



Major Works Framework 2012-2015

Highways England - Historical Railways Estate

AYT/55 Pont - Llanio Station, Ceredigion

BE4 Assessment and Inspection Report

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January 2016

VAR9/4635



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Executive Summary

Key Facts

Structure Type: Overbridge

Superstructure Form: Single span segmental brick arch

Substructure Form: Founded on rock outcrop to north, Gravity type masonry wingwalls and south abutment

Span: Clear skew span 8.387m (27' – 6")

Assessment Code: BE4

Live load capacity: Full 24 ton BE4 loading

Modified axle load: 11 tons

Restriction: None

Condition: Fair

Local Authority: Carmarthenshire

OS Reference: SN 652 570

This report presents the load carrying capacity for the bridge and identifies the data used to derive the assessment. It has been prepared by Jacobs for the exclusive use by HE-HRE and should not be relied on by third parties. It has been based on site measurements and investigation by Jacobs, and historical information provided by HE-HRE, as appropriate.

The description of condition does not represent a principal inspection; nor should it be relied on for the development of maintenance works. Identification of defects is principally based on ground level observation of visible members. Close inspection of members was limited by the constraints of safe access possible within a single site visit. Access to the formation was severely limited by wet boggy ground. The principal observations were taken from the south east corner adjacent to the old station platform.

The structural arrangement of the bridge meant that the following elements were not examined as part of the inspection for assessment:

- Arch barrel backfill was not investigated. By agreement with HE-HRE no intrusive investigation was carried out on this bridge. The fill is assumed to be well compacted material achieving a fill factor of 0.7
- The arch barrel extrados and the soil faces of the spandrel walls were considered to be built-in parts not amenable to inspection. Assessment followed standard methods based on appraisal of the visible parts of the bridge.

1. General Description and Structural Details

1.1 Introduction

Jacobs was appointed by Highways England – Historical Railways Estate (HE-HRE) to undertake a BE4 MEXE assessment of overbridge AYT/55.

1.2 Location and General Description

Bridge AYT/55 carries an unclassified road (a connecting road from the A485 to Llanddewi Brefi) over the track bed of the former Aberystwyth branch railway line, about 5km South West of Tregaron.

The road is a single carriageway; the overall carriageway width between the raised kerb on the east side and the west parapet is 6.3m. Refer to the plan at road level in Appendix E for carriageway dimensions.

Traffic flow across the bridge is light. Occasional HGV use was observed during the survey.

The OS grid reference is SN 652 570.

1.3 Construction type

The bridge is a highly skewed single span masonry arch overbridge. It has a measured clear skew span of 8.387m. From historical data the skew angle is about 22°.

The arch barrel profile is segmental; it is constructed from common bricks and has a rise of 1.416m at mid-span. The thickness of the arch barrel was taken from historical information as 508mm (1'-8"); refer to historical information in Appendix D.

The arch is supported on gravity type abutments constructed from random sized, rough-hewn squared stone blocks, uncoursed. The north abutment is raised on a natural rock ledge. The parapets, wingwalls and spandrels are constructed from similar stone.

Sketches of the plan at road level and the elevation are included in Appendix E.

2. Information Search

2.1 Services Search

A services search was not required as site intrusive investigations were not within the scope of the survey.

2.2 Site Investigation Description and Results

None. Historical information regarding the geometry of hidden elements is included in Appendix D.

2.3 Existing Drawings

Historical sketches from available records are included in Appendix D.

3. Structure Condition

3.1 General

The survey and inspection for BE4 assessment were undertaken on Tuesday 21st July 2015. Weather conditions were overcast with light showers and a temperature of 18°C.

Parking was available in the wide bell-mouth of the old station road about 5m south of the bridge.

Access to the formation was gained via by climbing over a locked steel gate leading to a derelict industrial unit in the old station yard, then crossing onto the old station platform. Observations were made from the station platform at the south east corner of the bridge. Access onto the formation was prevented as the ground was very soft with shallow flowing water.

3.2 Structure Condition

3.2.1 Arch barrel

The arch is constructed from common brick. There is extensive surface deterioration of bricks above the springing lines at both abutments. There are some old calcareous deposits on the arch above the west springing line (photograph 6) and to a lesser extent, above the east springing (photograph 7). There are areas of soot, algal staining and leachate throughout the arch barrel soffit (photograph 5 & 7). No signs of cracking can be seen. A barrel factor of 0.85 is considered appropriate for the arch ring in this condition (Table 3/1 of BA16/97). There are no signs of spandrel wall separation.

The staining and deposits mentioned above conceal some of the mortar joints. In areas where they are visible the joints appear to be well filled. The joints to the arch barrel faces do show some areas of minor mortar loss but also some areas of repointing. A joint depth factor of 0.9 (Table 3/5 of BA16/97) is recommended. The mortar appears to be competent but there may be softening in the areas with calcareous deposits; therefore a mortar factor of 0.9 is considered appropriate (Table 3/4 of BA16/97). There are some areas, particularly between the barrel rings which can be seen on the east face of the arch, where the joint widths exceed 12.5mm thus giving a joint width factor of 0.8 (Table 3/3 of BA16/97).

The carriageway construction over the arch shows no significant settlement or tracking; therefore, since no intrusive investigation was carried out, it is assumed that the back fill is well compacted granular material, dictating a fill factor of 0.7 (Table 3/2 of BA16/97).

The arch barrel shape is good with no distortion noted. There is no separation of the spandrel wall from the arch barrel as noted above. An overall condition factor of 0.9 is recommended to account for overall age related deterioration.

3.2.2 Abutments

The abutment faces are in a fair condition with both abutments exhibiting moderate algal, soot and leachate staining (Photograph 6).

3.2.3 Spandrels

The spandrel walls are in good condition with no defects visible. The mortar joint are well filled with no vegetation taking hold.

3.2.4 Wingwalls

The wingwalls are all in good condition apart from with some encroaching vegetation and moss. A substantial bush was growing on the northeast wingwall

3.2.5 Parapets

The east and west side parapets are both low stone walls (Photographs 9 and 10). Both are in satisfactory condition. The east parapet is protected against errant vehicles coming down the hill by a raised kerb plinth.

3.2.6 Formation

The formation is extensively overgrown on both sides of the bridge. The formation under the structure is very wet. There is an old water tank adjacent to the bridge which appears to be fed by a stream or spring. The overflowing water from the tank collects below the bridge.

No access is possible via the west side of the bridge.

3.2.7 Road Surface

The road surface is in good condition with no signs of settlement, cracking or tracking. It is on a fairly constant slight gradient downwards from north to south with an increase in gradient at the south end. However there is no prominent 'hump' over the bridge and therefore no axle lift off will need to be considered (Photographs 3 and 4).

4. Assessment to BE4

4.1 Methodology

The modified MEXE method as outlined in BE4 was used for this assessment. For the purpose of calculations, the arch ring thickness has been taken as 508mm at the crown. This is based on sketches from the historical information included in Appendix D.

The following factors were used indicating the condition of the arch for the MEXE assessment:

Description	Modifying Factor
Barrel Factor, F_b	0.85
Fill Factor, F_f	0.7
Width of Joint factor, F_w	0.8
Depth Factor, F_d	0.9
Mortar Factor, F_{mo}	0.9
General condition factor of bridge, F_{cm}	0.9

Table 1: Factors used for MEXE analysis

4.2 Results

4.2.1 Arch barrel (MEXE assessment)

Arch span	Modified axle load	BE4 assessment result
Span 8.387m	11 tons	Full BE4 loading

Table 2: MEXE analysis results

The minimum modified axle load obtained from the MEXE analysis was 11 tons. A rating greater than 9 tons means that the bridge can carry tandem 9 ton axles or vehicles with a single 11 ton axle and is therefore unrestricted for all vehicles complying with Construction and Use regulations (1967).

4.2.2 Substructure

The abutments show a few hairline fractures and moderate staining but none are currently considered to be of structural significance. By qualitative assessment, the substructure appears to be satisfactory for full C&U loading.

5. Conclusions and Recommendations

A weight restriction is not necessary on the bridge as determined by this MEXE assessment. The ratings for both single and tandem axle vehicles are well in excess of the 11 and 9 tons respectively required for full C&U (1967) rating.

Assignment of the general condition factors for the assessment is somewhat subjective and has a significant influence on the result. There is little excess capacity indicated by the assessment suggesting that the bridge would fall below assessment requirements with a modest reduction in condition factor. It is therefore imperative that the arch barrel is not allowed to deteriorate further.

The condition of the substructure is deemed to be sufficient for full BE4 loading given the low traffic levels across the structure.

Appendix A. Photographs



1) East elevation



2) West elevation



3) View of carriageway approach looking north



4) View over bridge looking south



5) View of arch soffit



6) South abutment, springing and arch barrel above – shows damp, calcareous deposits and algal staining



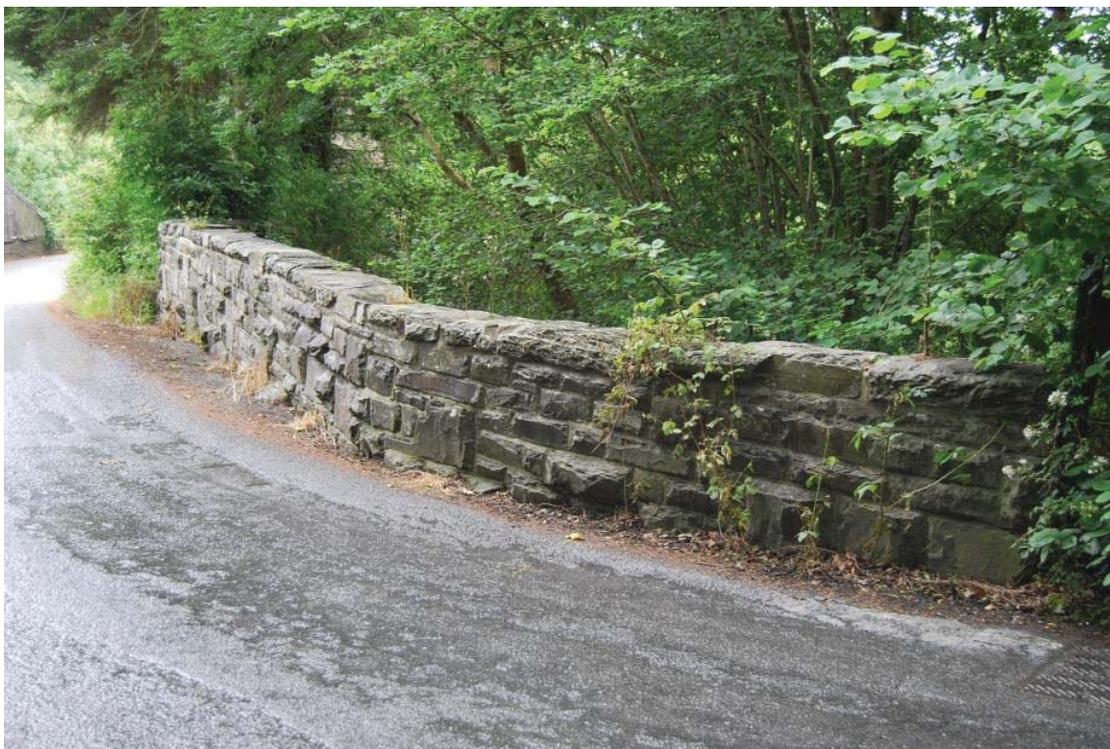
7) Arch soffit at north abutment - shows damp, leachate and algal staining



8) North east wingwall



9) East parapet



10) West parapet



11) Formation looking west from carriageway – shows vegetation coverage



12) Formation looking east from carriageway – shows old station platform



13) Formation looking west

Appendix B. Form AA

FORM 'AA' (BRIDGES)

GC/TP0356

ELR/ Bridge No: AYT/55

Appendix: B

Issue: 1

Revision: A (Aug 2015)

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Bridge/Line Name: Pont Llanio Station / Aberystwyth Branch

ELR/Bridge No. AYT/55

Brief Description of Existing Bridge:

(a) Span Arrangement

The bridge is a highly skewed single span masonry arch overbridge. It has a measured clear skew span of 8.387m. From historical data the skew angle is about 22°.

(b) Superstructure Type

The arch barrel profile is segmental; it is constructed from common bricks and has a rise of 1.416m at mid-span. The thickness of the arch barrel was taken from historical information as 508mm.

(c) Substructure Type

The arch is supported on gravity type abutments constructed from random sized, rough-hewn squared stone blocks, uncoursed. The north abutment is raised on a natural rock ledge. The parapets, wingwalls and spandrels are constructed from similar stone.

(d) Planned highway works/modifications at this site

None.

(e) Road designation class and whether classed as a heavy load route

The road is a single carriageway; the overall carriageway width between the raised kerb on the east side and the west parapet is 6.3m.

Traffic flow across the bridge is light. Occasional HGV use was observed during the survey.

(f) Any other requirements

None

FORM 'AA' (BRIDGES)**GC/TP0356**

ELR/ Bridge No: AYT/55

Appendix: B

Issue: 1

Revision: A (Aug 2015)

APPROVAL IN PRINCIPLE FOR ASSESSMENT**Assessment Criteria**

(a) Loadings and Speed

Dimensions, other than the arch ring thickness, and condition factors are obtained from site measurements and inspection. (See Jacobs report "VAR9-4635 Assessment Programme – BE4 Assessment and Inspection Report – Bridge Ref.: AYT/55" – January 2016). Standard BE4 axle loading up to twin 9 ton axles or a single 11 ton axle will be assessed. This is representative of 24 ton vehicles.

(b) Codes to be used

BE4 - "The Assessment of Highway Bridges for Construction and Use Vehicles" Ministry of Transport, 1967 (with amendments to 1969).

(c) Proposed Method of Structural Analysis

It is proposed to use the modified MEXE method of assessment as outlined in Part III of BE4.

A qualitative assessment, based on the site inspection, is to be used to estimate the load bearing capacity of the spandrels and sub structure.

The following factors are proposed for the modified MEXE assessment.

Barrel factor	Fb	0.85
Fill Factor	Ff	0.7
(Joint) width factor	Fw	0.8
(Joint) depth factor	Fd	0.9
Mortar factor	Fmo	0.9
Condition factor	Fcm	0.9

FORM 'AA' (BRIDGES)

GC/TP0356

ELR/ Bridge No: AYT/55

Appendix: B

Issue: 1

Revision: A (Aug 2015)

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Senior Civil Engineer's Comments

..... None

Proposed Category for Independent Check ... 1

Superstructure 1

Substructure 1

Name of Checker suggested if Cat 2 or 3 ... Not applicable

Category 1

The above assessment, with amendments shown, is approved in principle:

Signed [Redacted Signature] h

[Redacted Title]

[Redacted Date]

Category 2 and 3

The above assessment, with amendments shown, is approved in principle:

Signed

Title

Date

Signed

Title

Date

Appendix C. Form BA

FORM 'BA' (BRIDGES)

GC/TP0356

ELR/ Bridge No: AYT/55

Appendix: C

Issue: 1

Revision: A (Dec 2005)

CERTIFICATION FOR ASSESSMENT CHECK

Assessment Group: Jacobs UK Ltd
Bridge/Line Name: Pont Llanio Station / Aberystwyth Branch
Category of Check: 1
ELR/ Bridge No: AYT/55

We certify that reasonable professional skill and care have been used in the assessment of the above structure with a view to securing that:

- (1) It has been assessed in accordance with the Approval in Principle recorded in the accompanying Form AA.
- (2) It has been checked for compliance with the following principal British Standards, Codes of Practice, Highways England – Historical Railways Estate technical notes and Assessment standards:

BE4 - "The Assessment of Highway Bridges for Construction and Use Vehicles" Ministry of Transport, 1967 (with amendments to 1969).

List any departures from the above and additional methods or criteria adopted, with reference and justification for their acceptance.

None

Category 1

Name **Signature** **Date**



Assessor

Assessment Checker

Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible.

FORM 'BA' (BRIDGES)

GC/TP0356

ELR/ Bridge No: AYT/55

Appendix: C

Issue: 1

Revision: A (Dec 2005)

CERTIFICATION FOR ASSESSMENT CHECK

Category 2 and 3 (Note: Category 1 check must also be signed)

(a) Assessment

Name

Signature

Date

Assessor

Assessment Checker

Authorised signatory of
the firm of Consulting
Engineers to whom
Assessor/Checker is
responsible.

(b) Check

Name

Signature

Date

Assessor

Assessment Checker

Authorised signatory of
the firm of consulting
engineers to whom
Assessor/Checker is
responsible.

This Certificate is accepted by...



FORM 'BAA' (BRIDGES)

GC/TP0356

ELR/ Bridge No: AYT/55

Appendix: C

Issue: 1

Revision: A (Dec 2005)

CERTIFICATION FOR ASSESSMENT CHECK

Notification of Assessment Check

Assessment Group	Jacobs UK Ltd
Bridge Name/Road No.	Pont Llanio Station /unclassified
Line Name	Aberystwyth Branch
ELR Code/Structure No.	AYT/55

The above bridge has been assessed and checked in accordance with Standards which are listed on the appended Form BA. A summary of the results of the assessment in terms of capacity and restrictions is as follows:

STATEMENT OF CAPACITY

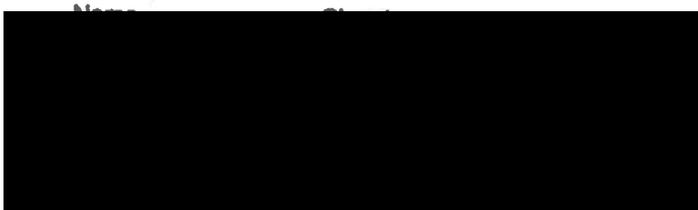
Masonry arch (MEXE)	Full C&U vehicle loading to BE4 – tandem 9 ton axles.
Substructure:	Full C&U loading by qualitative assessment.

Recommended Loading Restrictions

None

Description of Structural Deficiencies and Recommended Strengthening

None.



Assessor

Assessment Checker

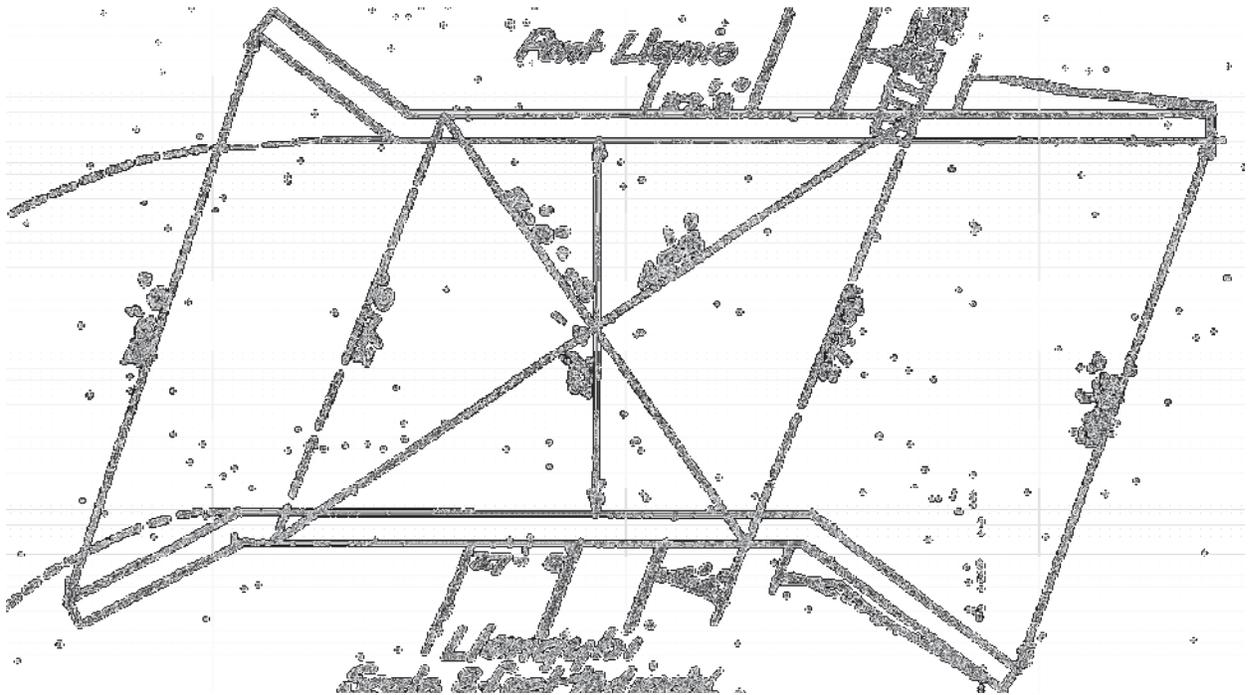
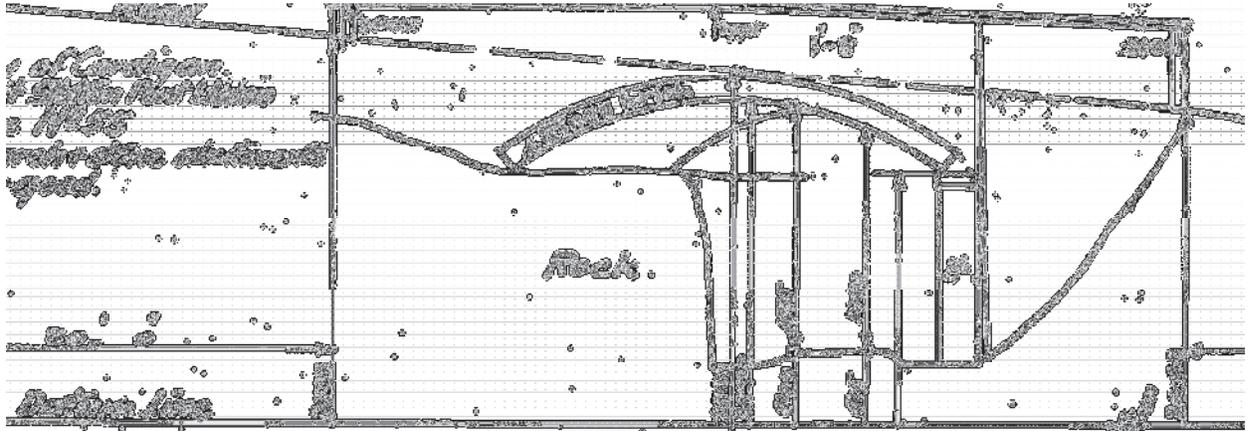
Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible.

This Certificate is accepted by.



.....

Appendix D. Historical Information



Extracts from sketch dated Oct 1906 included in 1979 BR assessment

Appendix F. Calculations

CALCULATION COVER SHEET

Jacobs
Winnersh

Project Title: HEHRE - Major Works 2012/2015		Calc. No.: 288
Job No: B18280DR		File: R22
Project Manager	[REDACTED]	Subject: AYT/55 Pont Llanio Station Bridge BE4 Assessment
Designer		
Project Group 31500		

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	2	AG	Aug-15	JDC	Jan-16				
Rev									
Rev									
Rev									
Rev									
Rev									

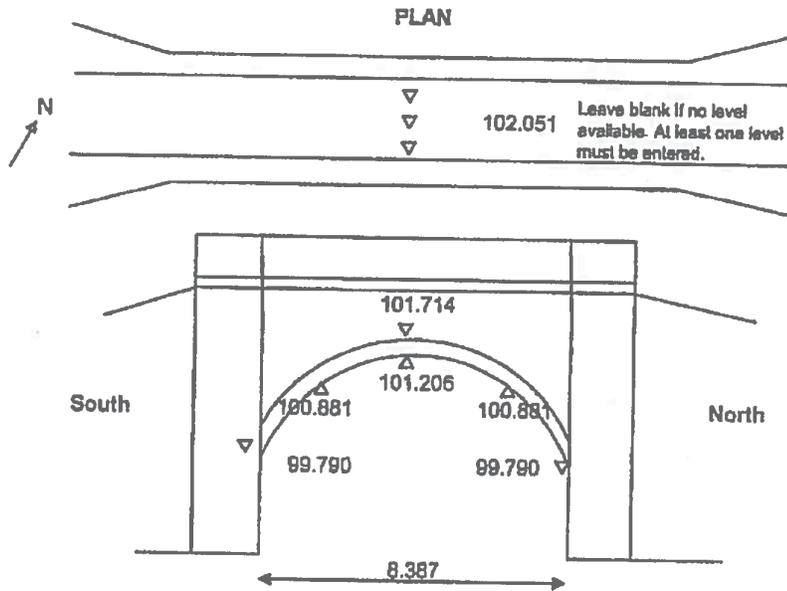
Superseded by Calculation No.	Date
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For design criteria, refer to Approval in Principle (Form AA) document

CALCULATION SHEET

JACOBS

Project Title :	HRE - MAJOR WORKS VAR9/4635	Sheet No :	1
Subject :	AYT/55 BE4 MEXE	Calc No :	288
Job No :	B18280DR	File :	R22
Made by :	[REDACTED]	Date :	10/08/2015
Checked by :	[REDACTED]	Revised by :	[REDACTED]
		Date :	5/1/16
		Checked by :	[REDACTED]
		Date :	[REDACTED]



Dimensions taken from site measurements / Desk study

Span	L =	8.387 m
Rise of arch barrel at crown	rc =	1.416 m
Rise of arch barrel at 1/4 pts	rq =	1.091 m
Thickness of arch barrel adjacent to keystone	d =	0.508 m
Average depth of fill bet. road surface & arch barrel at crown	h =	0.3370 m

Notes:

The factors represent the general condition of the soffit of the arch.

Note:-All measurements are in metres.

Structure Ref AYT/55 BE4 MEXE

Assessment of Masonry Arch by the Modified MEXE Method

Span L (m) 8.387
 Rise of arch barrel at crown r_c (m) 1.416
 Rise of arch barrel at 1/4 pto r_q (m) 1.091
 Thickness of arch barrel adjacent to keystones d (m) 0.508
 Av depth of fill between road surface & arch barrel at crown h (m) 0.337

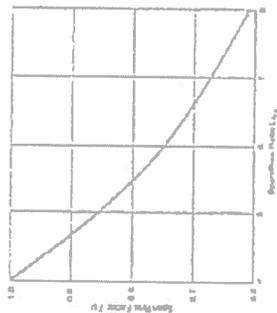


Fig 7

(max = 70)
 formula = $(748(d+h)^2 / L^3)$

(4 or less = span/rise factor = 1)

(Max = 1)

formula = $2.3(r_c - r_q / r_c)^{0.6}$

(table 3 BE4)

(table 4 BE4)

formula = $(r_c d) + (L h) / (d + h)$

(table 5 BE4)

(table 6 BE4)

(table 7 BE4)

formula = $F_w \cdot F_d \cdot F_m$

(0 = poor, 1 = good conditions)

Span factor due to pier flexibility

1.000

MODIFIED AXLE LOAD

11.04

formula = $F_w \cdot F_d \cdot F_m \cdot F_j \cdot F_{jk} \cdot PAL$

11 tons

According to Part III (Assessment of masonry and brick arch bridge-clause 2) a rating of >9 Tons means that the bridge is capable carrying vehicles with tandem 8 ton axles, and since a such bridge is also capable of carrying vehicles with a single 11 ton axle, it follows that the arch bridge with final assessment of >8 Tons is unsuited for all vehicles complying with Construction and Use Regulations (1967) issue



Figure 31 Arch Dimensions

Table 3

Concrete, unreinforced and half-reinforced masonry, with large shaped voussoirs	F _r	1.8
Concrete or engineering brick		1.2
Unreinforced, good masonry masonry and building bricks in good condition		1.0
Masonry of (any kind) in treatment in poor condition (masonry remains standing or fairly		0.7

Table 4

Concrete slab or masonry	F _m	1.0
Reinforced masonry (other than those with clay masonry)		0.9
Well compacted masonry		0.7
Weak masonry evidenced by cracking of fine masonry masonry		0.5

Table 5

Arch with width up to 6m	F _w	1.0
Arch with width between 6m and 12.5m		0.9
Arch with width over 12.5m		0.8

Table 6

Pierced piers in good condition	F _d	1.0
Unpierced piers, piers in poor condition and piers with up to 6.5m from edge (occasionally piers with less than 1.5m from edge) (masonry in the ring satisfactory) (Dist)		0.8
Arch	F _j	1.0
Unreliable		0.8
Table 7		

Table 8

Arch in good condition	F _m	1.0
Lesser or faulty masonry		0.8

Table 9

Span factor (from RIZCDD 15 Section 3 3.2)	F _w	1.0
Arch supported on one abutment and one pier		0.8
Arch supported on two piers		0.8
Arch supported on one abutment and two piers		0.8

