flange thickness

Figure 41: Cover of Transverse steel

Figure 42: 125mm wide bottom flange of internal beam

Figure 43: Wide angle view of breakout area

Test Area 5

Figure 44: Pilot hole reinstatement along with dust sample holes

Figure 45: Pilot hole depth measurement

Figure 46: Outline of scanned area

Test Area 6

Figure 47: Outline of scanned area with carbonation sample removed

Figure 48: Carbonation sample consisted of 100mm x 100mm x 80mm cuboid

Figure 49: TA6 carbonation sample depth into pier

Test Area 7

Figure 50: Wide angle view of test area

Figure 51: Pilot hole reinstatement

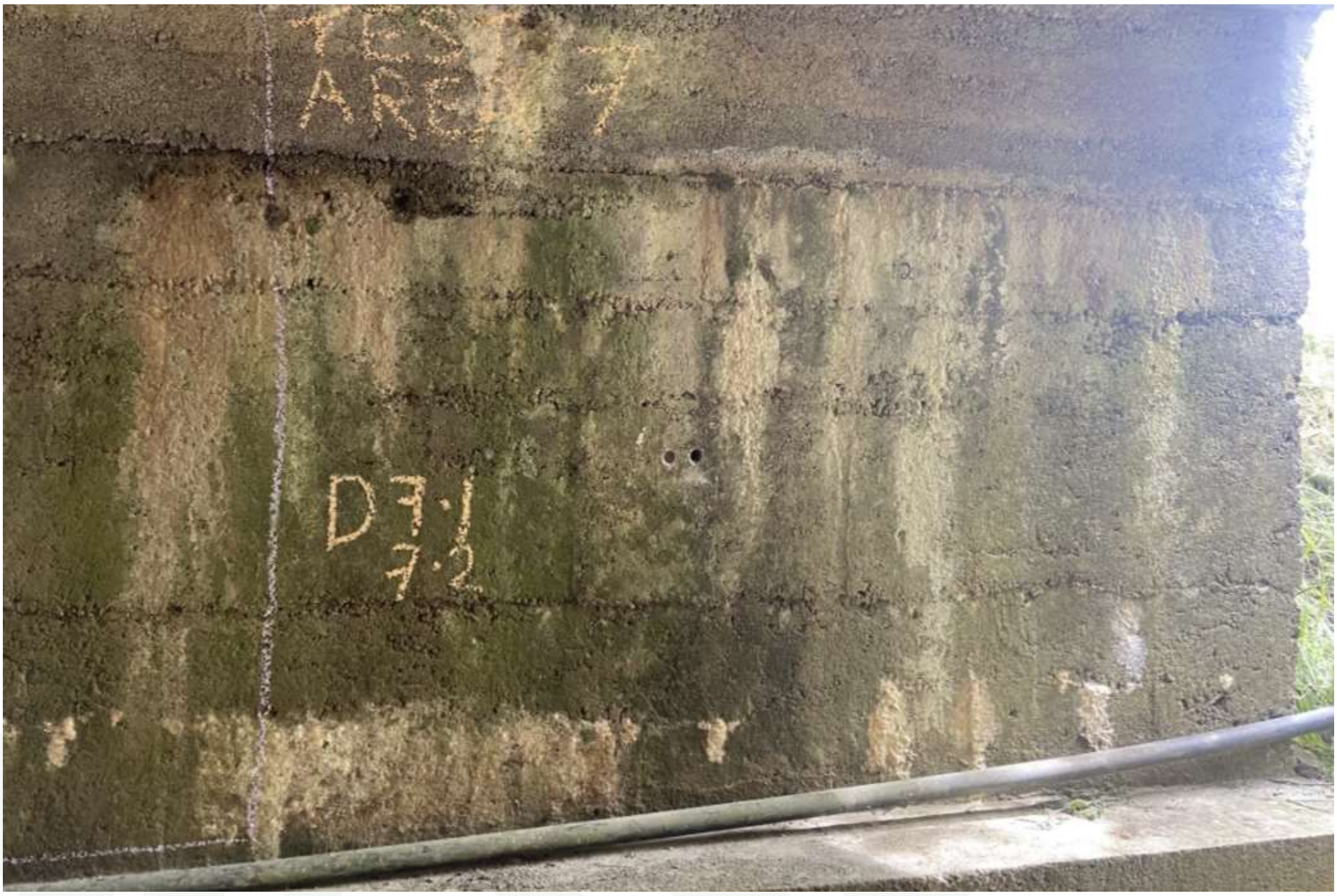
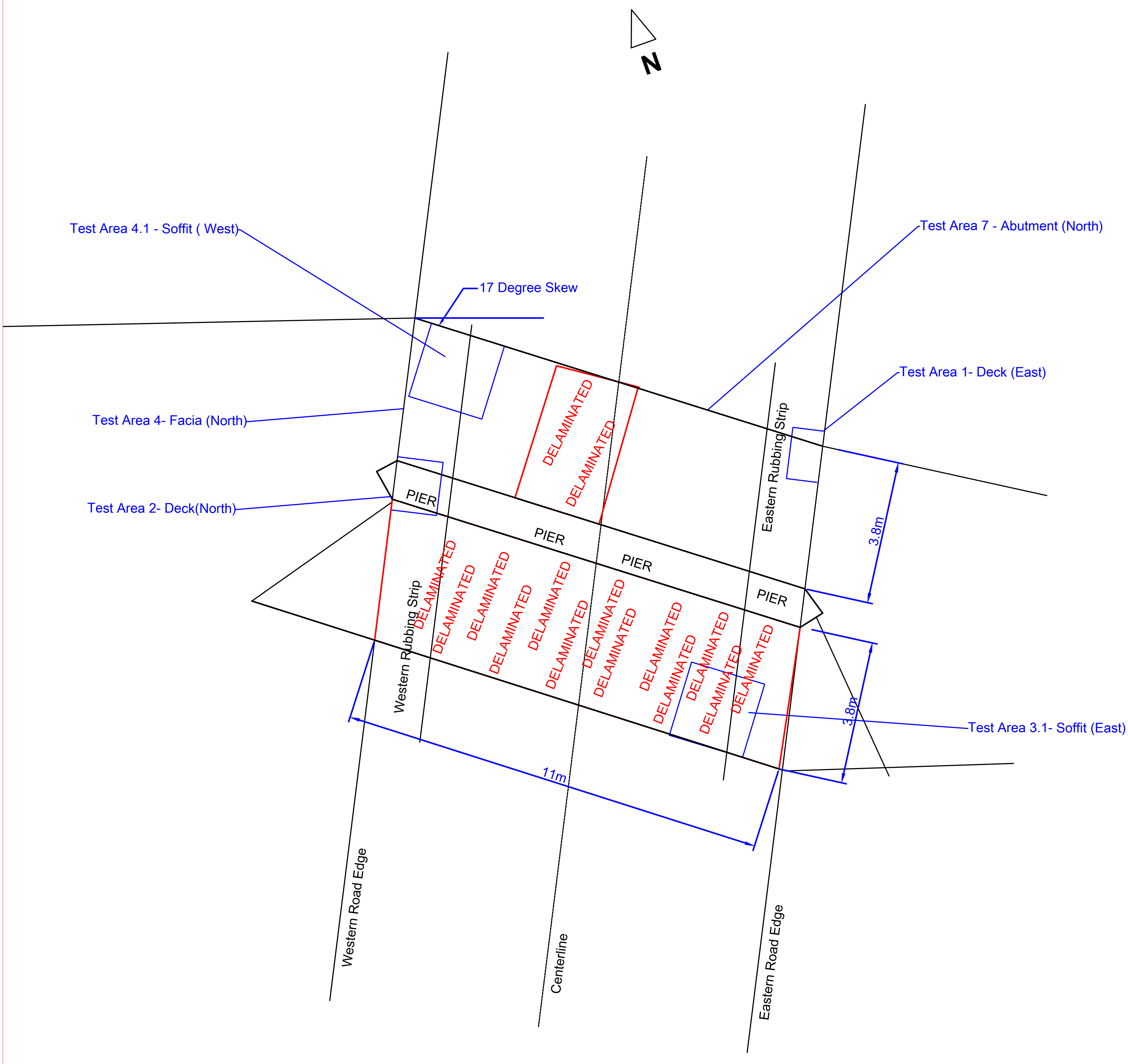


Figure 52:Drill holes used for dust collection located on the northesatern end of the abutment

Appendix 1 – Bridge Layout

Strade River Bridge Plan



Appendix 2 – Lab Test report

Mayo Bridges Inspection – Strade River Bridge

Concrete Testing Report

2024

Document Issue Register

Distribution	Report Status	Revision	Date of Issue	Prepared by	Approved by
Lurcan Donnellan Triur Construction	Final	A	27th August 2024	Anton Hajek	James Purcell

Contents

1.0 Project Overview

BHP was contracted by Lurcan Donnellan of Triur Construction to provide a survey of the concrete bridge.

The investigation is intended to provide information for the employer in respect of the structural condition of the concrete deck and parapets and to assess the existing condition to enable evaluation of the proposed need for strengthening/rehabilitation works.

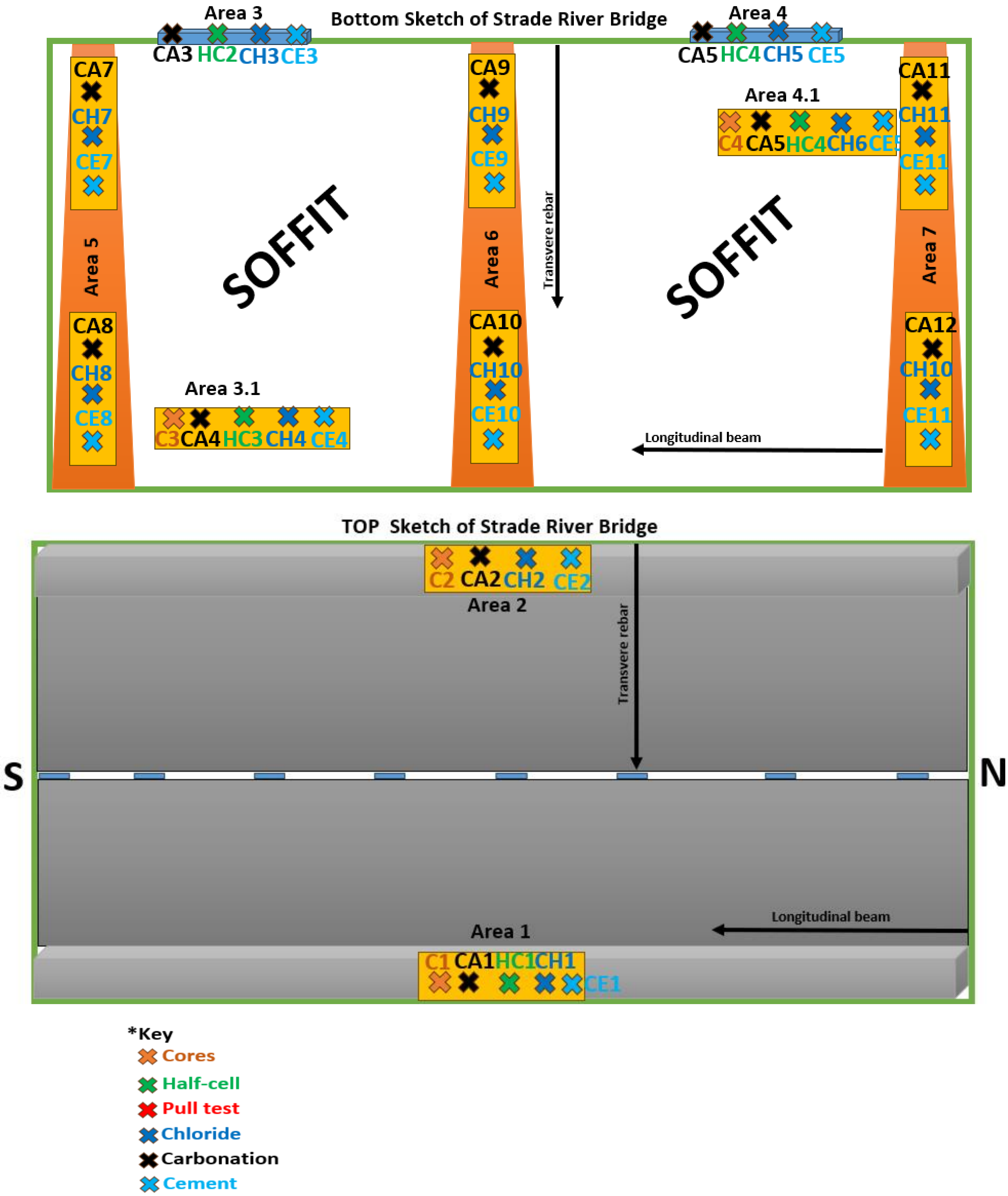
2.0 Project Requirements

As directed by the project specification the requirements of the works included:

- Drill 4No. 100 diameter cores.
- Test for Density, Compressive strength and Visual examination.
- Chemical testing includes chloride content, cement content and depth of carbonation.
- Pull off testing on the concrete deck.
- Reinforcement scanning of concrete deck and parapets.
- Half-cell potential and concrete resistivity.

3.0 Location of Works

4.0 Summary of Results



4.1 Concrete Cores – Compressive Strength

In line with the project specification, BHP removed several cores from the reinforced concrete elements. These were cored using a water-cooled diamond drill. The cores were individually marked and placed in sealed plastic bags for transportation to the laboratory.

The concrete cores were visually assessed by BHP's technical manager Seamus O'Connell.

A summary of the results with photographs is contained below:

BHP Ref:	**Core Ref.**	**Details**	**Density kg/m3**	**Compressive Strength N/mm2**
24/07/072-1	Core 1 – Area 1 – Deck	20mm Crushed Rock, 1.5% Voids	2280	18.9
24/07/072-2	Core 2 – Area 1 – Deck	20mm Crushed Rock, 2.5% Voids	2300	21.1
24/07/072-3	Core 3 – Area 3.1 – Soffit 1	20mm Crushed Rock, 0.5% Voids	2610	49.6
24/07/072-4	Core 4 – Area 4.1 – Soffit 2	20mm Crushed Rock, 0.5% Voids	2380	57.1

The mean result for compressive strength for the deck cores is 20.0N/mm² with a standard deviation of 1.56. The mean density of the test specimens is 2290kg/m³.

The mean result for compressive strength for all the cores is 53.4N/mm² with a standard deviation of 5.3. The mean density of the test specimens is 2500kg/m³.

4.2 Pull Off Test

In accordance with the project specification, the pull off test was to be performed at one location in the concrete deck.

A summary of the results is contained below with full reports contained in Appendix B of this report.

Test Reference	Max Applied Load (MPa)	Depth of failure (mm)	Failure occurred in
Area 1 top deck	1.4	3	Below adhesive in concrete substrate (cohesion failure)
Area 1 top deck	1.7	4	Below adhesive in concrete substrate (cohesion failure)
Area 1 top deck	2.3	5.0	Below adhesive in concrete substrate (cohesion failure)
Area 1 top deck	0.9	0	Below adhesive on top of concrete surface (adhesion failure)
Area 1 top deck	2.6	4.0	Below adhesive in concrete substrate (cohesion failure)
Mean	**1.78**		

4.3 Carbonation

In accordance with the project specification, the carbonation testing was to be performed at seven locations.

Carbonation testing is carried out to determine the depth of concrete affected due to a combined attack of atmospheric carbon dioxide and moisture causing a reduction in the level of alkalinity in concrete. Cement paste has a pH of approximately 13 which provides a protective layer (passive coating) to the steel reinforcement against corrosion. Loss of passivity occurs at about pH 9.

A 3% phenolphthalein indicator is used for the test. This is applied to freshly exposed concrete surface as detailed above.

Once the indicator is applied to the concrete surface, the change of colour of concrete to pink indicates that the concrete is in good health/condition. Where no change in colour takes place, it is suggestive of carbonation-affected concrete.

The results of the tests performed at Knockavrony Bridge, Co. Mayo are contained in Appendix C of this report.

A summary of the results is contained below:

Location	Depth of Carbonation (mm)
Carbonation Test 1 – Area 1 Top Deck	<1
Carbonation Test 2 – Area 2 Top Deck	<1
Carbonation Test 3 – Area 3 Face deck	<1
Carbonation Test – Area 3.1 Soffit	16
Carbonation Test 5 – Area 4 Face deck	<1
Carbonation Test 6 – Area 4.1 Soffit	<1
Carbonation Test 7 – Area 5 Abutment	>20
Carbonation Test 8 – Area 5 abutment	<1
Carbonation Test 9 – Area 6 abutment	<1
Carbonation Test 10 – Area 6 abutment	<1
Carbonation Test 11 – Area 7 abutment	<1
Carbonation Test 12 – Area 7 abutment	<1

There was no obvious reason for the differing levels of carbonation other than different locations. The two locations of high carbonation can be viewed as isolated instances of carbonation. All other results had negligible carbonation. At both soffit locations (3.1 and 4.1), there was clear visual spalling of concrete. However, the carbonation at 4.1 did not show high carbonation like at location 3.1. To understand a full assessment of carbonation, further samples would have to be taken at a number of locations throughout to ascertain the consistency. It must be noted that the chloride ingress into the concrete is very low, so refurbishment works including the application of protection paint/similar material should limit any increase in carbonation and reduce long-term risks of corrosion occurring.

4.4 Reinforcement Details

In following page, a summary of reinforcement investigation on deck, parapet sections and information on the reinforcement found in breakouts have been compiled from the survey conducted in Strade River Bridge, Co. Mayo

Full details are in Appendix D of this report.

Scan Location	Rebar direction	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)	Minimum Spacing (mm)	Maximum Spacing (mm)
Area 1 top deck longitudinal scan 001	T	153	n/a	n/a	n/a	n/a	n/a
Area 1 top deck transverse scan 001	L	164	158	170	180	n/a	n/a
Area 2 top of deck longitudinal scan 001	T	160	137	183	640	n/a	n/a
Area 2 top of deck longitudinal scan 002	T	156	150	162	620	n/a	n/a
Area 2 top of deck transverse scan 001	L	204	144	238	405	130	680
Area 3 deck face vertical scan 001	L	142	136	148	60	n/a	n/a
Area 3 deck face horizontal scan 001	T	135	n/a	n/a	n/a	n/a	n/a
Area 3.1 soffit longitudinal scan 001	T	38	28	48	684	560	710
Area 3.1 soffit longitudinal scan 002	T	42	37	48	657	620	690
Area 3.1 soffit transverse scan 001	L	46	42	55	166	140	198
Area 3.1 soffit transverse scan 002	L	62	54	68	165	140	196
Area 4 Deck Face Vertical scan 001	L	106	92	120	120	n/a	n/a

Area 4 Deck Face Horizontal scan 001	T	n/a	n/a	n/a	n/a	n/a	n/a
Area 4.1 Soffit longitudinal scan 001	T	48	42	51	666	640	700
Area 4.1 Soffit longitudinal scan 002	T	51	42	56	707	640	750
Area 4.1 Soffit transverse scan 001	L	60	44	69	227	120	330
Area 4.1 Soffit transverse scan 002	L	65	55	76	216	120	319
Area 5 Abutment vertical scan 001	L	n/a	n/a	n/a	n/a	n/a	n/a
Area 5 Abutment horizontal scan 001	T	n/a	n/a	n/a	n/a	n/a	n/a
Area 6 Pier horizontal scan 001	T	n/a	n/a	n/a	n/a	n/a	n/a
Area 6 Pier Vertical scan 001	L	n/a	n/a	n/a	n/a	n/a	n/a
Area 7 Abutment Vertical scan 001	L	n/a	n/a	n/a	n/a	n/a	n/a
Area 7 Abutment Horizontal scan 001	T	n/a	n/a	n/a	n/a	n/a	n/a

Rebar directions: L- longitudinal, T- transverse
* In Area 1(TP1), Area 2 (TP2) were not enough space to get more reinforcement readings due to lack of access for GPR as the Trail hole area only allowed for coring and breakouts
* In Area 5 – Area 7 GPR did not find any reinforcement

Reinforcement found by completing a breakout	**Actual cover (mm)**	**Diameter (mm)**	**Width(mm)**
Area 1 top of deck top flange	150	N/A	N/A
Area 1 top of deck transverse rebar square	109	14.3 / 25.7	N/A
Area 3 face deck web	129	N/A	N/A
Area 3 face deck bottom flange	32	10.89	123
Area 3 face deck bottom side flange	68	N/A	N/A
Area 3 face deck top flange	104	N/A	N/A
Area 3 face deck distance top-bottom flange	117	N/A	N/A
Area 3.1 soffit bottom flange	34	N/A	N/A
Area 3.1 soffit transverse rebar square	59	15.3 / 28.9	N/A
Area 4 face deck top side flange	104	31.39	N/A
Area 4 face deck web	132	N/A	N/A
Area 4 face deck bottom flange	80	N/A	N/A
Area 4 face deck bottom flange	37	8.86	N/A
Area 4.1 soffit bottom flange	47	N/A	N/A
Area 4.1 soffit transverse rebar square	51	13.5 / 23.6	N/A

4.5 Chloride Ion Testing

Corrosion of reinforcing steel and other embedded metals is the leading cause of deterioration in concrete. When steel corrodes, the resulting rust occupies a greater volume than the steel. This expansion creates tensile stresses in the concrete, which can eventually cause cracking, delamination and spalling.

Steel corrodes because it is not a naturally occurring material. Rather, iron ore is smelted and refined to produce steel. The production steps that transform iron ore into steel add energy to the metal. Steel, like most metals except gold and platinum, is thermodynamically unstable under normal atmospheric conditions and will release energy and revert back to its natural state – iron oxide, or rust. This process is called corrosion.

Corrosion is an electrochemical process involving the flow of charges (electrons and ions). At active sites on the reinforcement bar, called anodes, iron atoms lose electrons and move into the surrounding concrete as ferrous ions. This process is called a half-cell oxidation reaction, or anodic reaction.

Corrosion of embedded metals in concrete can be greatly reduced by placing crack-free concrete with low permeability and sufficient concrete cover. Additional measures to mitigate corrosion of steel reinforcement in concrete include the use of corrosion inhibiting admixtures, coating of reinforcement, and the use of sealers and membranes on the concrete surface.

As noted in section 4.3 carbonation, the breakdown in the protection of reinforcement bars leads to concrete spalling. The depth of carbonation provides a guide as to the risk of corrosion on a particular bar. Concrete that is not carbonated (or has very low levels of carbonation) protects the embedded steel reinforcement.

Exposure of reinforced concrete to chloride ions is the primary cause of premature corrosion of steel reinforcement. The intrusion of chloride ions present in deicing salts, seawater and other associated sources, into reinforced concrete can cause steel corrosion if oxygen and moisture are available to sustain the reaction. Chlorides dissolved in water can penetrate through sound concrete or reach the steel through cracks.

No other contaminant is documented as extensively in the literature as a cause of corrosion of metals in concrete than chloride ions. The risk of corrosion increases as the chloride content of concrete increases. For Strade River bridge, Co. Mayo, the major concern is the extent of any existing chloride within the various concrete structural elements. While the levels are assessed during this survey, as the concrete is continually exposed to the natural environments and weathering, the level of chloride in the concrete could increase with time.

To assess potentially chloride-contaminated concrete, it is necessary to determine the concentration of chloride ions at various depths in order to determine the likelihood of corrosion of the reinforcement steel. To do this dust samples are taken from incremental depths. As specified, this was to be carried out in four depths (5-30mm, 30-55mm, 55-80mm & 80-105mm). Note the first 5mm drilling are normally discarded as being non-representative. Care was taken to ensure all drilling dust was collected. This is important as studies have shown that more chloride is contained in the finer component of the dust.

In line with the Irish concrete standard (EN 206), the chloride content as a percentage of cement is to be below the maximum allowable of 0.4% for concrete mixes containing embedded steel. At all twelve locations, the chloride content as a percentage of cement is below this value.

A summary table of the results is found below:

Location Reference	Sample Reference	Depth (mm)	Chloride Content % by mass of	
			Sample	Cement
Area 1 - Car 1	24/07/072-1	5-30	0.01	0.08
		30-55	0.01	0.08
		55-80	0.02	0.15
		80-105	0.01	0.08
Area 2 - Car 2	24/07/072-2	5-30	0.04	0.20
		30-55	0.03	0.15
		55-80	0.03	0.15
		80-105	0.01	0.05
Area 3 - Car 3	24/07/072-3	5-30	0.02	0.13
		30-55	0.02	0.13
		55-80	0.02	0.13
		80-105	0.02	0.13
Area 3.1 - Car 4	24/07/072-4	5-30	0.03	0.20
		30-55	0.02	0.13
		55-80	0.03	0.20
		80-105	0.03	0.20
Area 4 - Car 5	24/07/072-5	5-30	0.04	0.19
		30-55	0.02	0.10
		55-80	0.02	0.10
		80-105	0.02	0.10
Area 4.1 - Car 6	24/07/072-6	5-30	0.04	0.33
		30-55	0.03	0.25
		55-80	0.03	0.25
		80-105	0.04	0.33

Location Reference	Sample Reference	Depth (mm)	Chloride Content % by mass of	
			Sample	Cement
Area 5 - Car 7	24/07/072-7	5-30	0.02	0.20
		30-55	0.01	0.10
		55-80	0.01	0.10
		80-105	0.01	0.10
Area 5 - Car 8	24/07/072-8	5-30	0.02	0.25
		30-55	0.01	0.13
		55-80	0.01	0.13
		80-105	0.01	0.13
Area 6 - Car 9	24/07/072-9	5-30	0.01	0.07
		30-55	0.01	0.07
		55-80	0.01	0.07
		80-105	0.01	0.07
Area 6 - Car 10	24/07/072-10	5-30	0.03	0.21
		30-55	0.03	0.21
		55-80	0.03	0.21
		80-105	0.03	0.21
Area 7 - Car 11	24/07/072-11	5-30	0.01	0.08
		30-55	0.01	0.08
		55-80	0.01	0.08
		80-105	0.01	0.08
Area 7 - Car 12	24/07/072-12	5-30	0.03	0.17
		30-55	0.03	0.17
		55-80	0.02	0.11
		80-105	0.02	0.11

4.6 Cement Content

The determination of the cement content (mix proportions) is undertaken largely for two reasons. The first is in the cases of problems to identify the reason for concrete failure or lack of quality. The second is to investigate old structural concrete for redevelopment and improvement works. This is the case in this project. The cement content analysis will also allow BHP to provide chloride and sulphate results as a percentage of cement for clear comparison with standard allowances.

We start by describing the raw materials that go into mortar and concrete and by defining some terms. Cement is a generic term meaning "glue." Portland cement is a gray powder that when mixed with water forms a paste that hardens and gains strength with time. This is the glue that holds mortar and concrete together. When sand or fine aggregate is added to paste the mixture is known as mortar which is suitable for thin cross sections. Grouts, plasters and stuccos are generally special mortars and contain much the same raw materials. Stone added to mortar makes concrete which can be used in structural or massive applications.

The cement most often used in construction is known as Portland cement. There are other types of construction cements, some used in masonry construction and other special cements used for repairs or high temperature applications. This paper addresses Portland cement and its derivatives only. The predominant chemical compounds in Portland cement are based upon oxides of calcium (lime), silicon (silica), aluminium (alumina) and iron. There are other compounds present in smaller quantities such as magnesia and carbon dioxide and a number of trace elements. The principal chemical compounds that combine with water (hydrate) to provide strength are calcium silicates. However, in all reported chemical analyses, the constituents of cement and concrete are reported simply as the appropriate oxides. Modern Portland cements, by definition, all tend to contain these compounds in a fairly tight range of values even if they come from different manufacturing facilities. Hydrated Portland cement has the unusual, and desirable, property that it will continue to gain strength (albeit at a decreasing rate) when in the presence of water. This complicates chemical analysis because the system is continually changing from the time of first mixing to the time of test.

The cement content analysis for Strade River bridge, Co. Mayo was undertaken on twelve samples. The samples came from deck, abutments and soffits in different levels. The mean cement content results for the twelve samples is 14% with a range of 8% – 20%. A summary table of the results is found below.

Location	Cement Content (%)	Compressive Strength (N/mm2) – from core test
Area 1 Top Deck	13	18.9
Area 2 Top Deck	20	21.1
Area 3 Face deck	16	-
Area 3.1 Soffit	15	49.6
Area 4 Face deck	21	-
Area 4.1 Soffit	12	57.1
Area 5 Abutment	10	-
Area 5 Abutment	8	-
Area 6 Pier	14	-
Area 6 Pier	14	-
Area 7 Abutment	12	-
Area 7 Abutment	18	-

A cement content of 16-17% would normally indicate an approximate in-situ compressive strength of 50N. The values found here find that the expected cement content for the soffit is a little lower than expected. The biggest different is the cement content in the top deck versus the actual compressive strength. Albeit one of the cores in the soffit contained reinforcement, the density of these concrete versus the concrete in the deck is much higher.

4.7 Half Cell and Resistivity

Corrosion of steel in concrete is one of the major problems with respect to the durability of reinforced concrete structures. Most concrete structures perform well even after a long period of use in normal environments. However, there are various reinforced concrete structures important for our infrastructure, especially bridges and buildings, which exhibit premature damage due to environmental actions (EN 206).

In contrast to mechanical actions (load, wind, etc.) the environmental actions are not reversible and accumulate hazardous components (such as chloride ions) in the concrete. A high percentage of the damage is caused by insufficient planning, wrong estimation of severity of environmental actions and by bad workmanship and this many of these structures need to be repaired after a short service life.

Half-cell potential measurements can be performed on structures with ordinary or stainless-steel reinforcement. Corrosion of prestressing steel in concrete can be assessed in the same way. Prestressing steel in the ducts of posttensioned cables cannot be assessed.

Half-cell potential measurements are suitable mainly on reinforced concrete structures exposed to the atmosphere. The method can be applied regardless of the depth of concrete cover and the rebar size. Half-cell potential measurements will indicate corroding rebars not only in the most external layers of reinforcement facing the references electrode but also in greater depth. The method can be used at any time during the life of a structure and in any kind of climate providing the temperature is higher than +2°C. Hal-cell potential measurements should be taken only on a free concrete surface. The presence of isolating layers (asphalt, organic coatings or paints etc.) may make measurements erroneous or impossible.

In the assessment of the half-cell results, ASTM C876 uses a numeric technique to assess the half-cell potential results.

Table 1: Relationship between the potential values and corrosion probability (adapted from ASTM C876)

Measured Potential(mV CSE)	Probability of steelcorrosion activity
>-200	Less than 10%
-200 to -350	Uncertain
<-350	More than 90%

Half Cell Potential Results

Location	Mean (mV)	Lowest (mV)	Highest (mV)	Standard Deviation (mV)
Area 1 Top deck	-239	-268	-207	19.8
Area 3 Face deck	-54.9	-97	-27	21
Area 3.1 Soffit	-333.5	-368	-320	13.2
Area 4 Face deck	-237.7	-283	-198	28.3
Area 4.1 Soffit	-165.8	-179	-129	13

Based on this, it sets our three phases of corrosion activity – Initial Phase, Transient Phase, and the Final Phase. For any half-cell potential results that are > -200 it is deemed to be in the initial phase where the probability of corrosion activity is less than 10%. Where the half-cell potential results that are in the range of -200 to -350 (Transient Phase), the probability of corrosion activity is uncertain. Where the half-cell potential results that are <-350 (Final Phase), the probability of corrosion activity is more than 90%. Based on the results and visual examination of the bars on site when broken out, the likelihood of corrosion based on half-cell results is moving from the initial phase to the transient phase.

In addition to half-cell potential surveying of concrete, resistivity measurements of the same concrete material provide further information on the potential for further corrosion taking or to take place. Corrosion of reinforcing steel is an electro-chemical process. For corrosion of the steel to occur a current must pass between the anodic and cathodic regions of the concrete. The electrical resistivity of the concrete affects the flow of ions and the rate at which corrosion can occur. A higher concrete resistivity decreases the flow; an empirical relationship between corrosion rate and resistivity has been determined from measurements on actual structures.

Electrical resistivity measurement techniques are becoming popular among consulting / design engineers for the quality assessment and durability assessment of concrete. The concept of durability of concrete depends largely on the properties of its microstructure, such as pore size distribution and the shape of the interconnections (that is, tortuosity). A finer pore network, with less connectivity, leads to lower permeability. A porous microstructure with larger degree of interconnections, on the other hand, results in higher permeability and reduced durability in general. The principal idea behind most electrical resistivity techniques is to somehow quantify the conductive properties of the microstructure of concrete. Overall, the electrical resistivity of concrete can be described as the ability of concrete to withstand the transfer of ions subjected to an electrical field. In this context, resistivity measurement can be used to assess the size and extent of the interconnectivity of pores.

Various approaches for measuring resistivity are available but the four-probe device is the most suitable. Modern devices are spring-loaded and are applied directly to the surface. A current is applied between the two outer probes and the potential difference measured between the two inner probes. Resistivity measurement is useful for identifying areas of reinforced concrete at risk from corrosion. It should not be considered in isolation but used in conjunction with other techniques such as half-cell potential. BHP employed the use of the latest version of Proceq's Resipod with 50mm spacings between the four probes.

From the testing undertaken at this structure, we found that there was a negligible risk of corrosion based on the resistivity results.

Location	**Result 1**	**Result 2**	**Result 3**	**Result 4**	**Result 5**
Area 1 Top deck	106	112	172	185	190
Area 3 Face deck	69	55	72	-	-
Area 3.1 Soffit	285	278	303	256	272
Area 4 Face deck	186	156	194	-	-
Area 4.1 Soffit	196	206	209	255	272

Appendix A

COMPRESSIVE STRENGTH OF A CONCRETE CORE TEST REPORT

BHP/MTIField/F058 V1 29/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-1
		Order No:	Not Supplied
		Date Tested:	09/07/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Core

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 1 C1 Deck
Test Standard: EN 12504-1:2019

Core Details			
Coring Date	12/07/2024	Age of specimen	Not Specified
End of core used as datum	Top	Reinforcement in test Specimen: Size (mm)	N/A
Drilling Direction	Vertical	Reinforcement in test Specimen: Position (mm)	N/A
Visual Assessment			
Condition of specimen when received	Good	Maximum nominal size of aggregate (mm)	20
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	1.5%	Ribbing on core surface	None
Honeycombing	Yes	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Crushed Rock	Straightness	Pass
Test Information			
Preparation		Surface condition at time of test	Dry
Length after end preparation	102	Type of failure	Satisfactory
Diameter after end preparation	99	Average Diameter (mm)	99
Length / diameter ratio of specimen	1.03	Maximum length of specimen, as received	144
		Minimum length of specimen, as received	144
		Density of the specimen, as received (kg/m^3)	2280
		Max Load (KN)	144.8
		Compressive Strength (N/mm^2)	18.9

REMARKS:

Method of determining volume used was displacement. Method of end preparation used was sawn & capped. The sample was stored in a sealed container prior to testing.

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	Lukasz Zalewski

For and On Behalf of BHP Laboratories — Issue Date: 19/07/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

COMPRESSIVE STRENGTH OF A CONCRETE CORE
TEST REPORT

BHP/MTIField/F058 V1 29/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-2
		Order No:	Not Supplied
		Date Tested:	09/07/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Core

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 2 C2 Deck
Test Standard: EN 12504-1:2019

Core Details			
Coring Date	12/07/2024	Age of specimen	Not Specified
End of core used as datum	Top	Reinforcement in test Specimen: Size (mm)	N/A
Drilling Direction	Vertical	Reinforcement in test Specimen: Position (mm)	N/A
Visual Assessment			
Condition of specimen when received	Good	Maximum nominal size of aggregate (mm)	20
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	2.5%	Ribbing on core surface	None
Honeycombing	Yes	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Crushed Rock	Straightness	Pass
Test Information			
Preparation		Surface condition at time of test	Dry
Length after end preparation	102	Type of failure	Satisfactory
Diameter after end preparation	99	Average Diameter (mm)	99
Length / diameter ratio of specimen	1.03	Maximum length of specimen, as received	123
		Minimum length of specimen, as received	123
		Density of the specimen, as received (kg/m^3)	2300
		Max Load (KN)	161.8
		Compressive Strength (N/mm^2)	21.1

REMARKS:
Method of determining volume used was displacement. Method of end preparation used was sawn & capped. The sample was stored in a sealed container prior to testing.

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories   Issue Date: 19/07/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

COMPRESSIVE STRENGTH OF A CONCRETE CORE
TEST REPORT

BHP/MTIField/F058 V1 29/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-3
		Order No:	Not Supplied
		Date Tested:	09/07/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Core

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 3.1 C3 Soffit
Test Standard: EN 12504-1:2019

Core Details			
Coring Date	12/07/2024	Age of specimen	Not Specified
End of core used as datum	Top	Reinforcement in test Specimen: Size (mm)	Square (14x25mm)
Drilling Direction	Vertical	Reinforcement in test Specimen: Position (mm)	60
Visual Assessment			
Condition of specimen when received	Good	Maximum nominal size of aggregate (mm)	20
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	0.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Crushed Rock	Straightness	Pass
Test Information			
Preparation		Surface condition at time of test	Dry
Length after end preparation	102	Type of failure	Satisfactory
Diameter after end preparation	99	Average Diameter (mm)	99
Length / diameter ratio of specimen	1.03	Maximum length of specimen, as received	145
		Minimum length of specimen, as received	145
		Density of the specimen, as received (kg/m^3)	2610
		Max Load (KN)	380.9
		Compressive Strength (N/mm^2)	49.6

REMARKS:

Method of determining volume used was displacement. Method of end preparation used was sawn & capped. The sample was stored in a sealed container prior to testing.

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	[signature]

For and On Behalf of BHP Laboratories — Issue Date: 28/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

COMPRESSIVE STRENGTH OF A CONCRETE CORE
TEST REPORT

BHP/MTIField/F058 V1 29/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-4
		Order No:	Not Supplied
		Date Tested:	09/07/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Core

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 4.1 C4 Soffit
Test Standard: EN 12504-1:2019

Core Details			
Coring Date	12/07/2024	Age of specimen	Not Specified
End of core used as datum	Top	Reinforcement in test Specimen: Size (mm)	N/A
Drilling Direction	Vertical	Reinforcement in test Specimen: Position (mm)	N/A
Visual Assessment			
Condition of specimen when received	Good	Maximum nominal size of aggregate (mm)	20
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	0.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Crushed Rock	Straightness	Pass
Test Information			
Preparation		Surface condition at time of test	Dry
Length after end preparation	102	Type of failure	Satisfactory
Diameter after end preparation	99	Average Diameter (mm)	99
Length / diameter ratio of specimen	1.03	Maximum length of specimen, as received	135
		Minimum length of specimen, as received	120
		Density of the specimen, as received (kg/m^3)	2380
		Max Load (KN)	438.9
		Compressive Strength (N/mm^2)	57.1

REMARKS:
Method of determining volume used was displacement. Method of end preparation used was sawn & capped. The sample was stored in a sealed container prior to testing.

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	*Lukasz Zalewski*

For and On Behalf of BHP Laboratories — Issue Date: 28/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

Appendix B

BOND STRENGTH BY PULL OFF
TEST REPORT

BHP/MTIField/F045 V1 15/04/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072
		Order No:	Not Supplied
		Date Tested:	12/07/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Surface

Project: Mayo Bridges - Strade River Bridge
Location Reference: See below
Test Standard: BS EN 1542

Surface Condition	Wet
Deck Surface Condition	As Supplied
Test Direction	Vertical

Test Reference	Max Applied Load (MPa)	Depth of Failure (mm)	Failure Occurred In
Area 1 deck	1.4	3.0	Below adhesive on top of substrate
Area 1 deck	1.7	4.0	Below adhesive on top of substrate
Area 1 deck	2.3	5.0	Below adhesive on top of substrate
Area 1 deck	0.9	0.0	Below adhesive on top of substrate
Area 1 deck	2.6	4.0	Below adhesive on top of substrate
Mean	**1.78**		

REMARKS:
Elcometer 506 Pull - Off Adhesion Tester

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 13/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

Appendix C

CARBONATION DEPTH OF CONCRETE
TEST REPORT

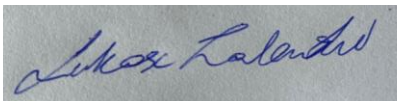
BHP/MTIField/F053 V1 15/05/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	09/07/2024
	Galway	**Test Specification**:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Core

Project: Mayo Bridges Investigation - Strade River
Location Reference: See below
Test Standard: BS EN 14630

Location Reference	Carbonation (mm)	Notes
Car 1	<1.0	Area 1
Car 2	<1.0	Area 2
Car 3	<1.0	Area 3
Car 4	16	Area 3.1
Car 5	<1.0	Area 4
Car 6	<1.0	Area 4.1
Car 7	>20	Area 5
Car 8	<1.0	Area 5
Car 9	<1.0	Area 6
Car 10	<1.0	Area 6
Car 11	<1.0	Area 7
Car 12	<1.0	Area 7

REMARKS:
Nill

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

Appendix D

TEST REPORT

Analysing
Testing
Consulting
Calibrating

BHP

New Road
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Account: Triur Construction Ltd,
13 Society Street,
Ballinasloe,
Galway

Customer: Mr. Lurcan Donnellan.

BHP Ref No.: 24/07/072
Order No.: Not Supplied
Date Received: Not Applicable
Date Tested: 12/07/2024
Specification: Client Specification

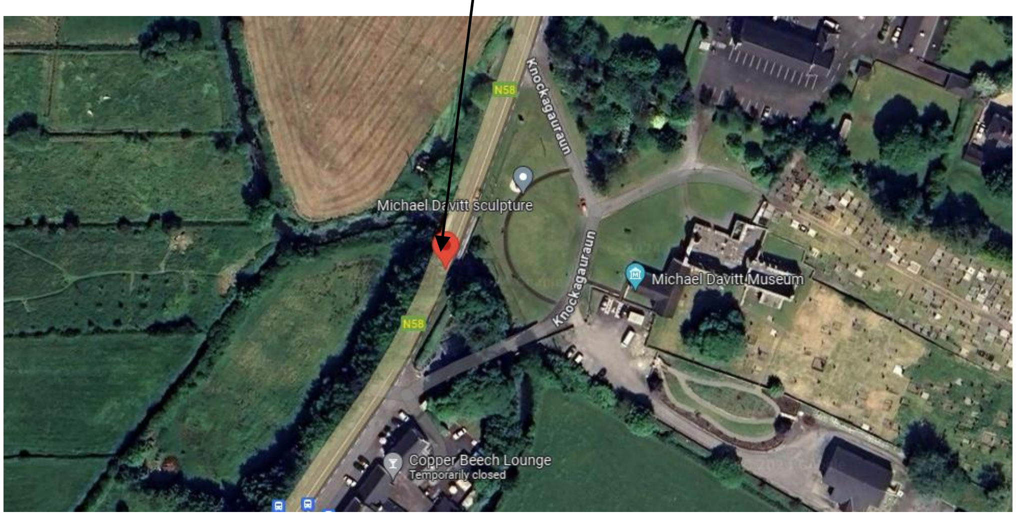
Customer Reference: Reinforcement Scanning at Strade River Bridge, Co. Mayo

Steel Reinforcement Survey

On Tuesday 9th July and Friday 12th July 2024, BHP Laboratories visited Strade River bridge, Co. Mayo. The purpose of these specific works was to conduct a series of reinforcement scans to determine the concrete cover and reinforcement layout in top deck, face deck and soffit of bridge.

BHP undertook scans of the top deck, face deck and soffit to ascertain the reinforcement position and cover. BHP conducted this reinforcement scanning using the latest from Proceq – Ground Penetrating Radar (GPR).

Site Location



The scanning of the top deck, face deck and soffit bridge has found the following information / key points:

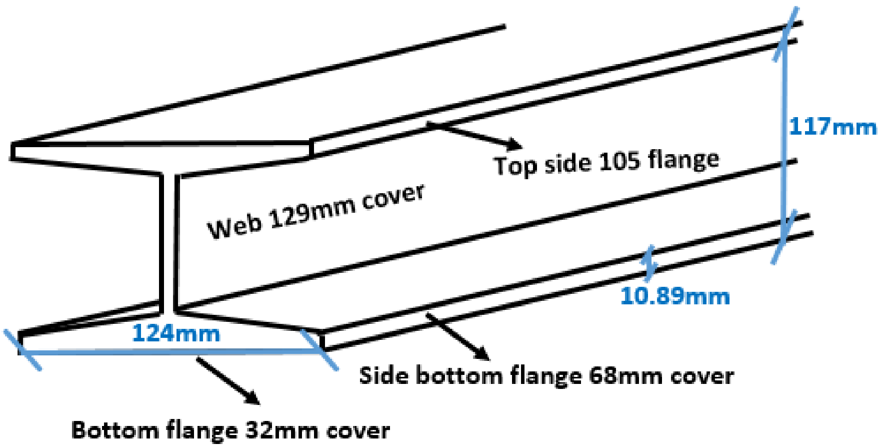
Scan Location	Rebar directions	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)	Minimum Spacing (mm)	Maximum Spacing (mm)
Area 1 top deck longitudinal scan 001	T	153	n/a	n/a	n/a	n/a	n/a
Area 1 top deck transverse scan 001	L	164	158	170	180	n/a	n/a
Area 2 top of deck longitudinal scan 001	T	160	137	183	640	n/a	n/a
Area 2 top of deck longitudinal scan 002	T	156	150	162	620	n/a	n/a
Area 2 top of deck transverse scan 001	L	204	144	238	405	130	680
Area 3 deck face vertical scan 001	L	142	136	148	60	n/a	n/a
Area 3 deck face horizontal scan 001	T	135	n/a	n/a	n/a	n/a	n/a
Area 3.1 soffit longitudinal scan 001	T	38	28	48	684	560	710
Area 3.1 soffit longitudinal scan 002	T	42	37	48	657	620	690
Area 3.1 soffit transverse scan 001	L	46	42	55	166	140	198
Area 3.1 soffit transverse scan 002	L	62	54	68	165	140	196
Area 4 Deck Face Vertical scan 001	L	106	92	120	120	n/a	n/a
Area 4 Deck Face Horizontal scan 001	T	n/a	n/a	n/a	n/a	n/a	n/a
Area 4.1 Soffit longitudinal scan 001	T	48	42	51	666	640	700
Area 4.1 Soffit longitudinal scan 002	T	51	42	56	707	640	750
Area 4.1 Soffit transverse scan 001	L	60	44	69	227	120	330
Area 4.1 Soffit transverse scan 002	L	65	55	76	216	120	319
Area 5 Abutment vertical scan 001	L	n/a	n/a	n/a	n/a	n/a	n/a

Scan Location	Rebar directions	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)	Minimum Spacing (mm)	Maximum Spacing (mm)
Area 5 Abutment horizontal scan 001	T	n/a	n/a	n/a	n/a	n/a	n/a
Area 6 Abutment horizontal scan 001	T	n/a	n/a	n/a	n/a	n/a	n/a
Area 6 Abutment Vertical scan 001	L	n/a	n/a	n/a	n/a	n/a	n/a
Area 7 Abutment Vertical scan 001	L	n/a	n/a	n/a	n/a	n/a	n/a
Area 7 Abutment Horizontal scan 001	T	n/a	n/a	n/a	n/a	n/a	n/a

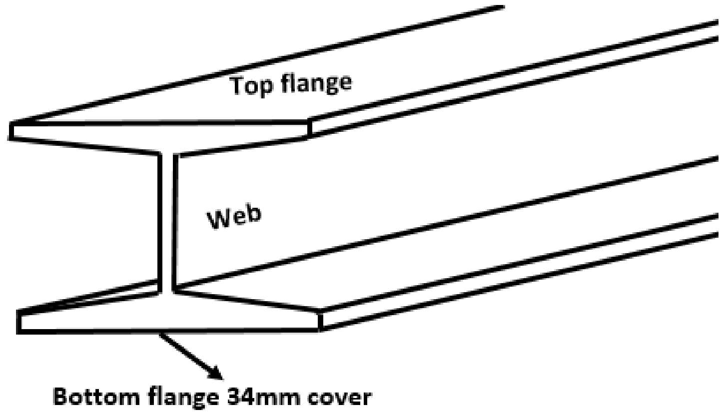
*Rebar directions: L- longitudinal, T- transverse
* In Area 1(TP1), Area 2 (TP2) were not enough space to get more reinforcement readings due to lack of access for GPR
* In Area 5 – Area 7 GPR did not find any reinforcement

Reinforcement found by completing a breakout	Actual cover (mm)	Diameter (mm)	Width(mm)
Area 1 top of deck top flange	150	n/a	n/a
Area 1 top of deck transverse rebar square	109	14.3/25.7	n/a
Area 3 face deck web	129	n/a	n/a
Area 3 face deck bottom flange	32	10.89	123mm
Area 3 face deck bottom side flange	68	n/a	n/a
Area 3 face deck top flange	104	n/a	n/a
Area 3 face deck distance top-bottom flange	117	n/a	n/a
Area 3.1 soffit bottom flange	34mm	n/a	n/a
Area 3.1 soffit transverse rebar square	59	15.3/28.9	n/a
Area 4 face deck top side flange	104	31.39	
Area 4 face deck web	132	n/a	n/a
Area 4 face deck bottom flange	80	n/a	n/a
Area 4 face deck bottom flange	37	8.86	n/a
Area 4.1 soffit bottom flange	47	n/a	n/a
Area 4.1 soffit transverse rebar square	51	13.5/23.6	

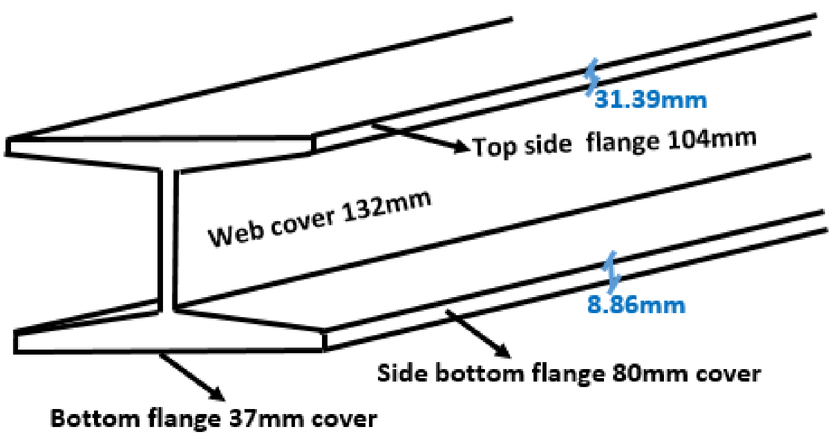
Area 3 beam sketch



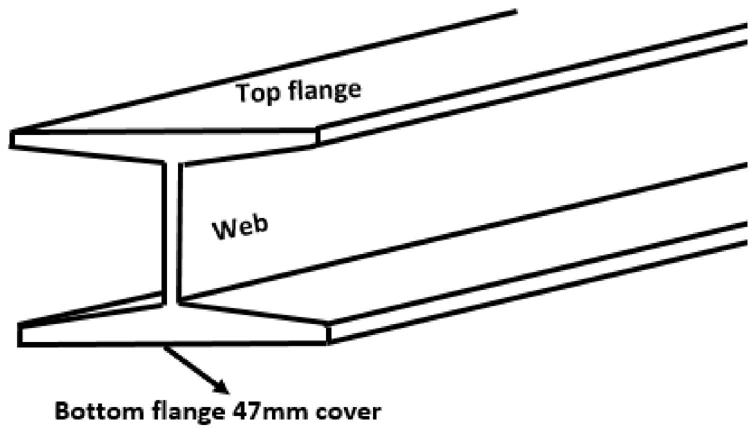
Area 3.1 beam sketch

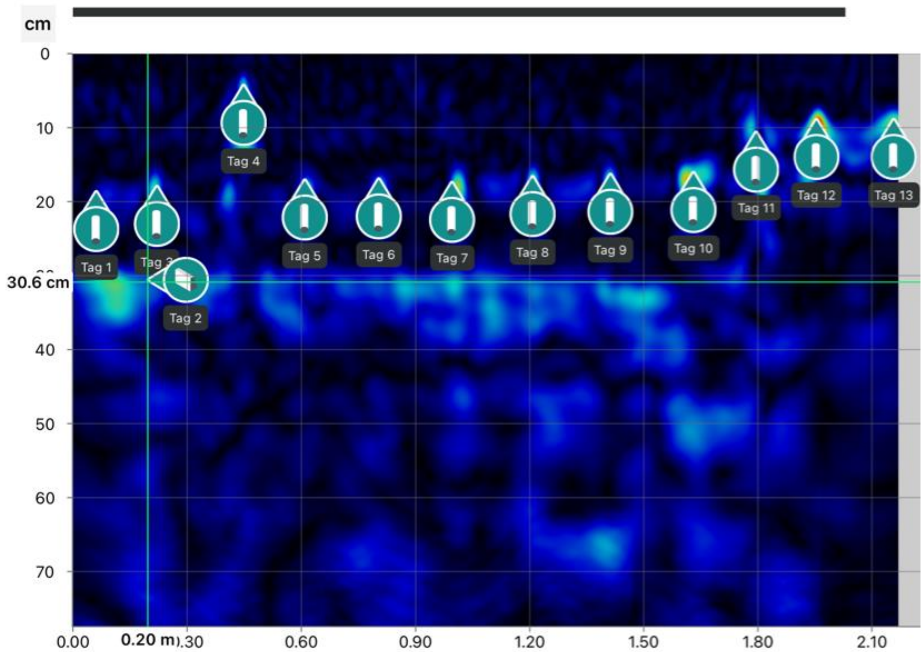


Area 4 beam sketch

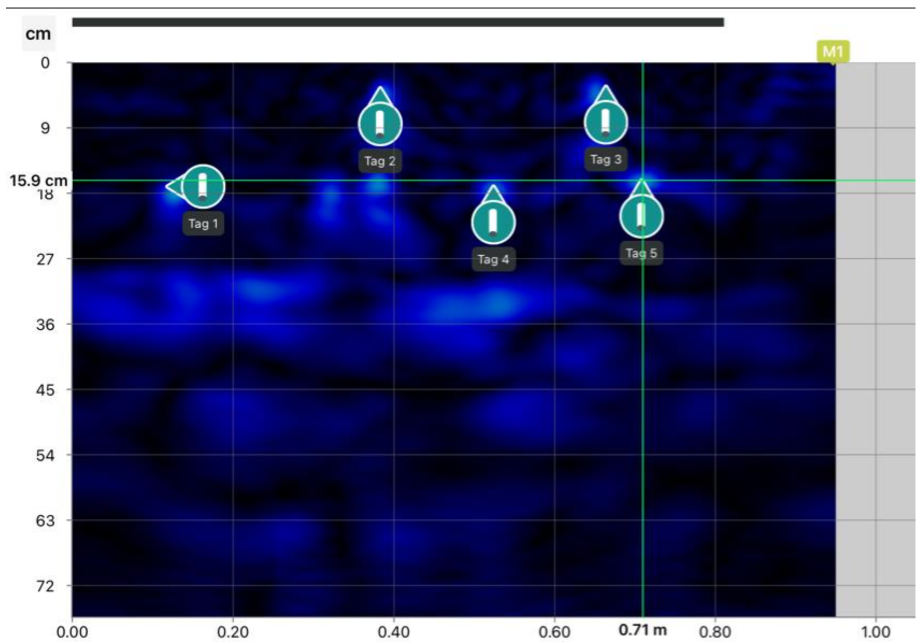


Area 4.1 beam sketch



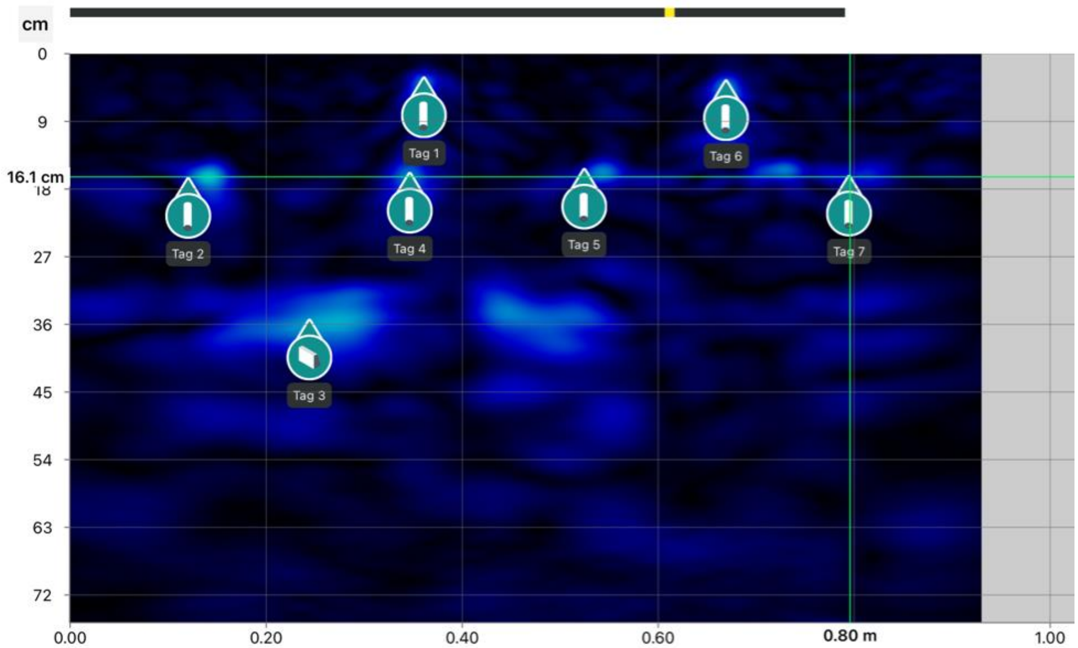


Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 1 top of footpath longitudinal scan	139	87	184	191



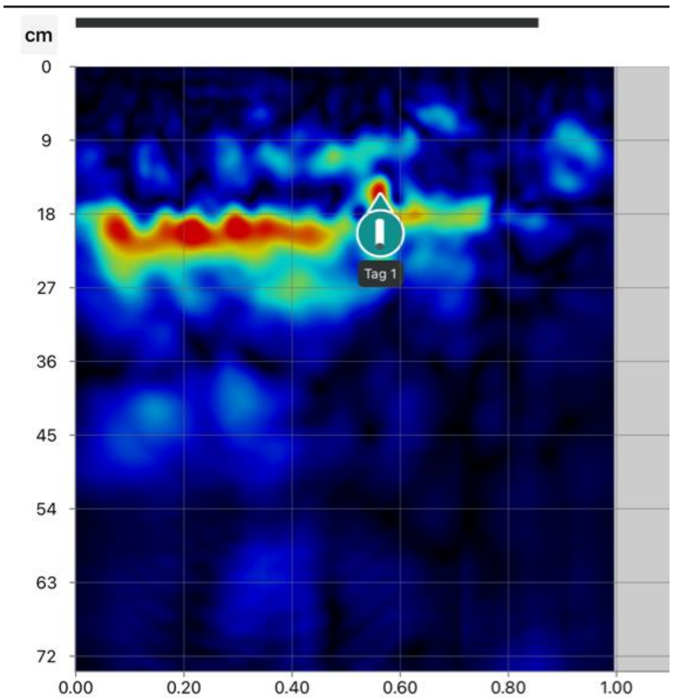
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 1 top of footpath transverse scan first layer	31	30	32	290

Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 1 top of footpath transverse l scan second layer	166	159	171	295

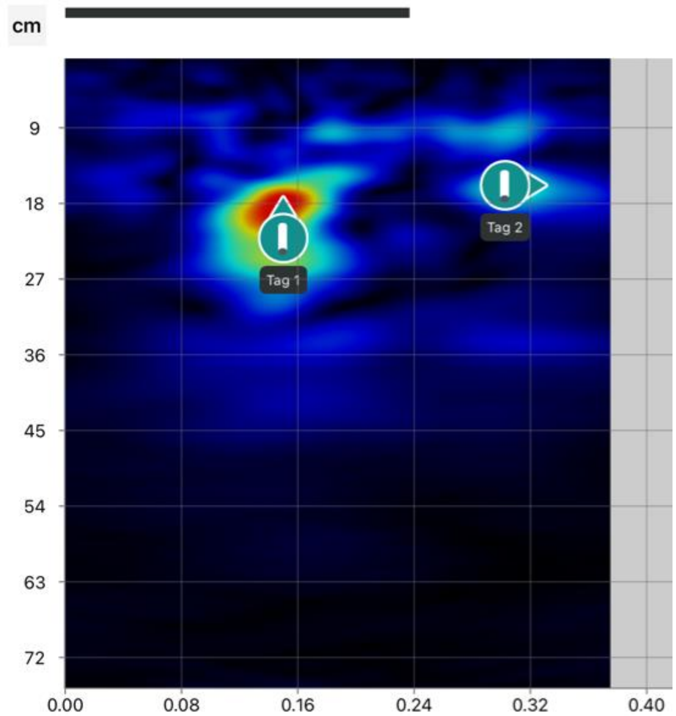


Scan Location	**Mean Cover (mm)**	**Lowest Cover (mm)**	**Highest Cover (mm)**	**Mean Spacing (mm)**
Area 1 top of footpath transverse scan first layer 002	32	30	34	310

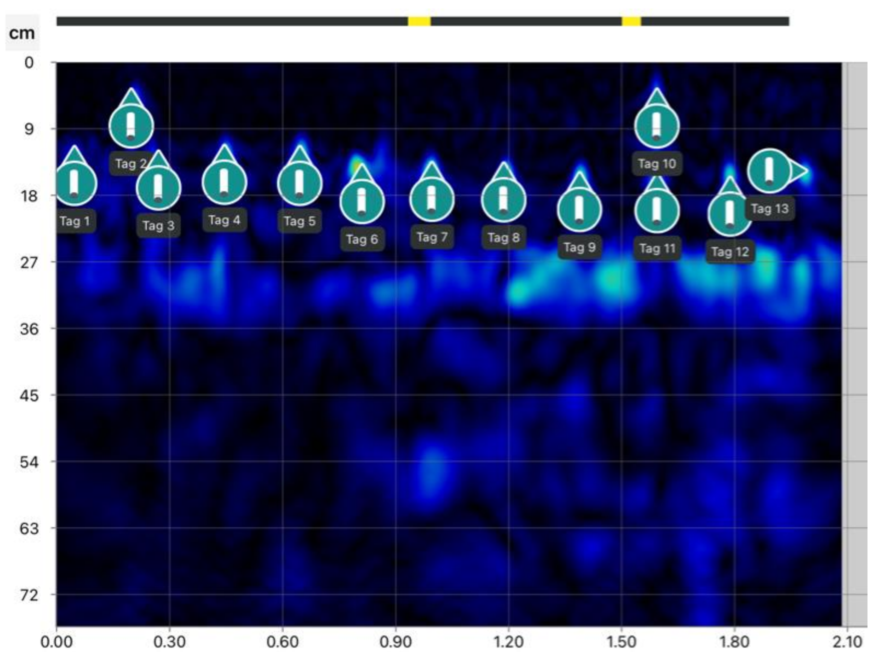
Scan Location	**Mean Cover (mm)**	**Lowest Cover (mm)**	**Highest Cover (mm)**	**Mean Spacing (mm)**
Area 1 top of footpath transverse scan second layer 002	159	152	164	227



Scan Location	**Mean Cover (mm)**	**Lowest Cover (mm)**	**Highest Cover (mm)**	**Mean Spacing (mm)**
Area 1 top deck longitudinal scan 001	153	n/a	n/a	n/a

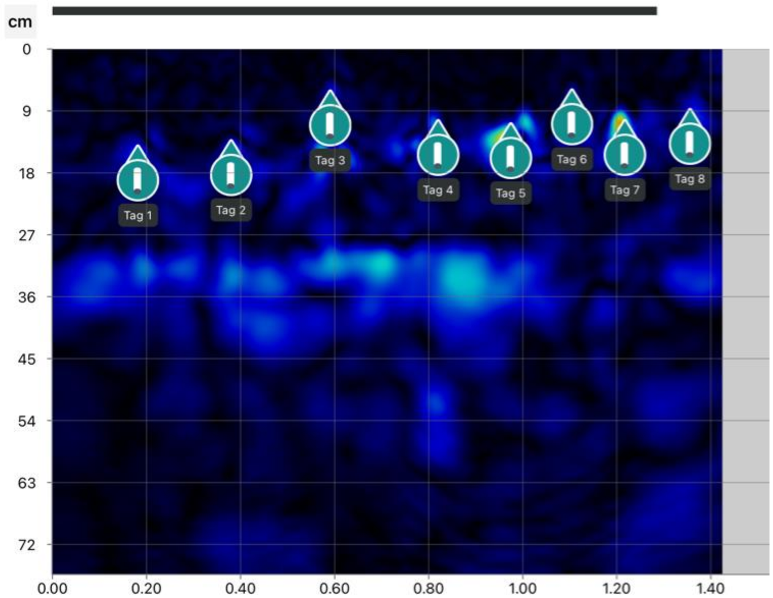


Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 1 top deck transverse scan 001	164	158	170	180



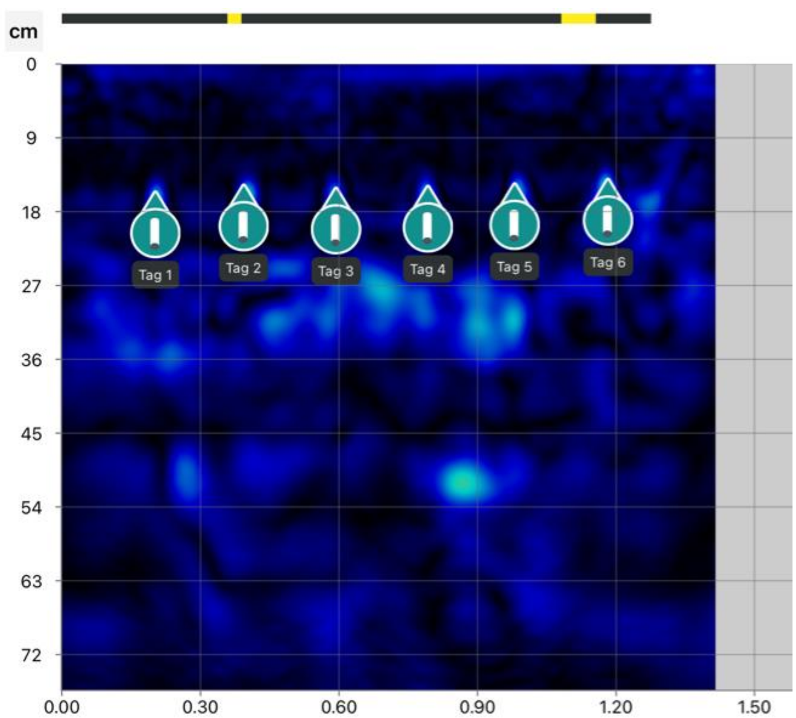
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 top of footpath longitudinal scan 001	34	34	34	1400

Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 top of footpath longitudinal scan 001	153	n/a	n/a	n/a

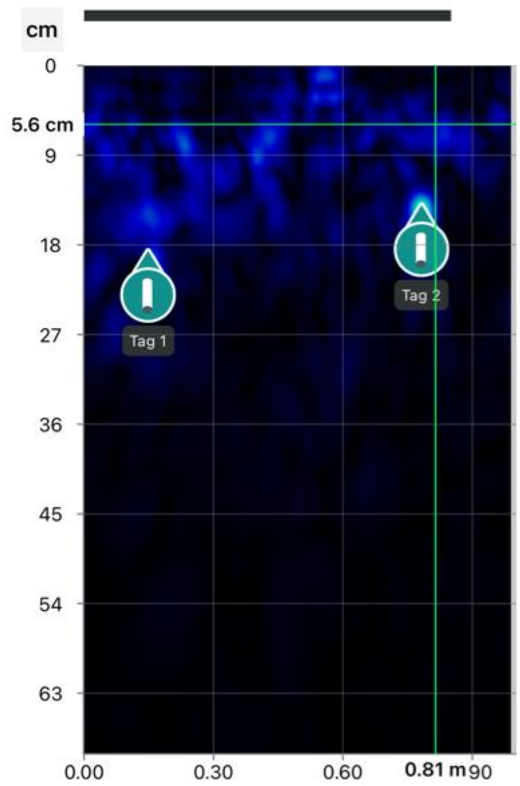


Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 top of footpath transverse scan 001 first layer	67	57	85	385

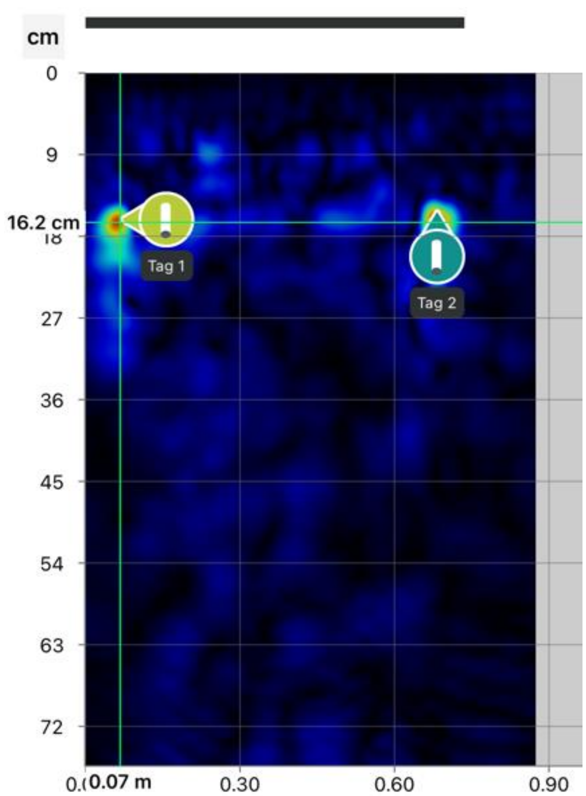
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 top of footpath transverse scan 001 second layer	116	102	138	260



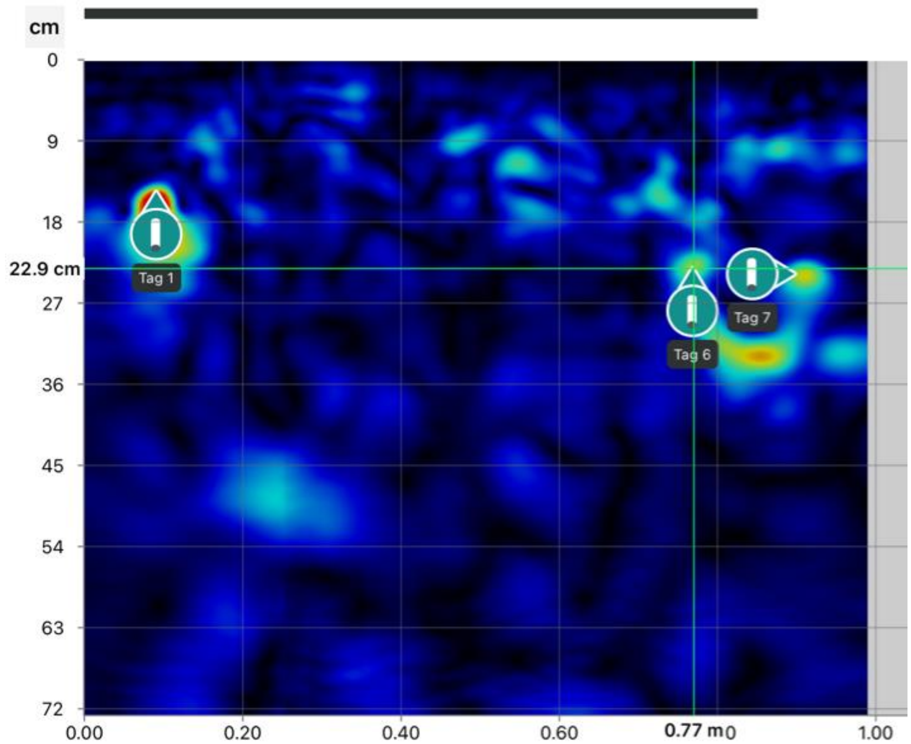
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 top of footpath transverse scan 002	146	138	154	196



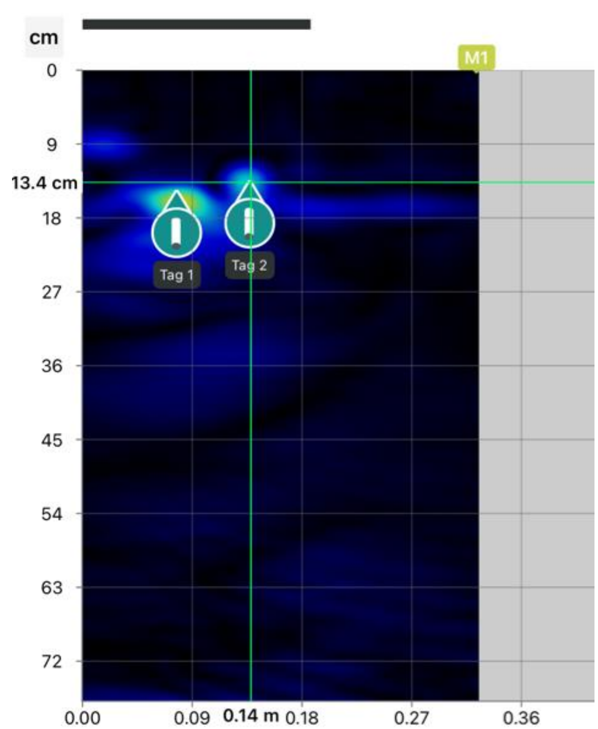
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 top of deck longitudinal scan 001	160	137	183	640



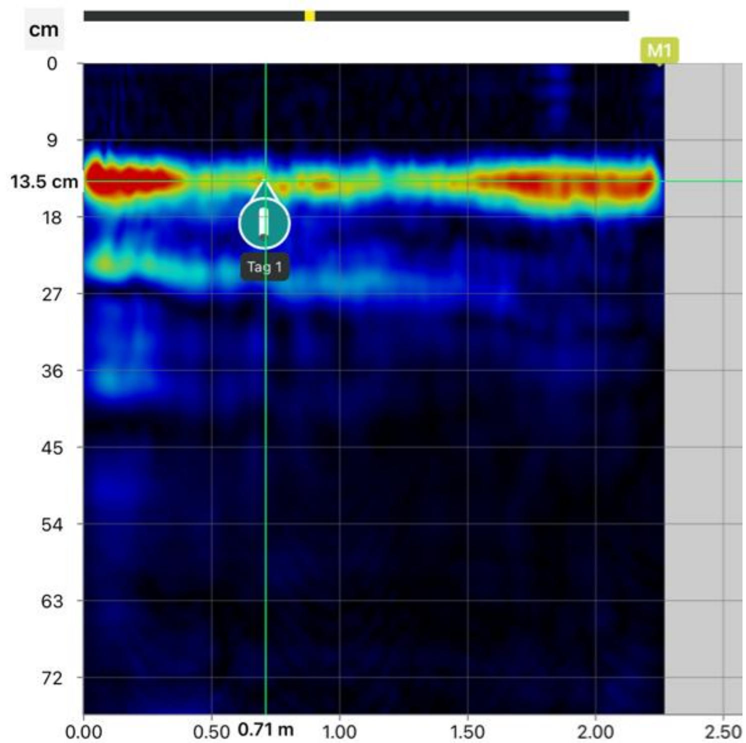
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 top of deck longitudinal scan 002	156	150	162	620



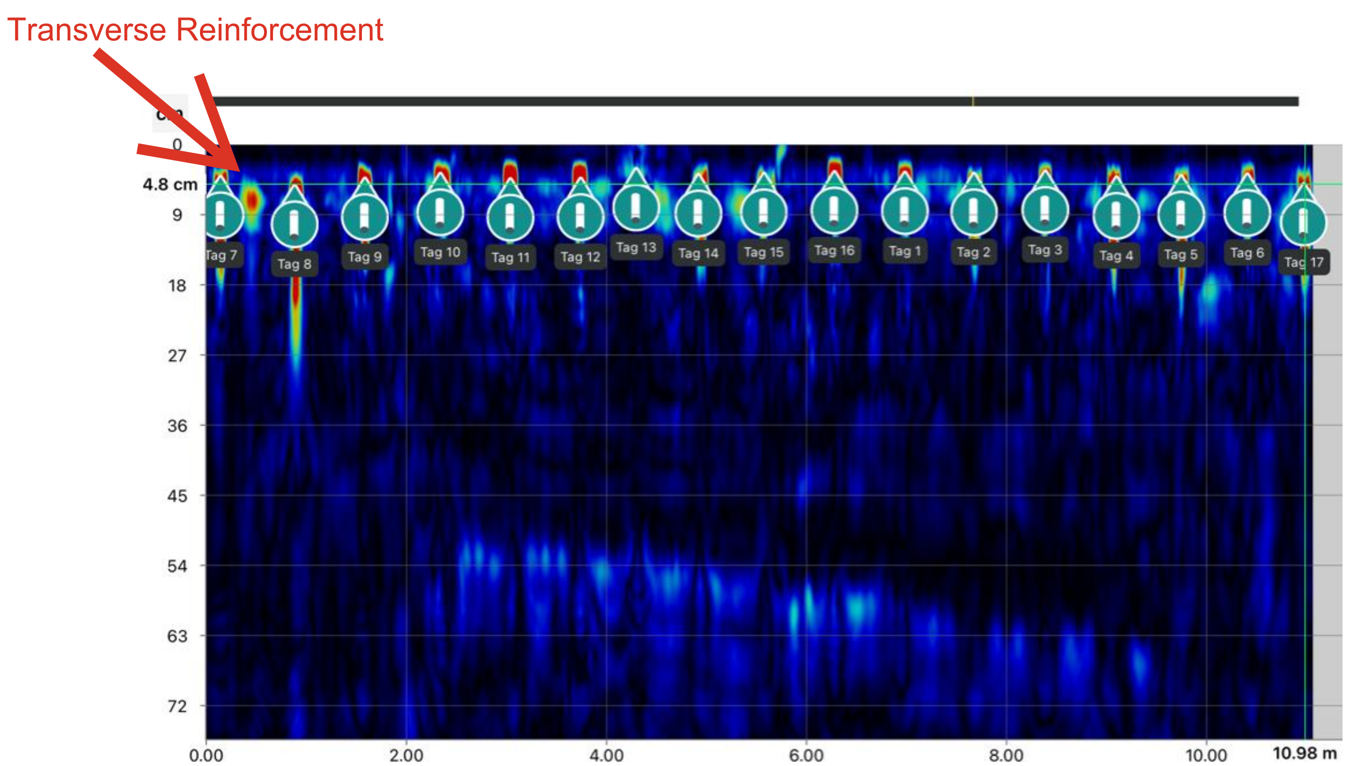
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 top of deck transverse scan 001	204	144	238	405



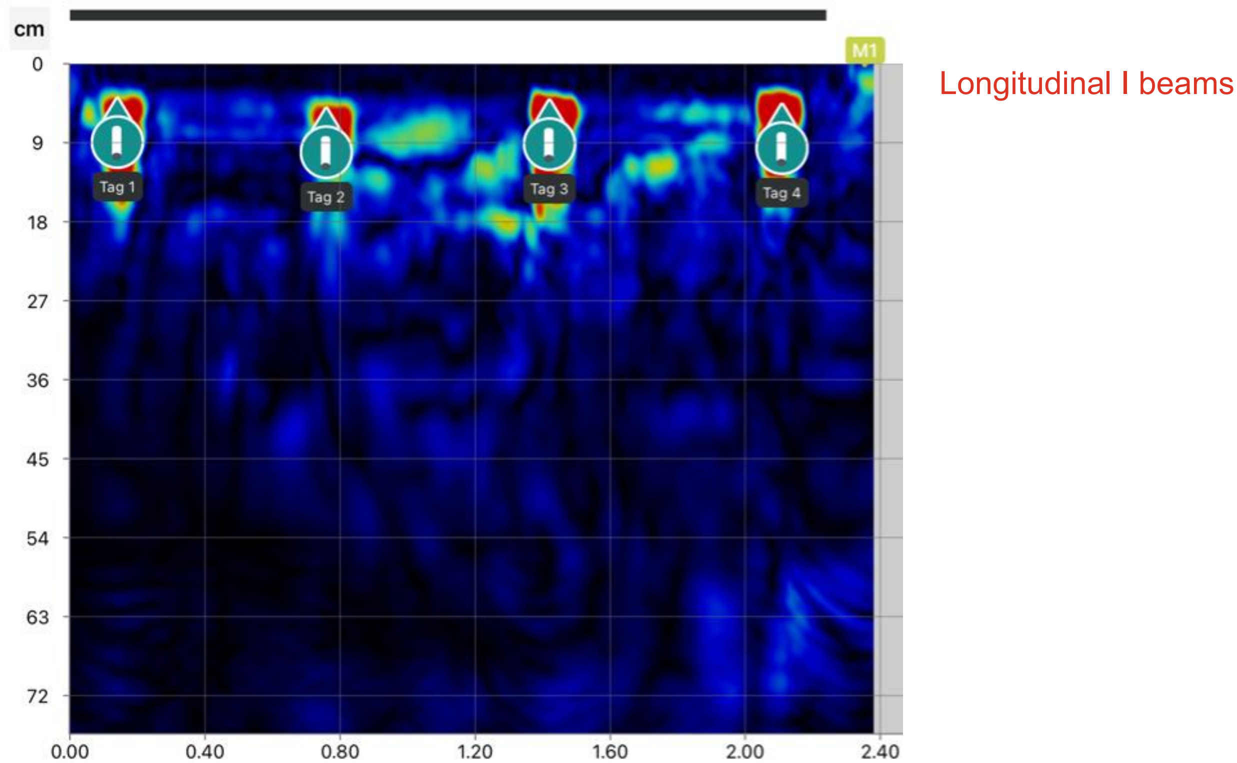
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 3 deck face vertical scan 001	142	136	148	60



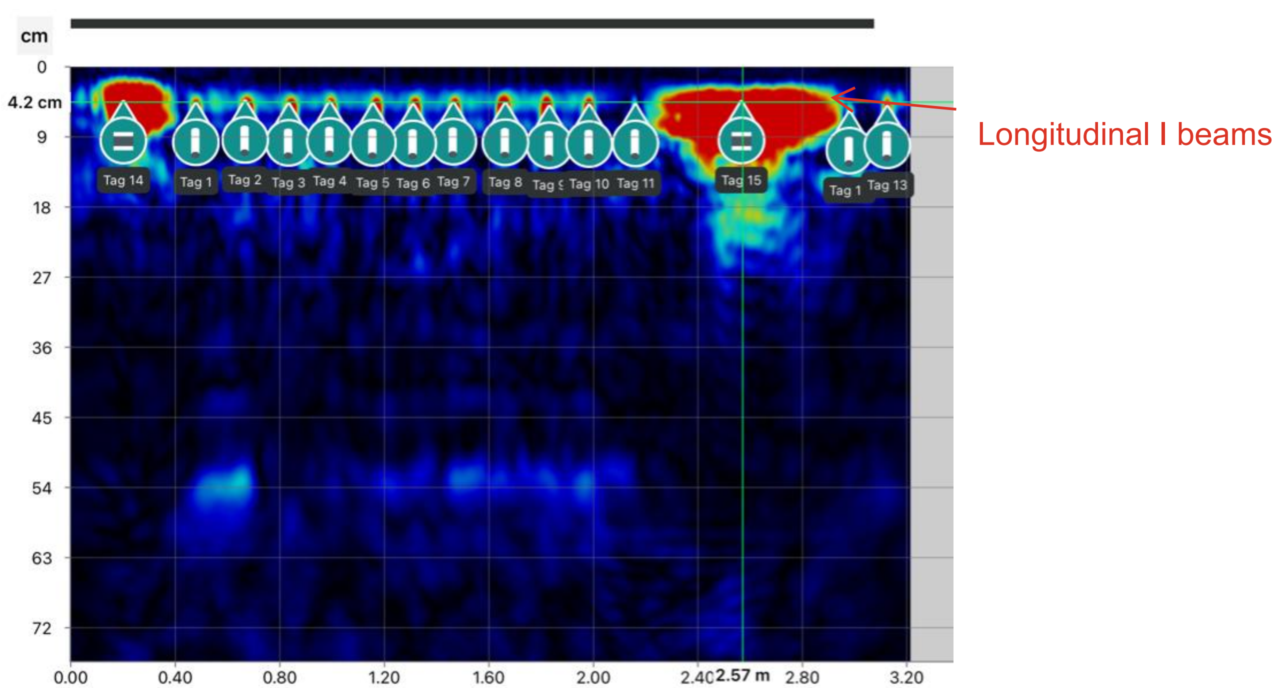
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 3 deck face horizontal scan 001	135	n/a	n/a	n/a



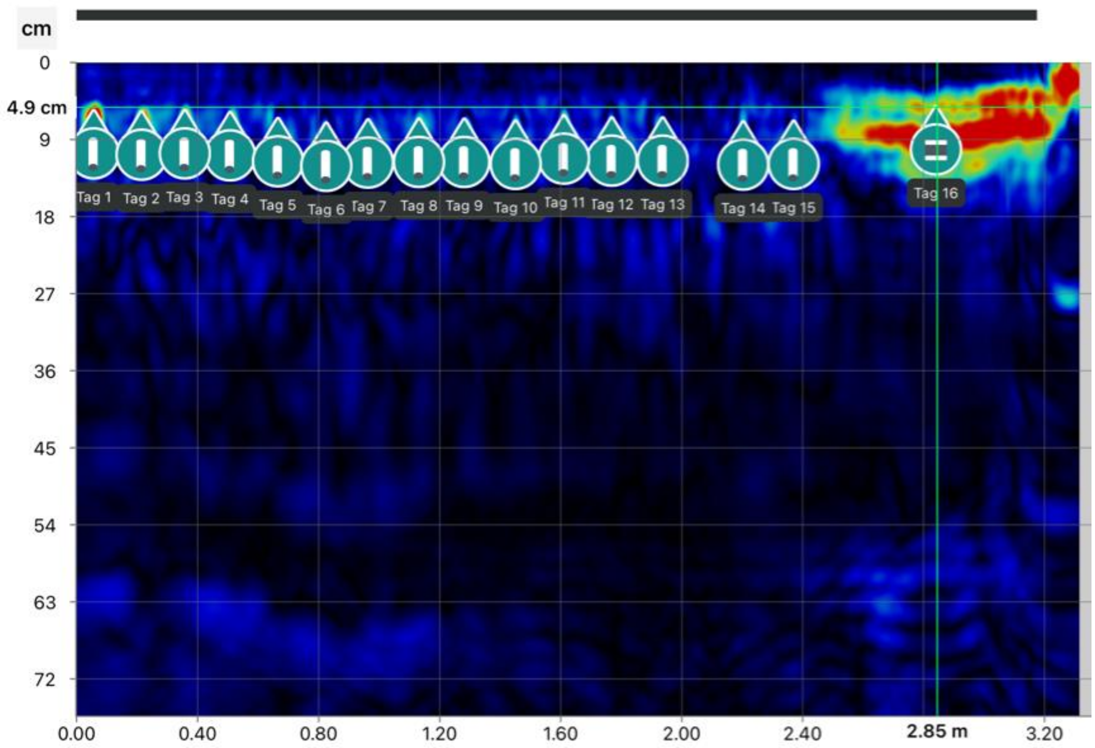
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 3.1 soffit longitudinal scan 001	38	28	48	249



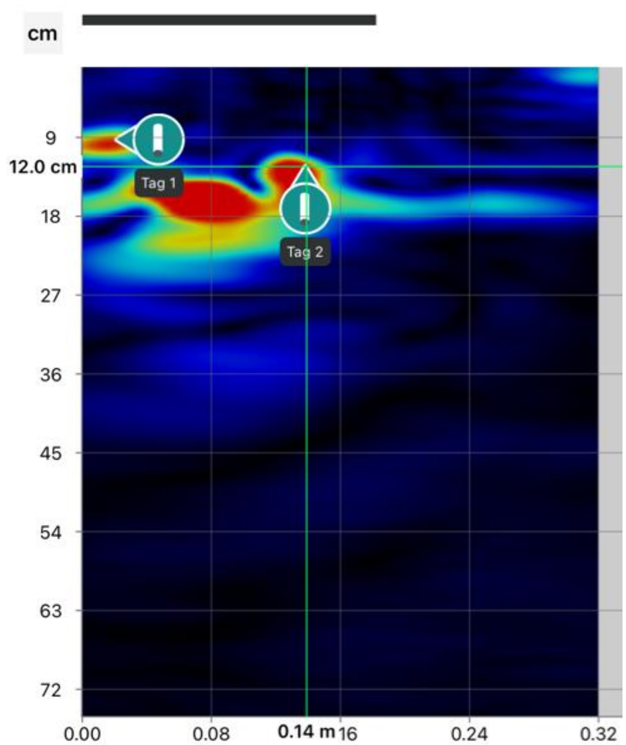
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 3.1 soffit longitudinal scan 002	42	37	48	657



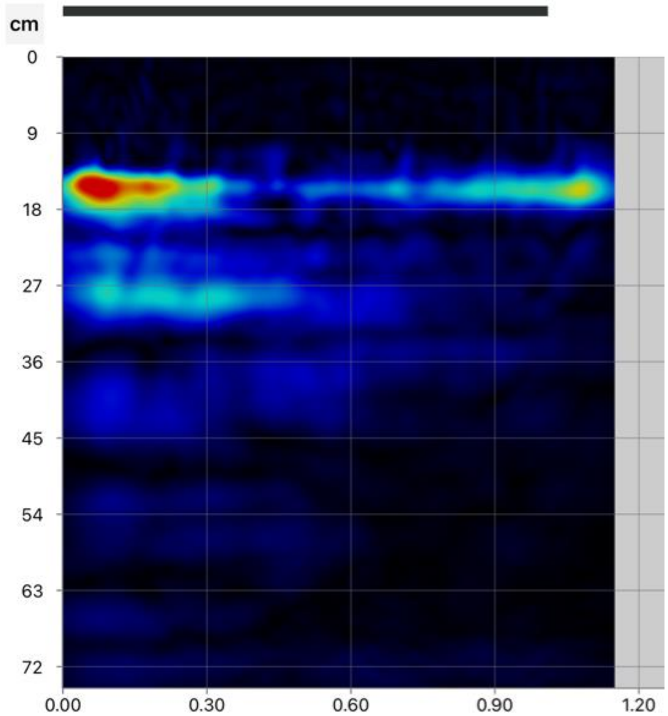
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 3.1 soffit transverse scan 001	46	42	55	166



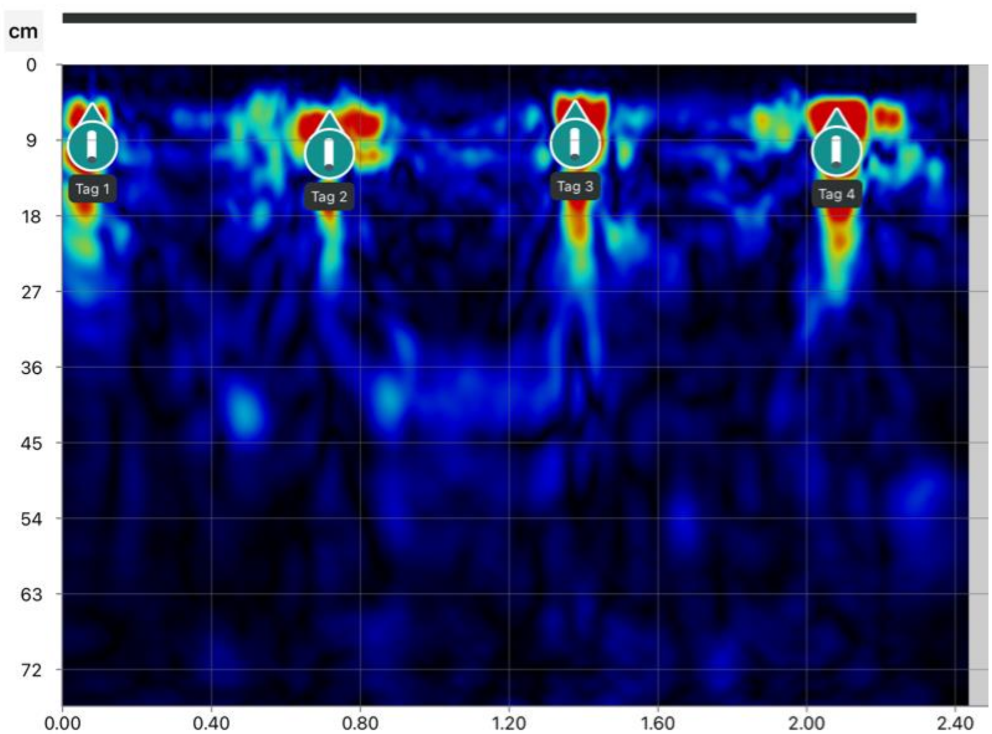
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 3.1 soffit transverse scan 002	62	54	68	165



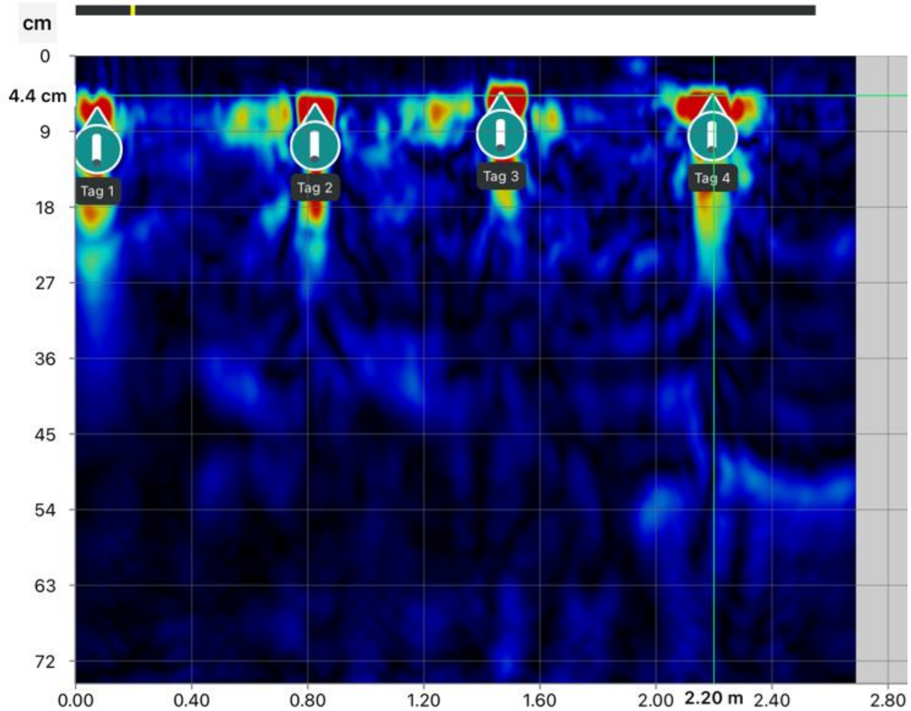
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 4 Deck Face Vertical scan 001	106	92	120	120



Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 4 Deck Face Vertical scan 001	106	92	120	120

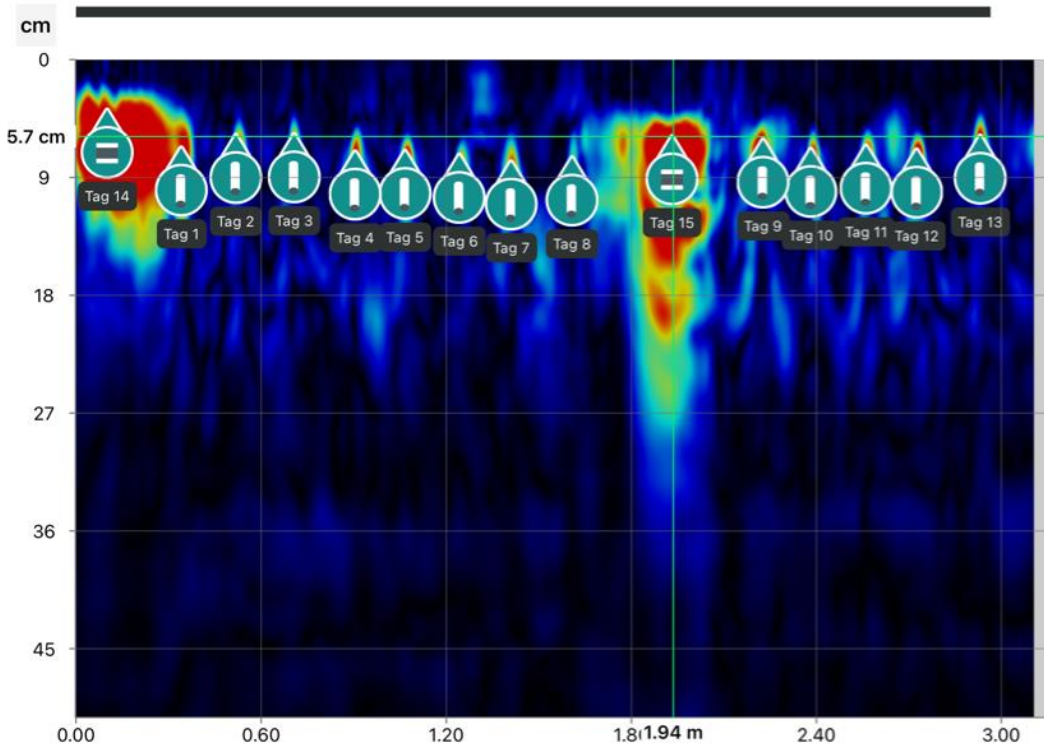


Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 4.1 Soffit longitudinal scan 001	48	42	51	666

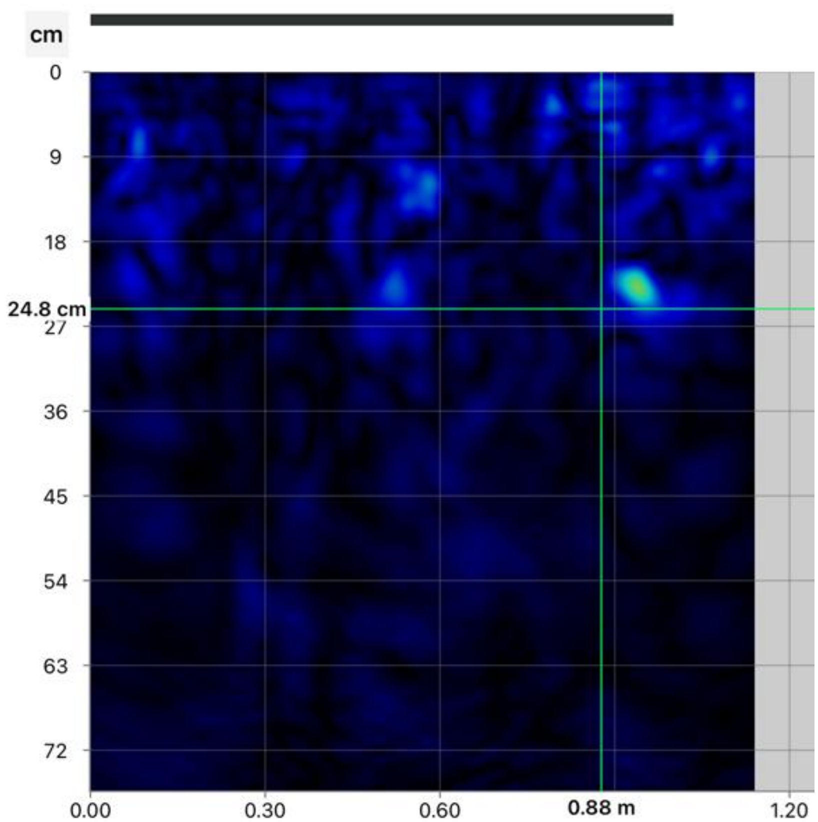


Scan Location	**Mean Cover (mm)**	**Lowest Cover (mm)**	**Highest Cover (mm)**	**Mean Spacing (mm)**
Area 4.1 Soffit longitudinal scan 002	51	42	56	707

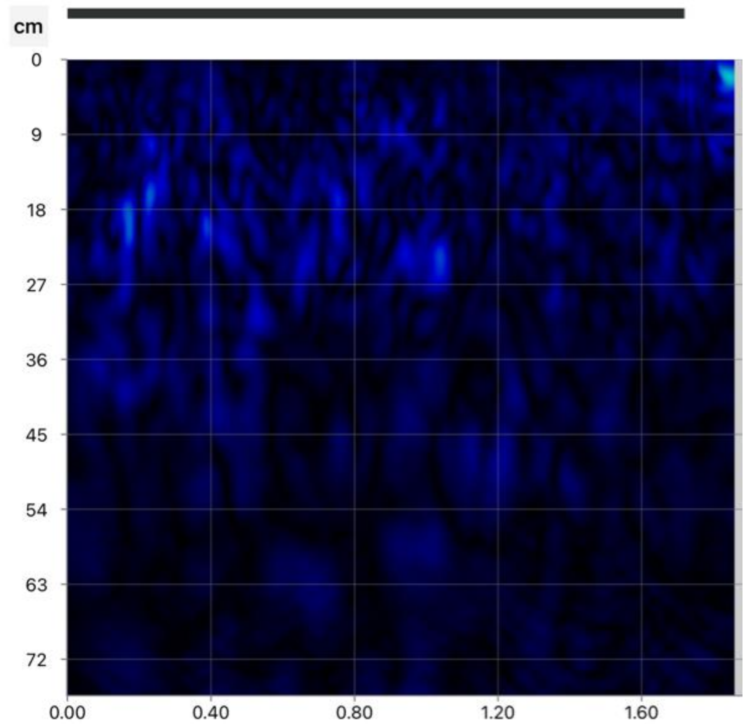
Scan Location	**Mean Cover (mm)**	**Lowest Cover (mm)**	**Highest Cover (mm)**	**Mean Spacing (mm)**
Area 4.1 Soffit transverse scan 001	60	44	69	227



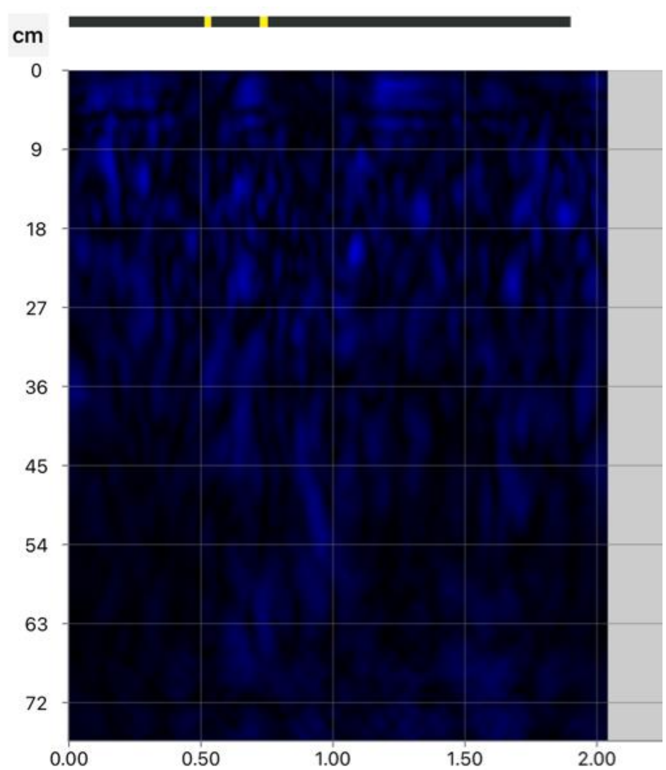
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 4.1 Soffit transverse scan 002	65	55	76	216



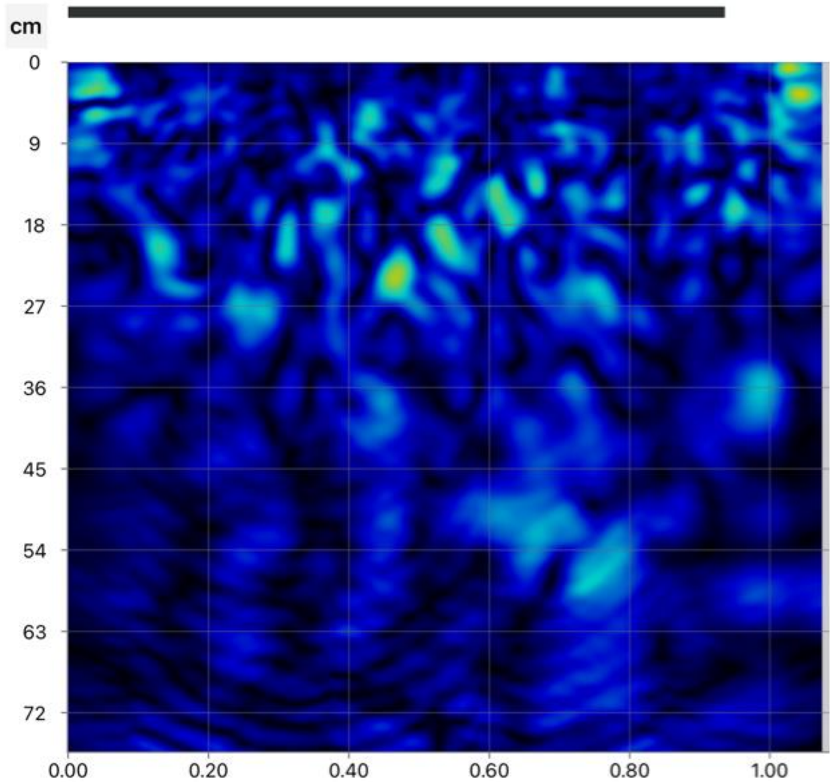
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 5 Abutment vertical scan 001	n/a	n/a	n/a	n/a



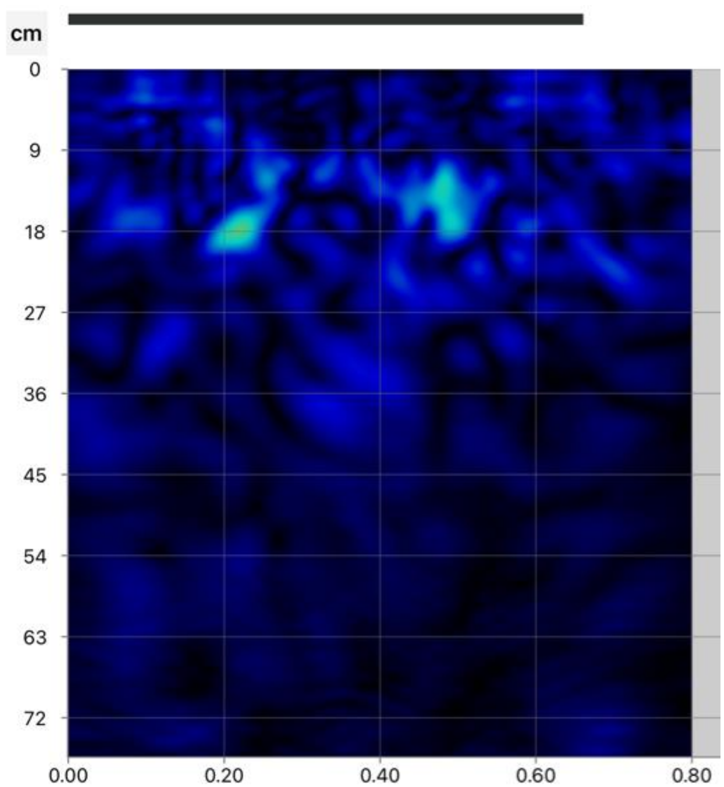
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 5 Abutment horizontal scan 001	n/a	n/a	n/a	n/a



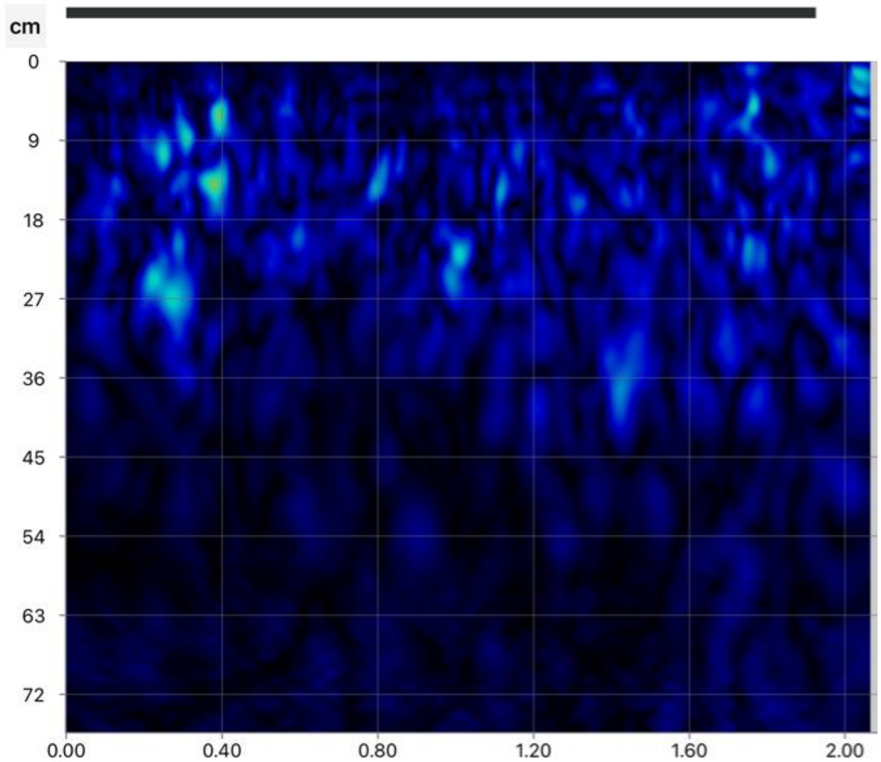
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 6 Abutment horizontal scan 001	n/a	n/a	n/a	n/a



Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 6 Abutment vertical scan 001	n/a	n/a	n/a	n/a



Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 7 Abutment vertical scan 001	n/a	n/a	n/a	n/a

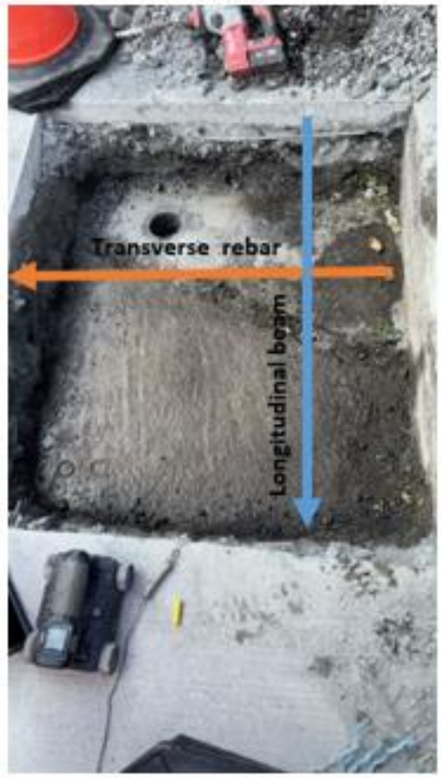


Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 7 Abutment horizontal scan 001	n/a	n/a	n/a	n/a

Photographs of breakout

Area 1

Area 2



Area 3 breakout

Area 3 – web 129mm cover

Area 3 - Bottom flange 32mm	Area 3 - Bottom of side flange 68mm
	
Area 3 - Top side flange 105mm cover side	Area 3 - 300mm
	

Area 3 - Bottom flange 10.89mm

Area 3 - Bottom flange 124mm width

Area 3 - 117mm

Area 4

Area 3.1 uncovered area

Area 3.1 Soffit breakout

Cover bottom flange 34mm

Cover transverse square rebar 59mm

Transverse rebar 28.9mm

Transverse rebar 15.38mm

Spacing transverse 160mm centre

Area 4 Face deck breakout

Area 4 –top side flange cover 104mm

Area 4 - 132mm cover web

Area 4 - Cover 80mm side bottom flange

Area 4 – 37mm bottom flange

Area 4 – bottom flange 8.86	Area 4 - top flange 31.39mm
	

Area 4.1 soffit breakout

BHP

Area 4.1 uncovered area

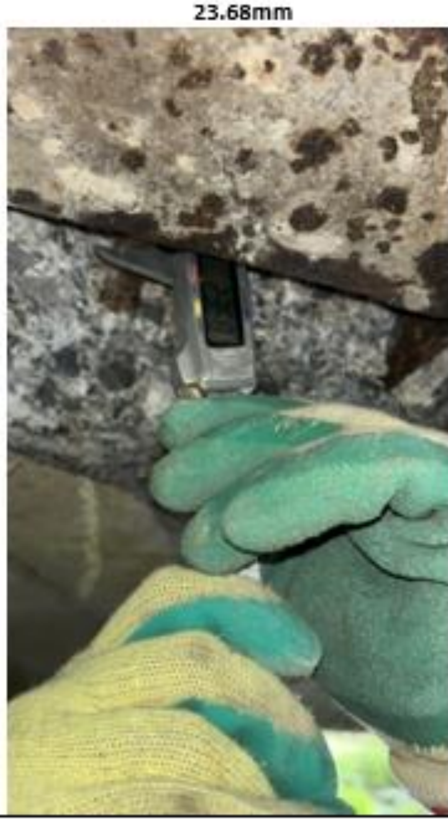
Area 1 Top of deck Breakout

Cover 109mm Transverse square rebar

Transverse square rebar cover 51mm

13,5mm

23.68mm



Area 4.1 bottom flange 47mm cover

Authorised by: Date Issued: 26th August 2024

James Purcell
Structural Testing Manager
For and on behalf of BHP Laboratories Ltd.

Test results relate only to this item. This test report shall not be duplicated except in full and with the permission of the test laboratory

Appendix E

CHLORIDE CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F063 V1 08/07/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072-1-6
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	20/08/2024
	Galway	**Test Specification**:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: See below
Test Standard: BS 1881 Part 124

Location Reference	Sample Reference	Depth (mm)	Chloride Content % by mass of	
			Sample	Cement
Area 1 - Car 1	24/07/072-1	5-30	0.01	0.08
		30-55	0.01	0.08
		55-80	0.02	0.15
		80-105	0.01	0.08
Area 2 - Car 2	24/07/072-2	5-30	0.04	0.20
		30-55	0.03	0.15
		55-80	0.03	0.15
		80-105	0.01	0.05
Area 3 - Car 3	24/07/072-3	5-30	0.02	0.13
		30-55	0.02	0.13
		55-80	0.02	0.13
		80-105	0.02	0.13
Area 3.1 - Car 4	24/07/072-4	5-30	0.03	0.20
		30-55	0.02	0.13
		55-80	0.03	0.20
		80-105	0.03	0.20
Area 4 - Car 5	24/07/072-5	5-30	0.04	0.19
		30-55	0.02	0.10
		55-80	0.02	0.10
		80-105	0.02	0.10
Area 4.1 - Car 6	24/07/072-6	5-30	0.04	0.33
		30-55	0.03	0.25
		55-80	0.03	0.25
		80-105	0.04	0.33

REMARKS:
The Chloride Content is a Acid Soluble Chloride value.
The Chloride Content as a % by mass of cements as stated in EN 206 is a maxium allowable of 0.4% (containing embedded steel).

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	Lukasz Zalewski

For and On Behalf of BHP Laboratories Issue Date: 27/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CHLORIDE CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F063 V1 08/07/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-7-12
		Order No:	Not Supplied
		Date Tested:	20/08/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: See below
Test Standard: BS 1881 Part 124

Location Reference	Sample Reference	Depth (mm)	Chloride Content *% by mass of* Sample	Chloride Content *% by mass of* Cement
Area 5 - Car 7	24/07/072-7	5-30	0.02	0.20
		30-55	0.01	0.10
		55-80	0.01	0.10
		80-105	0.01	0.10
Area 5 - Car 8	24/07/072-8	5-30	0.02	0.25
		30-55	0.01	0.13
		55-80	0.01	0.13
		80-105	0.01	0.13
Area 6 - Car 9	24/07/072-9	5-30	0.01	0.07
		30-55	0.01	0.07
		55-80	0.01	0.07
		80-105	0.01	0.07
Area 6 - Car 10	24/07/072-10	5-30	0.03	0.21
		30-55	0.03	0.21
		55-80	0.03	0.21
		80-105	0.03	0.21
Area 7 - Car 11	24/07/072-11	5-30	0.01	0.08
		30-55	0.01	0.08
		55-80	0.01	0.08
		80-105	0.01	0.08
Area 7 - Car 12	24/07/072-12	5-30	0.03	0.17
		30-55	0.03	0.17
		55-80	0.02	0.11
		80-105	0.02	0.11

REMARKS:
The Chloride Content is a Acid Soluble Chloride value.
The Chloride Content as a % by mass of cements as stated in EN 206 is a maxium allowable of 0.4% (containing embedded steel).

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 27/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

Appendix F

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client: TRIUR Construction Ltd
13 Society Street
Ballinasloe
Galway

FAO: Lurcan Donnellan

BHP Ref. No.: 24/07/072-1
Order No: Not Supplied
Date Tested: 20/08/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 1 - Car 1
Test Standard: BS 1881 Part 124

Sample Weight (g)	**5**
Determined Values	
Insoluble residue (%)	**32.4**
Soluble silica (%)	**2.9**
Calcium oxide (%)	**49**
Calculated Values	
Cement Content (%)	
ex silica	**13.5**
ex lime	**76**
preferred / mean value %	**13.5**
Reported to nearest whole figure (%)	**13**
Aggregate Content (%)	
ex silica	**83.4**
ex lime	**6.6**
preferred / mean value	**83.4**
Aggregate / Cement Ratio	
ex silica	**6.2**
ex lime	**0.1**
preferred / mean value	**6.2**

REMARKS:
The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:

Silica content of cement (CEM I)	20.2%
Soluble silica content of aggregate	0.5%
Calcium oxide content of cement (CEM I)	64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	Lukasz Zalewski

For and On Behalf of BHP Laboratories

Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-2
		Order No:	Not Supplied
		Date Tested:	20/08/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 2 - Car 2
Test Standard: BS 1881 Part 124

Sample Weight (g)	**9**
Determined Values	
Insoluble residue (%)	**15.2**
Soluble silica (%)	**4.2**
Calcium oxide (%)	**43.4**
Calculated Values	
Cement Content (%)	
ex silica	**19.9**
ex lime	**67.3**
preferred / mean value %	**19.9**
Reported to nearest whole figure (%)	**20**
Aggregate Content (%)	
ex silica	**75.5**
ex lime	**17.3**
preferred / mean value	**75.5**
Aggregate / Cement Ratio	
ex silica	**3.8**
ex lime	**0.3**
preferred / mean value	**3.8**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:
Silica content of cement (CEM I) 20.2%
Soluble silica content of aggregate 0.5%
Calcium oxide content of cement (CEM I) 64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	[signature]

For and On Behalf of BHP Laboratories

Issue Date: 21/08/2024

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-4
		Order No:	Not Supplied
		Date Tested:	20/08/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 3.1 - Car 4
Test Standard: BS 1881 Part 124

Sample Weight (g)	**12**
Determined Values	
Insoluble residue (%)	**20.7**
Soluble silica (%)	**3.3**
Calcium oxide (%)	**40.6**
Calculated Values	
Cement Content (%)	
ex silica	**15.4**
ex lime	**63**
preferred / mean value %	**15.4**
Reported to nearest whole figure (%)	**15**
Aggregate Content (%)	
ex silica	**81**
ex lime	**22.6**
preferred / mean value	**81**
Aggregate / Cement Ratio	
ex silica	**5.2**
ex lime	**0.4**
preferred / mean value	**5.2**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:

Silica content of cement (CEM I)	20.2%
Soluble silica content of aggregate	0.5%
Calcium oxide content of cement (CEM I)	64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories

Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-5
		Order No:	Not Supplied
		Date Tested:	20/08/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 4 - Car 5
Test Standard: BS 1881 Part 124

Sample Weight (g)	**17**
Determined Values	
Insoluble residue (%)	**10.3**
Soluble silica (%)	**4.4**
Calcium oxide (%)	**46.2**
Calculated Values	
Cement Content (%)	
ex silica	**21**
ex lime	**71.6**
preferred / mean value %	**21**
Reported to nearest whole figure (%)	**21**
Aggregate Content (%)	
ex silica	**74.1**
ex lime	**12**
preferred / mean value	**74.1**
Aggregate / Cement Ratio	
ex silica	**3.5**
ex lime	**0.2**
preferred / mean value	**3.5**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:

Silica content of cement (CEM I)	20.2%
Soluble silica content of aggregate	0.5%
Calcium oxide content of cement (CEM I)	64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 21/08/2024

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client: TRIUR Construction Ltd
13 Society Street
Ballinasloe
Galway
FAO: Lurcan Donnellan

BHP Ref. No.: 24/07/072-6
Order No: Not Supplied
Date Tested: 20/08/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 4.1 - Car 6
Test Standard: BS 1881 Part 124

Sample Weight (g)	**10**
Determined Values	
Insoluble residue (%)	**9.4**
Soluble silica (%)	**2.7**
Calcium oxide (%)	**46.7**
Calculated Values	
Cement Content (%)	
ex silica	**12.4**
ex lime	**72.4**
preferred / mean value %	**12.4**
Reported to nearest whole figure (%)	**12**
Aggregate Content (%)	
ex silica	**84.7**
ex lime	**11**
preferred / mean value	**84.7**
Aggregate / Cement Ratio	
ex silica	**6.8**
ex lime	**0.2**
preferred / mean value	**6.8**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:

Silica content of cement (CEM I)	20.2%
Soluble silica content of aggregate	0.5%
Calcium oxide content of cement (CEM I)	64.5%

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories

Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-7
		Order No:	Not Supplied
		Date Tested:	20/08/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 5 - Car 7
Test Standard: BS 1881 Part 124

Sample Weight (g)	**12**
Determined Values	
Insoluble residue (%)	**18.4**
Soluble silica (%)	**2.1**
Calcium oxide (%)	**43.1**
Calculated Values	
Cement Content (%)	
ex silica	**9.6**
ex lime	**66.9**
preferred / mean value %	**9.6**
Reported to nearest whole figure (%)	**10**
Aggregate Content (%)	
ex silica	**88.2**
ex lime	**17.7**
preferred / mean value	**88.2**
Aggregate / Cement Ratio	
ex silica	**9.2**
ex lime	**0.3**
preferred / mean value	**9.2**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:
Silica content of cement (CEM I) 20.2%
Soluble silica content of aggregate 0.5%
Calcium oxide content of cement (CEM I) 64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client: TRIUR Construction Ltd
13 Society Street
Ballinasloe
Galway
FAO: Lurcan Donnellan

BHP Ref. No.: 24/07/072-8
Order No: Not Supplied
Date Tested: 20/08/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 5 - Car 8
Test Standard: BS 1881 Part 124

Sample Weight (g)	**4**
Determined Values	
Insoluble residue (%)	**25.4**
Soluble silica (%)	**1.8**
Calcium oxide (%)	**37.9**
Calculated Values	
Cement Content (%)	
ex silica	**8**
ex lime	**58.8**
preferred / mean value %	**8**
Reported to nearest whole figure (%)	**8**
Aggregate Content (%)	
ex silica	**90.2**
ex lime	**27.7**
preferred / mean value	**90.2**
Aggregate / Cement Ratio	
ex silica	**11.3**
ex lime	**0.5**
preferred / mean value	**11.3**

REMARKS:
The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:
Silica content of cement (CEM I) 20.2%
Soluble silica content of aggregate 0.5%
Calcium oxide content of cement (CEM I) 64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories

Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-9
		Order No:	Not Supplied
		Date Tested:	20/08/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 6 - Car 9
Test Standard: BS 1881 Part 124

Sample Weight (g)	**10**
Determined Values	
Insoluble residue (%)	**35.2**
Soluble silica (%)	**2.9**
Calcium oxide (%)	**33**
Calculated Values	
Cement Content (%)	
ex silica	**13.6**
ex lime	**51.2**
preferred / mean value %	**13.6**
Reported to nearest whole figure (%)	**14**
Aggregate Content (%)	
ex silica	**83.3**
ex lime	**37**
preferred / mean value	**83.3**
Aggregate / Cement Ratio	
ex silica	**6.1**
ex lime	**0.7**
preferred / mean value	**6.1**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:

Silica content of cement (CEM I)	20.2%
Soluble silica content of aggregate	0.5%
Calcium oxide content of cement (CEM I)	64.5%

Approved By:	Signature:
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-10
		Order No:	Not Supplied
		Date Tested:	20/08/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 6 - Car 10
Test Standard: BS 1881 Part 124

Sample Weight (g)	**10**
Determined Values	
Insoluble residue (%)	**15.7**
Soluble silica (%)	**3**
Calcium oxide (%)	**42.1**
Calculated Values	
Cement Content (%)	
ex silica	**14**
ex lime	**65.3**
preferred / mean value %	**14**
Reported to nearest whole figure (%)	**14**
Aggregate Content (%)	
ex silica	**82.7**
ex lime	**19.7**
preferred / mean value	**82.7**
Aggregate / Cement Ratio	
ex silica	**5.9**
ex lime	**0.3**
preferred / mean value	**5.9**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:
Silica content of cement (CEM I) 20.2%
Soluble silica content of aggregate 0.5%
Calcium oxide content of cement (CEM I) 64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	Lukasz Zalewski

For and On Behalf of BHP Laboratories
Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-11
		Order No:	Not Supplied
		Date Tested:	20/08/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 7 - Car 11
Test Standard: BS 1881 Part 124

Sample Weight (g)	**9**
Determined Values	
Insoluble residue (%)	**19**
Soluble silica (%)	**2.5**
Calcium oxide (%)	**41.9**
Calculated Values	
Cement Content (%)	
ex silica	**11.7**
ex lime	**64.9**
preferred / mean value %	**11.7**
Reported to nearest whole figure (%)	**12**
Aggregate Content (%)	
ex silica	**85.6**
ex lime	**20.2**
preferred / mean value	**85.6**
Aggregate / Cement Ratio	
ex silica	**7.3**
ex lime	**0.3**
preferred / mean value	**7.3**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:

Silica content of cement (CEM I)	20.2%
Soluble silica content of aggregate	0.5%
Calcium oxide content of cement (CEM I)	64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories

Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CEMENT CONTENT OF CONCRETE
TEST REPORT

BHP/MTIField/F056 V1 20/05/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072-12
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	20/08/2024
	Galway	**Test Specification**:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Dust

Project: Mayo Bridges Investigation - Strade River Bridge
Location Reference: Area 7 - Car 12
Test Standard: BS 1881 Part 124

Sample Weight (g)	**9**
Determined Values	
Insoluble residue (%)	**20.6**
Soluble silica (%)	**3.9**
Calcium oxide (%)	**39.4**
Calculated Values	
Cement Content (%)	
ex silica	**18.4**
ex lime	**61**
preferred / mean value %	**18.4**
Reported to nearest whole figure (%)	**18**
Aggregate Content (%)	
ex silica	**77.4**
ex lime	**25**
preferred / mean value	**77.4**
Aggregate / Cement Ratio	
ex silica	**4.2**
ex lime	**0.4**
preferred / mean value	**4.2**

REMARKS:

The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.
Assumptions used for the cement and aggregate content calculations:

Silica content of cement (CEM I)	20.2%
Soluble silica content of aggregate	0.5%
Calcium oxide content of cement (CEM I)	64.5%

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	[signature]

For and On Behalf of BHP Laboratories — Issue Date: 21/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

Appendix G

CORROSION POTENTIAL ASSESSMENT OF STEEL REINFORCEMENT BY HALF CELL TESTING
TEST REPORT

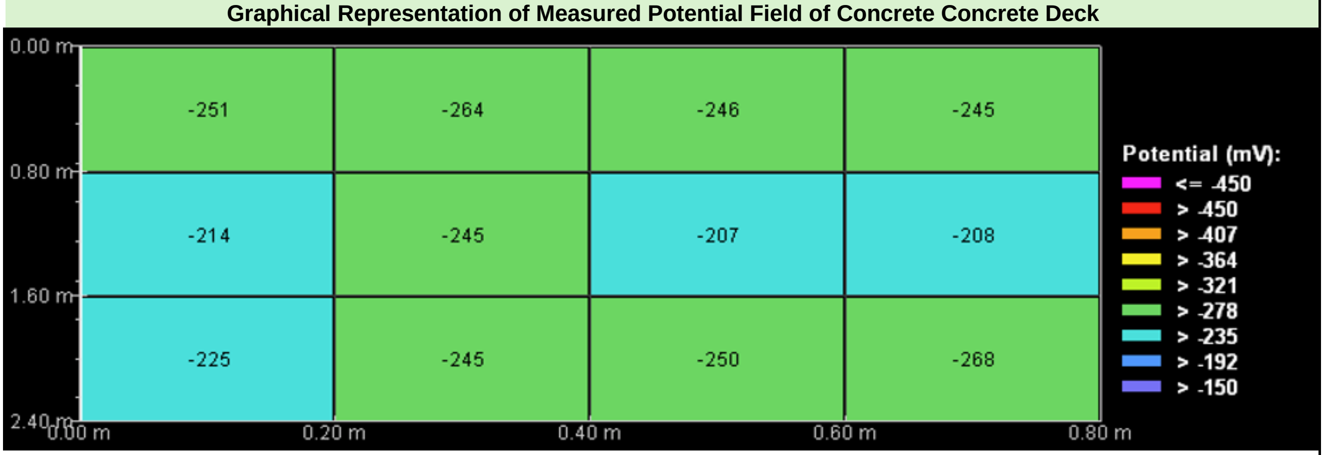
BHP/MTIField/F057 V1 21/05/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072-1
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	12/07/2024
	Galway	**Test Specification**:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Deck

Project:	Mayo Bridges - Strade River Bridge
Location Reference:	Area 1 C1 Deck
Test Standard:	ASTM C876

Test No.	1
No. of Readings	12
Median (mV)	-245
Mean (mV)	-239
Standard Deviation	19.8
Lowest (mV)	-268
Highest (mV)	-207
Reinforcement Condition	Intermediate Risk of Corrosion

Graphical Representation of Measured Potential Field of Concrete Concrete Deck



REMARKS:
This test was performed using a Copper-Copper Sulphate Electrode.

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 14/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CORROSION POTENTIAL ASSESSMENT OF STEEL REINFORCEMENT BY HALF CELL TESTING
TEST REPORT

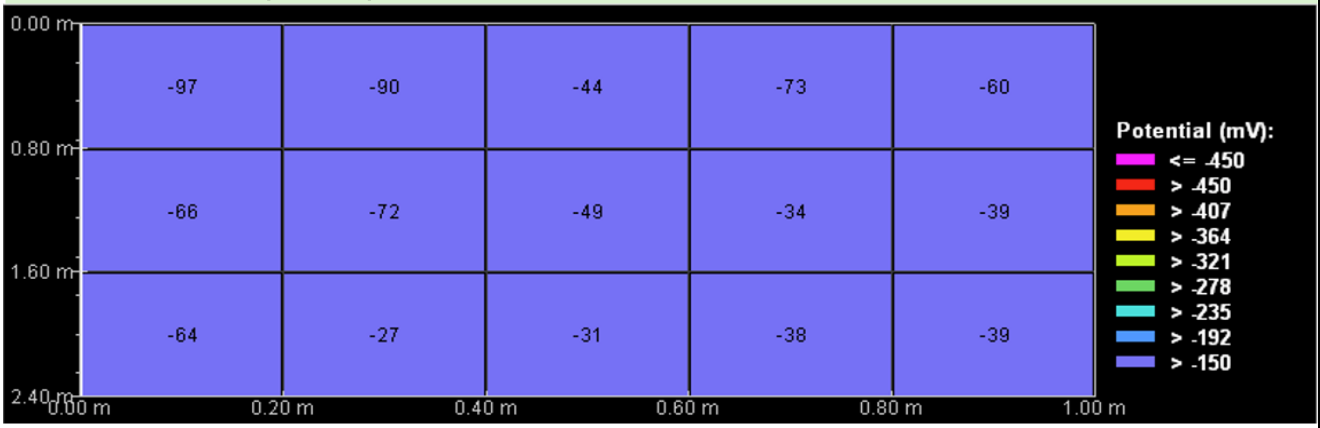
BHP/MTIField/F057 V1 21/05/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072-2
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	12/07/2024
	Galway	**Test Specification**:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Deck

Project: Mayo Bridges - Strade River Bridge
Location Reference: Area 3 Face Deck
Test Standard: ASTM C876

Test No.	2
No. of Readings	15
Median (mV)	-49
Mean (mV)	-54.9
Standard Deviation	21
Lowest (mV)	-97
Highest (mV)	-27
Reinforcement Condition	Low risk of Corrosion

Graphical Representation of Measured Potential Field of Concrete Concrete Deck



REMARKS:
This test was performed using a Copper-Copper Sulphate Electrode.

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 14/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

BHP

CORROSION POTENTIAL ASSESSMENT OF STEEL REINFORCEMENT BY HALF CELL TESTING
TEST REPORT

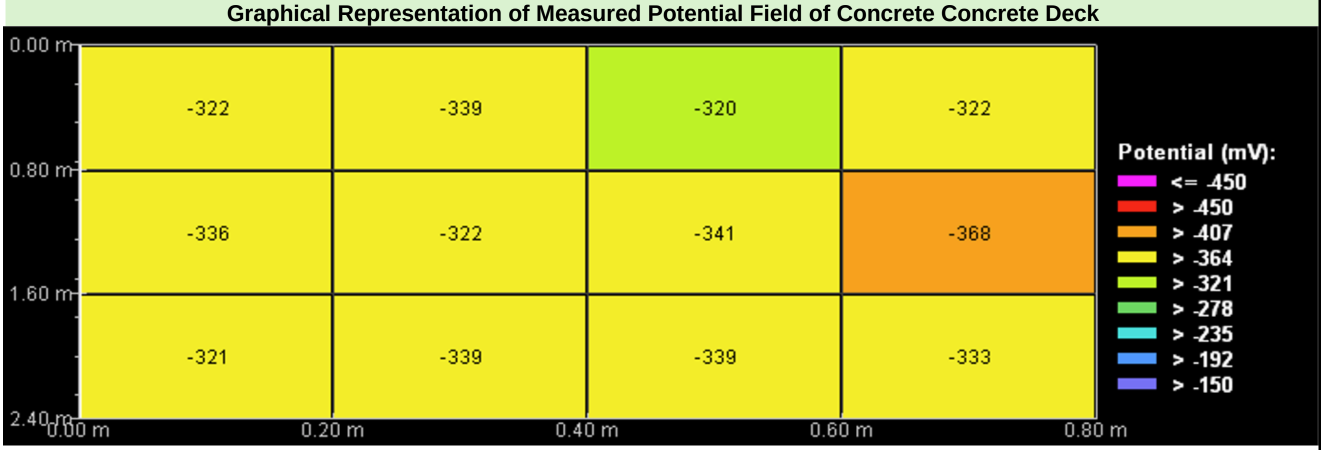
BHP/MTIField/F057 V1 21/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-3
		Order No:	Not Supplied
		Date Tested:	12/07/2024
		Test Specification:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Deck

Project: Mayo Bridges - Strade River Bridge
Location Reference: Area 3.1 Soffit
Test Standard: ASTM C876

Test No.	3
No. of Readings	12
Median (mV)	-335
Mean (mV)	-333.5
Standard Deviation	13.2
Lowest (mV)	-368
Highest (mV)	-320
Reinforcement Condition	Intermediate Risk of Corrosion

Graphical Representation of Measured Potential Field of Concrete Concrete Deck



REMARKS:
This test was performed using a Copper-Copper Sulphate Electrode.

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 14/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CORROSION POTENTIAL ASSESSMENT OF STEEL REINFORCEMENT BY HALF CELL TESTING
TEST REPORT

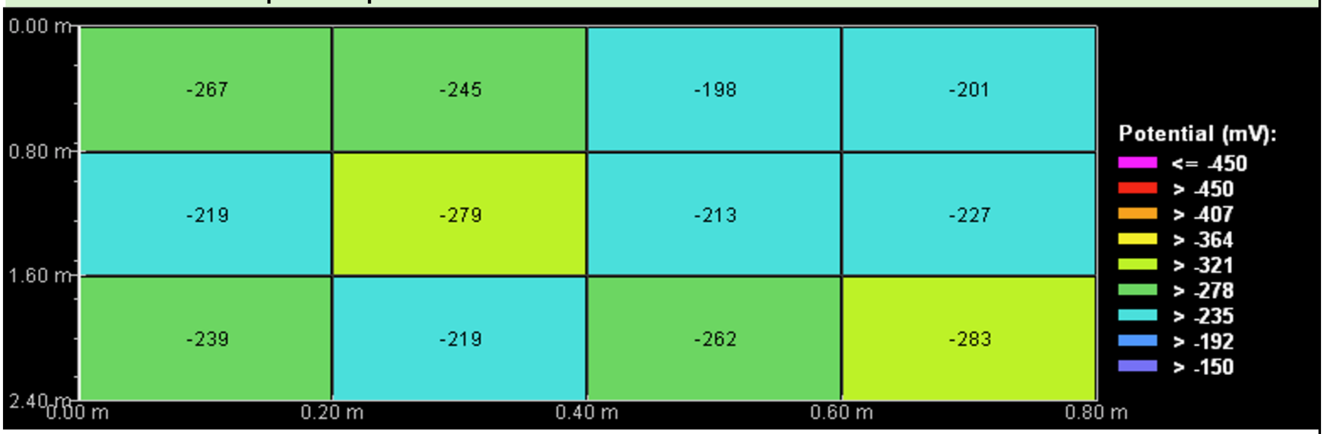
BHP/MTIField/F057 V1 21/05/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072-4
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	12/07/2024
	Galway	**Test Specification**:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Deck

Project: Mayo Bridges - Strade River Bridge
Location Reference: Area 4 Face Deck
Test Standard: ASTM C876

Test No.	4
No. of Readings	12
Median (mV)	-233
Mean (mV)	-237.7
Standard Deviation	28.3
Lowest (mV)	-283
Highest (mV)	-198
Reinforcement Condition	Intermediate Risk of Corrosion

Graphical Representation of Measured Potential Field of Concrete Concrete Deck



REMARKS:
This test was performed using a Copper-Copper Sulphate Electrode.

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 14/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

CORROSION POTENTIAL ASSESSMENT OF STEEL REINFORCEMENT BY HALF CELL TESTING
TEST REPORT

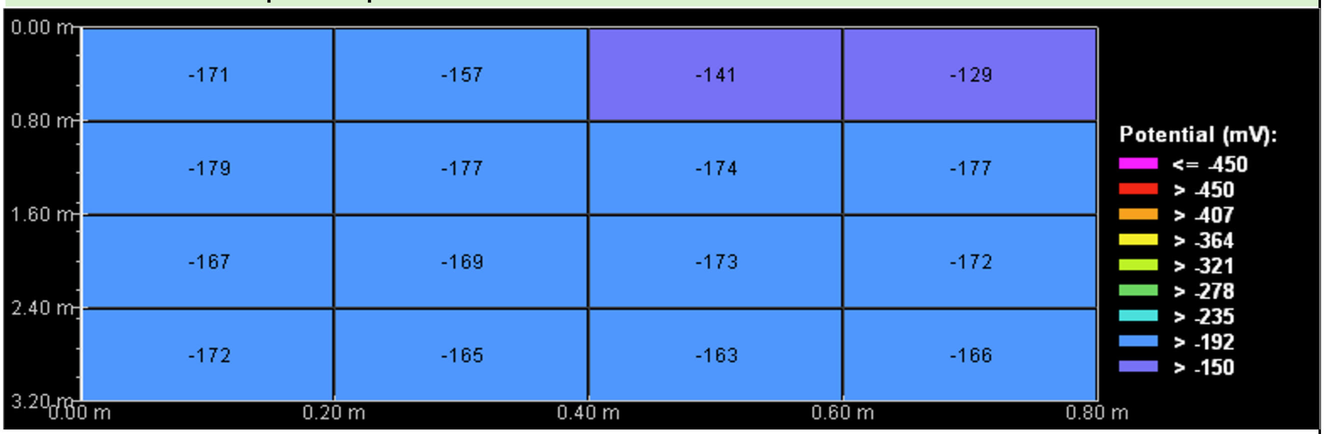
BHP/MTIField/F057 V1 21/05/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072-5
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	12/07/2024
	Galway	**Test Specification**:	Customer Spec.
FAO:	Lurcan Donnellan	**Test Element:**	Concrete Deck

Project:	Mayo Bridges - Strade River Bridge
Location Reference:	Area 4.1 Soffit
Test Standard:	ASTM C876

Test No.	5
No. of Readings	16
Median (mV)	-170
Mean (mV)	-165.8
Standard Deviation	13
Lowest (mV)	-179
Highest (mV)	-129
Reinforcement Condition	Low risk of Corrosion

Graphical Representation of Measured Potential Field of Concrete Concrete Deck



REMARKS:
This test was performed using a Copper-Copper Sulphate Electrode.

Approved By:	**Signature:**
Lukasz Zalewski *Field Service Manager*	

For and On Behalf of BHP Laboratories — Issue Date: 14/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

This test report shall not be duplicated in full without the permission of the test laboratory. Information identifying the 'Client', 'FAO', 'Project', 'Location Reference', 'Item', 'Test Specification' and 'Order No' has been provided by the customer. Results apply only to the sample tested and where the laboratory is not responsible for sampling, result apply to the sample as received. Sampling is outside the scope of accreditation.

DETERMINATION OF RESISTIVITY OF CONCRETE

BHP/MTIField/F048 V1 30/04/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-1
		Order No:	Not Supplied
		Date Tested:	09/07/2024
		Test Specification:	Client Spec.
FAO:	Lurcan Donnellan	**Material**	Concrete Element

Project: Mayo Bridges - Strade River Bridge
Location Reference: Area 1 Top Deck
Test Standard: EN 12390-19 2021

RESULTS				
Structural Element	Deck			
Measurement Mode	Surface			
Contact Spacing	50mm			
Specimen Shape	Flat			
Dimensions of Test Area (mm)	400x400			
Minimum Measurement (kΩcm)	106			
Maximum Measurement (kΩcm)	190			
Mean Value (kΩcm)	153			
Interpreatation of Result	Negligible risk of corrosion			
Resistivity Measurements (kΩcm)				
106	**112**	**172**	**185**	**190**
0	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**

REMARKS:
Resistivity measurements can be used to estimate the likelihood of corrosion. When the electrical resistivity of the concrete is low, the likelihood of corrosion increases. When the electrical resistivity is high, the likelihood of corrosion decreases.
A guide to interpretation of resistivity results is:

When ≥ 100 kΩcm	Negligible risk of corrosion
When 50 to 100 kΩcm	Low risk of corrosion
When 10 to 50 kΩcm	Moderate risk of corrosion
When ≤ 10 kΩcm	High risk of corrosion

Equipment used was a Proceq Resipod

Approved By:	**Signature:**
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories — Issue Date: 28/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

DETERMINATION OF RESISTIVITY OF CONCRETE

BHP/MTIField/F048 V1 30/04/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072-3
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	09/07/2024
	Galway	**Test Specification**:	Client Spec.
FAO:	Lurcan Donnellan	**Material**	Concrete Element

Project: Mayo Bridges - Strade River Bridge
Location Reference: Area 3 Face dek
Test Standard: EN 12390-19 2021

RESULTS	
Structural Element	Soffit
Measurement Mode	Surface
Contact Spacing	50mm
Specimen Shape	Flat
Dimensions of Test Area (mm)	200x200
Minimum Measurement (kΩcm)	55
Maximum Measurement (kΩcm)	72
Mean Value (kΩcm)	65
Interpreatation of Result	Negligible risk of corrosion

Resistivity Measurements (kΩcm)

69	**55**	**72**	**0**	**0**
0	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**

REMARKS:
Resistivity measurements can be used to estimate the likelihood of corrosion. When the electrical resistivity of the concrete is low, the likelihood of corrosion increases. When the electrical resistivity is high, the likelihood of corrosion decreases.
A guide to interpretation of resistivity results is:

When ≥ 100 kΩcm	Negligible risk of corrosion
When 50 to 100 kΩcm	Low risk of corrosion
When 10 to 50 kΩcm	Moderate risk of corrosion
When ≤ 10 kΩcm	High risk of corrosion

Equipment used was a Proceq Resipod

Approved By:	**Signature:**
Lukasz Zalewski Field Service Manager	Lukasz Zalewski

For and On Behalf of BHP Laboratories — Issue Date: 28/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

This test report shall not be duplicated in full without the permission of the test laboratory. Information identifying the 'Client', 'FAO', 'Project', 'Location Reference', 'Item', 'Test Specification' and 'Order No' has been provided by the customer. Results apply only to the sample tested and where the laboratory is not responsible for sampling, result apply to the sample as received. Sampling is outside the scope of accreditation.

DETERMINATION OF RESISTIVITY OF CONCRETE

BHP/MTIField/F048 V1 30/04/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-4
		Order No:	Not Supplied
		Date Tested:	09/07/2024
		Test Specification:	Client Spec.
FAO:	Lurcan Donnellan	**Material**	Concrete Element

Project: Mayo Bridges - Strade River Bridge
Location Reference: Area 3.1 Soffit
Test Standard: EN 12390-19 2021

RESULTS				
Structural Element	Soffit			
Measurement Mode	Surface			
Contact Spacing	50mm			
Specimen Shape	Flat			
Dimensions of Test Area (mm)	400x400			
Minimum Measurement (kΩcm)	256			
Maximum Measurement (kΩcm)	303			
Mean Value (kΩcm)	279			
Interpreatation of Result	Negligible risk of corrosion			
Resistivity Measurements (kΩcm)				
285	**278**	**303**	**256**	**272**
0	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**

REMARKS:
Resistivity measurements can be used to estimate the likelihood of corrosion. When the electrical resistivity of the concrete is low, the likelihood of corrosion increases. When the electrical resistivity is high, the likelihood of corrosion decreases.
A guide to interpretation of resistivity results is:

When ≥ 100 kΩcm	Negligible risk of corrosion
When 50 to 100 kΩcm	Low risk of corrosion
When 10 to 50 kΩcm	Moderate risk of corrosion
When ≤ 10 kΩcm	High risk of corrosion

Equipment used was a Proceq Resipod

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	Lukasz Zalewski

For and On Behalf of BHP Laboratories — Issue Date: 28/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

DETERMINATION OF RESISTIVITY OF CONCRETE

BHP/MTIField/F048 V1 30/04/24

Client:	TRIUR Construction Ltd	**BHP Ref. No.**:	24/07/072-5
	13 Society Street	**Order No**:	Not Supplied
	Ballinasloe	**Date Tested**:	09/07/2024
	Galway	**Test Specification**:	Client Spec.
FAO:	Lurcan Donnellan	**Material**	Concrete Element

Project: Mayo Bridges - Strade River Bridge
Location Reference: Area 4
Test Standard: EN 12390-19 2021

RESULTS	
Structural Element	Face Deck
Measurement Mode	Surface
Contact Spacing	50mm
Specimen Shape	Flat
Dimensions of Test Area (mm)	200x200
Minimum Measurement (kΩcm)	156
Maximum Measurement (kΩcm)	194
Mean Value (kΩcm)	179
Interpreatation of Result	Negligible risk of corrosion

Resistivity Measurements (kΩcm)

186	**156**	**194**	**0**	**0**
0	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**

REMARKS:

Resistivity measurements can be used to estimate the likelihood of corrosion. When the electrical resistivity of the concrete is low, the likelihood of corrosion increases. When the electrical resistivity is high, the likelihood of corrosion decreases.

A guide to interpretation of resistivity results is:

When ≥ 100 kΩcm	Negligible risk of corrosion
When 50 to 100 kΩcm	Low risk of corrosion
When 10 to 50 kΩcm	Moderate risk of corrosion
When ≤ 10 kΩcm	High risk of corrosion

Equipment used was a Proceq Resipod

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories Issue Date: 28/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

DETERMINATION OF RESISTIVITY OF CONCRETE

BHP/MTIField/F048 V1 30/04/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	**BHP Ref. No.**:	24/07/072-6
		Order No:	Not Supplied
		Date Tested:	09/07/2024
		Test Specification:	Client Spec.
FAO:	Lurcan Donnellan	**Material**	Concrete Element

Project: Mayo Bridges - Strade River Bridge
Location Reference: Area 4.1
Test Standard: EN 12390-19 2021

RESULTS	
Structural Element	Face Deck
Measurement Mode	Surface
Contact Spacing	50mm
Specimen Shape	Flat
Dimensions of Test Area (mm)	400x400
Minimum Measurement (kΩcm)	196
Maximum Measurement (kΩcm)	272
Mean Value (kΩcm)	228
Interpreatation of Result	Negligible risk of corrosion

Resistivity Measurements (kΩcm)

196	**206**	**209**	**255**	**272**
0	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**

REMARKS:
Resistivity measurements can be used to estimate the likelihood of corrosion. When the electrical resistivity of the concrete is low, the likelihood of corrosion increases. When the electrical resistivity is high, the likelihood of corrosion decreases.
A guide to interpretation of resistivity results is:

When ≥ 100 kΩcm	Negligible risk of corrosion
When 50 to 100 kΩcm	Low risk of corrosion
When 10 to 50 kΩcm	Moderate risk of corrosion
When ≤ 10 kΩcm	High risk of corrosion

Equipment used was a Proceq Resipod

Approved By:	**Signature:**
Lukasz Zalewski Field Service Manager	Lukasz Zalewski

For and On Behalf of BHP Laboratories — Issue Date: 28/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

Appendix F. Structure Idealisation Model and Model Inputs

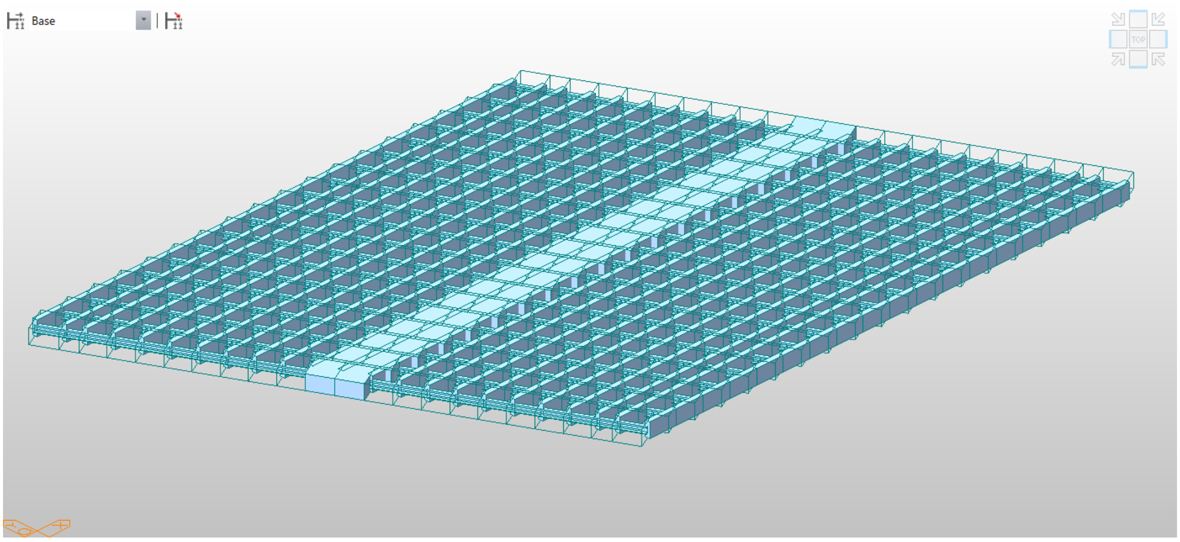


Figure F-1 – 3D Isometric view of the proposed model

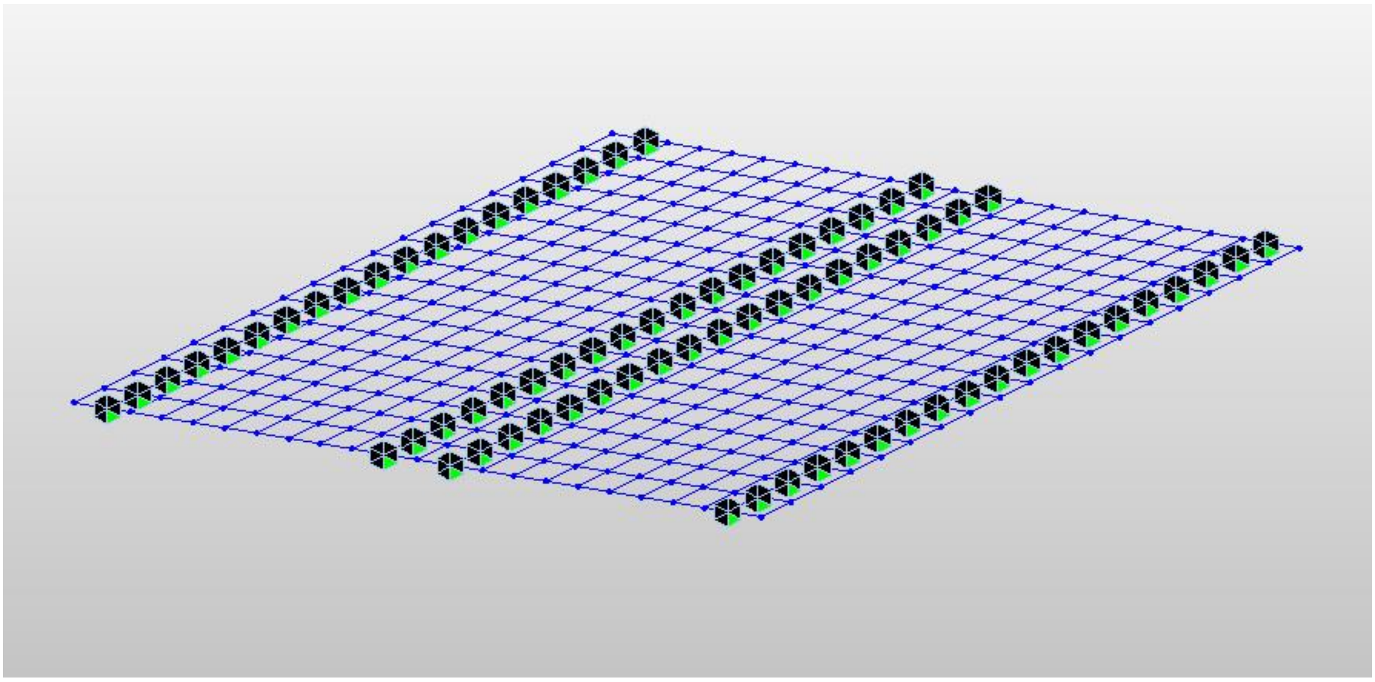


Figure F-2 – Top view of the model with support conditions

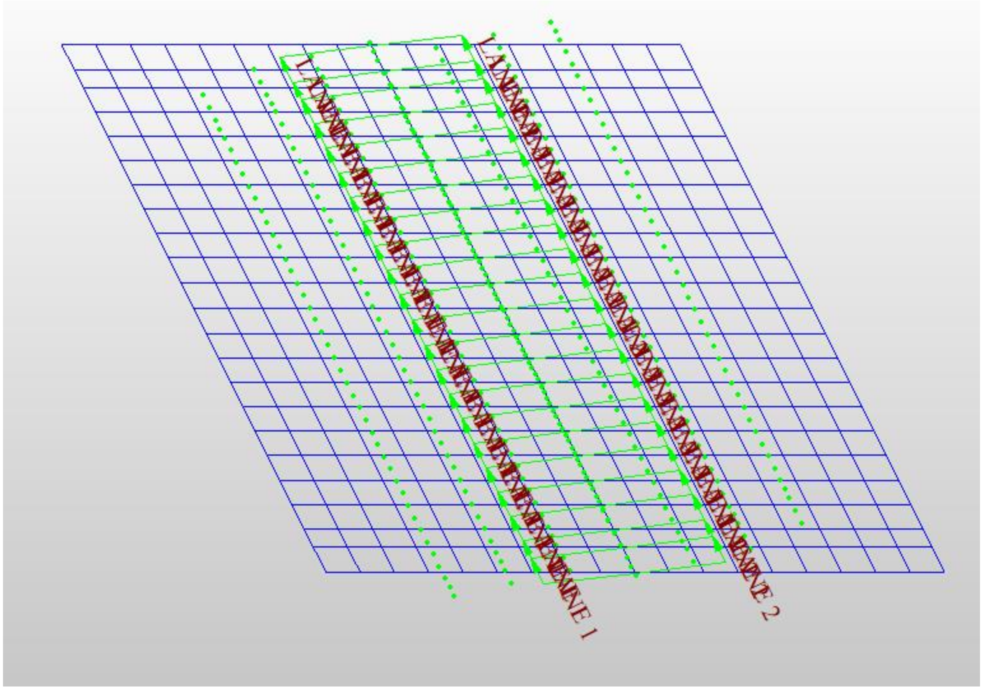


Figure F-3 – Live load Surface lanes

Appendix G. Calculations

AtkinsRéalis	Project	TO315 Mayo Bridges - Assessments		Job ref 10088572	
	Part of Structure	Strade River Bridge MO-N58-001.00		Calc sheet no.	rev 0
	Drawing Ref	Calc By VP	Date 17-Dec-24	Check by MG	Date 17/12/2024

Ref	Calculations	Output

1 Introduction

1.1 Spreadsheet Purpose

Stage 2 Assessment Calculations of Filler Beam Bridge.

1.2 Limitations

There is no clear Data about the Foundation of the structure.

2 Instructions for use

2.1 The Assessment is based on TII Publications AM-STR-06056 Stage 1 Structural Assessment of Road Structures and AM-STR-06057 The Stage 2 Structural Assessment of Sub-Standard Road Structures.Initial assessments of concrete composite decks were carried out using the strip method analysis as per AM-STR-06026 and AM-STR-06037. Assessment live loading comprised 40t HA loading in accordance with TII Publication AM-STR-06026.

3 Updates

3.1 Previous Updates

Revision	Date	Made By	Checked	Description
R0	17-Dec-24	VP	MG	

3.2 Planned/Suggested updates

	Date suggested	Made By	Description

Contents

Ref.	Calculations

1 **General**

AM-STR-06056

Initial assessments of concrete composite decks were carried out using the strip method analysis as per AM-STR-06026 and AM-STR-06037. Assessment live loading comprised 40t HA loading in accordance with TII Publication AM-STR-06026. Abnormal loading considered as part of the assessment comprised SV196 loading in accordance with TII Publication AM-STR-06048 and AM-STR-06030 Loads for Highway Bridges. If the structure fail to attain a 40/44T GVW capacity then a more rigorous assessment in the form of a grillage analysis shall be carried out and a revised capacity and HB rating given.

2 **Introduction**

* **The structure is a Filler beam slab bridge**
* Number of span = 2
* The clear skew span 1 / internal dimension is = 3.79 m
* The clear skew span 2 / internal dimension is = 3.81 m
* The Average thickness of Top slab is = 0.31 m
* Overall width of bridge (Width out to out) = 10.3 m
* Skew angle is = 26 degree
* Average depth of fill (CL804) over slab excluding surfacing = 0.15 m
* Width of the carriageway (Perpendicular to traffic) = 6.89 m
* Depth of concrete surfacing. (Assumed) = 0.100 m

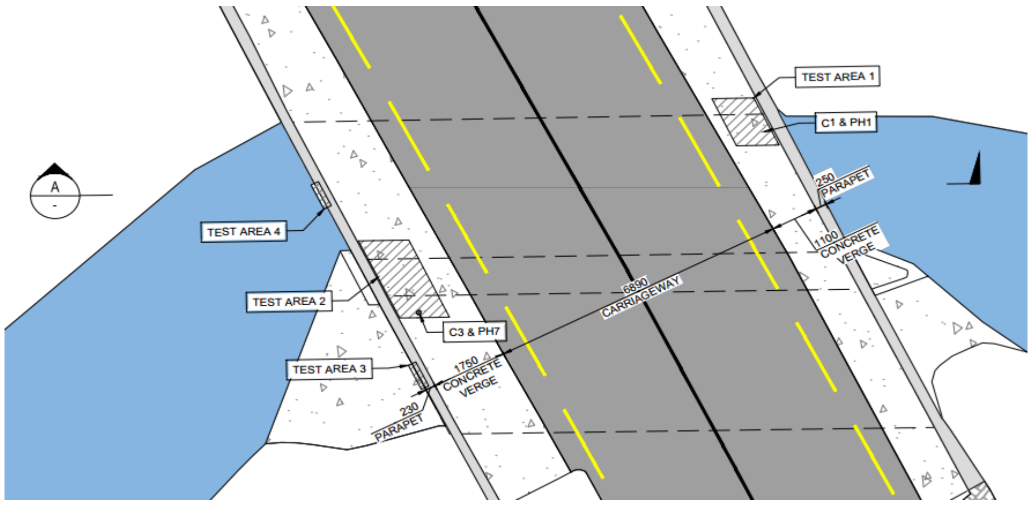
3 **Material parameters**

BD21/14
AM-STR-06026

Element	Reference	f_{ck} or fy (N/mm^2)
Filler Deck Concrete	As per Investigation	18.9
Assumed Steel beam Section	Cl 4.3 -AM-STR-06026	230.0

As per AM-STR-06026 Cl 4.3, in the absence of definite information on the characteristic yield strength of the structural steel section it may be assumed as 230 N/mm^2.

Density of Concrete	25.0	kN/m^3
Density of Road surfacing	24.0	kN/m^3
Density of Stuructural fill (CL804)	20.0	kN/m^3



AM-STR-06030
Table 1

Partial Safety Factors

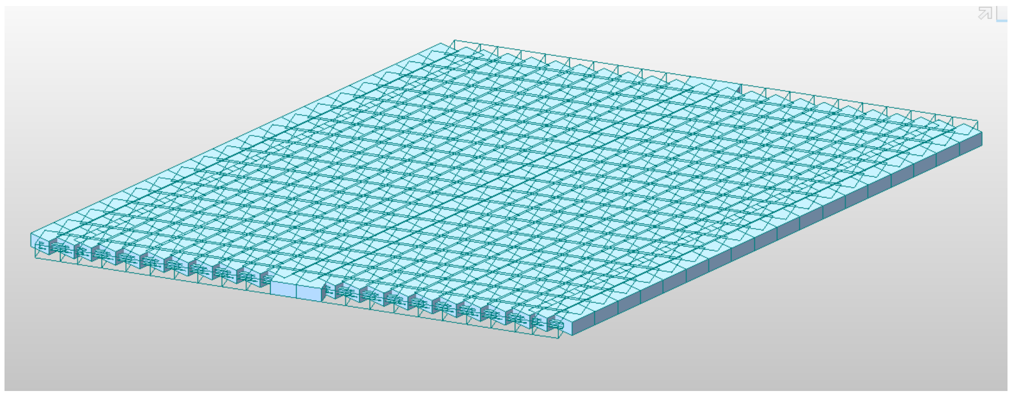
For concrete, the values of γm is taken as 1.2 considering worst credible strengths which is taken from Table 4A (4.3.3.3.) of AM-STR-06031 . For Structural steel the γm is taken as 1.05.
The partial safety factors taken from AM-STR-06030 Table 1 are represented below.

Partial Safety Factors for Assessment

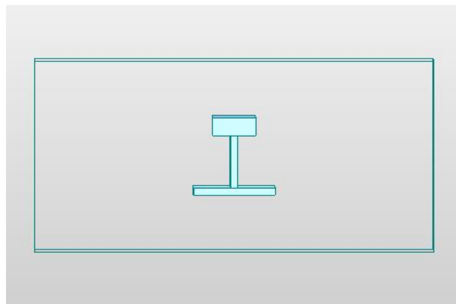
Load	γf3 for ULS	γfL for ULS
Dead Load	1.1	1.15
Super Imposed Dead Load	1.1	1.75
Soil Fill	1.1	1.2
Type HA Loading	1.1	1.5
Type HB	1.1	1.3
SV 196	1.1	1.1

4 **Grillage Analysis - 3D Model of Box**

Since the structure failed in the initial assessment, we created a grillage analysis for accurate bending results.



3D Grillage Model



Composite Section property-Filler Beam

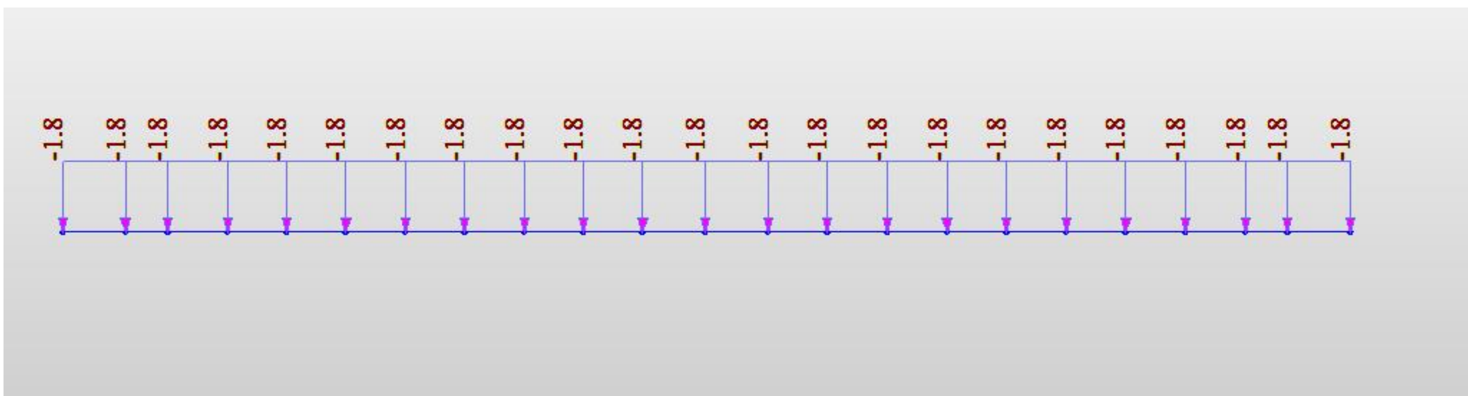
5 **Load Calculation**

Dead Load

Sections are defined in Midas and material property are defined .Self Weight is applied in the Midas.

Soil Fill

Unit Weight of Soil Fill	=	20.0	kN/m3
Depth of infill material	=	0.15 m	
Load per meter square	=	3.00	kN/m2
Average width of the Beam	=	0.60 m	
Load per beam	=	1.8	kN/m2



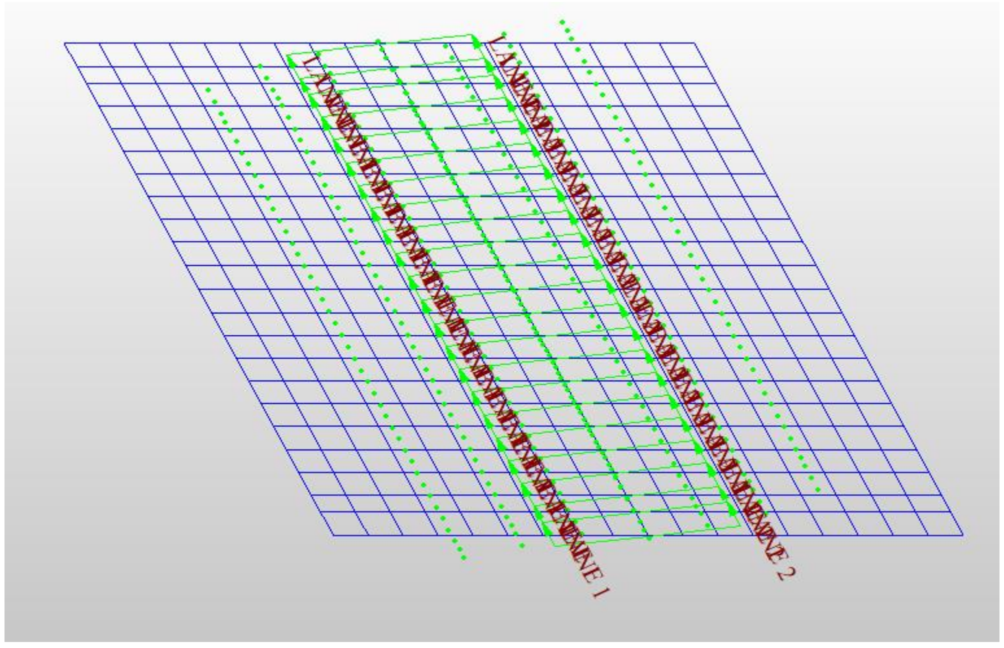
SIDL -Surfacing

Surfacing depth	100 mm thick	=	1.00	x	0.1	x	1	x	24.0
Weight of Surfacing - Load per meter square		=	2.40	kN/m2					
Average width of the Beam		=	0.60 m						
Load per beam		=	1.44	kN/m2					

Live Load

Carriageway width = 6.89 m
Number of Notional Lanes = 2
The loading to be applied for a Stage 2 Structural Assessment shall be in accordance with the requirements of Chapter 5 of AM-STR-06026.Reduction factors for uniformly distributed load (UDL) and knife-edge load (KEL) shall be in accordance with Chapter 5 of AM-STR-06026 unless otherwise agreed with TII.
For a Stage 2 Structural Assessment it is important to establish what component of the loading contributes most to the overall load effect. Therefore, load combinations shall be included for dead load, superimposed dead load and live load in isolation as well as in combination.

The Live Load are Defined in the Midas Civil for the Following Cases.
Additional cases will be added according to the requirements.
i) Type HA 40t
ii) Type HA + HB Combined
iii) Type HB 45 units
iv) SV 196



Line lane Defined in Midas Civil for Live Load

6 Investigation Summary

Filler Beam

MID SPAN

App. C1 /SI Report

	MAIN BEAM
Spacing (mm)	600
Average beam spacing	600
Depth of beam	125 mm
Bottom Cover	37 mm

NEAR SUPPORT

App. C1 /SI Report

	MAIN BEAM
Spacing (mm)	600
Average rebar spacing	600
Depth of beam	125 mm
Bottom Cover	32 mm

AtkinsRéalis	Project	TO315 Mayo Bridges - Assessments			Job ref 10088572	
	Part of Structure Strade River Bridge MO-N58-001.00				Calc sheet no. 1	rev 0
	Drawing Ref Strade River Bridge M	Calc By VP		Date 17-Dec-24	Check by MG	Date 18-Dec-24

Ref	Calculations	Output

CALCULATION OF WORST CREDIBLE STRENGTH

Input a maximum of 11 Core samples

App.C2
SI Report

LOCATION	CORE REFERENCE	ESTIMATED IN-SITU CUBE STRENGTH N/mm^2 (f_c)	(fc - MEAN)^2
	C1	**18.9**	315.95
	C2	**21.1**	242.58
	C3	**49.6**	167.06
	C4	**57.1**	417.18
			-
			-
			-
			-
			-
			-
	TOTAL	146.7	1142.7675
	No of cores	**4**	
	MEAN	**36.68**	
	Standard Deviation	**19.52**	

WCS will be calculated using 2 different methods:

1) LOCATION : Using equation from BA 44/96 with n = total number of core samples

Note - only use this for cores taken at the location of interest

n = 4

From BA 44/90, WCS = (Total fc*(100-(20/n^0.5)))/100n

WCS = **33.0 N/mm^2**

2) LOWEST CORE STRENGTH :

Lowest core strength = 18.9 N/mm2

WCS = **18.9 N/mm^2**

Using the above results and engineering judgement,
the proposed WCS = 18.9 N/mm^2

	Project TO315 Mayo Bridges - Assessments			Job ref 10088572	
AtkinsRéalis	Part of Structure Strade River Bridge MO-N58-001.00			Calc sheet no.	Rev 0
	Drawing ref.	Calc by VP	Date 17/12/24	Check by MG	Date 18/12/24

Ref	Calculations

7 **Filler Beam Capacity**

SAGGING - SECTION PROPERTIES (Using BS 5400 Part 3;2000) for composite section

Slab		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	Panel Length (mm)
	Slab	**600**	**309**		**18.9**	25.1	
Haunch		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	*NA*
	Haunch	**0**	**0**		0	0	*NA*
Girder		Width (mm)	Depth (mm)		f_y (MPa)	E (GPa)	
	Top Flange	**65**	**28**		**230**	205.0	
	Web	**10**	**85**		230	205.0	
	Bottom Flange	**123**	**10**		230	205.0	
	Bottom Cover		**37**	mm			

Section depth mm 123

m *8.17*

e) Plastic Section Properties

Condition factor for RC Filler - **0.8**

nb if NA lies below the web this doesn't work

Stress in concrete = $0.4*f_{cu}$

Stress in steel = σ_y/γ_m γ_m = **1.05**

	Depth (mm)	Width (mm)	Area (mm^2)	Stress (Nmm^{-2})	Force (kN)	Force above NA (kN)	Force below NA (kN)	y above NA (mm)	y below NA (mm)
Slab*	148.75	600	89250	8	675	675	-	81	-
Haunch	0	0	0	0	0	0	-	0	-
Top Flange	28	65	1820	219	399	90	309	3	11
Web	85	10	850	219	186	0	186	-22	64
Bottom Flange	10	123	1230	219	269	-	269	-	112

*Concrete above beam only taken in properties

NA lies in Top Flange

Depth of Neutral Axis From Top Slab

Concrete $M_{plastic}$ = 54 **kNm**

Single Beam $M_{plastic}$ = 37 **kNm**

	Depth (mm)
Slab	0.0
Haunch	0.0
Top Flange	155.1
Web	0.0

m= 0.0

Depth of Plastic NA = 155.1 153.7

f) Compactness Check

Ref						(Compact?)
9.3.7.2	If m < 0.5	Check web depth is less than	$(34t_w/m)*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If m > 0.5	Check web depth is less than	$(374t_w/(13m-1))*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If web fully in tension section is compact					yes

Section is Compact

SAGGING - PLASTIC CHECKS (Using BS 5400 Part 3;2000)

2. ULS Bending Capacity of Section

$M_{plastic}$ = 100 kNm

$M_{pe\ (unfactored)}$ = 105 kNm

$M_D = M_{pe}$ / 1.05 x 1.1 = 73 kNm (Also Adjusted by condition factor)

3/9.9.2.2 **3. ULS Pure Shear Capacity of Section**

Depth of panel = d_{we} = 85 mm

Aspect Ratio = $\varphi = a/d_{we}$ = 1.000

b_{fe} (top flange) = 0 b_{fe} (bottom flan = 0

m_{fw} (top flange) = $\sigma_{yf}b_{fe}t_f^2/(2d_{we}^2t_w\sigma_{yw})$ = 0.1763 m_{fw}(bot) = $\sigma_{yf}b_{fe}t_f^2/(2d_{we}^2t_w\sigma_{yw})$ 0.0426

Minimum value of m_{fw} for use in shear calcs. = 0.0426 $\lambda = (d_{we}/t_w)x(\sigma_{yw}/355)^{1/2}$ = 6.8

$\tau_y = \sigma_{yw}/\sqrt{3}$ = 132.79

3/Fig12-18 τ_l/τ_y for m_{fw} of 0.0426 = 1.295 τ_l = 171.95

τ_l/τ_y for m_{fw} of 0.000 = 1.295 τ_l = 171.95

3/9.9.2.2 $V_D = (d_w t_w x \tau_l) / (\gamma_m \gamma_{f3})$ = 101.2 kN When m_{fw} = 0.1763 (Adjusted by condition factor)

V_R = "" = 101.2 kN When m_{fw} = 0.0000 (Adjusted by condition factor)

Ref | Calculations

SAGGING - SECTION PROPERTIES (Using BS 5400 Part 3;2000) for Steel Section (IGNORING CONCRETE)

		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	Panel Length (mm)
Slab	Slab	600	123		18.9	25.103	
Haunch		Width (mm)	Depth (mm)		fcu (MPa)	E(short Term)	NA
	Haunch	0	0		0	0	NA
Girder		Width (mm)	Depth (mm)		f_y (MPa)	E (GPa)	
	Top Flange	65	28		230	205	
	Web	10	85		230	205	
	Bottom Flange	123	10		230	205	
	Bottom Cover		37	mm			

Section depth mm: 123

e) Plastic Section Properties

Condition factor for RC Filler | - | 0.8

nb if NA lies below the web this doesn't work

Stress in concrete = $0.4 f_{cu}$

Stress in steel = σ_y/γ_m γ_m = 1.05

	Depth (mm)	Width (mm)	Area (mm^2)	Stress (Nmm^{-2})	Force (kN)	Force above NA (kN)	Force below NA (kN)	y above NA (mm)	y below NA (mm)
Slab*	-37	600	-22200	8	-168	-168	-	61	-
Haunch	0	0	0	0	0	0	-	0	-
Top Flange	28	65	1820	219	399	399	0	65	-51
Web	85	10	850	219	186	112	74	26	17
Bottom Flange	10	123	1230	219	269	-	269	-	39

*Concrete above beam only taken in properties

NA lies in Web

Depth of Neutral Axis From Top Slab

	Depth (mm)
Slab	0.0
Haunch	0.0
Top Flange	0.0
Web	42.3

Concrete $M_{plastic}$ = -10 **kNm**
Single Beam $M_{plastic}$ = 32 **kNm**

m= 0.6

Depth of Plastic NA = 42.3

f) Compactness Check

Ref						(Compact?)
9.3.7.2	If m < 0.5	Check web depth is less than	$(34t_w/m)*(355/\sigma_{yw})$^0.5	n/a	mm	n/a
	If m > 0.5	Check web depth is less than	$(374t_w/(13m-1))*(355/\sigma_{yw})$^0.5	678.5790964	mm	yes
	If web fully in tension section is compact					n/a

Section is Compact

SAGGING - PLASTIC CHECKS (Using BS 5400 Part 3;2000)

2. ULS Bending Capacity of Section

$M_{plastic}$ = 30 kNm

$M_{pe\ (unfactored)}$ = 32 kNm

$M_D = M_{pe}$ / 1.05 x 1.1 = 22 kNm (Also Adjusted by condition factor)

	Project	TO315 Mayo Bridges - Assessments	Job ref 10088572
AtkinsRéalis	Part of Structure: Strade River Bridge MO-N58-001.00	Assessment using AM-STR-06026 Filler Beam	Calc sheet no. 5, rev 0
	Drawing Ref	Calc By: VP; Date: 17-Dec-24	Check by: MG; Date: 18-Dec-24

Ref	Calculations	Output

BD21/01
AM-STR-06026

Slab Details :

Filler Beam

Cl 5.3.1.1 of BD44/95 AM-STR-06031

Depth of slab	(mm)	309
Clear Span	(m)	3.81
Effective Span	(m)	4.08
Slab width	(mm)	600
Total Depth of fill above Filler Slab	(mm)	250
Depth of surfacing	(mm)	100
Condition factor for RC Slab	-	0.80

(Significant section loss and Corrosion)

SI Report

Material Details :

Page 1
Cl. 4.4 of BD21
Table 4A of BD44/95
AM-STR-06031

Main Tension Steel	**Beam Depth**	(mm)	123
	Spacing	(mm)	600
	As	(mm2)	4720
Concrete cover to tension steel		(mm)	37
Secondary reinforcement dia		(mm)	0
Is tension steel the outer layer of rebar?		Y/N	Y
effective depth	d	(mm)	272
Concrete Density		kN/m3	25.0
Surfacing Density		kN/m3	24.0
Fill Density		kN/m3	20.0
Concrete WCS Strength	WCS, fcu		19
Steel Characteristic Strength	fy	(N/mm2)	230
Material Factor for Concrete	Ymc		1.20
Material Factor for Steel	Yms		1.05

Calculation of Moment Capacity of Section at Mid Span :

=>	xu	(mm)	155.1
M. Capacity	**M_C**	**(kNm/m)**	73

Filler Beam
Moment Capacity
72.8 kNm

Calculation of Shear Capacity of Section near supports :

Shear checked at 2 locations (i) a_v = d from face of support (with shear enhancement if applicable)
(ii) a_v = 2d from face of support (without shear enhancement)

Table 4A of BD44/95
AM-STR-06031

$100A_s/b_wd$	-	-	2.9
Depth Factor	ξ_s	-	1.19
Material FOS for Concrete in Shear	Ymc		1.15
Ultimate shear stress	vc	(N/mm2)	0.784
Shear link diameter	dia.	mm	0
No. Legs	-		0
Shear link spacing	sv	mm	0
Asv	Asv	mm2	0.0
S. capacity section	-	kN/m	101
S. capacity links	-	kN/m	0
S.Capacity at av = 2d	**V_{C1}**	**kN/m**	101
Shear enhancement allowed?	Y/N	**-**	Y
S.Capacity at av = d	**V_{C2}**	**kN/m**	101

Slab
Shear Capacity
At 2d 101.2 kN/m
At d 101.2 kN/m

Assumed shear carried by steel sections only

AtkinsRéalis	**Project**	TO315 Mayo Bridges - Assessments		**Job ref** 10088572
	Part of Structure Strade River Bridge MO-N58-001.00	Assessment using AM-STR-06026 RC Slabs		**Calc sheet no.** 6 **rev** 0
	Drawing Ref	**Calc By** VP	**Date** 17-Dec-24	**Check by** MG **Date** 18-Dec-24

Ref	Calculations	Output

Filler Beam

Calculation of Moment due to Permanent Loads at Mid Span &

AM-STR-06026

Calculation of Shear due to Permanent Loads near supports:

					SLS Shear (kN)
Table 3.1/ BD21	**Self weight**	Load	(kN/m2)	4.9	
Cl.3. 1/ BD21 &		Yfl		1.15	
		Yf3		1.1	
Cl. 4.2.3/ BD 44		M_{sw}	(kNm/m)	**12.9**	
AM-STR-06031		Vsw	(kN/m)	**12.6**	10.0
Table 3.1/ BD21	**Surfacing**	Load	(kN/m2)	1.4	
Cl.3. 1/ BD21 &		Yfl		1.75	
		Yf3		1.1	
Cl. 4.2.3/ BD 44		M_s	(kNm/m)	**5.8**	
AM-STR-06031		Vs	(kN/m)	**5.7**	2.9
Table 3.1/ BD21	**Fill**	Load	(kN/m2)	1.8	
Cl.3. 1/ BD21 &		Yfl		1.20	
		Yf3		1.1	
Cl. 4.2.3/ BD 44		M_{fill}	(kNm/m)	**4.9**	
AM-STR-06031		V_{fill1}	(kN/m)	**5**	3.7
	Hence, Capacity Available for LL, M_{CLL}		(kNm/m)	**49**	16.6 kN
	Distance (x) from support to face of support		(mm)	136	
	Shear at support	V_{LLsup}	(kN/m)	23	
	Shear at av_1 = 2d	$V_{LLav1 = 2d}$	(kN/m)	15	
	Shear at av_2 = d	$V_{LLav2 = d}$	(kN/m)	18	
	Hence, Capacity Available for LL, $V_{CLL= 2d}$		(kNm/m)	**86**	
	Hence, Capacity Available for LL, $V_{CLL= d}$		(kNm/m)	**83**	

Available Capacity for LL

Moment
49.2 kNm

Shear
At 2d **85.8 kN/m**
At d **82.7 kN/m**

Traffic Flows & Surface Condition

	Annual Average Daily Traffic (Ref P I Report)		**5364**
	Percentage of heavy vehicles		**5%**
Cl. 5.21/ BD 21	Annual average hourly HGV flow (AAHHGVF)		11
AM-STR-06026	Traffic Flow Cl.5.2.2 of BD 21	L/M/H	Medium
	Condition of road surfacing (Good/ Poor)		**Good**
	Therefore Bridge Category		**Mg**
Figure 5.6	Factor **K** for 40 tonne loading		**0.76**

Bridge Category
Mg

HA + KEL and Equiv. 40 t Assessment Loading

					SLS shear
AM-STR-06026					
Cl. 5.18/ BD21	HA Loading	UDL	(kN/m)	130.9	
		KEL	(kN)	120.0	
	Lane Factor			1.0	
Cl 5.23/ BD 21	Adjustment Factor	AF		1.46	
AM-STR-06026	Therefore, Equivalent 40 t loading	UDL	(kN/m2)	**27.26**	
		KEL	(kN/m)	**24.99**	
		Yfl		1.50	
		Yf3		1.1	
	Moment Due 40 tonne loading	M_{LL}	(kNm)	**81**	
	Shear due to 40t at support	V_{LLsup}	(kN/m)	**80**	48 kN
	Shear due to 40t av = 2d	$V_{av = 2d}$	(kN/m)	**58**	
	Shear due to 40t av = d	$V_{LLav = d}$	(kN/m)	**67**	

Cl 5.27/ BD 21			
AM-STR-06026	Factor C for Moment at midspan	**0.46**	
	Loading Capacity Moment at midspan	**7.5t**	as per Figure 5.6
	Factor C for Shear at 3*d	**0.82**	
	Factor C for Shear at d	**1.08**	
	Loading Capacity Shear	**7.5t**	as per Figure 5.6

(HA + KEL Eqv.)
Moment Capacity
7.5t

Shear Capacity
7.5t

Check bond stress at support where shear is maximum

			Bond Stress (N/mm2)	Permissble Stress (N/mm2)
SLS Shear at support Dead Load	kN	16.58	1.59	0.7
SLS Shear at support Live Load	kN	48.38		

Ref	Calculations			Output
	Is bond stress okay? Y/N	N		**Bond Capacity**
	Load Capacity where bond stress exceeded	**7.5t**	Assuming no contribution from Concrete	**7.5t**
	Adequacy Factor for Bond Stress	101%		
	Adequacy Factor for Moment at Midspan	60%		**40 t Adequacy**
	Adequacy Factor for Shear	108%		**60%**

Table 5.3.1 of BD21 AM-STR-06026

Single Axle Load

Filler Beam

			Moment Check	Shear Check	Adequacy for 40t
Assessment Loading		(Tonne)	**3.0**	**7.5**	**40.0**
Nominal Single Axle Load		(kN)	43	86	170
Wheel Contact Area		(m)	0.140	0.198	0.278
Minimum Distance Possible from edge of slab to centre line of first wheel in width direction	on left side	(m)	**1.50**	**1.50**	**1.50**
	on right side	(m)	**3.00**	**3.00**	**3.00**
Dispersion for one axle, in transvesre direction		beff	1.40	1.52	1.68
Dispersion for two axle, in transverse direction		b'eff	2.80	2.97	3.21
Dispersion in longitudinal direction		b_L	0.70	0.76	0.84
=> Load for one axle (P)		kN	43.0	86.0	170.0
Load for two axle (P')		kN	86	172	340
$w = P/b_{eff}\ b_L$ assuming load dispersed long. & transversely		kN/m^2	43.9	74.9	121.0
$w' = P'/b'_{eff}\ b_L$ assuming load dispersed long. & transversely		kN/m^2	43.9	76.3	126.2
	Yfl		1.50	1.50	1.50
	Yf3		1.1	1.1	1.1
Moment due to one axle	M_{LL}	(kNm)	**47**	**-**	**153**
Moment due to two axles	M_{LL}	(kNm)	**47**	**-**	**160**
Adequacy Factor			104%	-	31%
=>Loading Capacity (Moment)			**3t**	-	-
Shear Due due to one axle at support				**84.9**	**150.2**
Shear Due due to two axles at support				**86.6**	**156.6**
Shear due to one axle at av = d	$V_{LLav = d}$	(kN/m)	-	**79**	**139**
Shear due to two axle at av = d	$V_{LLav = d}$	(kN/m)	-	**80**	**145**
Adequacy Factor			-	103%	57%
=>Loading Capacity (Shear) (av = d)			-	**7.5t**	**-**
Shear due to one axle at av = 2d	$V_{av = 2d}$	(kN/m)	-	**72**	**128**
Shear due to two axles av = 2d	$V_{av = 2d}$	(kN/m)	-	**74**	**133**
Adequacy Factor				116%	64%
=>Loading Capacity (Shear)(av = 2d)			-	**7.5t**	**-**

Single Axle Load
Moment Capacity
3t

Shear Capacity
7.5t

40 t Adequacy
31%

Table 5.3.1 of BD21 AM-STR-06026

Single Wheel Load

			Moment Check	Shear Check	Adequacy for 40t
Assessment Loading		(Tonne)	**3.0**	**7.5**	**40.0**
Nominal Single Wheel Load		(kN)	21	43	86
Wheel Contact Area		(m)	0.138	0.198	0.280
Minimum Distance Possible from edge of slab to centre line of first wheel	on left side	(m)	**1.50**	**1.50**	**1.50**
	on right side	(m)	**3.00**	**3.00**	**3.00**
Dispersion for Wheel Load		beff	0.70	0.76	0.84
$w = P/b_{eff}^2$ assuming load dispersed long. & transversely		kN/m^2	**43.1**	**74.9**	**122.0**
	Yfl		1.50	1.50	1.50
	Yf3		1.1	1.1	1.1
Moment Due Single Wheel Load	M_{LL}	(kNm)	**46.3**	**-**	**154.7**
Adequacy Factor			106%	**-**	32%
=>Loading Capacity (Moment)			**3t**	**-**	**-**
Shear Due Single Wheel Load	V_{LL}	(kN)	-	**84.9**	**151.6**
Shear due to 40t av = d	$V_{LLav = d}$	(kN)	-	**78.7**	**140.4**
Adequacy Factor				105%	59%
=>Loading Capacity (Shear) (av = d)				**7.5t**	**-**
Shear due to 40t av = 2d	$V_{av = 2d}$	(kN)	-	**72.5**	**129.1**
Adequacy Factor				118%	66%
=>Loading Capacity (Shear)(av = 2d)				**7.5t**	**-**

Single Wheel Load
Moment Capacity
3t

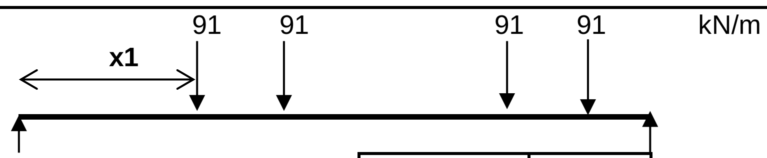
Shear Capacity
7.5t

40 t Adequacy
32%

AtkinsRéalis	Project	TO315 Mayo Bridges - Assessments		Job ref 10088572	
	Part of Structure Strade River Bridge MO-N58-001.00	Assessment using AM-STR-06026 RC Slabs		**Calc sheet no.** 8	**rev** 0
	Drawing Ref Strade River Bridge MO-N58-001.00	**Calc By** VP	**Date** 17-Dec-24	**Check by** MG	**Date** 18-Dec-24

Ref	Calculations	Output

HB Load



Ref				Moment	Shear
Table 5.3.1 of BD21 AM-STR-06026	Assessment Loading		HB	30.0	30.0
	Nominal Single Axle Load		(kN)	300	300
	Wheel Contact Area		(m)	0.261	0.261
	Minimum Distance Possible from edge of slab to centre line of first wheel	on left side	(m)	1.50	1.50
		on right side	(m)	3.00	3.00
	Dispersion for HB Axle		beff	0.82	0.82
	=> Load for HB axle		kN	75.0	75.0
			kN/m	**91.3**	**91.3**
		Yfl		1.50	Moment Factor as per Influence Line
		Yf3		1.1	
	Moment Capacity Check				↓
	Position of first axle from left support centre line		**x1**	1.14	0.6
	Hence, distance of other axle from left support		x2	2.9	0.6
			x3	0.0	0.0
			x4	0.0	0.0
	Moment Due to HB Load	M_{LL}	(kNm)	**103**	
	Adequacy Factor			48%	
	=>Loading Capacity (Moment)			**<30HB**	

				for shear at d	for shear at 2d	Shear Factor at d	Shear Factor at 2d
	Shear Capacity Check						
	Position of first axle from left support centre line		**x1**	0.41	0.68	0.90	0.8
	Hence, distance of other axle from left support		x2	2.2	2.5	0.27	0.2
			x3	0.000	0.0	0.00	0.0
	Shear Due HB Loading		x4	0.000	0.0	0.00	0.0
	Shear at av = d	$V_{LLav = d}$	(kN/m)	**106**			**HB Load**
	Adequacy Factor			78%			
	=>Loading Capacity (Shear) (av = d)			**<30HB**			**Moment Capacity** **<30HB**
	Shear at av = 2d	$V_{av = 2d}$	(kN/m)	**106**			
	Adequacy Factor			81%			**Shear Capacity**
	=>Loading Capacity (Shear)(av = 2d)			**<30HB**			**<30HB**

Ref Page 4&5

Check Bond Stress

				Output
Moment Capacity for non composite section	=	<30HB	Assuming no contribution from Concrete	**Bond Capacity** **<30HB**
Adequacy Factor for 45HB		24%		

AtkinsRéalis	Project	TO315 Mayo Bridges - Assessments			Job ref 10088572
	Part of Structure Strade River Bridge MO-N58-001.00	Assessment using AM-STR-06026 RC Slabs			Calc sheet no. 1 / rev 0
	Drawing Ref	Calc By VP		Date 17-Dec-24	Check by MG / Date 18-Dec-24

Ref	Calculations	Output

SV Load

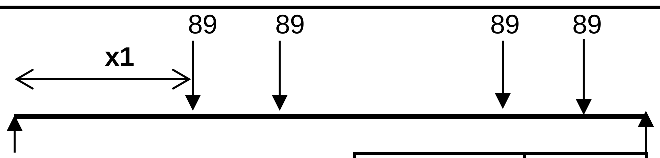


Table 5.3.1 of BD21 AM-STR-06026

			Moment	Shear		
Assessment Loading		SV	80.0	80.0		
Nominal Single Axle Load		(kN)	130	130		
Wheel Contact Area		(m)	0.172	0.172		
Minimum Distance Possible from edge of slab to centre line of first wheel	on left side	(m)	1.14	1.14		
	on right side	(m)	2.94	2.94		
Dispersion for HB Axle		beff	0.73	0.73		
=> Load for HB axle		kN	65.0	65.0		
		kN/m	**88.8**	**88.8**		
	Yfl		1.50	Moment Factor as per Influence Line		
	Yf3		1.1			
Moment Capacity Check						
Position of first axle from left support centre line		**x1**	1.14	0.6		
Hence, distance of other axle from left support		x2	2.9	0.6		
		x3	0.0	0.0		
		x4	0.0	0.0		
Moment Due to HB Load	M_{LL}	(kNm)	**132**			
Adequacy Factor			37%			
=>Loading Capacity (Moment)			**<SV80**			
Shear Capacity Check			for shear at d	for shear at 2d	Shear Factor at d	Shear Factor at 2d
Position of first axle from left support centre line		**x1**	0.41	0.68	0.90	0.8
Hence, distance of other axle from left support		x2	2.2	2.5	0.27	0.2
		x3	0.000	0.0	0.00	0.0
Shear Due HB Loading		x4	0.000	0.0	0.00	0.0
Shear at av = d	$V_{LLav = d}$	(kN/m)	**106**			
Adequacy Factor			78%			
=>Loading Capacity (Shear) (av = d)			**<SV80**			
Shear at av = 2d	$V_{av = 2d}$	(kN/m)	**106**			
Adequacy Factor			81%			
=>Loading Capacity (Shear)(av = 2d)			**<SV80**			

SV Load

Moment Capacity
<SV80

Shear Capacity
<SV80

Assessment Summary

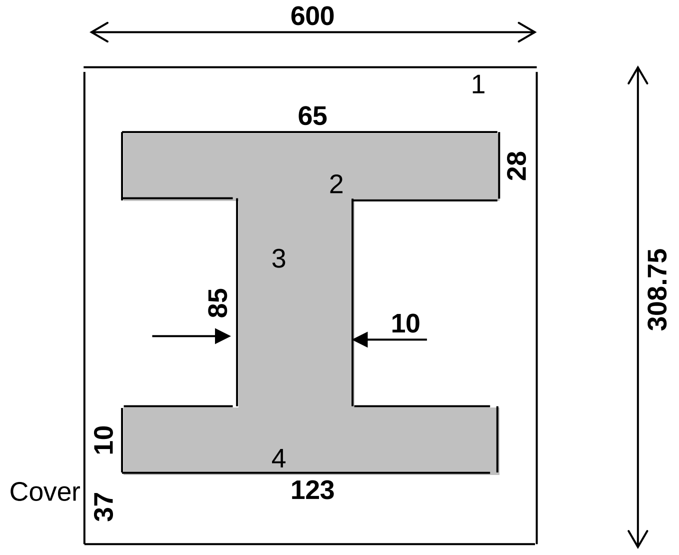
Filler Beam

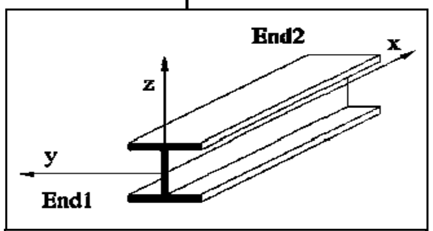
	HA UDL & KEL	Single Axle	Single Wheel	HB	SV
Moment	**7.5t**	**3t**	**3t**	**<30HB**	**<SV80**
Shear	**7.5t**	**7.5t**	**7.5t**	**<30HB**	**<SV80**

Since the Filler beam slab failed under 40T GVW, we have carried out a grillage analysis taking into account the transverse distribution.

Ref	Calculations	Output

8 **Composite Section Properties**





Axes used in Calculations to coincide with Superstress Axes

Idealised Section Short Term

fcu = 18.9

$E_c = (20 + 0.27f_{cu}) =$ 25

Es = 205 **m** = Es / Ec = **8.17**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	308.75	1	1.00	185250	154.375	28597968.8	4414811426	1471603809	Concrete
Top Flange	2	65	28	1	8.17	14862.77	146	2169963.75	316814707.4	118906.667	Steel
Web	3	10	85	1	8.17	6941.401	89.5	621255.428	55602360.77	511770.833	Steel
Bot Flange	4	123	10	1	8.17	10044.62	42	421873.88	17718702.94	10250	Steel
						Σ A	Σ y	Σ Ay	ΣAy^2	ΣI_{self}	
	Sum					217098.8	431.875	31811061.8	4804947197	1472244736	

$Y_{CG} = \frac{\Sigma Ay}{\Sigma A}$ for bottom $= \frac{31811061.81}{217098.783} =$ 146.53 mm

$I_{CG} = Iyy - (\Sigma A \times y_{CG}^2)$

$Iyy = (\Sigma I_{self} + \Sigma Ay^2)$

$I_{CG} = (\Sigma I_{self} + \Sigma Ay^2) - (\Sigma A \times y_{CG}^2)$

$= (1.5E+09 + 4.805E+09) - (217098.78)\times(146.5281^2)$

$=$ 1.616E+09 mm4

Idealised Section Long Term

Es = 205 **m** = Es / Ec = **16.33**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	308.75	1	1.00	185250	154.375	28597968.8	4414811426	1471603809	Concrete
Top Flange	2	65	28	1	16.33	29725.53	146	4339927.5	633629414.8	118906.667	Steel
Web	3	10	85	1	16.33	13882.8	89.5	1242510.86	111204721.5	511770.833	Steel
Bot Flange	4	123	10	1	16.33	20089.23	42	843747.759	35437405.89	10250	Steel
						Σ A	Σ y	Σ Ay	ΣAy^2	ΣI_{self}	
	Sum					248947.6	431.875	35024154.9	5195082968	1472244736	

$Y_{CG} = \frac{\Sigma Ay}{\Sigma A}$ for bottom $= \frac{35024154.86}{248947.566} =$ 140.69 mm

$I_{CG} = Iyy - (\Sigma A \times y_{CG}^2)$

$Iyy = (\Sigma I_{self} + \Sigma Ay^2)$

$I_{CG} = (\Sigma I_{self} + \Sigma Ay^2) - (\Sigma A \times y_{CG}^2)$

$= (1.5E+09 + 5.195E+09) - (248947.57)\times(140.6889^2)$

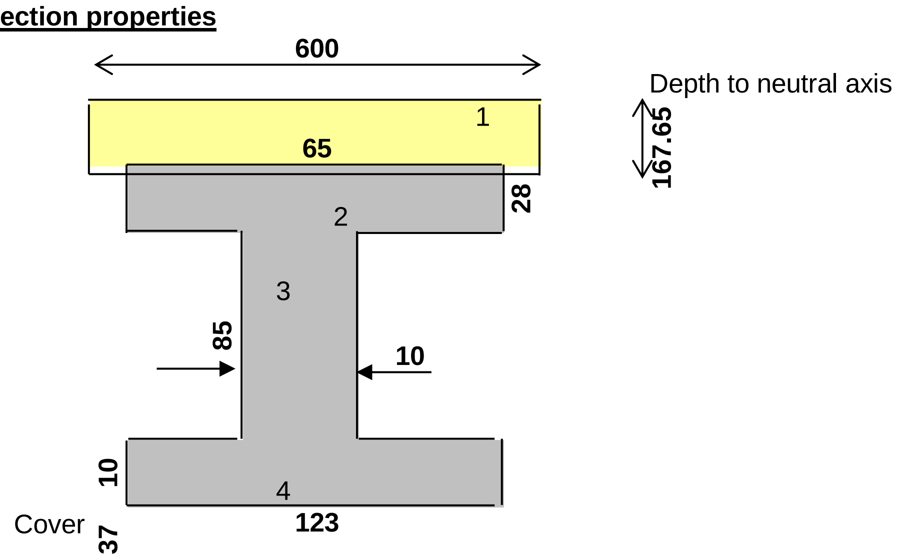
$=$ 1.74E+09 mm4

AtkinsRéalis	**Project** TO315 Mayo Bridges - Assessments	Job ref **10088572**
	Part of Structure Section Properties Strade River Bridge MO-N58-001.00	Calc sheet no. 1 rev 0
	Drawing Ref 0 / Calc By **VP** / Date **17/12/24**	Check by **MG** / Date **17/12/24**

Ref	Calculations	Output

Section Properties

Cracked Section properties



Idealised Section Short Term

fcu = 18.9

$E_c = (20 + 0.27 f_{cu})$ = 25

Es = 205 **m** = Es / Ec = **8.17**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	167.65	1	1.00	100589.9	224.92504	22625198.5	5088973743	235602565	Concrete
Top Flange	2	65	28	1	8.17	14862.77	146	2169963.75	316814707.4	118906.667	Steel
Web	3	10	85	1	8.17	6941.401	89.5	621255.428	55602360.77	511770.833	Steel
Bot Flange	4	123	10	1	8.17	10044.62	42	421873.88	17718702.94	10250	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					132438.7	502.42504	25838291.6	5479109514	236243492	

$Y_{CG} = \frac{\Sigma Ay}{\Sigma A}$ for bottom $= \frac{25838291.57}{132438.7317}$ = 195.10 mm

$I_{CG} = Iyy - (\Sigma A \times y_{CG}^2)$

$Iyy = (\Sigma I_{self} + \Sigma Ay^2)$

$I_{CG} = (\Sigma I_{self} + \Sigma Ay^2) - (\Sigma A \times y_{CG}^2)$

$= (2.4E+08 + 5.479E+09) - (132438.73) \times (195.0962^2)$

= 6.74E+08 mm4

Idealised Section Long Term

Es = 205 **m** = Es / Ec = **16.33**

	Sr No.	b	h	No.	E_S/E_C	Area b x h	CG y-y (y)	Ay	Ay^2	I_{self}	
	1	600	167.65	1	1.00	100589.9	224.92504	22625198.5	5088973743	235602565	Concrete
Top Flange	2	65	28	1	16.33	29725.53	146	4339927.5	633629414.8	118906.667	Steel
Web	3	10	85	1	16.33	13882.8	89.5	1242510.86	111204721.5	511770.833	Steel
Bot Flange	4	123	10	1	16.33	20089.23	42	843747.759	35437405.89	10250	Steel
						Σ A	Σ y	Σ Ay	Σ Ay^2	Σ I_{self}	
	Sum					164287.5	502.42504	29051384.6	5869245285	236243492	

$Y_{CG} = \frac{\Sigma Ay}{\Sigma A}$ for bottom $= \frac{29051384.63}{164287.5148}$ = 176.83 mm

$I_{CG} = Iyy - (\Sigma A \times y_{CG}^2)$

$Iyy = (\Sigma I_{self} + \Sigma Ay^2)$

$I_{CG} = (\Sigma I_{self} + \Sigma Ay^2) - (\Sigma A \times y_{CG}^2)$

$= (2.4E+08 + 5.869E+09) - (164287.51) \times (176.8326^2)$

= 9.68E+08 mm4

	Project	TO315 Mayo Bridges - Assessments	Job ref 10088572	
AtkinsRéalis	Part of Structure: Filler Beam Capacity, Strade River Bridge MO-N58-001.00		Calc sheet 1	Rev 0
	Drawing ref.	Calc by VP / Date 17/12/24	Check by MG	Date 18/12/24

Ref	Calculations	Ouptut

9 Check bond stress of section

Dimensions in mm

Allowable f_{cu}=	18.9	b=	600
γ_{mc}=	1.05	d_c=	308.75
Allowable f_{st}=	230	d_s=	123
γ_{ms}=	1.05	A_{st}=	1820
γ_{f3}=	1.1	t_{ft}=	28
Bottom Cover=	37	t_{fb}=	10
		A_{sb}=	1230
		t_w=	10

Short Term Ec (BD 44/95 cl. 4.3.2.1)

$Ec = (20 + 0.27f_{cu}) = 25$

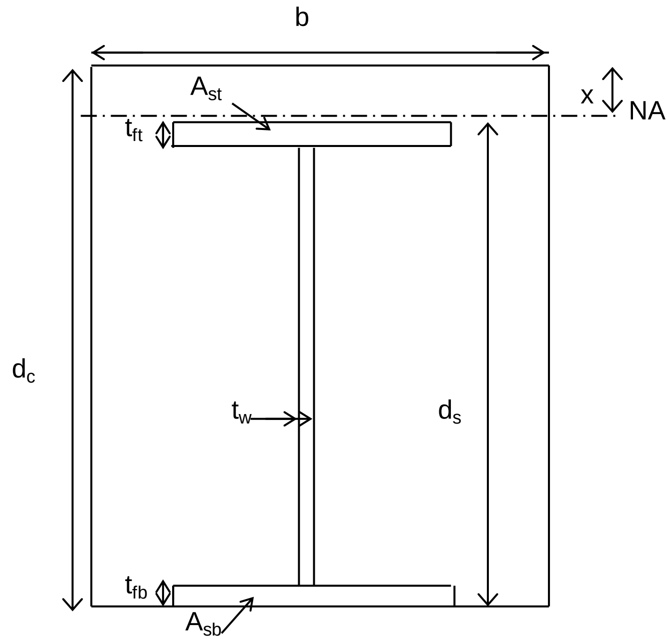
Es = 205 **m** = Es / Ec = **8.17**

Long Term Ec (BD 44/95 cl. 4.3.2.1)

Twice Short Term **m** = **16.33**

Allowable Conc stress = $0.75f_{cu}/\gamma_{mc}\gamma_{f3}$ = **12.273**

Allowable steel stress = $f_{st}/\gamma_{ms}\gamma_{f3}$ = **199.134**



Uncracked Section for Grillage Analysis

	Short Term	Long Term Ec	
m =	8.17	16.33	
x =	167.65	177.53	mm
Area of section (concrete units) =	217098.78	248947.57	mm^2
Area of section (steel units) =	26584.54	15242.27	mm^2
I_{NA} (concrete units)=	1.62E+09	1.74E+09	mm^4
I_{NA} (steel units)=	2.16E+08	1.23E+08	mm^4

Cracked Section

	Short Term	Long Term Ec	
m =	8.17	16.33	
x =	152.65	147.18	mm
Area of concrete in compression =	91591.59	88307.85	mm^2
Centroid of conc. in comp.(from NA) =	76.33	73.59	mm
I_{NA} (cracked section)=	6.74E+08	9.68E+08	mm^4
A * y / I_{NA} =	0.01037	0.00671	/mm

AM-STR-06037 Cl 8.5.1: *"The bond may be assumed to be developed uniformly only over both sides of the web and the upper surface of the top and bottom flanges of the steel beam where there is complete encasement and over both sides of the web and the upper surface of the top flange of the steel beam where the beam soffit is exposed."*

Hence, as cover to soffit of bottom flange is 37mm, Ls = 348 mm

	Project TO315 Mayo Bridges - Assessments			Job ref 10088572.00	
AtkinsRéalis	Part of Structure: Filler Beam Capacity Strade River Bridge MO-N58-001.00			Calc sheet 2	Rev 0
	Drawing ref.	Calc by VP	Date 17/12/2024	Check by MG	Date 18/12/2024

Ref	Calculations	Ouptut

Check for Max Shear (at support) HA Loading

Serviceability Loads (F)

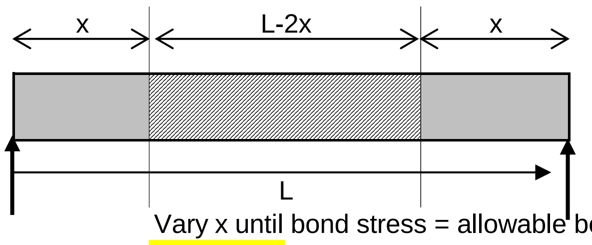
Shear at support	kN
Dead Load	22.00
Live Load	39.00

	Live Load	Dead Load	
'l Shear Force = FAy/I_{NA}	404.27	147.66	N/mm
Bond stress =	1.162	0.424	N/mm^2
Total bond stress =		1.586	N/mm^2
Allowable bond stress at SLS =		0.700	N/mm^2

Result: Section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check capacity of section unsuitable for composite action

Find distance x such that bond stress due to combined Dead Load and Live Load = 0.7N/mm2



Legend:

bond stress <0.7N/mm2 suitable for composite action

bond stress >0.7N/mm2 unsuitable for composite action

Vary x until bond stress = allowable bond stress

Try x = **1.42** m (Max x = L/2 = 2.040875 m)

Okay Hint:Use Goalseek

Serviceability Loads (F)

Shear at location x	kN
Dead Load	**5.00**
Live Load	**20.26**

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	210.04	33.56	N/mm
Bond stress using =	0.604	0.096	N/mm^2
Total bond stress=		**0.700**	N/mm^2
Allowable bond stress at SLS =		**0.700**	N/mm^2

Result: Bond stress okay

Check corresponding moment capacity at x

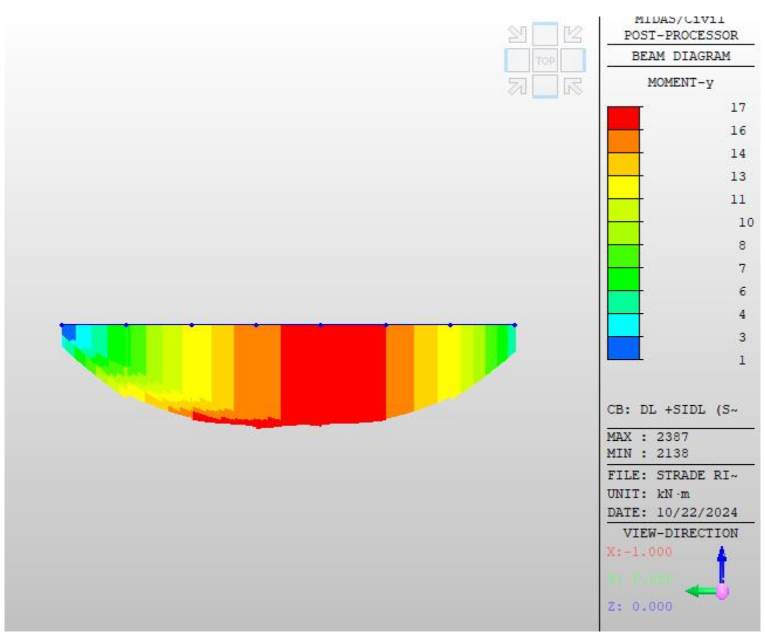
Factor **K** for 40 tonne loading	0.76	
Moment Capacity of steel section	30.38	kNm
Moment Capacity of composite section	36.54	kNm

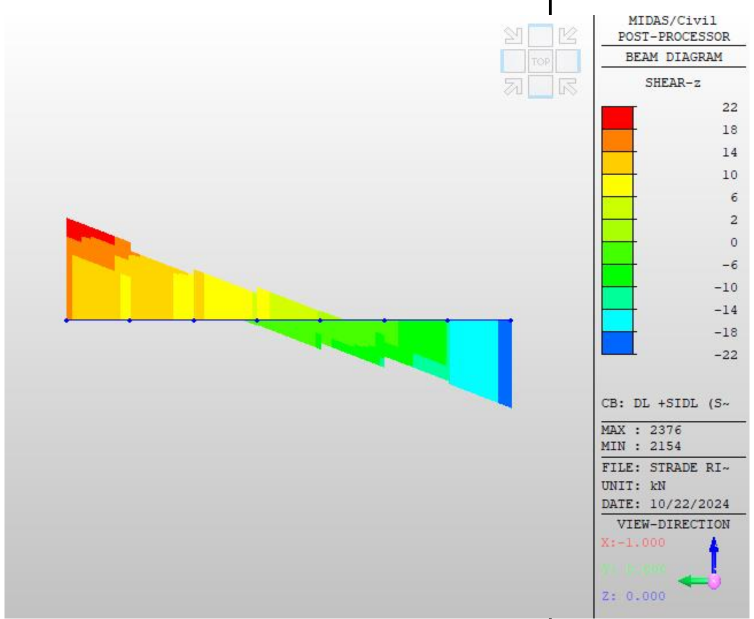
ULS Moment at x	kNm
Dead Load	12.24
Available capacity for live load	24.30
Live Load	24.00

Factor C for Moment	0.77	
Loading Capacity Moment	**7.5t**	as per Figure 5.6
Adequacy Factor	1.01	

Output: **(HA + KEL Eqv.)** **Moment Capacity** **7.5t**

Results from Grillage analysis -Dead Load

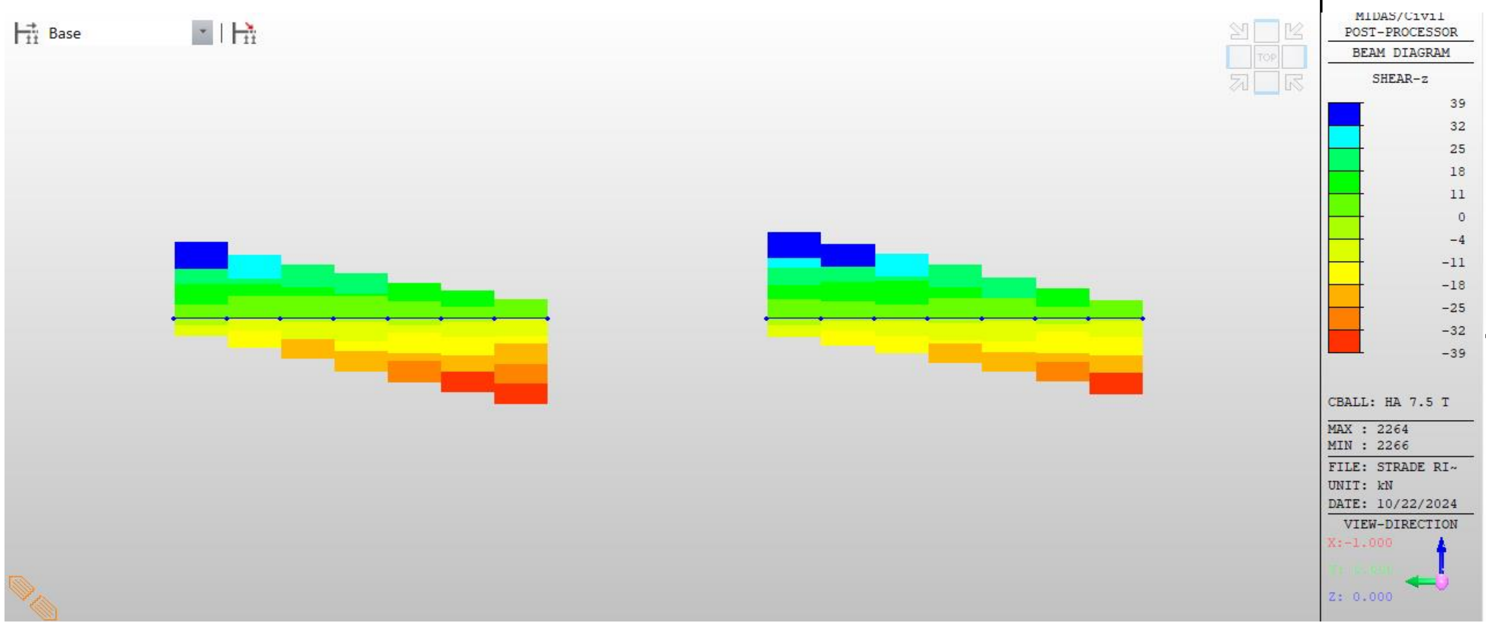




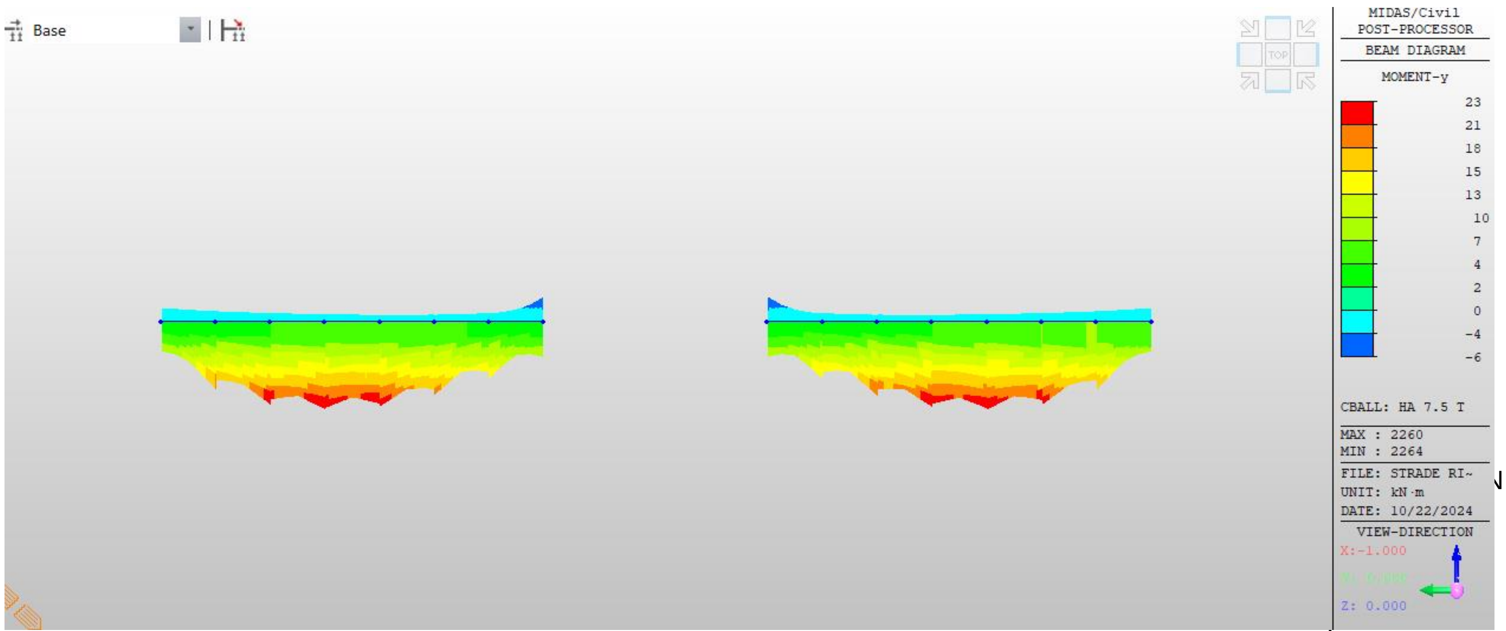
AtkinsRéalis	Project: TO315 Mayo Bridges - Assessments			Job ref: 10088572	
	Part of Structure: Filler Beam Capacity Strade River Bridge MO-N58-001.00			Calc sheet: 3	Rev: 0.00
	Drawing ref.	Calc by: VP	Date: 17/12/2024	Check by: MG	Date: 18/12/2024

Ref	Calculations	Ouptut

HA 7.5T Shear Diagram



HA 7.5t GVW Moment Diagram



Vx	9.78 kN
Vmax	14.99 kN
Mx	13.88 kNm
Mmax	13.88 kNm
Mmax P at centre	15.30 kNm

Combined load effect

	per m width	ULS (Yf3=1.5)
Combined Moment Mx	16.00 kNm	24.00
Combined Shear Vx	20.26 kN	30.39
		ULS (Yf3=1.5)
Max M	23.00 kNm	34.50 kNm
Max V	39.00 kN	58.50 kN

Project	TO315 Mayo Bridges - Assessments		Job ref 10088572.00	
Part of Structure	Filler Beam Capacity		Calc sheet 4	Rev 0.00
Strade River Bridge MO-N58-001.00				
Drawing ref.	Calc by VP	Date 17/12/2024	Check by MG	Date 18/12/2024

AtkinsRéalis

Ref	Calculations	Ouptut

HB Live Load

Check for Max Shear (at support) 45HB

Serviceability Loads (F)

Shear at support	kN
Dead Load	22.00
Live Load	71.00

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	735.99	147.66	N/mm
Bond stress using=	2.115	0.424	N/mm^2
Total bond stress using =	2.539		N/mm^2
Allowable bond stress at SLS =	0.700		N/mm^2

Result: Bond Stress (2.54) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check section at x

45HB Loading

Vary x until bond stress = allowable bond stress

Try x = **1.70** m Load **45.00** HB

x okay Hint:Use Goalseek

Serviceability Loads (F)

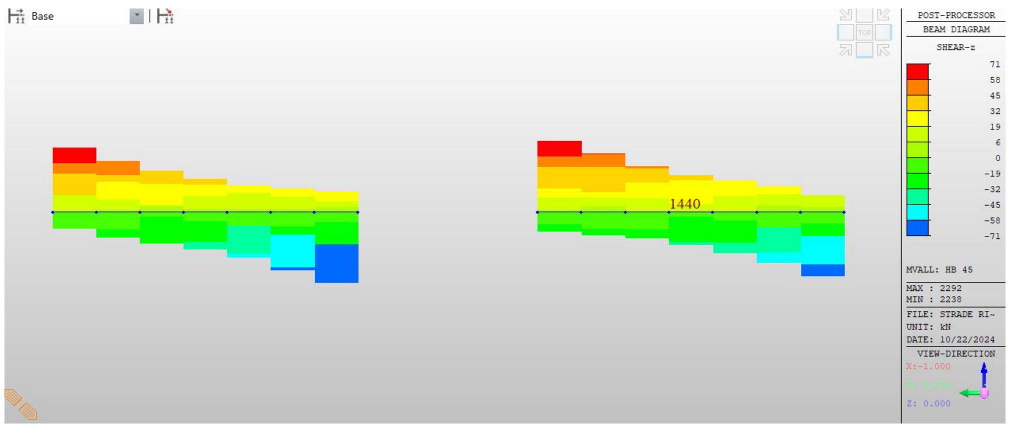
Shear at location x	kN
Dead Load	**4.00**
Live Load	**20.91**

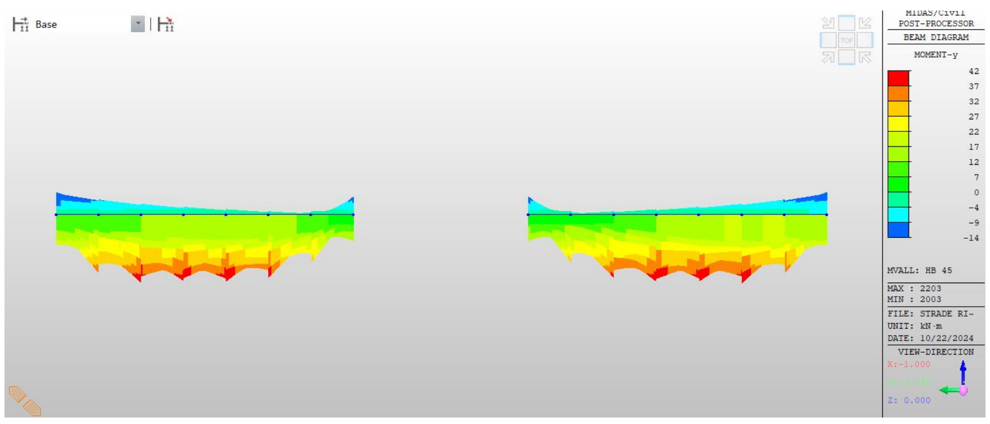
Check for Shear at x - 45HB

Note: If bottom flange is exposed use L_{S1} otherwise use L_{S2}

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	217	26.85	N/mm
Bond stress=	0.623	0.077	N/mm^2
Total bond stress=	**0.700**		N/mm^2
Allowable bond stress at SLS = 0.7	**0.700**		N/mm^2

Result: Bond stress okay using Ls2





					ULS	
Vx	4.00 kN		Vx	20.91 kN	31.37	kN
Vmax	22.00 kN		Vmax	71.00 kN	106.50	kN
Mx	14.00 kNm		Mx	37.00 kNm	55.50	kNm
Mmax	17.00 kNm		Mmax	42.00 kNm	63.00	kNm

Check corresponding moment capacity at x

	ULS Moment at x	kNm	
	Dead Load	16.80	
Available capacity for live load		13.58	Adequacy
45HB	Live Load	55.50	0.24 Fail

Moment Capacity <45HB

AtkinsRéalis	Project TO315 Mayo Bridges - Assessments			Job ref 10088572.00	
	Part of Structure Filler Beam Capacity Strade River Bridge MO-N58-001.00			Calc sheet 5	Rev 0.00
	Drawing ref.	Calc by VP	Date 17/12/2024	Check by MG	Date 18/12/2024

Ref	Calculations	Ouptut

HB Live Load

Check for Max Shear (at support) 30HB

Serviceability Loads (F)

Shear at support	kN
Dead Load	22.00
Live Load	70.50

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	730.80	147.66	N/mm
Bond stress using=	2.100	0.424	N/mm^2
Total bond stress using =	2.524		N/mm^2
Allowable bond stress at SLS =	0.700		N/mm^2

Result: Bond Stress (2.52) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check section at x

30HB Loading

Vary x until bond stress = allowable bond stress

Try x = **1.62** m Load **30.00** HB

x okay Hint:Use Goalseek

Serviceability Loads (F)

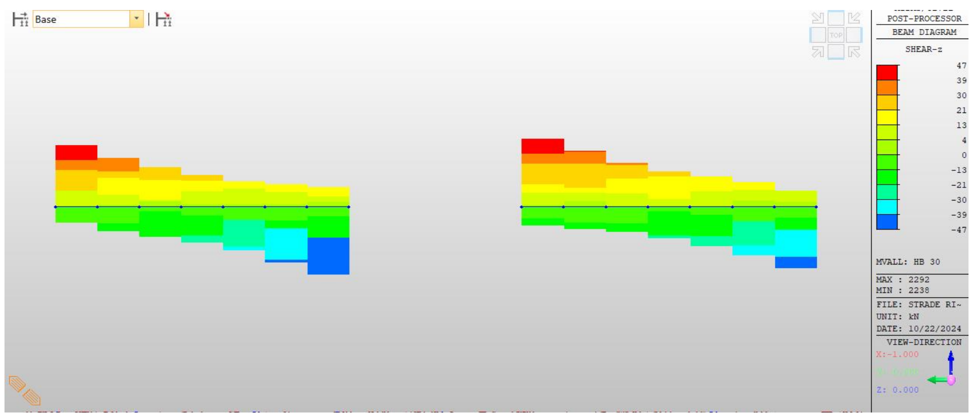
Shear at location x	kN
Dead Load	**4.50**
Live Load	**20.59**

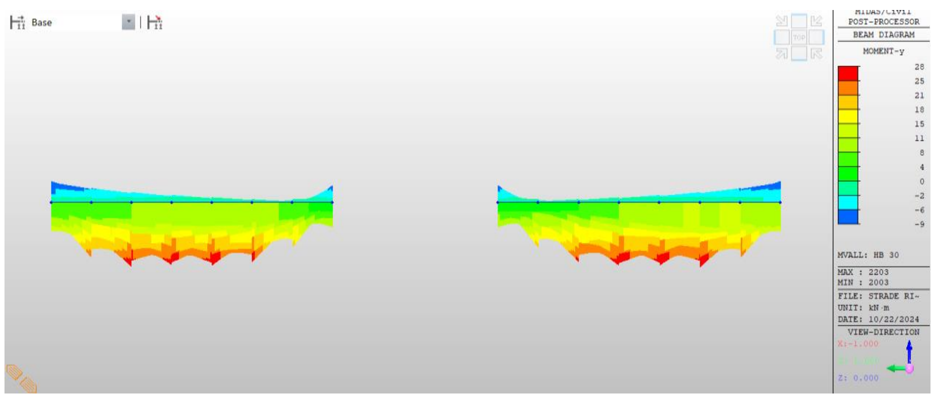
Check for Shear at x - 30HB

Note: If bottom flange is exposed use L_{S1} otherwise use L_{S2}

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	213	30.20	N/mm
Bond stress=	0.613	0.087	N/mm^2
Total bond stress=	**0.700**		N/mm^2
Allowable bond stress at SLS = 0.7	**0.700**		N/mm^2

Result: Bond stress okay using Ls2





						ULS	
Vx	4.00	kN	Vx	20.59	kN	30.88	kN
Vmax	22.00	kN	Vmax	47.00	kN	70.50	kN
Mx	14.00	kNm	Mx	23.00	kNm	34.50	kNm
Mmax	17.00	kNm	Mmax	28.00	kNm	42.00	kNm

Check corresponding moment capacity at x

	ULS Moment at x	kNm	
	Dead Load	16.80	
Available capacity for live load		13.58	Adequacy
30HB	Live Load	34.50	0.39 Fail

Moment Capacity <30HB

Check for Max Shear (at support) SV 80

Serviceability Loads (F)

Shear at support	kN
Dead Load	22.00
Live Load	71.00

Note: If bottom flange is exposed use L_{S1} otherwise use L_{S2}

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	735.99	147.66	N/mm
Bond stress=	2.115	0.424	N/mm^2
Total bond stress=	2.539		N/mm^2
Allowable bond stress at SLS =	0.700		N/mm^2

Result: Bond Stress (2.54) greater or equal than Permissible Bond Stress (0.7) hence section is unsuitable for composite action (see BD 61/10 Clause 8.5.1)

Check section at x SV 80HB

Vary x until bond stress = allowable bond stress

Loading Try x = **1.70** m Load **SV 80** HB

x okay Hint:Use Goalseek

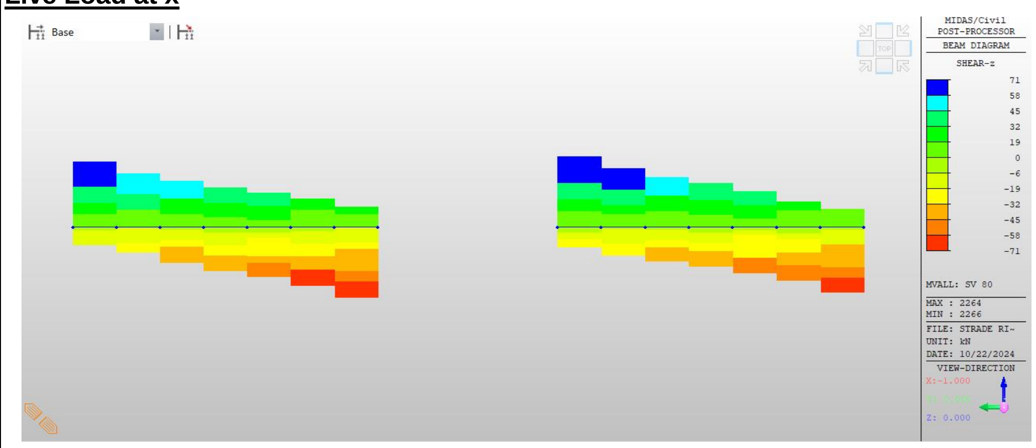
Serviceability Loads (F)

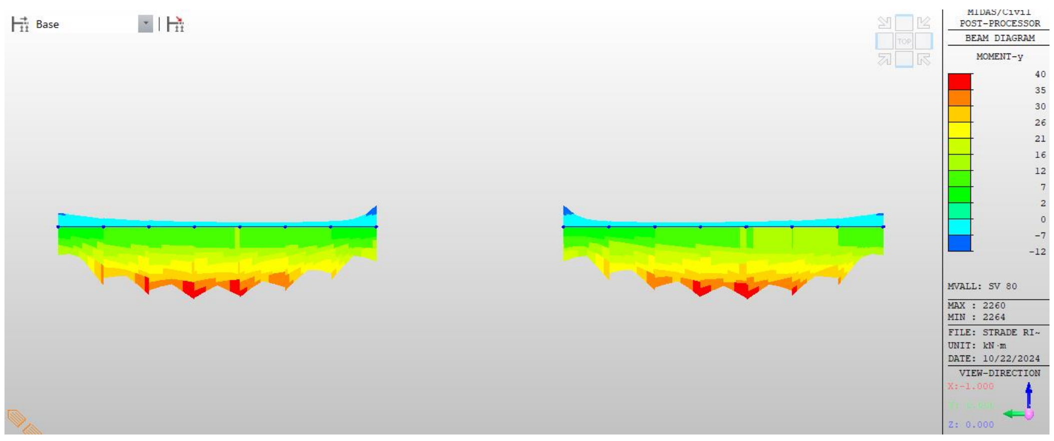
Shear at location x	kN
Dead Load	**4.00**
Live Load	**20.91**

	Live Load	Dead Load	
Longt'l Shear Force = FAy/I_{NA}	217	26.85	N/mm
Bond stress=	0.623	0.077	N/mm^2
Total bond stress=	**0.700**		N/mm^2
Allowable bond stress at SLS = 0.7	**0.700**		N/mm^2

Result: Bond stress okay using Ls2

Live Load at x





						ULS	
Vx	4.00 kN		Vx	13.94 kN		20.91	kN
Vmax	22.00 kN		Vmax	71.00 kN		106.50	kN
Mx	14.00 kNm		Mx	26.00 kNm		39.00	kNm
Mmax	17.00 kNm		Mmax	40.00 kNm		60.00	kNm

ULS Moment at x	kNm
Dead Load	16.80
Available capacity for live load	13.58
SV 80HB Live Load	39.00

Adequacy

0.35 Fail

Moment Capacity <SV 80

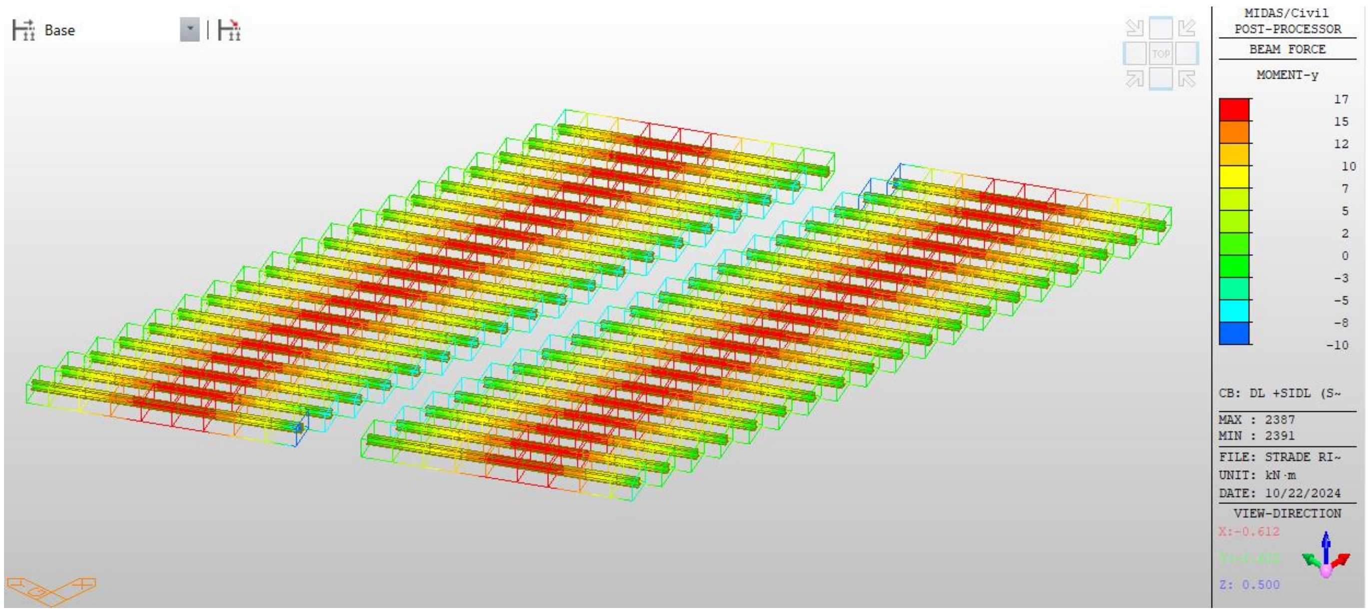
Ref.	Calculations	Output

10

Grillage Analysis Results Diagram

Since the Filler beam slab failed under 40T GVW, we have carried out a grillage analysis taking into account the transverse distribution.

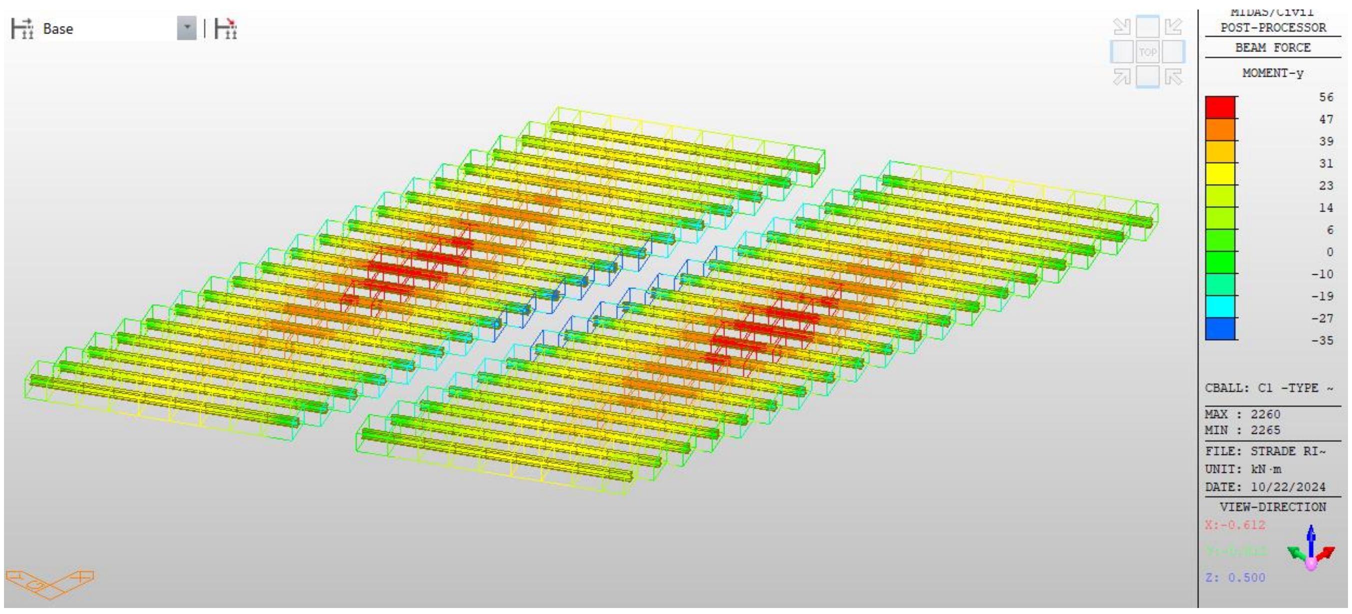
Dead Load + Super Imposed Dead load (SD*)



Maximum of Moment along both axis (Mxx & Myy)

Moment near Support (Sagging)	=	5	kNm
Maximum Sagging Moment	=	17	kNm
Maximum Shear at d from support	=	53	kN

Load effect due to Type HA 40t Loading - ULS Case 1 (SHA-40T*)

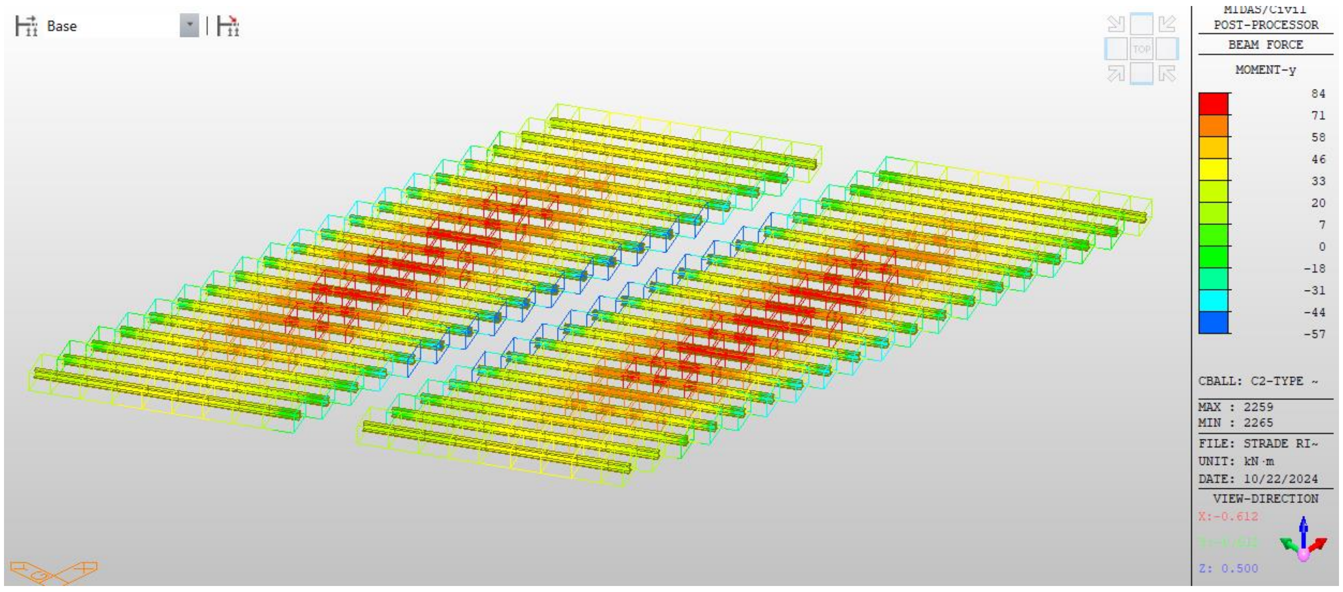


Maximum of Moment along both axis (Mxx & Myy)

		ULS Case 1 (SHA-40T*)		ULS Case 2 (SHA-26T*)	
Moment near Support (Sagging)	=	12	kNm	10	kNm
Maximum Sagging Moment	=	56	kNm	55	kNm
Maximum Shear at d from support	=	85	kN	84	kN

Since the structure also failed to have enough capacity under HA 40T, results for HA 26T units are only shown above.

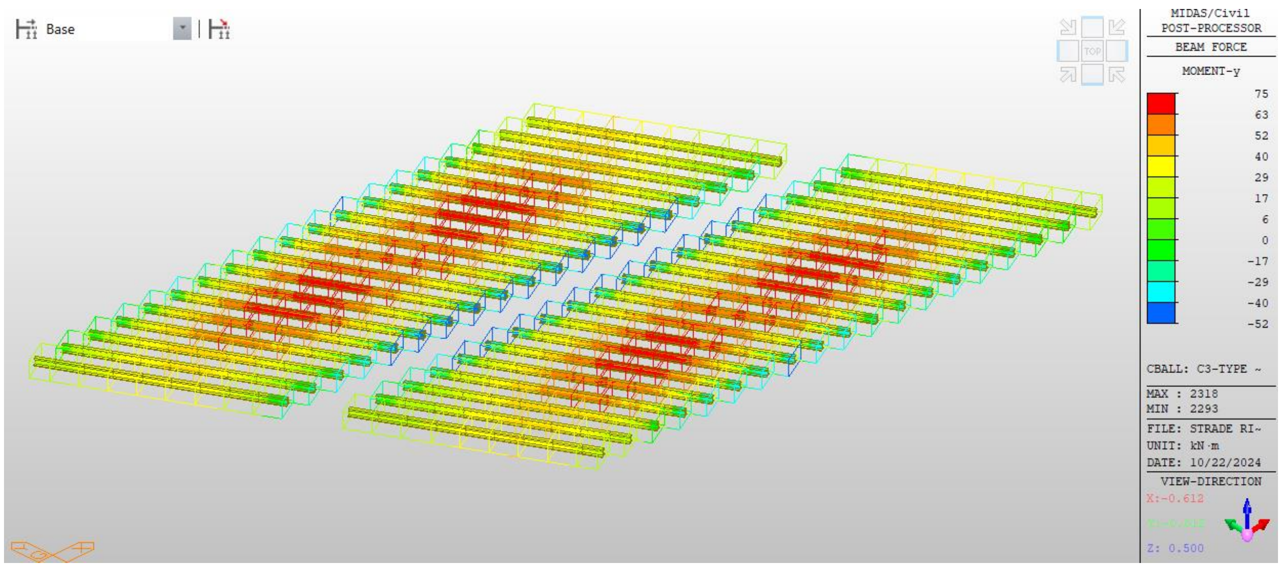
Load effect due to Type HA +HB -combined (40T HA + HB -45units)



Maximum of Moment along both axis (Mxx & Myy)

		ULS Case 3 (SHA+HB-45*)	
Moment near Support (Sagging)	=	20	kNm
Maximum Sagging Moment	=	84	kNm
Maximum Shear at d from support	=	146	kN

Load effect due to Type HB 45 units Loading



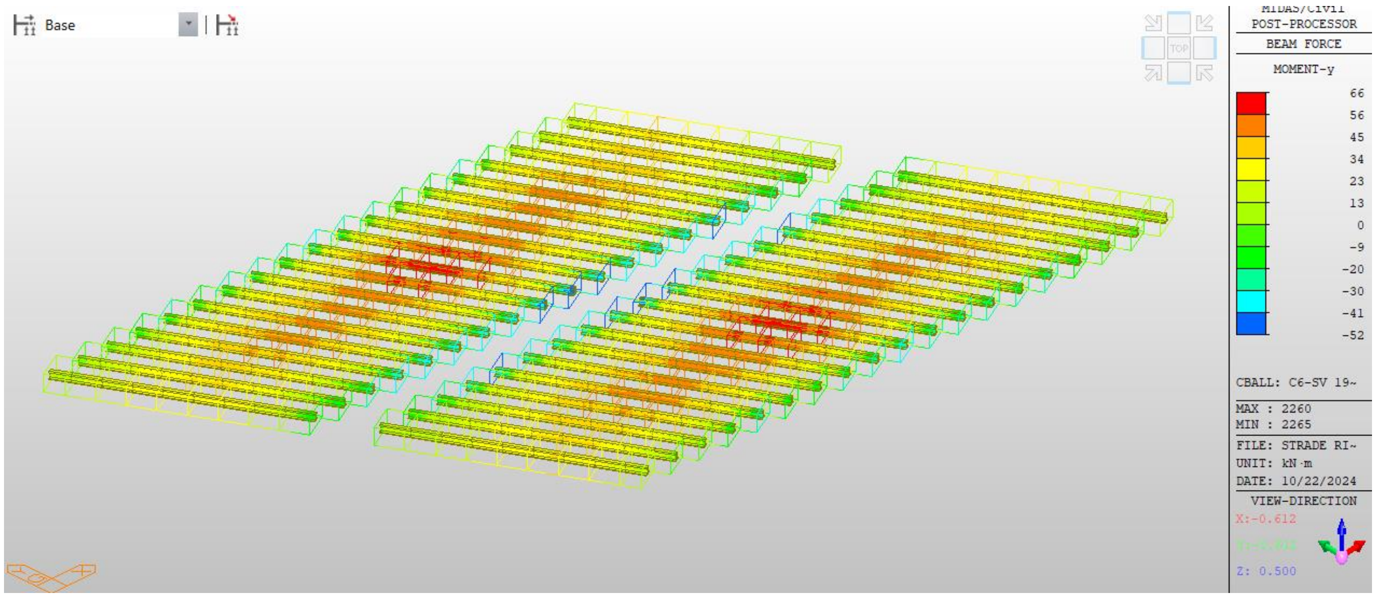
Maximum of Moment along both axis (Mxx & Myy)

		ULS Case 4 (SHB-45*)		ULS Case 5 (SHB-30*)	
Moment near Support (Sagging)	=	14	kNm	12	kNm
Maximum Sagging Moment	=	75	kNm	55	kNm
Maximum Shear at d from support	=	121	kN	87	kN

AtkinsRéalis	Project Name TO315 Mayo Bridges - Assessments			Job Number **10088572**	
	Calculation Location Strade River Bridge MO-N58-001.00			Sheet Number 15 of	Rev. 0
	Drawing Reference 0	Originator **VP**	Date Oct-24	Checker MG	Date Oct-24

Ref.	Calculations	Output

Load effect due to SV 196 Loading - ULS Case 6 (SV 196*)

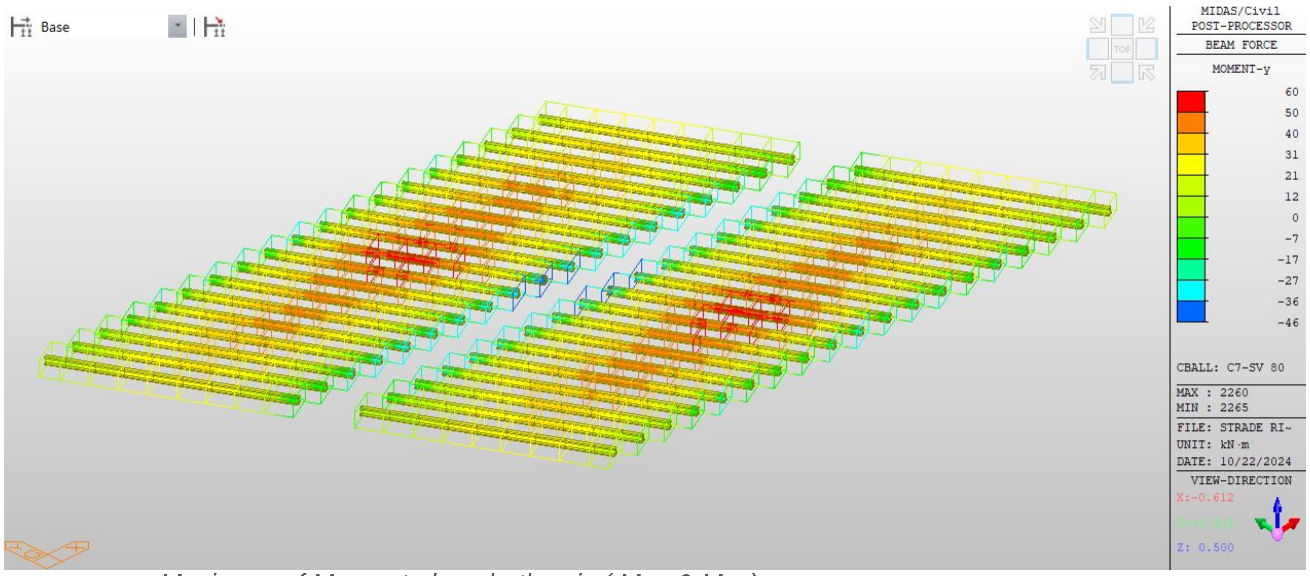


Maximum of Moment along both axis (Mxx & Myy)

Moment near Support (Sagging)	=	18	kNm
Maximum Sagging Moment	=	66	kNm
Maximum Shear at d from support	=	110	kN

Load effect due to SV 80 Loading - ULS Case 7 (SV 80*)

Since the structure also failed to have enough capacity under SV 100 vehicle, results for SV 80 are only shown below. SV 100 has the same 165 kN axle as SV 196.



Maximum of Moment along both axis (Mxx & Myy)

Moment near Support (Sagging)	=	17	kNm
Maximum Sagging Moment	=	60	kNm
Maximum Shear at d from support	=	98	kN

Assessment Summary Table.

Load Effect	RA*	SD*	Case 1 SHA-40T*	Case 2 SHA-7.5T*	Case 3 SHA+H45*	Case 4 SHB45*	Case 5 SHB30*	Case 6 SSV196*	Case 7 SSV80*
Moment near Support (Sagging) (kNm)	**73**	5	12	10	20	14	12	18	17
RA*/SA*		14.6	6.1	7.3	3.6	5.2	6.1	4.0	4.3
Check		OK	OK	OK	OK	OK	OK	OK	OK
Maximum Sagging Moment (kNm)	**73**	17	56	55	84	75	55	66	60
RA*/SA*		4.28	1.30	1.32	0.87	0.971	1.32	1.10	1.21
Check		OK	OK	OK	Not Ok	Not Ok	OK	OK	OK
Maximum Shear at d from support (kN)	**101**	53	85	84	146	121	87	110	98
RA*/SA*		1.9	1.2	1.2	0.7	0.8	1.2	0.9	1.0
Check		OK	OK	OK	Not Ok	Not Ok	OK	Not Ok	OK

Where

RA* = Assessment Resistance (flexure, shear etc.)
SD* = Assessment load effects due to dead and superimposed dead loads
SHA* = Assessment load effect due to the associated Type HA loading
SHB* = Load effect due to HB loading
SA* = Assessment load effects
RA*/SA* = Structural Assessment Factor

Element	Load Effect	R_{A*}	S_{D*}	S_{HA40t*}	$S_{HA+HB45*}$	S_{HB45*}	S_{SV196*}	R_A*/S_A*
Filler beam slab bridge	Moment near Support (Sagging) (kNm)	**73**	5	12	20	14	18	3.64
	Max. Sagging Moment (kNm)	**73**	17	56	84	75	66	0.87
	Max. Shear (kN)	**101**	53	85	146	121	110	0.69
	Bond Capacity	7.5 T			< HB 30 units		< SV 80	

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Assessed Capacity (ALL)	HB Capacity	SV Capacity
MO-N58-001.00	Strade River Bridge	Filler beam concrete slab	2	3.81	7.5t	Fails HB30 units	Fails SV 80

Appendix H. Photographs

Figure H-1 - View of the carriageway looking south

Figure H-2 - View of the cracking to the northwest corner of the carriageway

Figure H-3 - View of the eastern footway

Figure H-4 - View of the western footway

Figure H-5 - View of the eastern parapet

Figure H-6 - View of the western parapet

Figure H-7 - View of the northwest embankment

Figure H-8 - View of the southeast embankment

Figure H-9 - View of the southwest wing wall

Figure H-10 - View of the south abutment

Figure H-11 - View of the north abutment

Figure H-12 - View of the northeast pier face

Figure H-13 – View of the south pier face

Figure H-14 – View of the cracking to the north face of the pier

Figure H-15 – View of the north span deck slab

Figure H-16 – View of the south span deck slab

Figure H-17 - South span - Cracking sealed with calcite

Figure H-18 - South span - spalling with exposed filler beam

Figure H-19 - North span - cracking sealed with calcite, water staining and spalling

Figure H-20 – North span - exposed filler beam with delamination evident

Figure H-21 – View of riverbed west of structure looking east

Figure H-22 - View of the west elevation

Figure H-23 - View of the east elevation

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