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HRE Assessment Programme

Highways England - Historical Railways Estate

WAB/8, Waltham to Chadwell Road, Leicestershire

BD21 Assessment and Inspection Report

0450000 | Form AA/BA

December 2016

VAR9/4924

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Document control sheet

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July 2015

Project:	HRE Assessment Programme		
Client:	Highways England - Historical Railways Estate	**Project Number:**	**B28280AT**
Document Title:	WAB/8 BD21 Assessment and Inspection Report		
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		Originated by		Checked by		Reviewed by	
ORIGINAL	**ISSUE 01**	NAME [redacted]	Initials	[redacted]	Initials	NAME [redacted]	Initials [redacted]
Approved by		NAME [redacted]	I confirm that the above document(s) have been subjected to Jacobs' Check and Review procedure and that I approve them for issue				
DATE	**Dec 2016**	**Document status: Contractor Issue**					

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Contents

Executive Summary 1
1. General Description and Structural Details 2
1.1 Introduction 2
1.2 Location and General Description 2
1.3 Construction type 2
2. Information Search 3
2.1 Services Search 3
2.2 Site Investigation Description and Results 3
2.3 Existing Drawings 3
3. Structure Condition 4
3.1 General 4
3.2 Structure Condition 4
3.2.1 Arch barrel 4
3.2.2 Abutments 4
3.2.3 Spandrels 4
3.2.4 Wingwalls 4
3.2.5 Parapets 5
3.2.6 Formation 5
3.2.7 Road Surface 5
4. Assessment to BD21/01 6
4.1 Methodology 6
4.2 Results 6
4.2.1 Arch barrel (MEXE assessment) 6
4.2.2 Substructure 6
5. Conclusions and Recommendations 7

Appendix A. Photographs
Appendix B. Form AA
Appendix C. Form BA
Appendix D. Historical Information
Appendix E. Survey Sketches
Appendix F. Calculations

Executive Summary

Structure Type: Single span overbridge

Superstructure Form: Segmental profiled, common red brick arch

Substructure Form: Gravity type, masonry abutments, spandrels and wingwalls

Span: Clear square span 4.87m (16' – 0"), clear skew span 5.03m (16' – 6"), skew angle of 14°

Assessment Code: BD21

Live load capacity: 40/44 tonnes GVW – Full BD21 Loading

Modified Axle Load: 13 tonnes

Restriction: None

Condition: Fair

Local Authority: Leicestershire

OS Reference: SK 799 268

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 HRE and should not be relied on by third parties. It has been based on site measurements and investigation by Jacobs or historical information provided by 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. Close inspection of members was limited by the constraints of safe access possible within a single site visit.

Identification of defects is principally based on ground level observation of visible members. The structural arrangement of the bridge meant that the following elements were not examined as part of the inspection for assessment:

- The arch barrel backfill was not investigated; by agreement with 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 capacity demonstrated by this assessment shows that even a significant reduction of this factor would not cause the bridge to fail.
- 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 (HRE) to undertake a BD21 MEXE assessment of overbridge WAB/8.

1.2 Location and General Description

Bridge WAB/8 carries an unclassified road over the dismantled Waltham Branch (Melton Mowbray) railway line, approximately 2.25 miles north east of Scalford, Leicester.

The road is a single carriageway, 3.25m (10' – 8") wide at the centre of the span. Grass verges line both sides of the road, 1.42m (4' – 8") and 3.03m (9' – 11") wide on the east and west sides respectively. The overall width between parapets is 7.70m (25' – 3"). Refer to the plan at road level in Appendix E for carriageway dimensions.

Traffic flow across the bridge is light. No HGV use was observed during the survey but due to the nature of the surrounding land, agricultural vehicle use is expected.

The OS grid reference is SK 799 268.

The line opened in 1879 and it is probable that the bridge dates from this time.

1.3 Construction type

The bridge is a skewed, single span overbridge. The clear square span is 4.87m (16' – 0") and the clear skew span is 5.03m (16' – 6"), giving a skew angle of 14°.

The arch barrel profile is segmental constructed from common red brick. It has a rise of 1.51m (4' – 11") at the crown. The thickness of the arch barrel was taken from historical information as 458mm (1' – 6"); refer to Appendix D.

The arch is supported on gravity type abutments constructed from common red brick. The parapets, wingwalls and spandrels are constructed from stone blocks.

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.

2.3 Existing Drawings

None.

3. Structure Condition

3.1 General

The survey and inspection for BD21 assessment was undertaken on Thursday 16th June 2016. Weather conditions were sunny with a temperature of 15°C.

Parking was available to the north of the structure on a wide verge.

Access to the formation was gained via the vehicle access slope to the south west of the structure.

3.2 Structure Condition

3.2.1 Arch barrel

A 15mm wide vertical fracture, originating from the crown of arch extends down to the abutment face along the centreline of the barrel (Photograph 6). The fracture appears to be active judging by the freshly exposed brick surfaces. It is noted that although detailed monitoring is being carried out on cracks in the parapets, this fracture is not even tabbed. The arch appears to be breaking into two independent sections. A condition factor of 0.4 is derived accounting for the longitudinal fracture, slight flattening of the arch towards the north east corner and ring separation (Photograph 1); (BA16/97 Clause 3.17 – 3.21).

The arch barrel is constructed from common red bricks in fair condition. There are damp patches, isolated open joints and spalled brickwork up to 20 mm depth within the central 1/3. The southern central area of arch barrel has algal staining with mortar loss up to 20mm and 50mm depth of spalled brickwork (Photographs 5, 7 and 8). A barrel factor of 0.85 is considered appropriate for common red brick in fair condition (BA 16/97 Table 3/1).

The carriageway construction above the arch is in fair condition with no significant settlement or tracking. Since no intrusive investigation was carried out it is assumed that the backfill is compacted granular material; therefore a fill factor of 0.7 applies (BA 16/97 Table 3/2).

The mortar joints are up to 12.5mm in width; therefore a width factor of 0.9 is applicable (BA 16/97 Table 3/3). A mortar factor of 0.9 is recommended to account for possible softening of the mortar due to the widespread dampness and algal staining (BA 16/97 Table 3/4). Apart from isolated areas of open joints and mortar loss at the crown, the joints appear to be well filled; therefore a depth factor of 0.95 is appropriate (BA 16/97 Table 3/5).

3.2.2 Abutments

The north abutment is in poor condition. There is a fracture 15mm wide the height of the abutment which continues into the crown of arch barrel. Due to the presence of a timber shed adjacent to the abutment wall, a close inspection of the fracture was not possible (Photograph 9). There is algal staining throughout with isolated leachate patches across the whole surface. A vertical fracture, 2mm wide, originating from the north east springing point stretches approx.1.9m down to the abutment face (Photograph 10).

The south abutment is in fair condition with algal covering a third of the surface area. There are stowed materials across the wall which prevents the closest inspection of the lower half (Photograph 11).

3.2.3 Spandrels

Both spandrel walls are in fair condition (Photographs 16- 20). Mortar repairs have been carried out between the south east spandrel and the buttress.

3.2.4 Wingwalls

The wingwalls are all in fair condition.

The north east and south west wingwalls are in similar condition with isolated fractured and spalled blocks. There are patches of open joints, up to 10mm wide. There is light vegetation growth within the open joints on the south east wall. Dense vegetation and mature trees growing in front of the north east wall limited close inspection (Photographs 12 and 13).

The north west and south west wingwalls have isolated areas of mortar loss. There is a mortar repair 0.5m^2 at the base of south west wall (Photographs 14 and 15).

3.2.5 Parapets

Both parapets are in fair condition with damp stains and weathering. On both sides of the parapets there are mortar repairs up to 20mm in width. The majority of the repairs are open up to 2mm. On both inner faces there are step fractures adjacent to repaired fractures with open up to 5mm (Photographs 20 and 21). This is could be a result of ground settlement above all wingwalls of the structure.

3.2.6 Formation

Mature trees are growing on the shallow cutting slopes both east and west of the structure (Photographs 23 and 24). There is a shed and materials storage on the formation beneath the arch with light vegetation growth towards the north east (Photographs 1 and 2).

3.2.7 Road Surface

The road surface above the structure is in fair condition (Photographs 3 and 4).

4. Assessment to BD21/01

4.1 Methodology

The following table summarises the condition/modifying factors used in the modified MEXE method of assessment as outlined in Chapter 3 of BA16/97. The factors represent general condition of the elements of the structure, as taken from justifications in section 3.2.1 of this report. The thickness of the arch barrel was ascertained via level survey as 458mm (1' – 6") for the purpose of this assessment.

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	0.70
Width of Joint factor, F_w	0.90
Depth Factor, F_d	0.95
Mortar Factor, F_{mo}	0.90
General condition factor of bridge, F_{cm}	0.40

Table 1: Factors used for MEXE analysis

Axle lift off was not considered as part of these calculations.

4.2 Results

4.2.1 Arch barrel (MEXE assessment)

Arch span	Modified axle load	BD21 assessment result
5.03m	13	**40/44 tonnes**

Table 2: MEXE analysis results

Axle Factor		Permitted Axle load
Single	1.15	15.475
Two axle bogie	1.00	13.490
Three axle bogie	1.00	13.490

Table 3: Axle factors and resulting modified axle loads

The modified axle load obtained from the MEXE analysis was 13 tonnes. After applying the axle factors, a rating greater than 11.5, 10 and 8 for single, double and triple axles respectively means that the bridge can carry a max gross vehicle weight of 40/44 tonnes and is therefore unrestricted for all vehicles complying with Road Vehicles (Authorised Weight) Regulations (BD 21 (DMRB 3.4.3)).

4.2.2 Substructure

The vertical fracture through the north abutment raises concerns regarding the capacity of the substructure. The substructure currently appears to be satisfactory for vehicles conforming to the Road Vehicles (Authorised Weight) Regulations (BD 21 (DMRB 3.4.3)), though should be monitored closely.

5. Conclusions and Recommendations

As determined by this MEXE assessment, the bridge can carry 40/44 tonne AW loading in accordance with BD21/01, however the longitudinal fracture through the northern half of the bridge's centreline raises concerns regarding the bridge's condition. The fracture is an indication that the arch barrel is actively breaking up into independent sections; it is recommended that major works to prevent further deterioration are undertaken.

The fracture appears to be a result of differential settlement across the northern abutment. This is also reflected in movement in the parapets. Traditional brickwork repairs alone would not be sufficient to repair the fracture or prevent further movement. More extensive repair works, such as underpinning, may prevent further separation of the arch, though structural infilling may provide a more cost effective solution once the additional arch defect repairs are considered.

Previous examinations detail the fracture in a similar condition to that recorded during this assessment as early as 2003. Although it would appear that the fracture is old standing and no longer active, parapet fracture movements have been recorded in recent years. There are no devices such as mortar tabs or avonguards installed to monitor and confirm movement across the abutment or arch barrel. The fracture should be monitored closely for further movement prior to the completion of major works.

The vertical fracture through the north abutment raises concerns regarding the capacity of the substructure also. This should also be monitored closely prior to the completion of major works.

Appendix A. Photographs

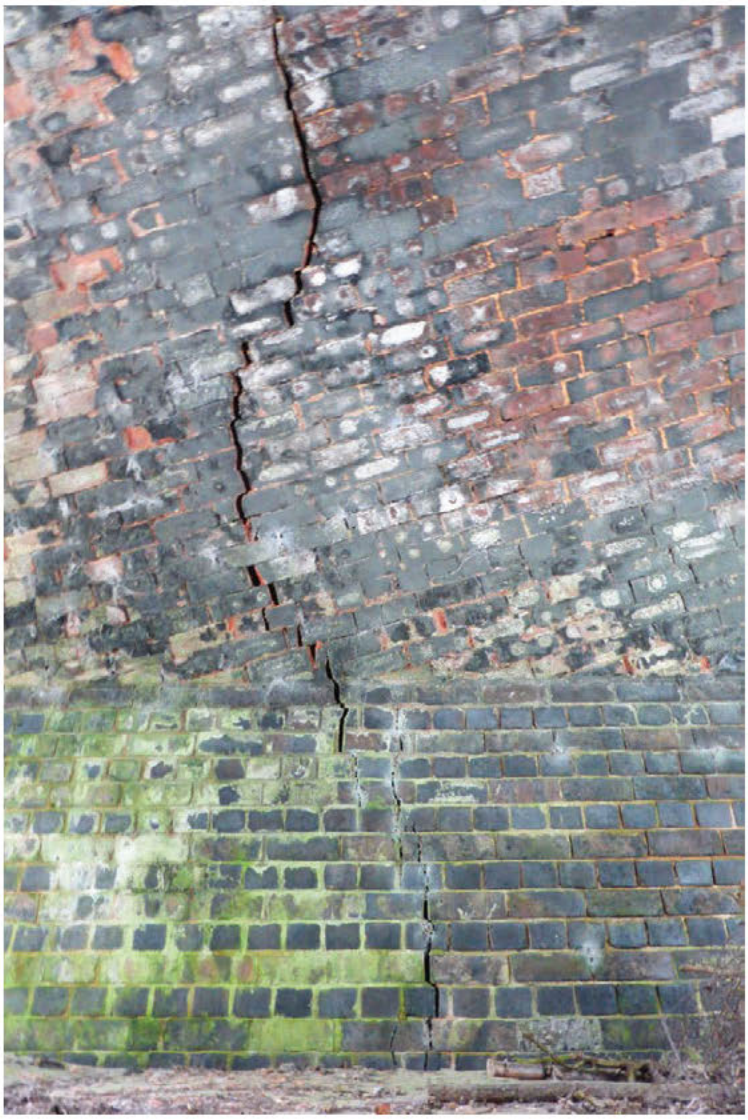
1) East elevation

2) West elevation

3) View of carriageway approach looking north

4) View of carriageway approach looking south

5) North east view of the arch barrel



6) North west view of the arch barrel – fracture originating from arch barrel down to abutment

7) South east view of the arch barrel

8) South west view pf the arch barrel

9) North abutment

10) North abutment – fracture view behind the shed

11) South abutment

12) South east wingwall

13) North east wingwall

14) South west wingwall

15) North west wingwall

16) North west spandrel

17) South west spandrel

18) South east spandrel

19) North east spandrel

20) East central spandrel

21) West parapet

22) East parapet

23) Formation looking east

24) Formation looking west

Appendix B. Form AA

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

Appendix: 4

ELR/ Bridge No WAB/8 Issue: 1

Revision: B (Nov 2000)

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Bridge/Line Name: **Waltham to Chadwell Road / Waltham Branch (Melton Mowbray)**

ELR/Bridge No. **WAB/8**

Brief Description of Existing Bridge:

(a) Span Arrangement

The structure is a skewed, single span overbridge. The clear square span is 4.87m (16' – 0") and the clear skew span is 5.03m (16' – 6"), giving a skew angle of 14°.

(b) Superstructure Type

The arch barrel profile is segmental constructed from red common brick. It has a rise of 1.51m (4' – 11") at the crown. The thickness of the arch barrel was taken from historical information as 458mm (1' – 6").

(c) Substructure Type

The substructure comprises gravity type abutments constructed from common red brick. The parapets, wingwalls and spandrels are constructed from masonry blocks.

(d) Planned highway works/modifications at this site

None

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

The bridge carries an unclassified road over the dismantled Waltham Branch (Melton Mowbray) railway line, approximately 2.25 miles north east of Scalford, Leicester. The road is a single carriageway, 3.25m (10' – 8") wide at the centre of the span. Grass verges line both sides of the road, 1.42m (4' – 8") and 3.03m (9' – 11") wide on the east and west sides respectively. The overall width between parapets is 7.70m (25' – 3"). Traffic flow across the bridge is light. No HGV use was observed during the survey but due to the nature of the surrounding land, agricultural vehicle use is expected.

(f) Any other requirements

None

Assessment Criteria

(a) Loadings and Speed

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

Appendix: 4

ELR/ Bridge No WAB/8 Issue: 1

Revision: B (Nov 2000)

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Dimensions and condition factors are obtained from site measurements and inspection. (See Jacobs report "VAR9-4924 Assessment Programme – Assessment and Inspection Report – Bridge Ref.: WAB/8 – December 2016). The bridge is to be assessed vehicle loading obtained from and applied in accordance with BD/21. A permissible axle load will be calculated and the allowable gross vehicle weight will be identified from Table 3/6 of BA16/97.

(b) Codes to be used

BD21/01 "The Assessment of Highway Bridges and Structures"

BA16/97 "The Assessment of Highway Bridges and Structures" (Incorporating amendment No 1 dated November 1997 and Amendment No 2 dated November 2001) Proposed Method of Structural Analysis

(c) Proposed Method of Structural Analysis

It is proposed to use the modified MEXE method outlined in BA16/97 Chapter 3 to assess the arch barrel capacity.

The following factors are proposed for the modified MEXE assessment:

Barrel factor	F_b	0.85
Fill Factor	F_f	0.70
(Joint) width factor	F_w	0.90
(Joint) depth factor	F_d	0.95
Mortar factor	F_{mo}	0.90
Condition factor	F_{cm}	0.40

A qualitative assessment based on the site inspection is to be used to estimate the capacity of the substructure.

FORM 'AA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: B (Nov 2000)

ELR/ Bridge No WAB/8

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 [redacted]

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
Appendix: 4
Issue: 1
Revision: A (Dec 2005)

ELR/ Bridge No WAB/8

CERTIFICATION FOR ASSESSMENT CHECK

Assessment Group: **Jacobs UK Ltd**

Bridge/Line Name: **Waltham to Chadwell Road / Waltham Branch (Melton Mowbray)**

Category of Check: **1**

ELR/ Bridge No: **WAB/8**

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 as recorded on the accompanying Form AA.

(2) It has been checked for compliance with the following principal British Standards, Codes of Practice, BRB (Residuary) Limited technical notes and Assessment standards:

- BD21/01 – The Assessment of Highway Bridges and Structures
- BA16/97 – The Assessment of Highway Bridges and Structures

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

None

Category 1

[redacted]

Assessor

Assessment Checker

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

FORM 'BA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Dec 2005)

ELR/ Bridge No WAB/8

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 [redacted] cker is

This Certificate is accepted by... [redacted] .....

FORM 'BAA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Dec 2005)

ELR/ Bridge No WAB/8

CERTIFICATION FOR ASSESSMENT CHECK

Notification of Assessment Check

Assessment Group	Jacobs UK Ltd
Bridge Name/Road No.	Waltham to Chadwell Road / unclassified road
Line Name	Waltham Branch (Melton Mowbray)
ELR Code/Structure No.	WAB/8

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

Superstructure	Full loading to BD21 – 40/44tonne GVW
Substructure	Full BD21 loading by qualitative assessment

Recommended Loading Restrictions

None

Description of Structural Deficiencies and Recommended Strengthening

The longitudinal fracture through the northern half of the bridge's centreline raises concerns regarding the bridge's condition. It is recommended that major works such as extensive repair works which may prevent further separation of the arch or structural infilling which may provide a more cost effective solution are undertaken.

[redacted]

or

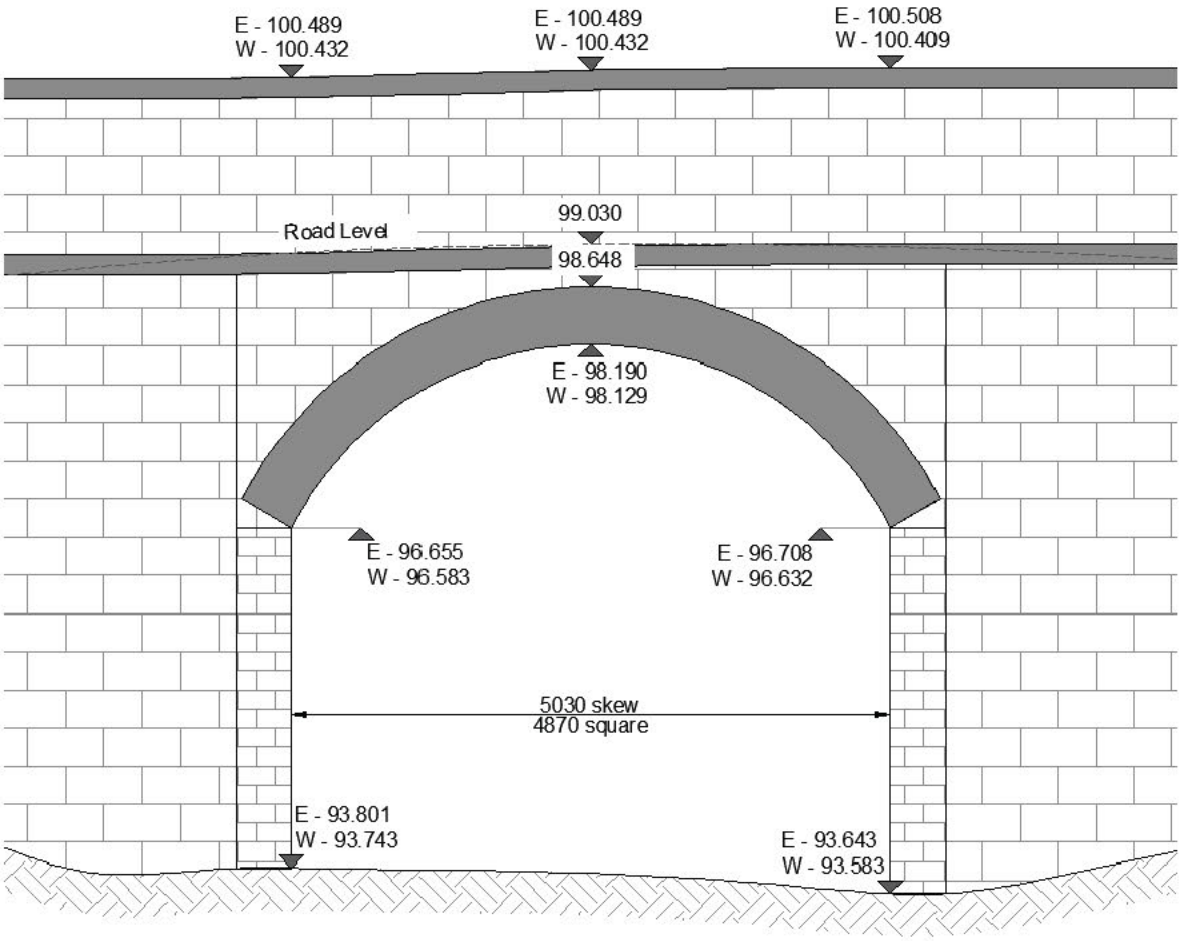
ment Checker

ed signatory of the firm of Consulting Engineers to whom sessor/Checker is sponsible.

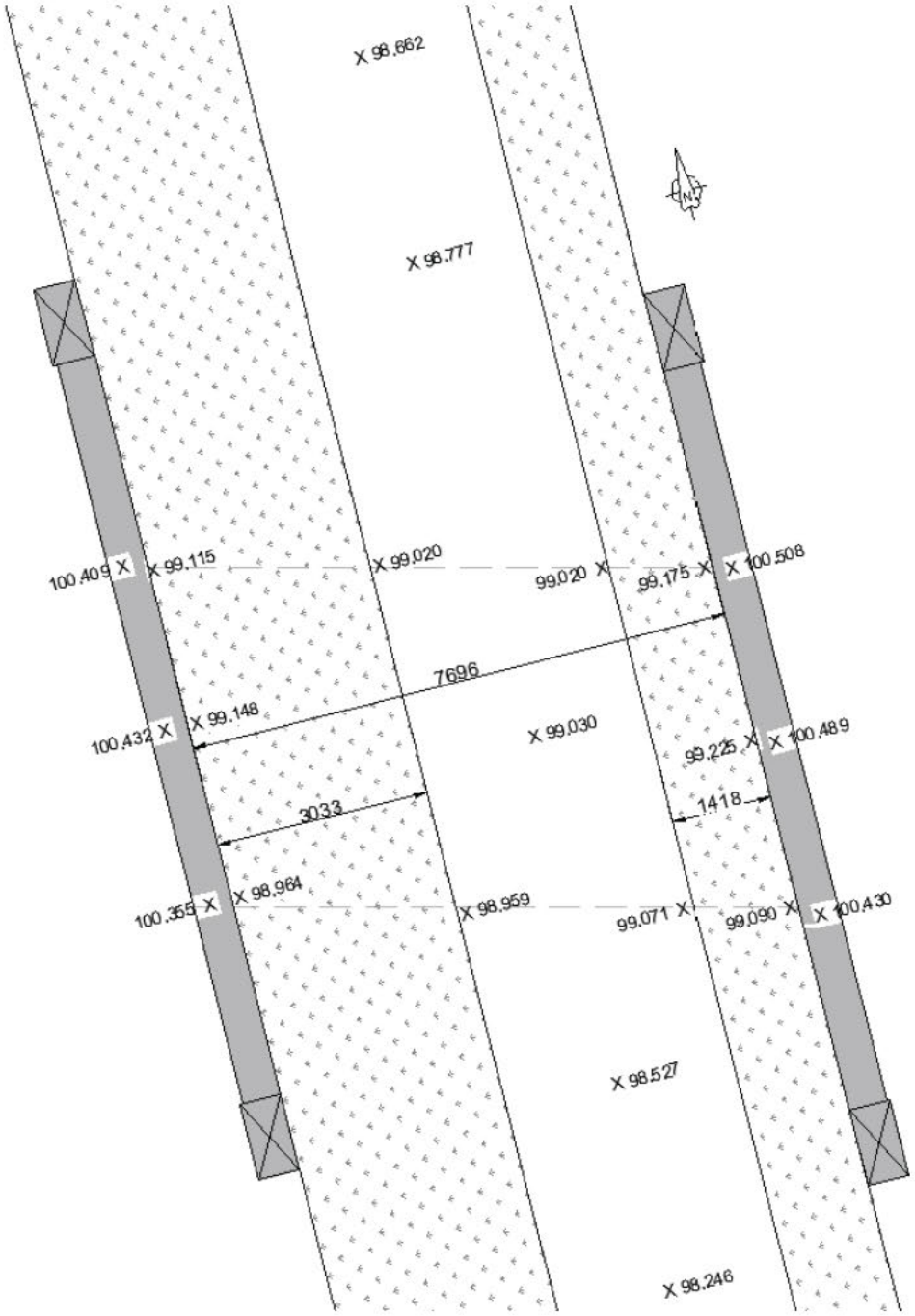
This Certificate is accepted by.. [redacted] .....

Appendix D. Historical Information

Appendix E. Survey Sketches



East elevation


X 98.662
X 98.777
100.409 X
X 99.115
X 99.020
99.020 X
99.175 X
X 100.508
7696
100.432 X
X 99.148
X 99.030
99.225 X
X 100.489
3033
1418
100.355 X
X 98.964
X 98.959
99.071 X
99.090 X
X 100.430
X 98.527
X 98.246

Plan

Appendix F. Calculations

CALCULATION COVER SHEET

Jacobs
York

Project Title: HRE Works Framework	Calc. No.: 449943
Job No: B28280AT	File: VAR9/4924

Project Manager	[redacted]	Subject:	**WAB/8**
Assessor			Leicestershire
Project Group	31200		BD21 Assessment

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	3	[redacted]	Oct-16	[redacted]	Oct-16	[redacted]	Dec-16		
Rev									
Rev									
Rev									
Rev									
Rev									

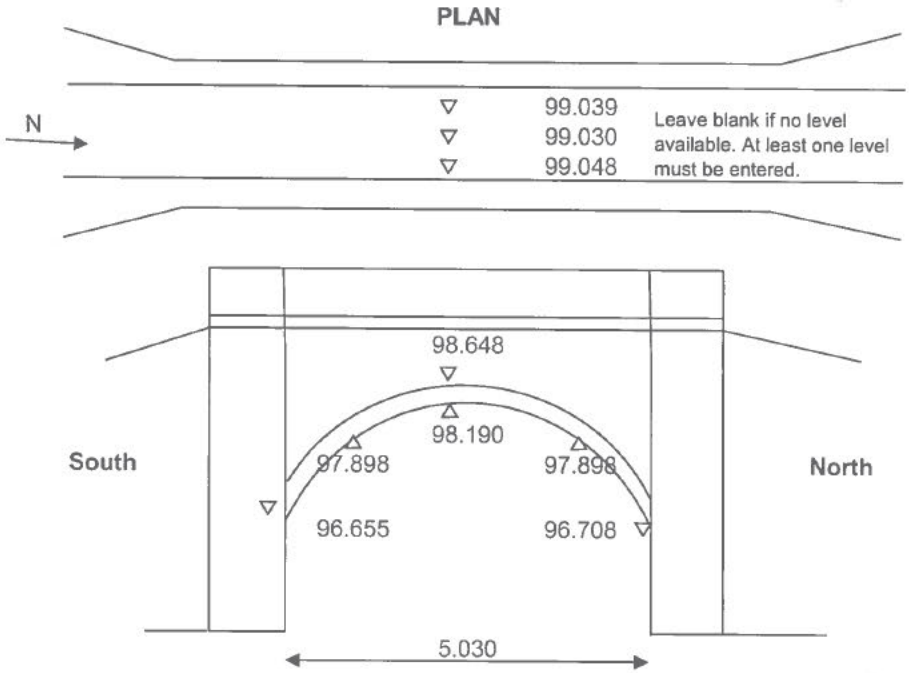
Superseded by Calculation No. Date

For assessment criteria, refer to Approval in Principle (Form AA/BA) document

CALCULATION SHEET

JACOBS

Project Title :	HRE Assessment Programme			Sheet No :	1
Subject :	WAB/8			Calc No :	449943
Job No :	B28280AT			File :	VAR9/4924
Made by :	[redacted]	Date : 11/10/2016	Revised by :	[redacted]	Date : 20/12/2016
Checked by :	[redacted]	Date : 03/11/2016	Checked by		Date :



Dimensions taken from site measurements / ~~Desk study~~

Span	L =	5.03 m
Rise of arch barrel at crown	rc =	1.509 m
Rise of arch barrel at 1/4 pts	rq =	1.216 m
Thickness of arch barrel adjacent to keystone	d =	0.458 m
Av depth of fill bet. road surface & arch barrel at crown	h =	0.3910 m

Notes:
Arch barrel profile is segmental, therefore rise at quarter points are calculated through calculations.
Thickness of arch barrel ascertained via historical information

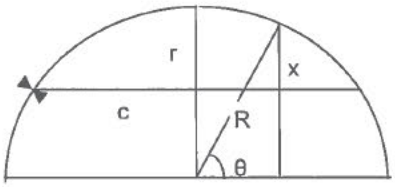
The factors represent the general condition of the soffit of the arch.

Note:-*All measurements are in metres.*

CALCULATION SHEET

JACOBS

Project Titl	HRE Assessment Programme			Sheet No :	2
Subject :	WAB/8			Calc No :	449943
Job No :	B28280AT			File :	VAR9/4924
Made by	[redacted]	Date :	11/10/2016	Revised by :	Date :
Checked by :		Date :		Checked by	Date :



Rise at crown, r = 1.5085 m
Span = 5.030 m
Half span, c= 2.515 m

Radius $R = (c^2 + r^2) / 2r$

Radius R = 2.850778 m

Angle subtended, $\theta = \cos^{-1}((\text{span}/4) / R)$ = 63.82542 deg

Quarter. pt. rise, $x = R \sin\theta - (R - r)$ = 1.216 m

Structure Ref WAB/8

Assessment of Masonry Arch by the Modified MEXE Method

Span L (m)	5.030	Data from survey
Rise of arch barrel at crown r_c (m)	1.509	Data from survey
Rise of arch barrel at 1/4 pts r_q (m)	1.216	Data from survey
Thickness of arch barrel adjacent to keystone d (m)	0.458	Data from survey
Av depth of fill between road surface & arch barrel at crown h (m)	0.391	Data from survey

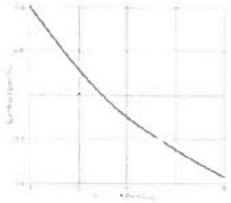


Fig 3/3

PAL	65.31437	(max = 70)
PAL	**65.3144**	*(formula =(740[d+h]^2)/L$^{1.3}$)*
Span/Rise Ratio	**3.334438**	(4 or less = span/rise factor =1)
Span/Rise factor F_{sr}	1	(if greater than 4, F_{sr} from figure 3/3 of BA16/97)
Profile factor F_p	**0.85927**	(Max = 1) *(formula =2.3([r_c-r_q]/r_c)$^{0.8}$)*
Barrel factor F_b	0.85	(refer table 3/1 BA16/97)
Fill factor Ff	0.7	(refer table 3/2 BA16/97)
Material Factor F_m	**0.78**	*(formula =[(f_b.d)+(ff.h)]/(d+h)*
Width factor F_w	0.9	(refer table 3/3 BA16/97)
Depth Factor F_d	0.95	(refer table 3/5 BA16/97)
Mortar factor F_{mo}	0.9	(refer table 3/4 BA16/97)
Joint Factor F_j	**0.7695**	*(formula = F_w.F_d.F_{mo})*
Condition factor F_{cM}	0.4	(0= poor, 1 = good condition)
MODIFIED AXLE LOAD	**13.49**	
(formula = F_w.F_p.F_m.F_j.F_{cM}.PAL)	13 tonnes	(Round up or down to nearest ton)

AXLE FACTORS

single axle factor	1.15
two axle bogie factor	1.00
3 axle bogie factor	1.00

AXLE LOAD (TONNES)

Single	15.47498
Double	13.49002
Triple	13.49002

rating 40/44 tonnes GVW **(see table 3/6)**

Allowable Axle Load (tonnes) per axle			Max Gross Vehicle Weight (gvw) (tonnes)	Weight Restriction (tonnes)	Type of Vehicle
Single	Double	Triple			
11.5	10	8*	40/44	N/A	HGV 5 or 6 axles
11.5	9.5	-	32	33	HGV 4 axles
11.5	9.5	-	26	26	HGV 3 axles
11.5	-	-	18	18	HGV 2 axles
9	-	-	12.5	13	
7	-	-	10	10	
5.5	-	-	7.5	7.5	LGV
2	-	-	3	3	Car/Van

Table 3.6 Load Capacity and Gross Vehicle Weight Restrictions for Masonry Arches

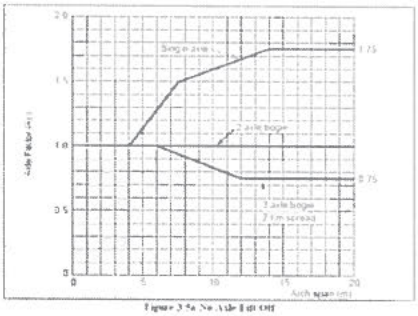


Figure 3.5a No Axle Limit

SHEET No	3
CALC No	449943
FILE	VAR9/4924
JOB No	B28280AT
MADE BY	[redacted]
CHECKED BY	