British Rail Property Board, 2001/02

Bedfordshire County Council

Southill Road Railway Bridge

No. HIB27

Assessment Report

080714

October 2002

Babtie Group Box 272, The Merton Centre, 45 St. Peter's Street, Bedford MK40 2ZY
Tel No 01234 763400 Fax No 01234 763401

Our ref BP/80714
Please reply to [redacted]
Direct Dialling No
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Your ref

Bedfordshire
county council

c/o Babtie Group
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The Merton Centre
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Tel : 01234 763400
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9th July 2003

Mr [redacted]
British Railways Board (Residuary) Ltd
Rail Property Ltd
Hudson House
YORK
Y01 6HP

Dear [redacted]

ASSESSMENT OF BRB BRIDGES IN BEDFORDSHIRE
SOUTHILL ROAD RAILWAY BRIDGE (HIB27)
AMENDED ASSESSMENT

We have now completed our re-assessment of HIB27 as discussed at our meeting of 25th June 2003.

As expected, the use of the revised joint depth factor has increased the allowable single axle load to 9.0 tonnes. The assessed capacity of the bridge is now 13 Tonnes (12.5T GVW).

As previously agreed at our meeting I enclose the following revised pages for incorporation into your copy of the previous report.

- Page Nos 1, 2, 4, 6 & 7 of the assessment report
- Amended Form BA (2 pages)
- Amended Form BAA (2 pages)
- Amended calculation pages 5, 6, 6a, 10 & 15.

I look forward to receiving a copy of the countersigned Forms BA and BAA in due course.

Yours sincerely

[redacted]

DOCUMENT ISSUE RECORD

Document	Status	Issued to	No. of copies	Date of issue	Signed
Form AA	Final	Rail Property Ltd	1	1/05/2002	
Assessment Report	Final	Rail Property Ltd	1	28/10/02	MY
Assessment Report	Final	Beds CC	1	11/11/02	MY
Assessment Report Revised pages	Final	Rail Property Ltd	1	9/7/03	BEY
Assessment Report Revised pages	Final	Beds CC	1	9/7/03	BEY

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APPENDICES

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SYNOPSIS OF ASSESSMENT RESULTS

Arch Assessment

The Assessment Capacity of the Bridge is 12.5 Tonnes GVW (13 Tonne Restricted Live Loading) with no restriction to Fire Engine Group 2.

1.0 Introduction

1.1 Structure Details

Bridge name	Southill Road Bridge
Bridge no.	Rail: HIB 27
	BCC U147/9027
OS reference	TL 0907 4689

1.2 Structure Description

The bridge carries the U147 Southill Road over a disused railway and is located 1 km south of Cardington village. The date of construction is not known, but possibly built in 1855 as other bridges on the same line.

The bridge is a single span four ring brick arch supported on brick abutments. The wingwalls, spandrels and parapets are of brick. The foundations are assumed to be spread footings. The Bridge has a skew of 21 degree.

2.0 Assessment

2.1 Assessment of Brick Arches

The assessment of the arch has been carried out using the Modified MEXE Method, and the capacity has been confirmed, using the ARCHIE computer program.

The assessment is based upon the AA form dated 28th April 2002, prepared by the Babtie Group on behalf of Bedfordshire County Council. Centrifugal effects have been ignored in the assessment as the road is of straight alignment over the structure. Axle-lift off has been considered in the assessment because of the humped vertical curve over the structure.

2.2 Assessment of Substructure and Foundations

The abutments and wing walls have been assessed qualitatively in accordance with Chapter 8 of BD 21/01.

3.0 Design Parameters and Material Strengths used in the Assessment

The following parameters and material strengths (as stated in the Principle Inspection report, Appendix F) have been used in the assessment.

3.1 Factors used for modified MEXE method and ARCHIE collapse mechanism method

The following factors have been determined from the assessment inspection and used in the MEXE and ARCHIE assessments of each arch:

Barrel Factor F_b	1.0	
Fill Factor F_f	0.7	
Joint Width Factor F_w	0.9	
Mortar Factor F_{mo}	1.0	
Joint Depth Factor F_d	0.9	(As bottom ring ignored, F_d taken as 1.0)
Condition Factor F_{cm}	0.6	

No record drawings are available for the structure, which state type of brickwork and mortar used.

3.2 Arch Profile

The inspection has identified that there is longitudinal cracking, seepage deposit and areas of hollow sounding brickwork in the arch intrados. Therefore a barrel with thickness of 3 rings has been used in the assessment as it is assumed the lower (fourth) ring is ineffective due to ring separation.

3.3 Additional information

Additional information was obtained from the following drawings, which are contained in Appendix B and D of the Assessment Inspection Report.

Drg. Nos.	Drawing Description
HIB27/1	Plan And Levels
HIB27/2	East Elevation
HIB27/3	West Elevation
HIB27/4	Cross Sections 1
HIB27/5	General Arrangement
HIB27/06	Elevations Defects
HIB27/07	Arch Defects
HIB27/08	Abutment Defects
HIB27/09	Carriageway Defects

3.4 Assessment Loading

The structure has been assessed for the 40/44 tonne assessment live loading in accordance with the Approval in Principle document.

4.0 Assessment Results

4.1 Structure Assessment Summary of Results:

Structure Name: **SOUTHILL ROAD BRIDGE**	HIB 27 BCC U147/9027	
MODIFIED MEXE ANALYSIS		
ASSESSMENT LIVE LOADING		
Allowable gross Axle Weight:	Axle weight	Capacity
Single axle	9.03 T	12.5 T GVW
Double axle bogie (lift off)	4.37 T	-
Triple axle bogie	5.25 T	-
CAPACITY	**12.5 Tonnes GVW (13 Tonne Restriction) with no Restriction to Fire Engine Group 2** (From ANNEX F. Table F1 – BD21/01)	

Structure Name: **SOUTHILL ROAD BRIDGE**	HIB 27 BCC U147/9027
ARCHIE ANALYSIS	
ASSESSMENT LIVE LOADING	**PASS/FAIL**
Single Axle 10.5t (33-17t Restriction)	Fail
Double Axle 18t (25t Restriction)	Fail
Single Axle (13t Restriction)	Fail
Single Axle (10t Restriction)	Fail
Single Axle (7.5t Restriction)	Fail
Single Axle (3.0t Restriction	Pass

The following boxes are NOT to be completed by the Consultant unless authorised to do so by the Employer's Representative.

SI 1705 (1972) Loading Pass / Fail	

4.2 Substructure and Foundations

The abutments and the walls were assessed visually during the assessment inspection in accordance with Chapter 8 of BD 21/01. There are a number of hairline cracks in both north and south abutment walls, which may appear to be due to movement/settlement of foundations. However it is considered that the condition factor of 0.6 has taken this into account in the assessment of the arch.

There are a number of defects such as areas of poor joints, surface spalling, hollow brickwork, bulging and cracks to both south-east and south-west wingwalls. Whilst there is no evidence of failure of the walls due to rotation or forward movement, the above mentioned defects do give cause of concern. The walls are accordingly considered to be inadequate by inspection until such time as the defects are repaired, and the walls proven adequate by calculation. As the thicknesses of the walls and dimensions of their foundations, and ground conditions are unknown, an extensive site investigation would need to be carried out prior to any proposed analytical assessment.

5.0 Discussion of Assessment Results

5.1 The assessment of the arch using the Modified MEXE Method indicates that it is capable of carrying vehicles of 12.5 T GVW (13 tonne restricted live loading) with no restrictions to Fire Engine Group 2.

5.2 A collapse mechanism analysis was carried out using the computer program ARCHIE in order to confirm the capacity of the arch. It gave a result of 3.0 tonnes. Therefore, in accordance with Clause 6.19 (i) in Chapter 6 of BD21/01, the capacity of 12.5 tonnes GVW calculated by the Modified MEXE Method shall be taken.

5.3 Ignoring the bottom ring in the assessment may be considered overly conservative. A sensitivity analysis was carried out in order to determine whether using 4 ring thick arch barrel and reducing the condition factor from 0.6 to 0.4 would significantly affect the results. The Capacity of the structure using modified MEXE method appears to lie between 10 and 18 tonnes depending upon the condition factor and number of rings used.

5.4 Investigation to determine the extent of ring separation is likely to prove inconclusive and is therefore not considered to be cost effective. Strictly in accordance with AIP, the capacity of the structure is 12.5 tonnes.

6.0 Conclusions

6.1 The overall carrying capacity of the structure is 12.5 tonnes GVW (13T Live Load Restriction) with no restrictions to Fire Engine Group 2.

Signed: [redacted]...

Date:

Name:

Signed: [redacted].....

Date:

Name:

APPENDIX A

Approval in Principle

FORM 'AA' (BRIDGES)

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

ELR/ Bridge No HIB 27

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Bridge/Line Name Southill Road Railway Bridge
ELR/Bridge No. HIB 27

Brief Description of Existing Bridge:

(a) Span Arrangement .

Single span masonry arch with skew span of 8.575 metres

(b) Superstructure Type

Square spanning single span brickwork arch. Voussoirs indicate a 4 ring arch 2 bricks thick.

(c) Substructure Type

Brickwork abutment, spandrels and wing walls.

(d) Details of any Special Features

None

Assessment Criteria

(a) Loadings and Speed

40/44 Tonne assessment loading of BD21/01.

There is no specific speed restriction on the road over the bridge. Therefore the general speed limit of 60mph (97 kph) for single carriageway roads applies.

(b) Codes to be used
RT/CE/P/010 (Issue 2-Dec 1997) Technical Approval Procedures for Assessment of Bridges and Other Structures.
BD21/01 The Assessment of Highways Bridges and Structures
BA16/97 The Assessment of Highways Bridges and Structures (Advice Note)
BA55/00 The Assessment of Bridge Substructures and Foundations, Retaining Walls and Buried Structures (Advice Note)

FORM 'AA' (BRIDGES)

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

ELR/ Bridge No HIB 27

APPROVAL IN PRINCIPLE FOR ASSESSMENT

(c) Proposed Method of Structural Analysis

The structure will be assessed initially using the Modified MEXE method. The inspection indicated large areas of hollow sounding brickwork. Accordingly it is proposed that the arch is assessed as consisting of 3 rings rather than 4. If the depth of fill over the arch exceeds the arch ring thickness then the depth of fill will be restricted to this lesser value in the calculations. If the capacity of the arch is below the 40/44 Tonne assessment level then the arch capacity will be confirmed using the ARCHIE computer program.(see Cl. 6.17 of BD21/01). Abutments and wingwalls will be assessed qualitatively in accordance with BD21/01 and BA55/00.

(d) Details of any Special Requirements

None

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 .....

Category 1

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

Signed ..
Title ..
Date ..

[redacted]

FORM 'AA' (BRIDGES)

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

ELR/ Bridge No HIB 27

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Category 2 and 3

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

Signed .....
Title .....
Date .....

Signed .....
Title .....
Date .....

FORM 'AA/1' (BRIDGES)

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

ELR/ Bridge No HIB 27

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Additional Information Required For BRB (Residuary) Limited Owned Public Road Overbridges Assessed As Part Of Bridgeguard III

Bridge/Line Name . Southill Road Railway Bridge

ELR/Bridge No. HIB 27

Scope Of Assessment Assessment of ability of the structure to carry current highway loading

Assessment Criteria

(a) Standards And Codes Of Practice To Be Used In Assessment

RT/CE/P/010 (Issue 2-Dec 1997) Technical Approval Procedures for Assessment of Bridges and Other Structures.
BD21/01 The Assessment of Highways Bridges and Structures
BA16/97 The Assessment of Highways Bridges and Structures (Advice Note)
BA55/00 The Assessment of Bridge Substructures and Foundations, Retaining Walls and Buried Structures (Advice Note)

(b) Proposed Method Of Structural Analysis

The structure will be assessed initially using the Modified MEXE method. The inspection indicated large areas of hollow sounding brickwork. Accordingly it is proposed that the arch is assessed as consisting of 3 rings rather than 4. If the depth of fill over the arch exceeds the arch ring thickness then the depth of fill will be restricted to this lesser value in the calculations. If the capacity of the arch is below the 40/44 Tonne assessment level then the arch capacity will be confirmed using the ARCHIE computer program.(see Cl. 6.17 of BD21/01). Abutments and wingwalls will be assessed qualitatively in accordance with BD21/01 and BA55/00.

(c) Planned Highway Works/Modifications At This Site

None

(d) Road Designation Class And Whether Classed As A Heavy Load Route

Unclassified county road. Not a Heavy Load Route.

FORM 'AA/1' (BRIDGES)

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

ELR/ Bridge No HIB 27

APPROVAL IN PRINCIPLE FOR ASSESSMENT

(e) Any Other Requirements

None

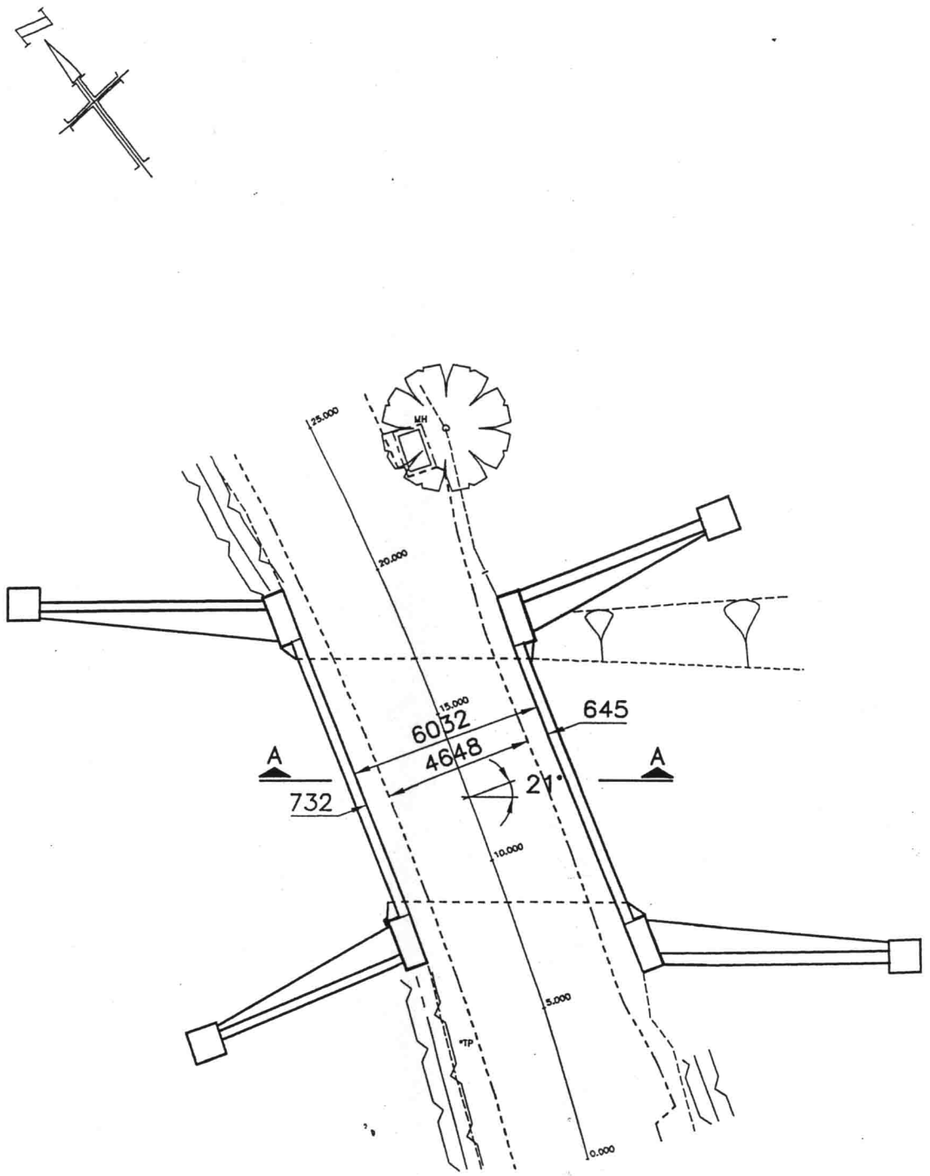
The Above Is Agreed Subject To The Amendments And Comments Shown Below.

Signed [redacted]

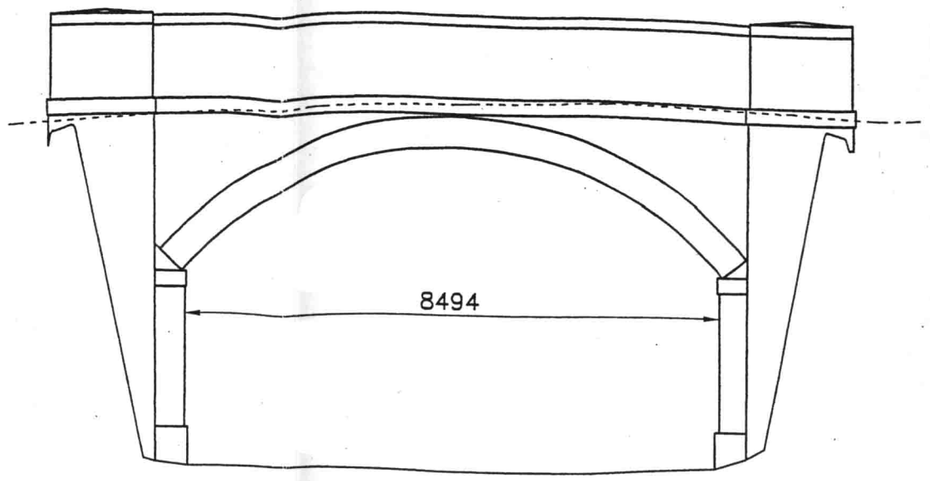
Title

For And On B

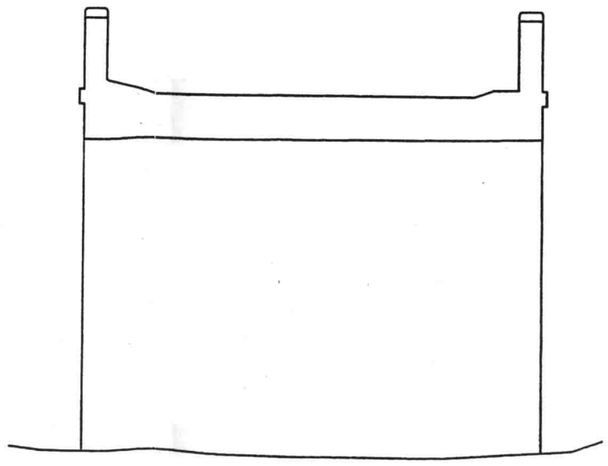
Date



PLAN
1:200



EAST ELEVATION
1:100



SECTION A–A
1:100

Drawing Number

HIB27/05

Notes

Do not scale this drawing

Rev	Date		Checked

Babtie

Client	BEDFORDSHIRE COUNTY COUNCIL
Project	ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES
Title	SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON GENERAL ARRANGEMENT
Drawing No.	HIB27/05
Scale	AS SHOWN
Date	APRIL 2002
Drawn	SR
Checked	PDB
Approved	

Box 272, The Merton Centre, 45 St.Peters Street, Bedford MK40 2ZY

APPENDIX B

Assessment and Check Certificate

FORM 'BA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Feb 1993)

ELR/ Bridge No HIB/27

CERTIFICATION FOR ASSESSMENT CHECK

Assessment Group: Babtie Group, on behalf of Bedfordshire County Council

Bridge/Line Name: Southill Road Railway Bridge

Category Of Check: Category 1

ELR/ Bridge No HIB27

I 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 (where appropriate) as recorded on Form AA approved on 3rd May 2002.

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

List any departures from the above, and additional methods or criteria adopted, with reference and justification for their acceptance (commenting on the results if appropriate). .....

.....

.....

Category 1

Name Signature Date

[redacted]ctor

FORM 'BA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Feb 1993)

ELR/ Bridge No HIB/27

CERTIFICATION FOR ASSESSMENT CHECK

Category 2 and 3 (Note: Category 1 Check Must Also Be Signed)

(a) Assessment

Name	Signature	Date	
			Assessor
			Assessment Checker
			Partner Of the Firm Of Consulting Engineers To Whom Assessor/ Checker Is Responsible

(b) Check

Name	Signature	Date	
			Assessor
			Assessment Checker
			Partner Of the Firm Of Consulting Engineers To Whom Assessor/ Checker Is Responsible

This Certificate Is Accepted By..... [redacted] ..... 20/8/2003 .....

FORM 'BAA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Feb 1993)

ELR/ Bridge No HIB/27

CERTIFICATION FOR ASSESSMENT CHECK

Notification of Assessment Check

Assessment Group: Babtie Group, on behalf of Bedfordshire County Council

Bridge/Line Name: Southill Road Railway Bridge

Category Of Check: Category 1

ELR/ Bridge No HIB27

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

a) 13 Tonnes with no restriction to Fire Engine Group 2.
b) Fails under dead loads (by inspection).

Critical member/s:

a) Arch Barrel.
b) South-east & South-west wingwalls.

Recommended Loading Restrictions

Temporary measures to be put in place in accordance with BA 79/98

Description of Structural Deficiencies and Recommended Strengthening

Name	Signature	Date	
[redacted]	[redacted]	6/03	Assessor
		/03	Assessment Checker
		7/03	Business Centre Director Babtie Group

FORM 'BAA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Feb 1993)

ELR/ Bridge No HIB/27

CERTIFICATION FOR ASSESSMENT CHECK

Category 2 and 3 (Note: Category 1 Check Must Also Be Signed)

(c) Assessment

Name	Signature	Date	
			Assessor
			Assessment Checker
			Partner Of the Firm Of Consulting Engineers To Whom Assessor/ Checker Is Responsible

(d) Check

Name	Signature	Date	
			Assessor
			Assessment Checker
			Partner Of the Firm Of Consulting Engineers Whom Assessor/ ecker Is Responsible

This Certificate Is Accepted By.. [redacted] ..20/8/2003.....

APPENDIX C

Assessment Calculations

Client:	**Bedfordshire County Council**
Commission Title:	**British Rail Property Board 2001/2**
Bridge Title:	**Southill Road Railway Bridge, Cardington, No. HIB27**
File Title:	**Assessment Calculations**
File Ref:	**080714**

BABTIE				CALCULATION SHEET	
OFFICE	BEDFORD	PAGE No.	INDEX	CONT'N PAGE No.	
JOB No. & TITLE	080714 - SOUTHILL RAILWAY BR	ORIGINATOR	MY	DATE	OCT '02
SECTION	ASSESSMENT CALC'S	CHECKER	AEF	DATE	17/10/02

CALCULATION INDEX

	Page
Assessment Summary	Summary
Survey Data	1 - 2
MEXE Assessment	3 - 6
ARCHIE Assessment	7 - 10
ARCHIE Printouts	11 - 13
Arch Parameters	14
Sensitivity Analysis	15 - 19

BABTIE				CALCULATION SHEET	
OFFICE	BEDFORD	PAGE No.	SUMMARY	CONT'N PAGE No.	
JOB No. & TITLE	080714 - SOUTHILL RAILWAY BR	ORIGINATOR	MY	DATE	OCT '02
SECTION	ASSESSMENT CALC's	CHECKER	RSH	DATE	17/10/02

ASSESSMENT SUMMARY

MEXE – 10 TONNES

ARCHIE – 3.0 TONNES.

THE ASSESSMENT CAPACITY OF THE BRIDGE IS 10 TONNES.

BABTIE			CALCULATION SHEET		
OFFICE	BEDFORD	PAGE No.	1	CONT'N PAGE No.	
JOB No. & TITLE	080714 – SOUTHILL RAILWAY BR – CARDINGTON	ORIGINATOR	MY	DATE	28.08.07
SECTION	MEXE ASSESSMENT	CHECKER	QA7	DATE	17/10/07

ASSESSMENT OF MASONRY ARCH BRIDGE BY MODIFIED MEXE METHOD

3 rng thick arch barrel is used in the assessment (AID)

- Span (L) : = East Elevation = 8.794 m
  West Elevation = 8.739 m

$\therefore L = \frac{8.794 + 8.739}{2} = 8.767\ m$

L = 8.767 (m)

(All dimensions measured off survey drawing using Autocad) - drg No. H1827/02 & H1627/03 see Pages 283)

- Rise of the arch barrel at the crown (r_c) :

East Elevation = 1.993 m
West Elevation = 1.989 m

$= \frac{1.993 + 1.989}{2} = 1.991\ m$

r_c = 1.991 (m)

- The Rise of the arch barrel at the quarter points (r_q):

West Elev	East Elev
1.580	1.568
1.573	1.572

$\therefore r_q = \frac{1.580 + 1.573 + 1.568 + 1.572}{4}$

$r_q = 1.573$

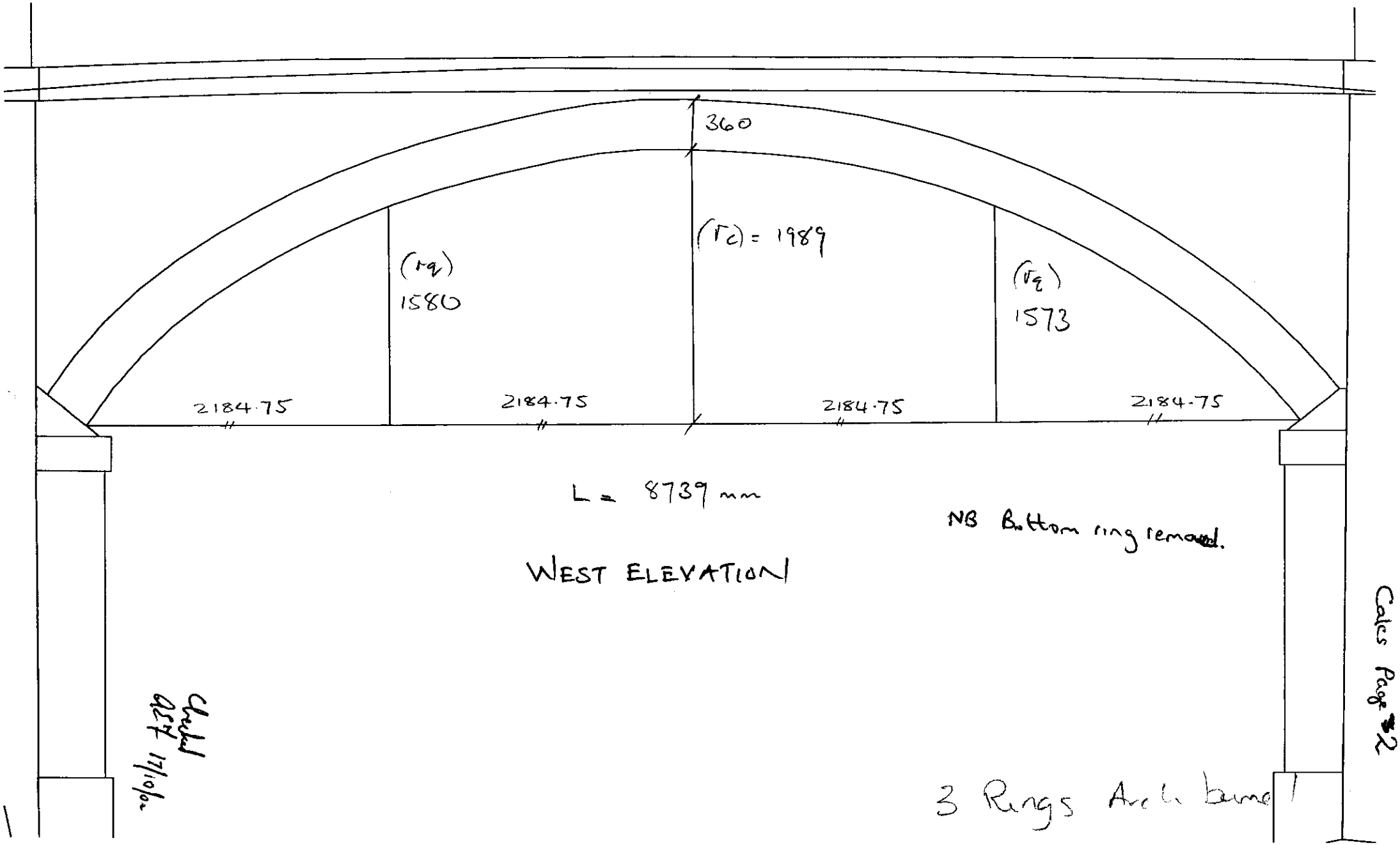
r_q = 1.573 (m)

- Thickness of the arch barrel adjacent to the key stone (3 Ring) "d" = 0.360 m

d = 0.360 (m)

Southill Railway Bridge - Carlington

SURVEY DATA SHEET (1)



L = 8739 mm

NB Bottom ring removed.

WEST ELEVATION

Checked QSF 17/10/02

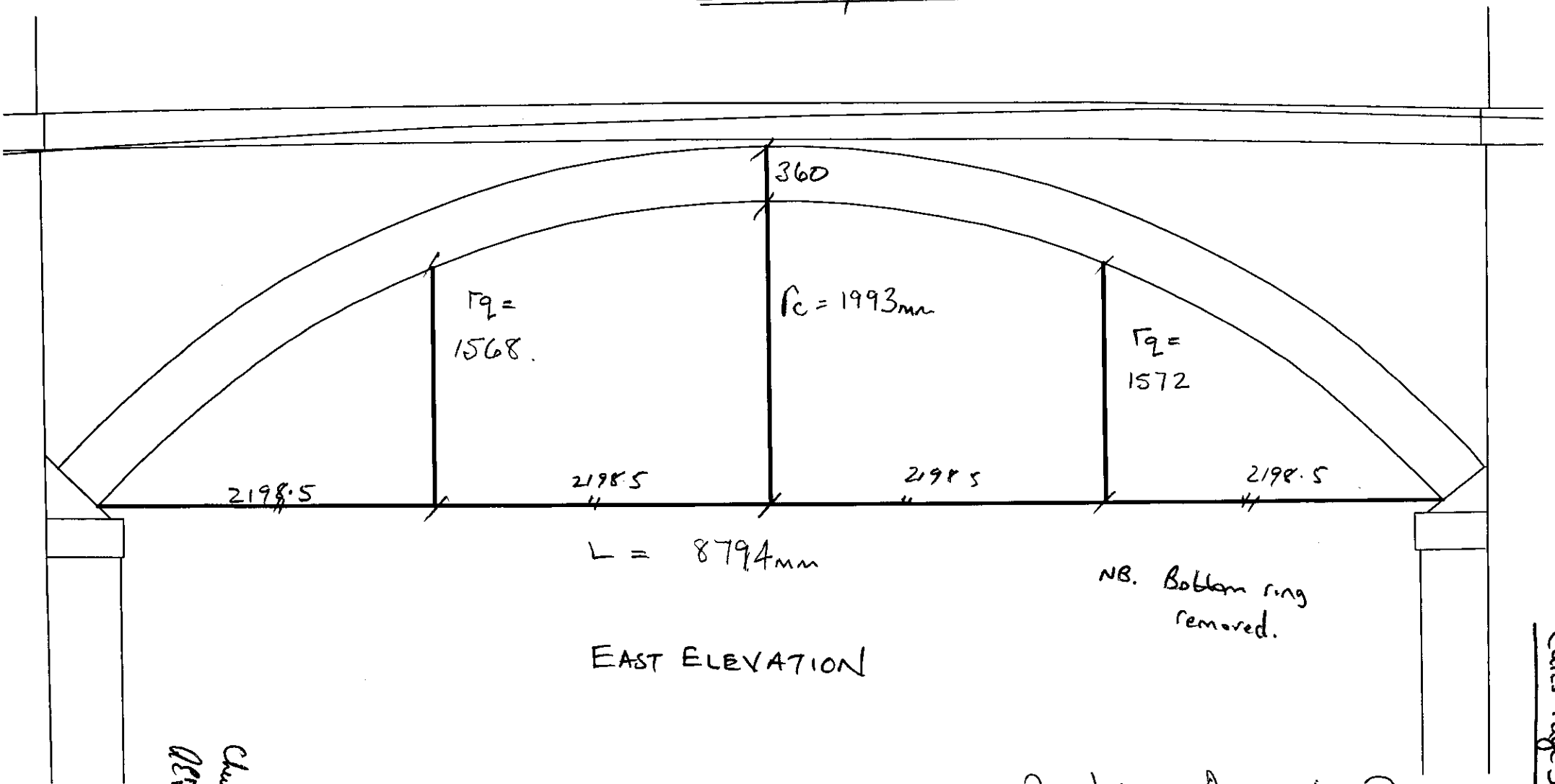
Calcs Page 2

3 Rings Arch barrel

Southill Railway Bridge – Cardington

EAST ELEVATION

SURVEY DATA SHEET (2)



L = 8794mm

NB. Bottom ring removed.

EAST ELEVATION

Checked AEH 17/10/02

3 RINGS ARCH BARREL.

Calcs Page 3

- Average depth of fill (h) = (4 ring grouted)

$$d+h = \frac{0.673 + 0.708}{2} = 0.691 - 0.120 = 0.571\ m$$

(d+h measured off Drg HIB27/02 & HIB27/03) (4th ring)

$$\therefore\ h = (d+h) - d \Rightarrow 0.691 - (0.360 + 0.120)$$

$$h = 0.211\ m$$

h = 0.211 (m)

Provisonal axle loading (P_{AL})

$$P_{AL} = \frac{740\,(d+h)^2}{L^{1.3}}$$

$$P_{AL} = \frac{740\,(0.360 + 0.211)^2}{8.767^{1.3}}$$

$$P_{AL} = 14.348\ \text{TONNES}$$

P_{AL} = 14.348 TONNES

MODIFYING FACTORS

- Span/Rise Factor (F_{sr}):

$$F_{sr} = L/r_c \Rightarrow 8.767/1.991 = 4.403$$

As 4.403 > 4.000, the F_{sr} from Fig 3/3 = 0.94

F_{sr} = 0.94

- Profile Factor (F_p)

$$F_p = r_q/r_c \Rightarrow 1.573/1.991 = 0.79$$

$0.79 > 0.75$ $\therefore$ $F_p = 2.3\left[\frac{r_c - r_q}{r_c}\right]^{0.6} \Rightarrow 2.3\left[\frac{1.991 - 1.573}{1.991}\right]^{0.6}$

F_p = 0.90

F_p = 0.90

Fcm = 0.6

BABTIE			CALCULATION SHEET	
OFFICE BEDFORD	PAGE No.	5	CONT'N PAGE No.	
JOB No. & TITLE 08/0714 - SOUTHILL RAILWAY BR - CARDINGTON	ORIGINATOR	MY	DATE	28.08.02
SECTION MEXE ASSESSMENT	CHECKER	QEF	DATE	17/10/02

Condition Factors (from Assessment Inspection Report)

$F_b = 1.0$ $F_f = 0.7$

$F_w = 0.9$ $F_{mo} = 1.0$

$F_d = ~~0.9~~$ 1.0 (if bottom ring ignored) $F_{cm} = 0.6$ (Due to longitudinal cracking)

QEF 25/6/03

Material Factor (F_m):

$$F_m = \frac{(F_b \times d) + (F_f \times h)}{d + h}$$

$$F_m = \frac{(1.0 \times 0.360) + (0.7 \times 0.211)}{0.3600 + 0.211}$$

$$F_m = 0.89$$

$F_m = 0.89$

joint Factor (F_j)

$$F_j = F_w \times F_d \times F_{mo}$$

$$F_j = 0.9 \times \frac{~~0.9~~}{1.0} \times 1.0 \Rightarrow ~~0.81~~\ 0.9$$

$F_j = ~~0.81~~$ 0.9

QEF 25/6/03

Modified axle load $= F_{sr} \times F_p \times F_m \times F_j \times F_{cm} \times PAL$

$= 0.94 \times 0.90 \times 0.89 \times ~~0.81~~\ 0.9 \times 0.6 \times 14.348$

$= ~~5.250~~$ (T)

$= 5.83$ T

QEF 25/6/03

Axle lift off assumed due to hump backed road alignment.

BABTIE			CALCULATION SHEET		
OFFICE	BEDFORD	PAGE No.	6	CONT'N PAGE No.	6a
JOB No. & TITLE	080714 – SOUTHILL RAILWAY BR – CARDINGTON	ORIGINATOR	MY	DATE	28.08.02
SECTION	MEXE ASSESSMENT	CHECKER	QEF	DATE	17/10/02

Allowable axle loads : (Lift-off)

Single Axle : 5.83 / 5.250 × 1.55 (Fig 3/5a) = 9.03 ~~8.136~~ (T)

2 Axle bogie : 5.83 / ~~5.250~~ × 0.75 (Fig 3/5b) = 4.37 ~~3.936~~ (T)

3 Axle bogie : 5.83 / ~~5.250~~ × 0.90 (Fig 3/5a) = 5.25 ~~4.725~~ (T)

QEF 25/6/03

MAX GROSS VEHICLE WEIGHT = 12.5 ~~13~~ TONNES

(ANNEX F, Table F1 BD 21/01)

QEF 25/6/03

Pg 6a

QEA 25/6/03.

MEXE ASSESSMENT

Check Spreadsheet

Project: 80714
Structure: **Southill Road Railway Bridge HIB27 (With bottom ring ignored due to ring seperation)**

Sheet No. 1

MEXE Analysis to BA 16/97 (With axle lift-off)

L = 8.767 r_c = 1.991 r_q = 1.573 d = 0.36 h+d = 0.571

Adjustment to limit h+d to 2*d not required 1

F_b = 1 F_f = 0.7 F_w = 0.9 F_{mo} = 1 F_d = 1 F_{CM} = 0.6

Taken as 1.0 as bottom ring being ignored.

Clause No:

3.10) Provisional Axle Load = $740(d+h)^2/L^{1.3}$ = 14.35 tonnes

3.11) Span/Rise Factor L/r_c = 4.40 Hence F_{sr} = 0.94 (Fig 3/3)

3.12) Profile Factor $F_p = 2.3((r_c - r_q)/ r_c)^{0.6}$ = 0.90

3.13) Material Factor $F_m = ((F_b * d)+(F_f * h)) / (d+h)$ = 0.89

3.16) Joint Factor $F_j = F_w * F_d * F_{mo}$ = 0.90

3.24) Modified Axle Load = $F_{sr} * F_p * F_m * F_j * F_{CM} * PAL$ = 5.83 tonnes

3.27) With axle lift - off : Fig's 3/5a and 3/5b Af for 2 axle bogie = 0.75

a) Single Axle A_f = 1.55 Allowable Axle = 9.0 tonnes

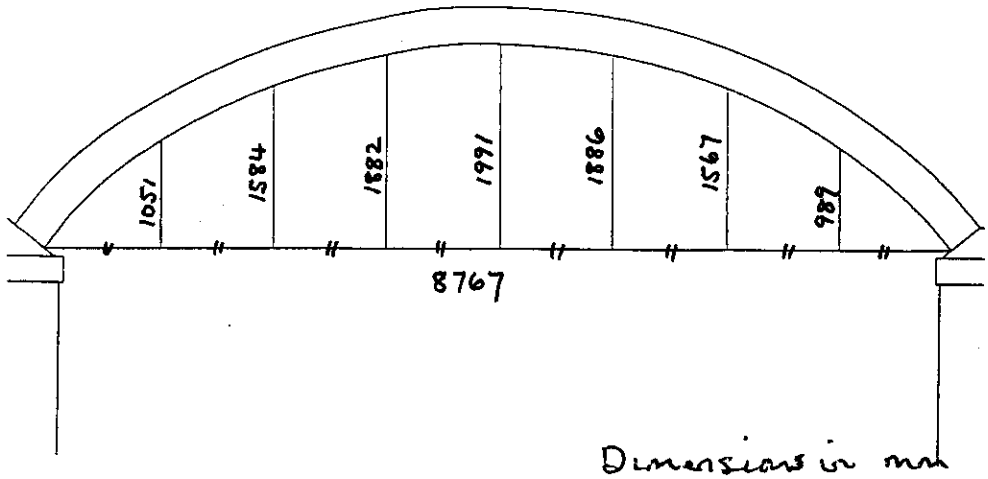
b) 2 Axle bogie A_f = 0.75 Allowable Axle = 4.0 tonnes

From Table 3/6 Max Gross Vehcle Weight = 12.5 tonnes

BABTIE			CALCULATION SHEET		
OFFICE	BEDFORD	PAGE No.	7	CONT'N PAGE No.	
JOB No. & TITLE	080714 – SOUTHILL RAILWAY BRIDGE	ORIGINATOR	MY	DATE	02.09.02
SECTION	ARCHIE ASSESSMENT	CHECKER	AEF	DATE	17/10/02

MEXE Results to be checked on ARCHIE

ARCH PROFILE

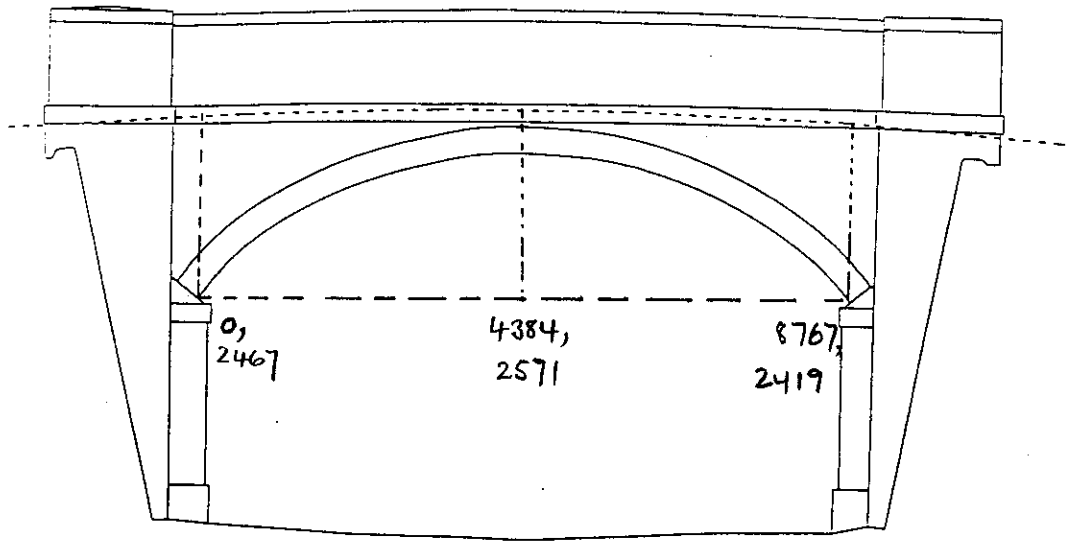


Dimensions in mm

Arch Co-ordinates

0	,	0
1096	,	1051
2192	,	1584
3288	,	1882
4384	,	1991
5479	,	1886
6575	,	1567
7671	,	989
8767	,	0

- Span (L) : 8.767 m
- Rise (Rc) = 1.991 m
- Road profile - obtained from elevation drawings.



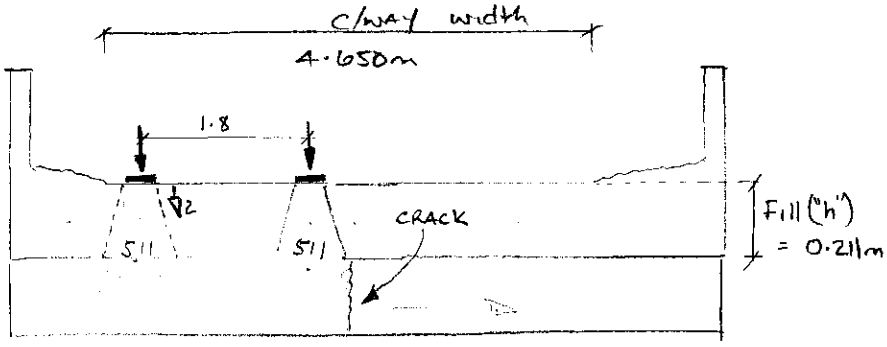
Dimensions in mm

- Ring thickness (3 Rings) = 0.360 m

d = 0.360 (m)

- Masonry Density = 21 kN/m³
- Fill Density = 20 kN/m³
- ϕ = 30°
- Material strength = 2.5 N/mm² (Reduction of Material strength not necessary as 4th ring is ignored in assessment)
- Surfacing depth = 100 mm
- Surfacing density = 22 kN/m³
- Position of backfill unknown therefore not considered

Effective Barrel width



Wheel spread = $300 + 211 \times 3/2$ = 511 mm.
C/way width = 4.650 (m) - (AIP)

Longitudinal crack approx in the centre of c/way,

∴ only one vehicle can be positioned on the bridge.

Effective Barrel width = $1.5 + h \Rightarrow 1.5 + 0.211$
= 1.711 m

Eff Barrel W/2 (No of wheels) = $1.711/2 \Rightarrow$ 0.856m

Actual Axle load W = 1.8 + 0.511 = 2.311 m

Effective Barrel width = $2.311 + (0.856 - \frac{0.511}{2})$ = 2.912m

∴ use loadspread of 3.0 m

BABTIE			CALCULATION SHEET		
OFFICE BEDFORD		PAGE No.	10	CONT'N PAGE No.	
JOB No. & TITLE 080714 – SOUTHILL ROAD RAILWAY BR		ORIGINATOR	MY	DATE	27.09.02
SECTION ARCHIE ASSESSMENT		CHECKER	QST	DATE	17/10/02

Archie data files : S\BRIDGES\STRUCT\SHILL01.DAT

Archie printouts : COMMISSION FOLDER\Assessments\HIB27

Load Spread of 3.0m was used in Archie Assessment

Archie Results

	Reg ring thickness (mm)	PASS / FAIL
1. Single Axle 10.5(T) (33-17t restrict)	537	FAILS
2. Double Axle 18(T) (25t Restriction)	577	FAILS
3. Single Axle 13T Restriction	496	FAILS
4. Single Axle 10T Restriction	432	FAILS
5. Single Axle 7.5T Restriction	380	FAILS
6. Single Axle 3.0T Restriction	230	PASSES (see Archie printouts attached as pages AA05 – AA07)

ASSESSMENT RESULTS

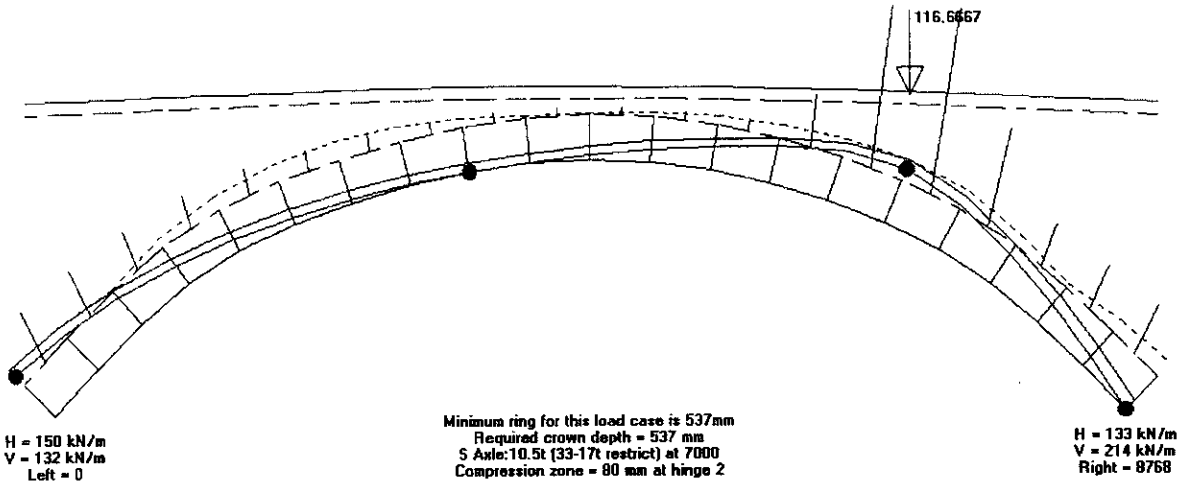
MEXE – ~~10~~ 12.5 TONNES

ARCHIE – 3.0 TONNES

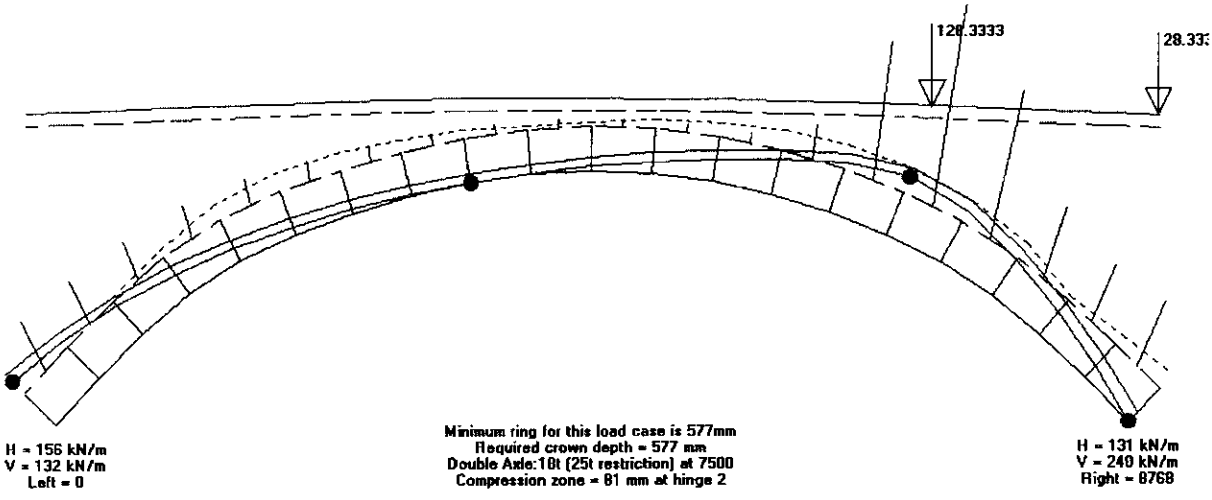
QST 25/6/03

∴ According to BD21/97 (6.19(i)), modified MEXE assessment shall stand.

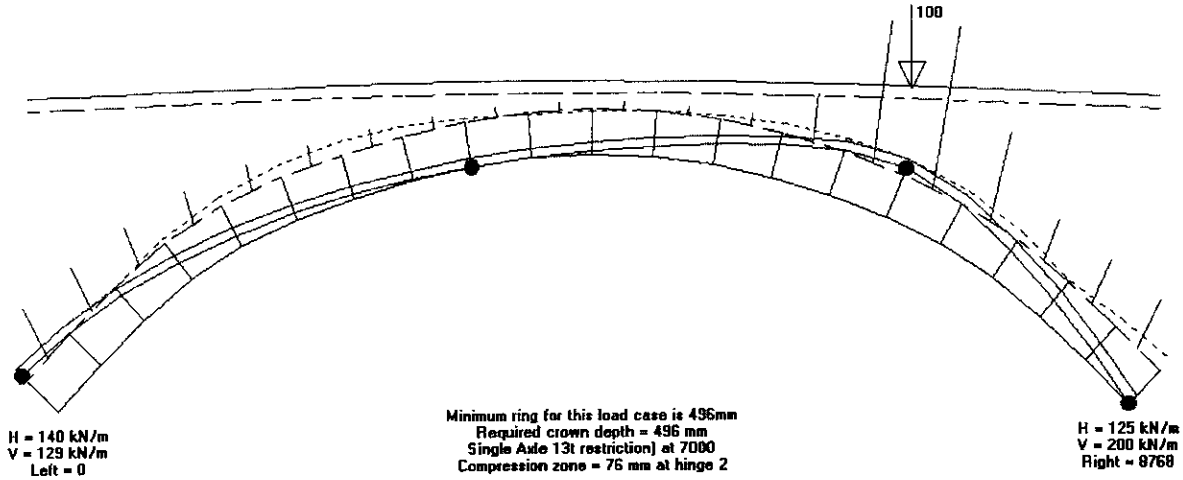
CAPACITY OF STRUCTURE = ~~10~~ 12.5 TONNES.


116.6667
H = 150 kN/m
V = 132 kN/m
Left = 0
Minimum ring for this load case is 537mm
Required crown depth = 537 mm
S Axle:10.5t (33-17t restrict) at 7000
Compression zone = 80 mm at hinge 2
H = 133 kN/m
V = 214 kN/m
Right = 8768

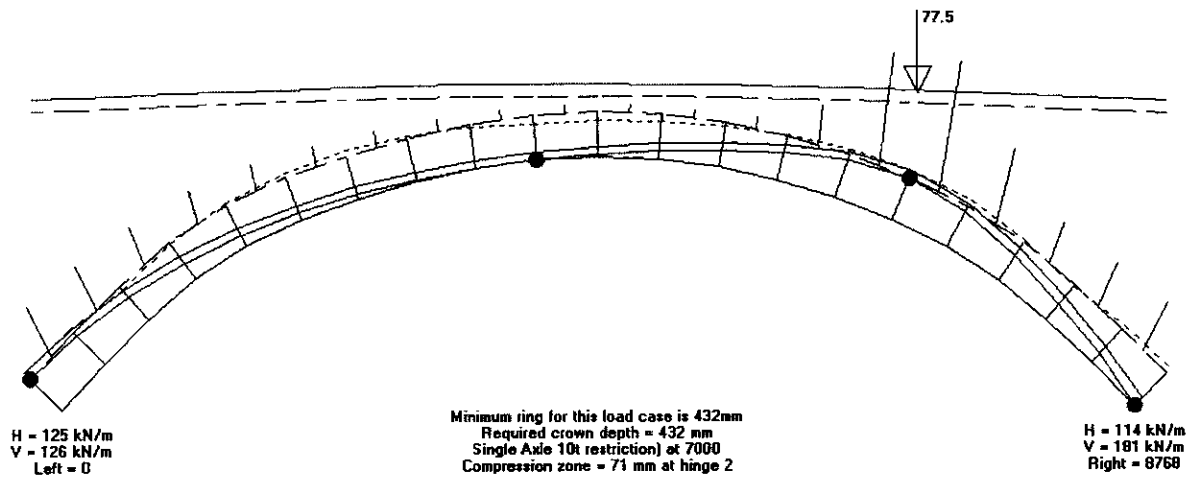
FAILS


128.3333
28.33
H = 156 kN/m
V = 132 kN/m
Left = 0
Minimum ring for this load case is 577mm
Required crown depth = 577 mm
Double Axle:18t (25t restriction) at 7500
Compression zone = 81 mm at hinge 2
H = 131 kN/m
V = 249 kN/m
Right = 8768

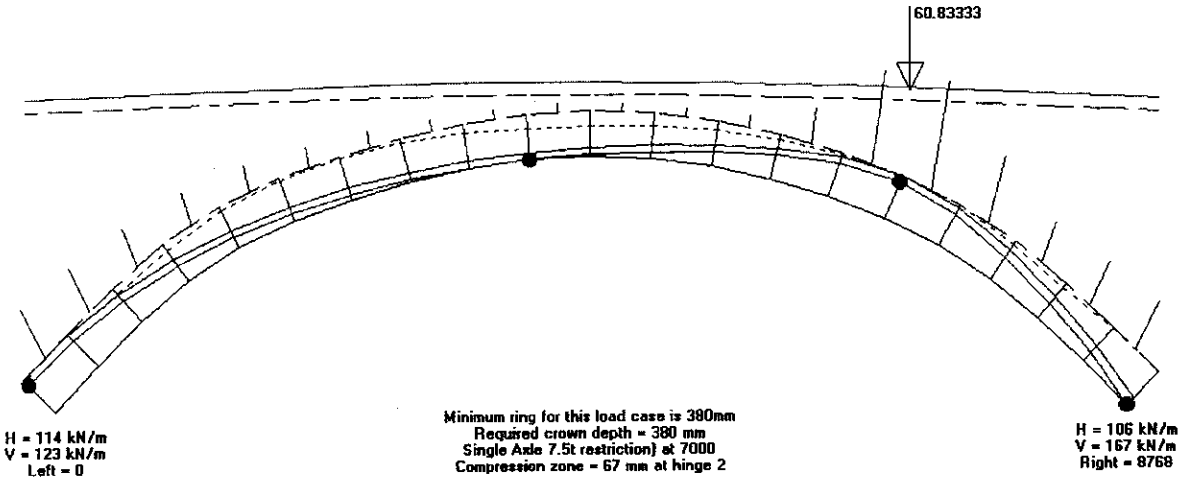
FAILS


100
H = 140 kN/m
V = 129 kN/m
Left = 0
Minimum ring for this load case is 496mm
Required crown depth = 496 mm
Single Axle 13t restriction) at 7000
Compression zone = 76 mm at hinge 2
H = 125 kN/m
V = 200 kN/m
Right = 8768

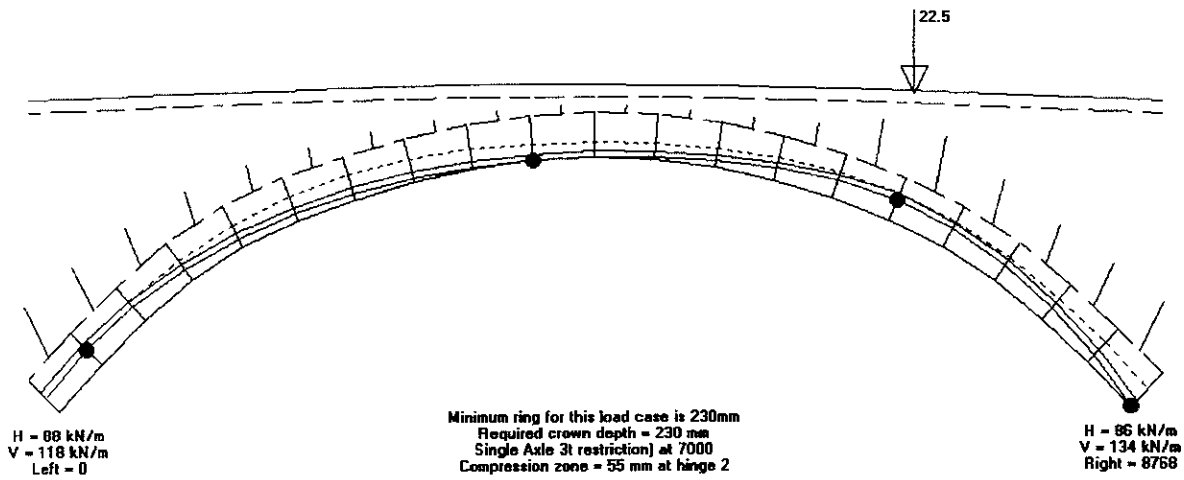
FAILS


77.5
H = 125 kN/m
V = 126 kN/m
Left = 0
Minimum ring for this load case is 432mm
Required crown depth = 432 mm
Single Axle 10t restriction) at 7000
Compression zone = 71 mm at hinge 2
H = 114 kN/m
V = 181 kN/m
Right = 8768

FAILS



FAILS



PASSES

Southill

Span	8767 mm	Rise	1991 mm
Depth of fill	220 mm	Depth of surfacing	100 mm
Ring depth	360 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	20 kN/m^3	Masonry Density	21 kN/m^3
Surfacing density	22 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.5 N/mm^2

Load	Single Axle 3t restriction) at 7000		
Lane width	3000mm		
Required ring depth	216 mm	Geometric F.O.S	1.67
H Left	82 kN/m	H Right	88 kN/m
V Left	117 kN/m	V Right	135 kN/m
Comp. zone at hinge 2	53 mm	Factor on pass. press.	.33

Hinges
1 AT 2 2 AT 11 3 AT 16 4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-3.8	-14.2	7.5	0	0	0
2	-3.9	-12.6	6.3	0	0	1.3
3	-3.9	-11.2	4.7	0	0	1.8
4	-3.9	-9.7	3	0	0	1.6
5	-3.9	-8	1.8	0	0	1.2
6	-3.8	-6.2	1.1	0	0	.8
7	-3.8	-4.9	.7	0	0	.6
8	-3.9	-3.8	.4	0	0	.4
9	-3.9	-3	.2	0	0	.2
10	-3.9	-2.6	.1	0	0	.1
11	-3.9	-2.5	0	0	0	0
12	-3.9	-2.9	-.2	0	0	0
13	-3.9	-3.6	-.4	0	0	0
14	-3.9	-4.7	-.7	-2.1	-.2	0
15	-3.9	-6.1	-1.2	-7.8	-1	0
16	-3.9	-7.8	-1.9	-8.7	-1.4	0
17	-3.9	-9.6	-3	-3.6	-.8	0
18	-3.9	-11.2	-4.5	-.2	-.1	0
19	-3.8	-12.7	-5.9	0	0	0
20	-3.8	-14.5	-7.1	0	0	0

Ignoring the bottom ring may be considered overly conservative, accordingly further assessment with 4 rings is carried out.

Sensitivity Analysis to determine whether 4 ring thick arch barrel would increase capacity.

L =	8.522 m	F_b =	1.0	For dimensions see pages 18 & 19.
r_c =	1.951 m	F_f =	0.7	
r_q =	1.540 m	F_w =	0.9	
d =	0.480	F_{mo} =	1.0	
$h+d$ =	0.691	F_d =	0.9	
		F_{cm} =	0.6	

See attached spreadsheet on Page 16 following.

The overall Capacity increases to 18 TONNES

The overall condition factor of 0.6 is possibly too high. A reduced figure will be used to find the sensitivity of the structure to this parameter.

If Condition Factor is reduced to 0.4 (See Page 17)

The overall capacity ~~remains to some~~ reduces to 10 TONNES 26/6/03

See attached MEXE check spread sheets.

∴ The capacity of the structure is governed by the assumed ring Seperation

The capacity of the structure appears to lie between 10 & 18 tonnes depending upon number of rings used and condition factor.

Strictly in accordance with the ATP. the Capacity is ~~10~~ 12.5 TONNES. AEH 26/6/03

Sensitivity Analysis

4 ring thick arch barrel -480mm

Project: **80714**
Structure: **Southill Road Railway Bridge HIB27** Sheet No. 2

MEXE Analysis to BA 16/97 (With axle lift-off)

L = 8.522 r_c = 1.951 r_q = 1.54 d = 0.48 h+d = 0.691

Adjustment to limit h+d to 2*d not required 1

F_b = 1 F_f = 0.7 F_w = 0.9 F_{mo} = 1 F_d = 0.9 F_{CM} = 0.6

Clause No:

3.10) Provisional Axle Load = $740(d+h)^2/L^{1.3}$ = 21.80 tonnes

3.11) Span/Rise Factor L/r_c = 4.37 Hence F_{sr} = 0.94 (Fig 3/3)

3.12) Profile Factor $F_p = 2.3((r_c - r_q)/ r_c)^{0.6}$ = 0.90

3.13) Material Factor $F_m = ((F_b * d)+(F_f * h)) / (d+h)$ = 0.91

3.16) Joint Factor $F_j = F_w * F_d * F_{mo}$ = 0.81

3.24) Modified Axle Load = $F_{sr} * F_p * F_m * F_j * F_{CM} * PAL$ = 8.21 tonnes

3.27) With axle lift - off : Fig's 3/5a and 3/5b Af for 2 axle bogie = 0.75

a) Single Axle A_f = 1.54 Allowable Axle = 12.5 tonnes

b) 2 Axle bogie A_f = 0.75 Allowable Axle = 6.0 tonnes

From Table 3/6 Max Gross Vehcle Weight = 18 tonnes

17/10/02

Sensitivity Analysis

Condition Factor Reduced to 0.4

Project: 80714
Structure: **Southill Road Railway Bridge HIB27** Sheet No. 2

MEXE Analysis to BA 16/97 (With axle lift-off)

L = 8.522 r_c = 1.951 r_q = 1.54 d = 0.48 h+d = 0.691

Adjustment to limit h+d to 2*d not required 1

F_b = 1 F_f = 0.7 F_w = 0.9 F_{mo} = 1 F_d = 0.9 F_{CM} = 0.4

Clause No:

3.10) Provisional Axle Load = $740(d+h)^2/L^{1.3}$ = 21.80 tonnes

3.11) Span/Rise Factor L/r_c = 4.37 Hence F_{sr} = 0.94 (Fig 3/3)

3.12) Profile Factor $F_p = 2.3((r_c - r_q)/ r_c)^{0.6}$ = 0.90

3.13) Material Factor $F_m = ((F_b * d)+(F_f * h)) / (d+h)$ = 0.91

3.16) Joint Factor $F_j = F_w * F_d * F_{mo}$ = 0.81

3.24) Modified Axle Load = $F_{sr} * F_p * F_m * F_j * F_{CM} * PAL$ = 5.47 tonnes

3.27) With axle lift - off : Fig's 3/5a and 3/5b Af for 2 axle bogie = 0.75

a) Single Axle A_f = 1.54 Allowable Axle = 8.0 tonnes

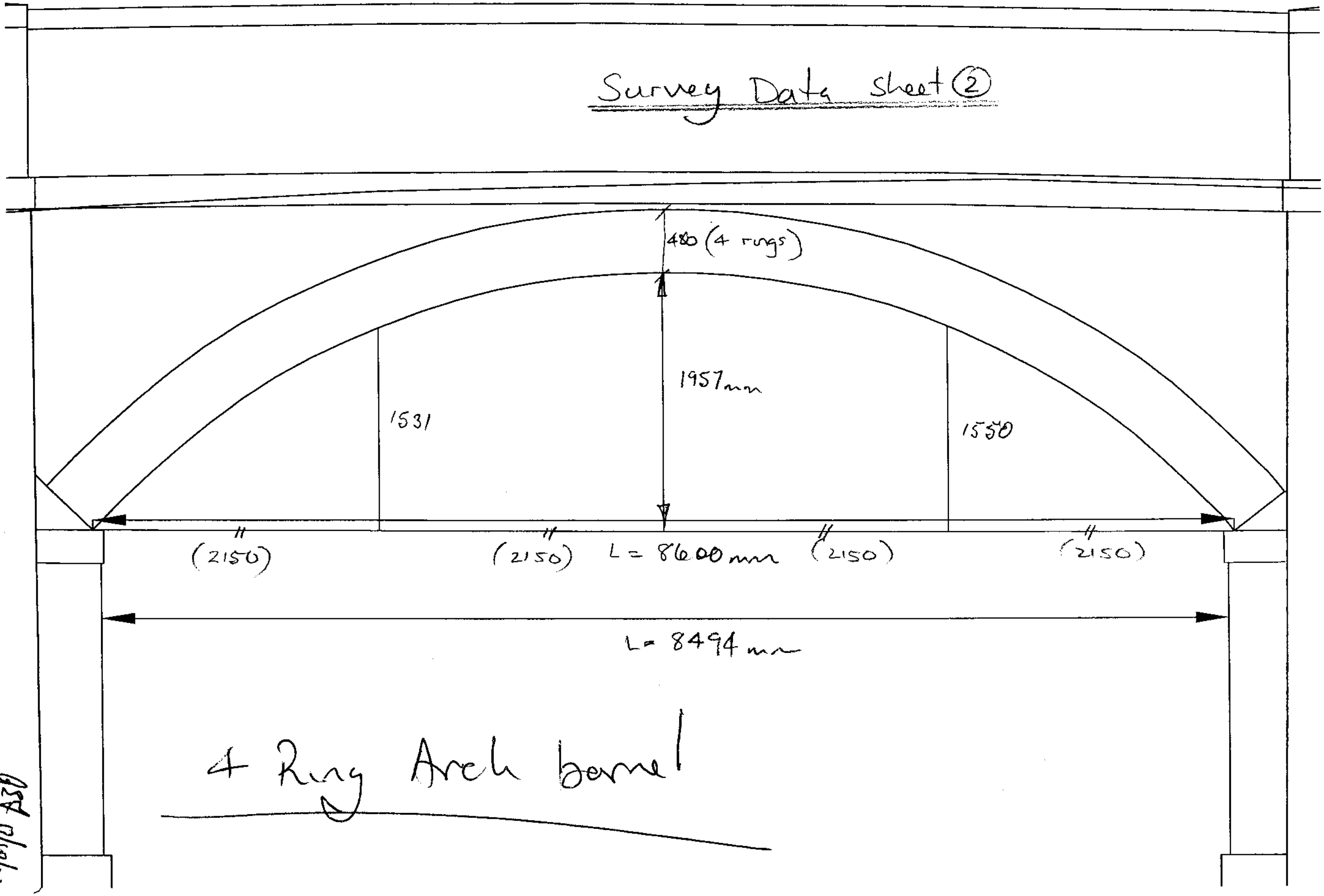
b) 2 Axle bogie A_f = 0.75 Allowable Axle = 4.0 tonnes

From Table 3/6 Max Gross Vehcle Weight = 10 tonnes

QZ 17/10/02

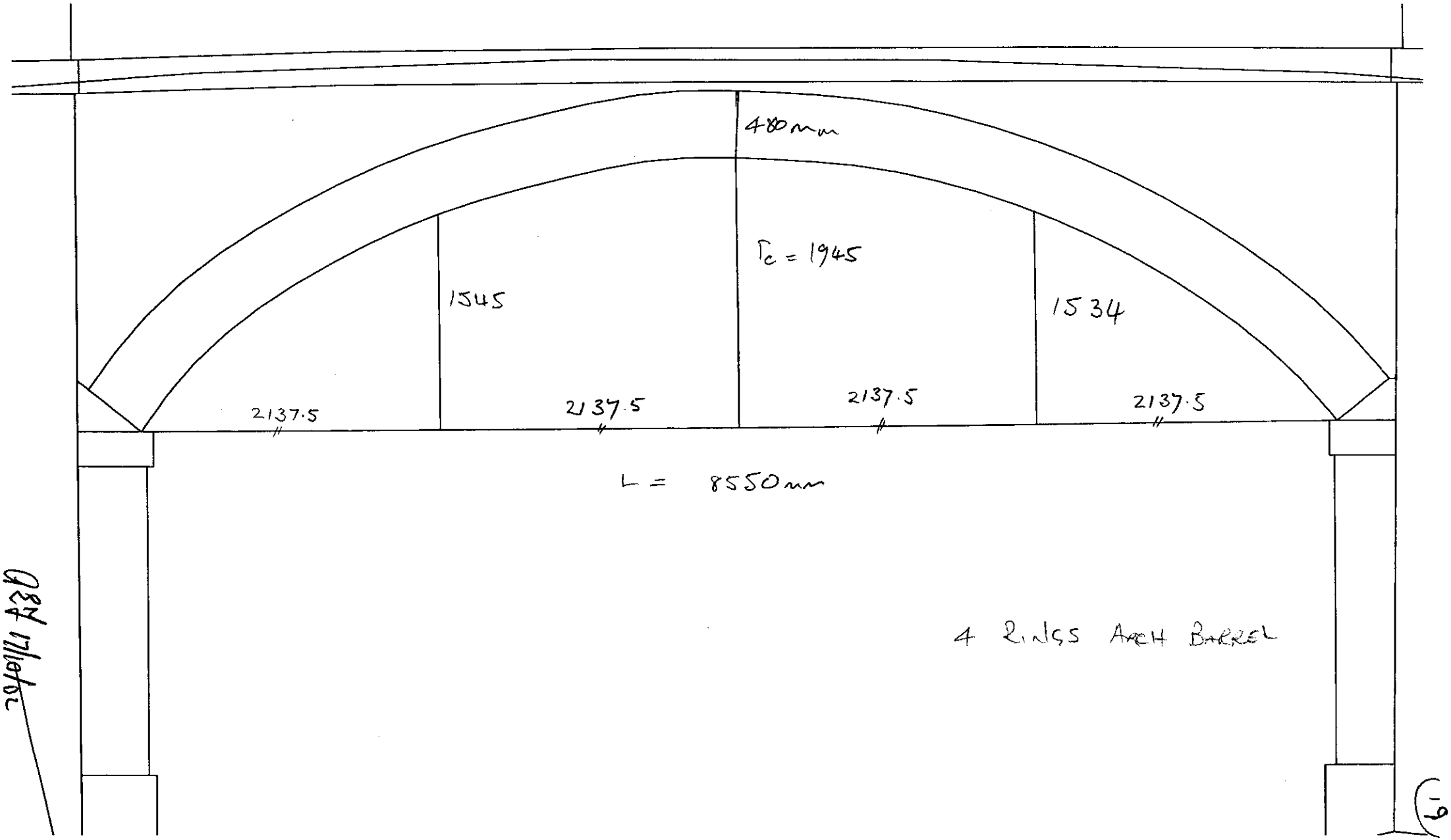
Southill Railway Bridge - Cardington

EAST ELEVATION



WEST ELEVATION

Survey Data sheet (1)



APPENDIX D

Assessment Inspection Report

British Rail Property Board, 2001/02

Client: Bedfordshire County Council

Southill Road Railway Bridge

No. HIB27

Draft
Assessment Inspection Report

080714 March 2002

Babtie Group Box 272, The Merton Centre, 45 St. Peter's Street, Bedford MK40 2ZY
Tel No 01234 763400 Fax No 01234 763401

DOCUMENT ISSUE RECORD

Document	Status	Issued to	No. of copies	Date of issue	Signed

Southill Road Railway Bridge No. HIB27

Contents

1.00	Introduction, Location Plans and General Arrangement	Page 2
2.00	Inspection and Inspection Report Form BE11/94	Page 6
3.00	Conclusions	Page 13
4.00	Recommendations	Page 14

Appendices

A	Photographs
B	Defects Drawings
C	Statutory Undertakers Apparatus Information
D	Dimension Check List and Survey Drawings
E	List of Record Drawings
F	Site Factors Affecting Assessment
G	AIP Form

1.00 **Introduction**

1.01 Structure Details

Bridge no.	HIB27
OS reference	TL 0907 4689
Date of inspection	20/03/2002

1.02 Structure Description

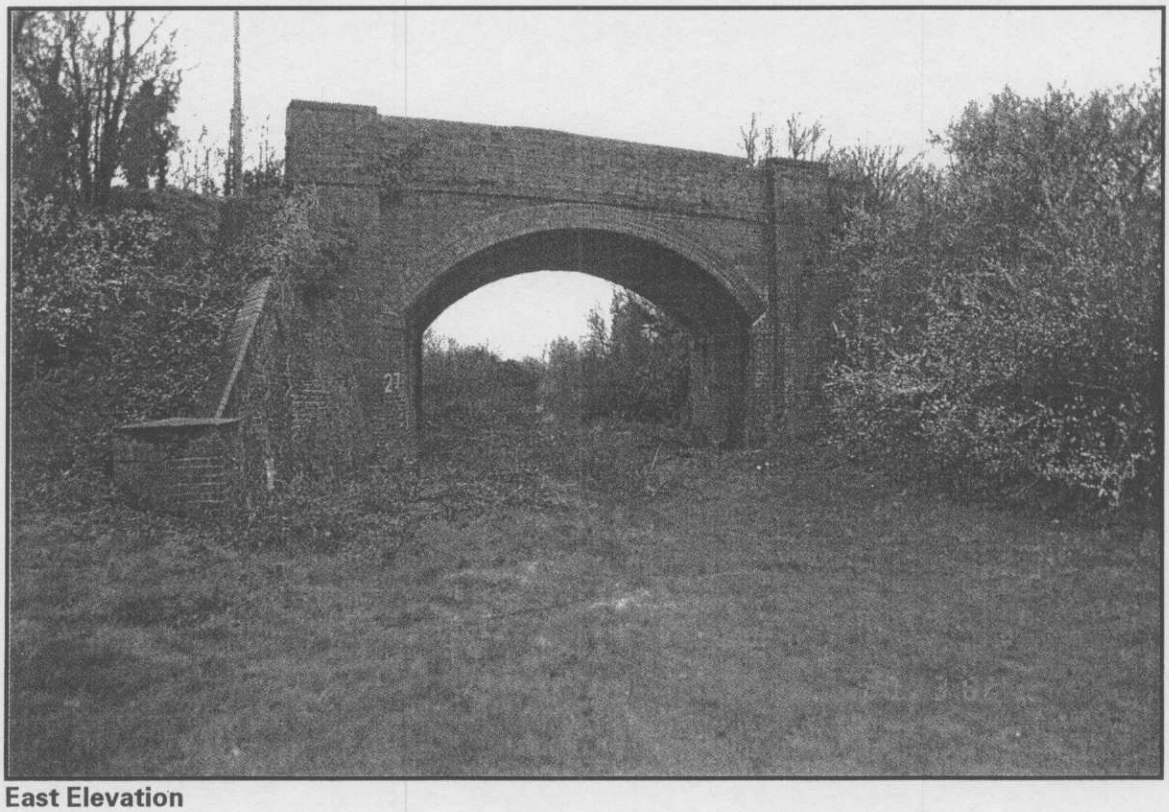
1.02.1 The bridge carries the U147 Southill Road two-way single carriageway over a disused railway and is located 1 km south of Cardington village. The date of construction is not known but bridges on the same line were possibly built in 1855.

1.02.2 The bridge is a single span 4-ring brick arch springing from brick abutments. The wingwalls, spandrels and parapets are of brick.

1.02.3 There are no weight limit signs on the bridge.

1.03 Structure dimensions

Skew Span: 8.49m Skew: 21° Width between parapets: 6.03m



East Elevation

1.00 **Introduction cont.**

1.04 Inspection Details

1.04.1 The structure was inspected as part of the British Rail Property Board Assessment programme.

1.04.2 The structure was inspected in accordance with Department of Transport documents:

Standard BD 63/94	Inspection of Highway Structures.
Advice Note BA 63/94	Inspection of Highway Structures.

1.04.3 The structure was inspected on the 20th March 2002.

1.04.4 The inspection was undertaken during the day. The weather conditions were good/rain.

1.04.5 The inspector was P Butler.

1.04.6 The structure was inspected on foot and using an underbridge unit.

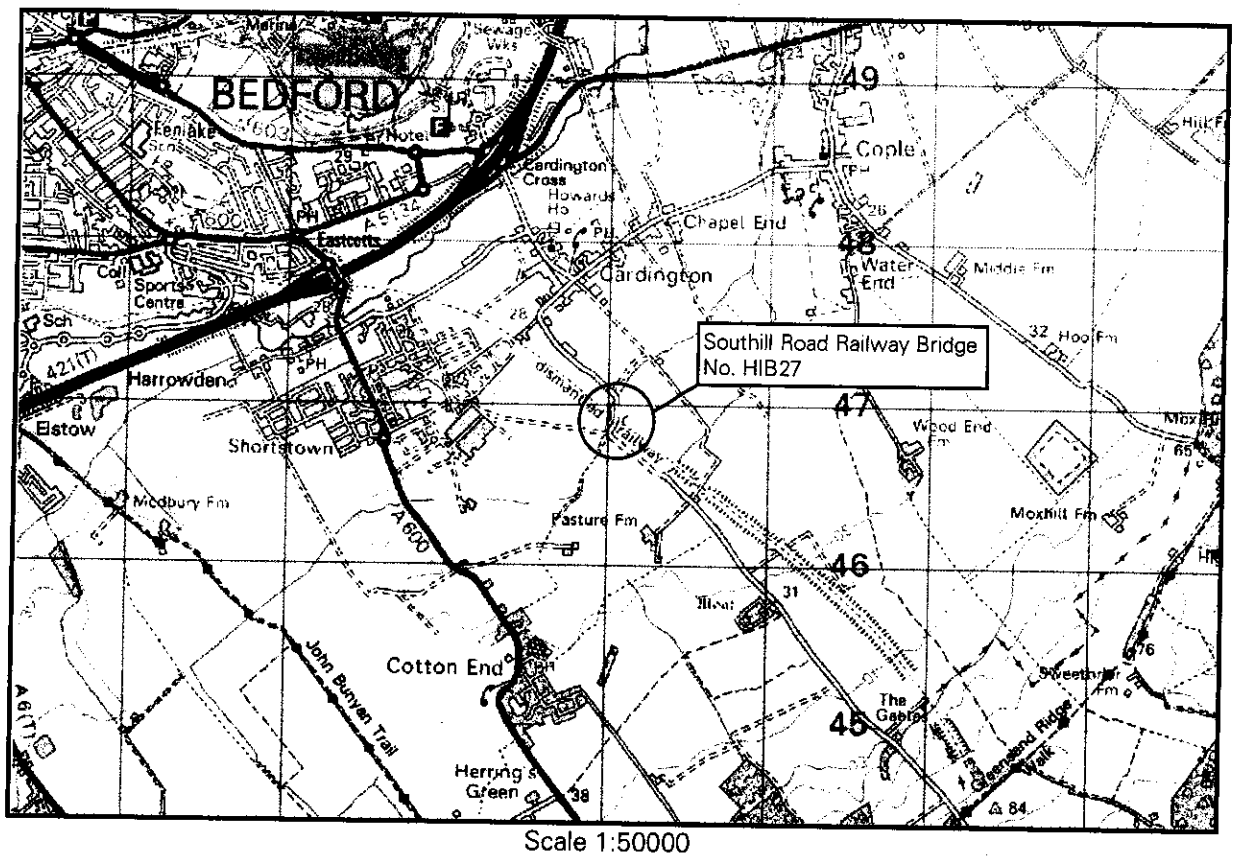
1.04.7 No record drawings are available.

1.04.8 The bridge was surveyed by the Bedford Babtie Group survey team and a plan, elevations and cross sections produced. Copies are enclosed in Appendix D.

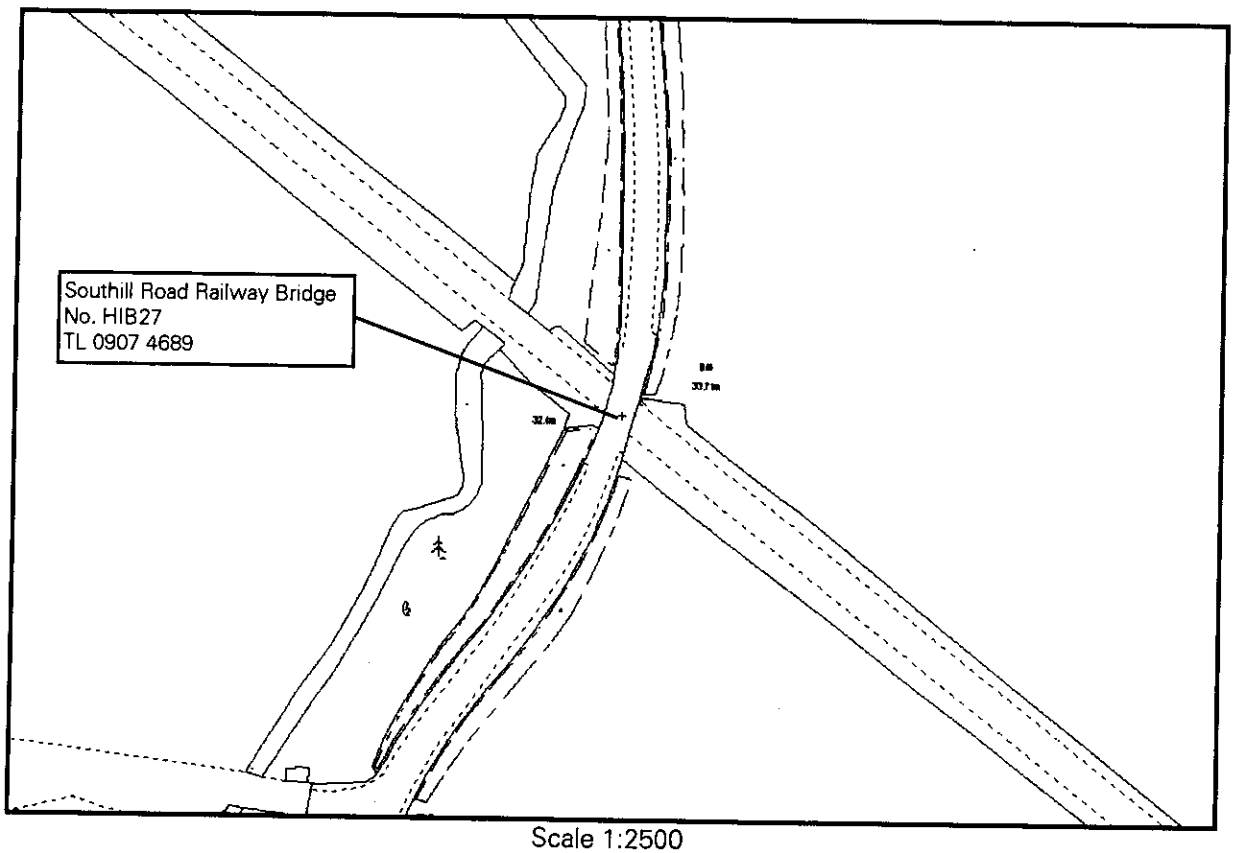
1.05 Previous Inspection and Summary

1.05.1 No previous inspection records were made available.

Location Plans



Scale 1:50000



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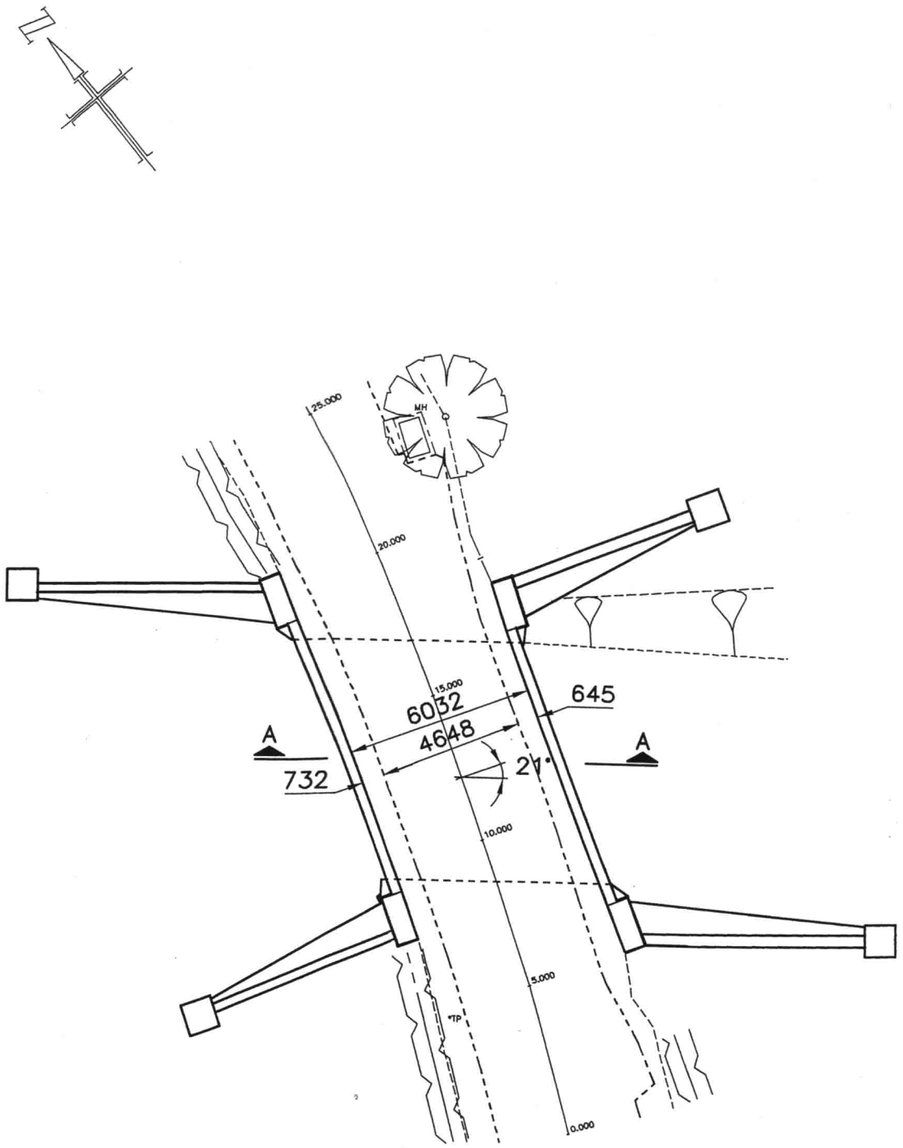
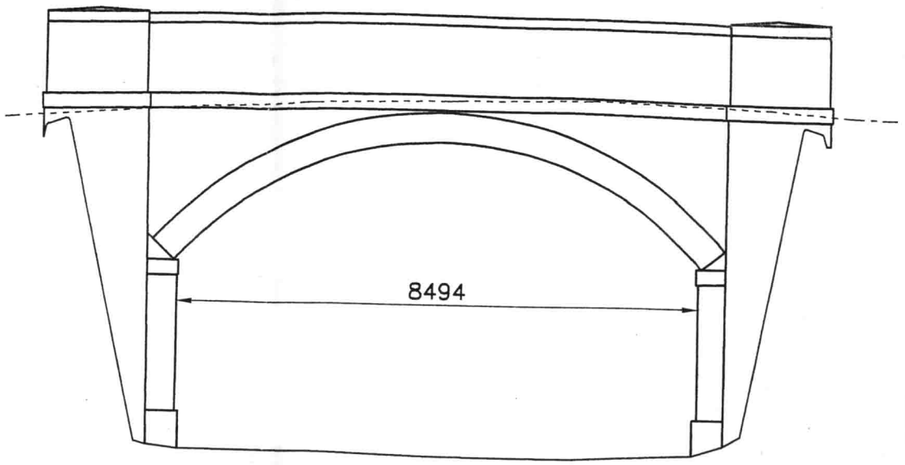
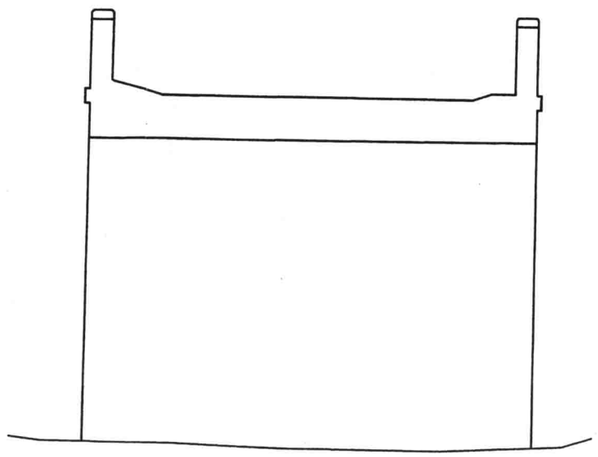


PLAN
1:200



EAST ELEVATION
1:100



SECTION A–A
1:100

Drawing Number

HIB27/05

Notes

Do not scale this drawing

Rev	Date		Checked

Babtie

Client	BEDFORDSHIRE COUNTY COUNCIL
Project	ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES
Title	SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON GENERAL ARRANGEMENT
Drawing No.	HIB27/05
Scale	AS SHOWN
	Drawn SR Checked PDB
	Date APRIL 2002
	Approved

Box 272, The Merton Centre, 45 St.Peters Street, Bedford MK40 2ZY

Structure Inspection Report

BE 11/94

Structure Number: HIB27

Grid Reference: TL 0907 4689 (E N)

Structure Name: SOUTHILL ROAD RAILWAY BRIDGE

Location (Parish): CARDINGTON

Date of Inspection: 20 MAR 2002

Type of Inspection: G [ ] P [✓] S [ ]

Inspected by: [redacted]

Overall Assessment: G [ ] F [ ] P [✓]

From Span: 1 To Span: 1

Defect Assessment

	Estimated Cost	Extent	Severity	Work	Priority	PD	Comments
1. Foundation				B			NO VISIBLE DEFECTS.
2. Inverts or Aprons		B	2	N			SOME DEBRIS.
3. Fenders							
4. Piers or Columns							
5. Abutments		B	2	N			CRACKS. HOLLOW/SPALLED BRICKWORK. IVY.
6. Wing walls		C	3	R	M		CRACKS. BULGING. SPALLED BRICKWORK. IVY.
7. Retaining walls or Revetments							
8. Approach Embankments		B	2	N			SOME SETTLEMENT TO EDGES.
9. Bearings							
10. Main beams/Tunnel portals/Mast							
11. Transverse beams/Catenary Cables							
12. Diaphragms or bracings							
13. Concrete slab							
14. Metal deck plates/Tunnel linings							

Defect Assessment (Cont.)

	Estimated cost	Extent	Severity	Work	Priority	PD	
15. Jack arches							
16. Arch ring/Corrugated Metal		C	4	R	H		CRACKS. HOLLOW BRICKWORK. POOR JOINTS.
17. Spandrels		D	3	R	H		CRACKS. BULGING. MOVEMENT.
18. Tie rods							
19. Drainage Systems				B			MINOR SEEPAGE/DAMP AREAS.
20. Waterproofing				A			SEEPAGE.
21. Surfacing		B	2	N			MINOR SETTLEMENT. CRACK.
22. Service Ducts							
23. Expansion Joints							
24. Parapets/Handrails		D	3	R	H		SPALLING. POOR JOINTS. VEGETATION.
25. Access gantries or walkways							
32. Dry Stone Walls							
33. Troughing							

Reason for priority allocation

06	WINGWALLS	Remove vegetation, replace spalled/hollow brickwork and repoint to prevent further deterioration.
16	ARCH RING	Remove roots/repoint joints in intrados and replace brickwork in arch ends to prevent further deterioration.
17	SPANDRELS	Install RC backing to spandrels to prevent further movement.
20	WATERPROOFING	Consider installing waterproofing to prevent water ingress.
24	PARAPETS	Replace spalled brickwork and repoint to prevent further deterioration and restore strength.

Signed

Name

Date

2.00 Inspection

2.01 Foundations

2.01.1 There are no record drawings available. The foundations are assumed to be spread footings.

2.01.2 There would not appear to be any foundation defects.

2.02 Invert

2.02.1 There are no record drawings available. From inspection the invert is of soil (see plates 1 and 2).

2.02.2 The invert has some debris present, including the missing copings from the parapet, and there is evidence of fires adjacent to the abutments (see plates 1-5).

2.05 Abutments

2.05.1 There are no record drawings available. From inspection the abutments are of brick (see plates 1-5).

2.05.2 The south abutment has a vertical hairline crack 0.85m from the east end for much of the height. There is a diagonal hairline crack from the stringcourse 0.6m from the east end running down to the abutment end at half height then horizontally into the east face and pilaster 1-2mm wide. There is a large area of hollow sounding brickwork west of centre, which may be fire damage. There is some spalled and hollow sounding brickwork to the east end base. The west face has a horizontal crack 1mm at the base plinth and a horizontal hairline crack at the springing, both extending into the pilaster. The pilaster has a further horizontal crack 1-2mm wide towards the top (see plates 3 and 4).

2.05.3 The north abutment has a vertical hairline crack west of centre for the full height extending into the arch. There is a vertical crack towards the west end at half height which extends horizontally to the west end just above the base plinth at 1mm wide. The west end has some ivy growth. The east end has two vertical hairline cracks over the centre, one running horizontally at half height into the east face and pilaster, joining a vertical hairline crack. The east end brickwork is spalled and hollow sounding and has seepage deposits. The east face has a horizontal crack 1-2mm wide at springing level running through the pilaster and vertically up the wingwall joint. The west pilaster is overgrown with ivy (see plates 5 and 6).

2.00 **Inspection**

2.06 Wingwalls

2.06.1 There are no record drawings available. From inspection the wingwalls are of brick (see plates 7-9)

2.06.2 The southeast wingwall/pilaster joint is cracked at the top 1mm wide. The top of the wall has much ivy growth. The centre has an area of surface spalling and hollow sounding brickwork, some spalling up to 100mm deep and a slight bulge. The base adjacent to the abutment has spalling up to 100mm deep (see plate 7)

2.06.3 The southwest wingwall has a diagonal hairline crack emanating from the abutment joint at springing level running down towards the base. There is a horizontal crack at half height 2mm wide from the centre to the copings. The central area is bulging and hollow sounding (see plate 8).

2.06.4 The northwest wingwall is covered in ivy (see plate 9).

2.06.5 The northeast wingwall has a spalled area adjacent to the abutment just above half height. There are some surface spalled bricks and poor joints present.

2.08 Approach Embankments

2.08.1 There are no record drawings available. From inspection the bridge has approach embankments to both sides (see plates 1, 2 and 10).

2.08.2 The embankments are heavily overgrown in places with numerous trees growing, some adjacent to the bridge (see plates 1, 2 and 10).

2.00 Inspection

2.16 Arch Ring

2.16.1 There are no record drawings available. From inspection the arch is of 4-ring brick construction 460mm thick (see plates 1, 2 and 11).

2.16.2 The arch west face original brickwork over the crown between the blue brick facing is all hollow sounding, cracked, spalled and loose. The face north of the crown is bulging 10mm. There is a crack around the barrel running from the south abutment at hairline wide, over the south ¼ point at 5mm wide, over the crown at hairline wide, over the north ¼ point at 3-4mm wide and finishing near the north abutment at hairline wide (see plates 11-16).

2.16.3 The arch intrados has a longitudinal crack 200mm from the west face, hairline at the north abutment, 3-4mm at the north ¼ point, 10mm at the south ¼ point and hairline at the south abutment. There is a crack running parallel 400mm from the face hairline at the crown, 2-3mm over the north ¼ point then running diagonally to the north abutment at hairline wide and a short crack 400mm from the face 1-2mm wide towards the south abutment. The west end over the crown has spalled bricks and the brickwork to the south side is hollow sounding. The northwest corner of the intrados has ivy roots in the joints. The west end has seepage deposits to both sides. There is a longitudinal crack at the centre 2-3mm wide running from the north abutment to south of the crown and a longitudinal hairline/0.5mm wide crack 0.6m west of centre from near the north abutment to near the crown. There is an area of eroded joints 20mm deep at the centre towards the north abutment. There is a longitudinal crack 240mm from the east face, hairline wide at the north abutment, 2-3mm at the north ¼ point, 3-4mm at the crown, 2-3mm at the south ¼ point then 440mm from the face running to the south abutment 2-3mm wide. The east end has seepage deposits to both sides and there is an area of spalled and hollow sounding brickwork at the south abutment (see plates 12, 14, 16-18, 20, 22 and 26).

2.16.4 The arch east face has a crack around the barrel running from the north abutment to the north ¼ point 1mm wide and from the south abutment to the south ¼ point 1mm wide. There is some bulging with the spandrel wall over the south ¼ point (see plates 19-26).

2.00 Inspection

2.17 Spandrels

2.17.1 There are no record drawings available. From inspection the spandrels are of brick (see plates 1 and 2).

2.17.2 The west spandrel/arch barrel joint is cracked from the south abutment at hairline wide, over the south ¼ point at 5mm wide, over the crown at hairline wide and at the north ¼ point 3-4mm wide, extending towards the north abutment at hairline wide. At the north ¼ point there is a horizontal crack 1-2mm wide running from the arch barrel/spandrel joint to the pilaster. The south side has a vertical crack south of the ¼ point from the arch barrel at hairline wide to the parapet stringcourse 2-3mm wide. There is a vertical hairline crack at the south pilaster joint from the parapet stringcourse to half height and continuing horizontally into the pilaster. The north end of the spandrel has ivy growth (see plates 12-15).

2.17.3 The east spandrel has a crack around the barrel running from the north abutment to the north ¼ point 1mm wide. The barrel/spandrel joint is cracked from the south abutment to the south ¼ point 1mm wide then vertically up through the spandrel. The south side has a horizontal crack 1mm wide at half height and a vertical crack 4-5mm wide at the south end. The south side is bulging. The north side has some bulging and an area of eroded joints 20mm deep (see plates 19-26).

2.19 Drainage Systems

2.19.1 There are no record drawings available. From inspection there are no drainage weep-pipes visible.

2.19.2 The abutments have some minor seepage deposits and the wingwalls have some damp patches along the base.

2.20 Waterproofing

2.20.1 There are no record drawings available. The waterproofing could not be inspected.

2.20.2 The arch has seepage deposits at both ends (see plates 17 and 18).

2.00 Inspection

2.21 Surfacing

2.21.1 There are no record drawings available. From inspection the surfacing is 4.65m wide and there are soft verges to both sides (see plates 27 and 28).

2.21.2 The carriageway has a wide trench reinstatement over the east side. There is minor cracking across the west side of the carriageway at the south end. The west carriageway edge has slight settlement up to 10mm at both ends of the parapet (see plates 27 and 28).

2.24 Parapets

2.24.1 There are no record drawings available. From inspection the parapets are of brick (see plates 1, 2, 27 and 28).

2.24.2 The west parapet has some spalled bricks and poor joints and has ivy growth to the ends. The north pilaster brickwork has cracking and is dislodged 20mm (see plates 2, 13 and 27-29

2.24.3 The east parapet has much spalling and poor joints, with much ivy growth in the joints. The north pilaster has a vertical crack 1mm wide and there are missing copings adjacent to the wall. The south end has some bulging with the spandrel wall below and there is vegetation growth at the south pilaster. There is a diagonal crack 1mm wide to the road face adjacent to the south pilaster (see plates 1, 19-21, 25, 27, 28 and 30).

3.00 Conclusions

3.01 The bridge is in poor condition and has spandrel movement and longitudinal cracks at the arch ends.

3.02 The spalled brickwork and poor joints in the abutments would appear to be due to weathering and ivy growth, which is made worse by the seepage present. The hollow sounding brickwork may be due to fire damage, as the walls have evidence of fires adjacent. The defects do not appear severe at present. The vertical crack at the north abutment centre may indicate there is some movement to the abutment, but this would not appear excessive. The cracking at the abutment ends may be due to some movement to the abutment and wingwalls and possibly the movement of the spandrels and arch ends.

3.03 The spalled brickwork and poor joints in the wingwalls would appear to be due to weathering and ivy growth, which should be repaired to prevent further deterioration.

3.04 The approach embankments are overgrown but this would not appear to be causing distress to the structure.

3.05 The arch intrados longitudinal cracking at the arch ends indicates both spandrels are moving, taking the arch ends with them. The longitudinal cracking at the centre may indicate there is some movement to the arch and north abutment.

3.06 The cracking and bulging to the east spandrel indicates movement has taken place. The longitudinal cracking at the arch ends indicates both spandrels are moving, taking the arch ends with them. The spandrels require strengthening, possibly with reinforced concrete backing, to prevent further movement and damage to the structure.

3.07 The seepage in the arch indicates the waterproofing is ineffective. The water ingress may be causing the spalling and poor joints present. Waterproofing should be considered to prevent the water ingress.

3.08 The surfacing defects are minor only and do not require repair at the present time.

3.09 The east parapet has many open joints and spalled bricks, which would appear to have been caused by the growth of ivy along the wall, there still being many roots in the joints. The wall requires repointing, and the spalled and missing brickwork and copings replacing, to restore the parapet strength. The dislodged brickwork to the west parapet end appears to be due to vehicle impact. The wall requires the dislodged section rebuilding and the ivy growth removing and joints repointed.

4.00 Recommendations

4.06 Wingwalls

4.06.1 Remove vegetation, replace spalled/hollow brickwork and repoint to prevent further deterioration.

4.16 Arch Ring

4.16.1 Remove ivy roots from the west end of the arch intrados and repoint joints to prevent further deterioration.

4.16.2 Replace brickwork to arch faces to prevent further deterioration.

4.17 Spandrels

4.17.1 Install RC backing to spandrels to prevent further movement.

4.20 Waterproofing

4.20.1 Consider installing waterproofing to prevent water ingress.

4.24 Parapets

4.24.1 Remove ivy roots from the parapet brickwork, repoint joints, and replace spalled and displaced/missing bricks and copings to prevent further deterioration and restore parapet strength.

Signed [redacted]

Date:

Name:

Signed [redacted]

Date:

Name:

Appendix A

Photographs

Plate 1	East elevation.
Plate 2	West elevation.
Plate 3	South abutment.
Plate 4	South abutment west end.
Plate 5	North abutment.
Plate 6	North abutment east end.
Plate 7	Southeast wingwall.
Plate 8	Southwest wingwall.
Plate 9	Northwest wingwall.
Plate 10	South approach embankment.
Plate 11	Elevation through arch from the west side.
Plate 12	Arch and north abutment west end.
Plate 13	Arch west face north side.
Plate 14	Arch west end over north abutment.
Plate 15	Arch west face and spandrel south side.
Plate 16	Arch west end over south abutment.
Plate 17	Arch north side.
Plate 18	Arch south side.
Plate 19	Elevation through arch from the east side.
Plate 20	Arch east face and spandrel south side.
Plate 21	Arch east face, spandrel and parapet south side.
Plate 22	Arch and south abutment east end.
Plate 23	Arch east face and spandrel south side.
Plate 24	East spandrel south end.
Plate 25	Arch east face and spandrel north side.
Plate 26	Arch and north abutment east end.
Plate 27	Carriageway elevation from the south.
Plate 28	Carriageway elevation from the north.
Plate 29	West parapet north end.
Plate 30	East parapet north end.

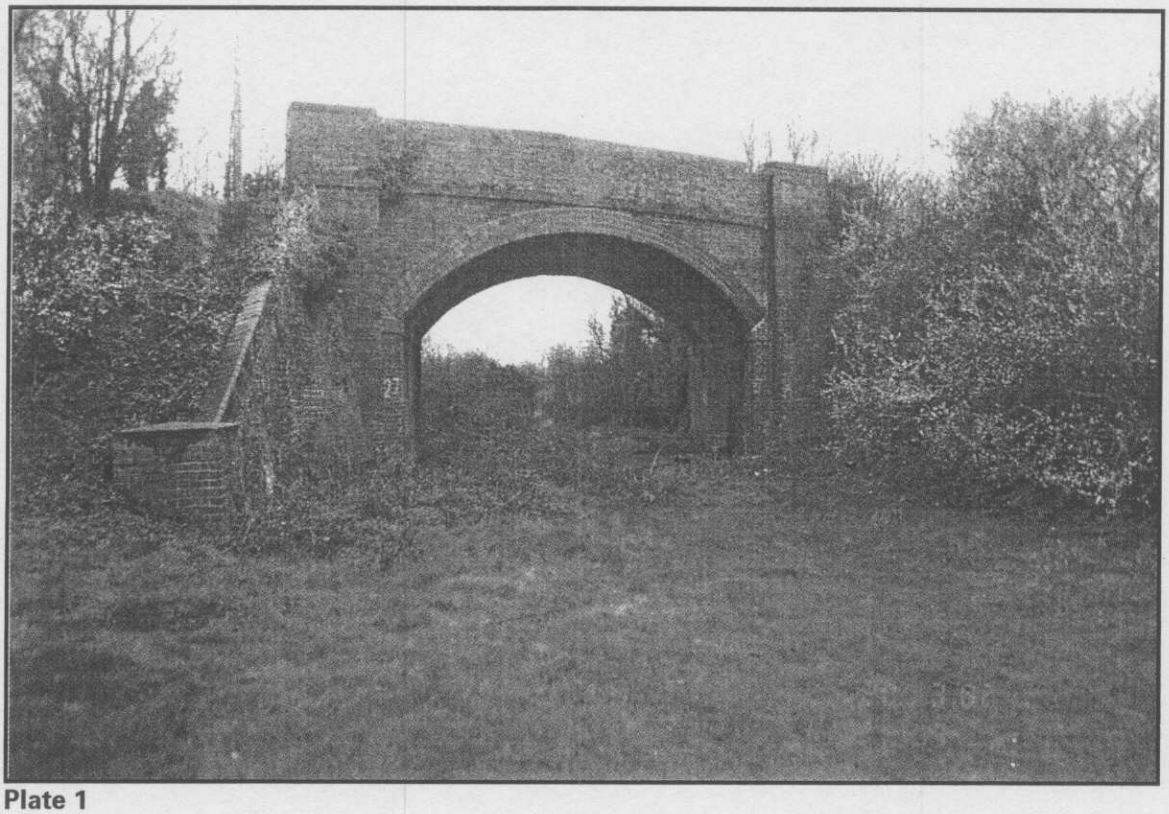


Plate 1
East elevation

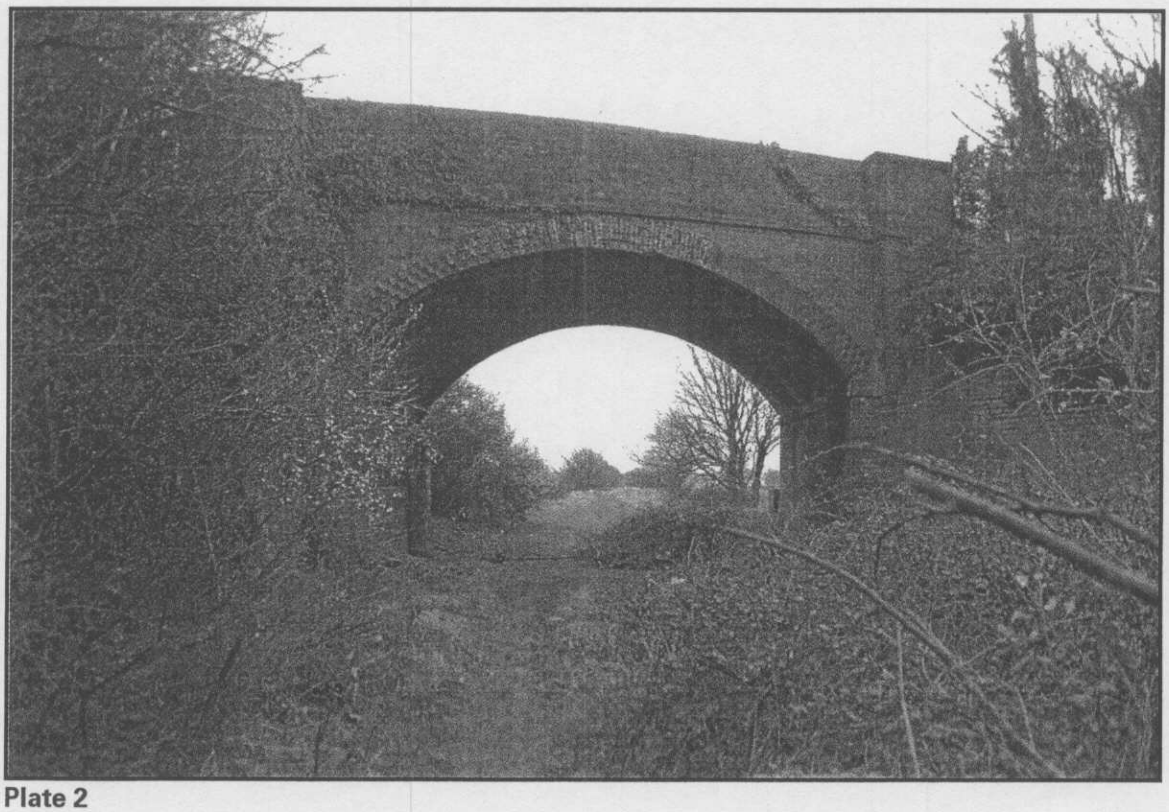


Plate 2
West elevation

Plate 3
South abutment

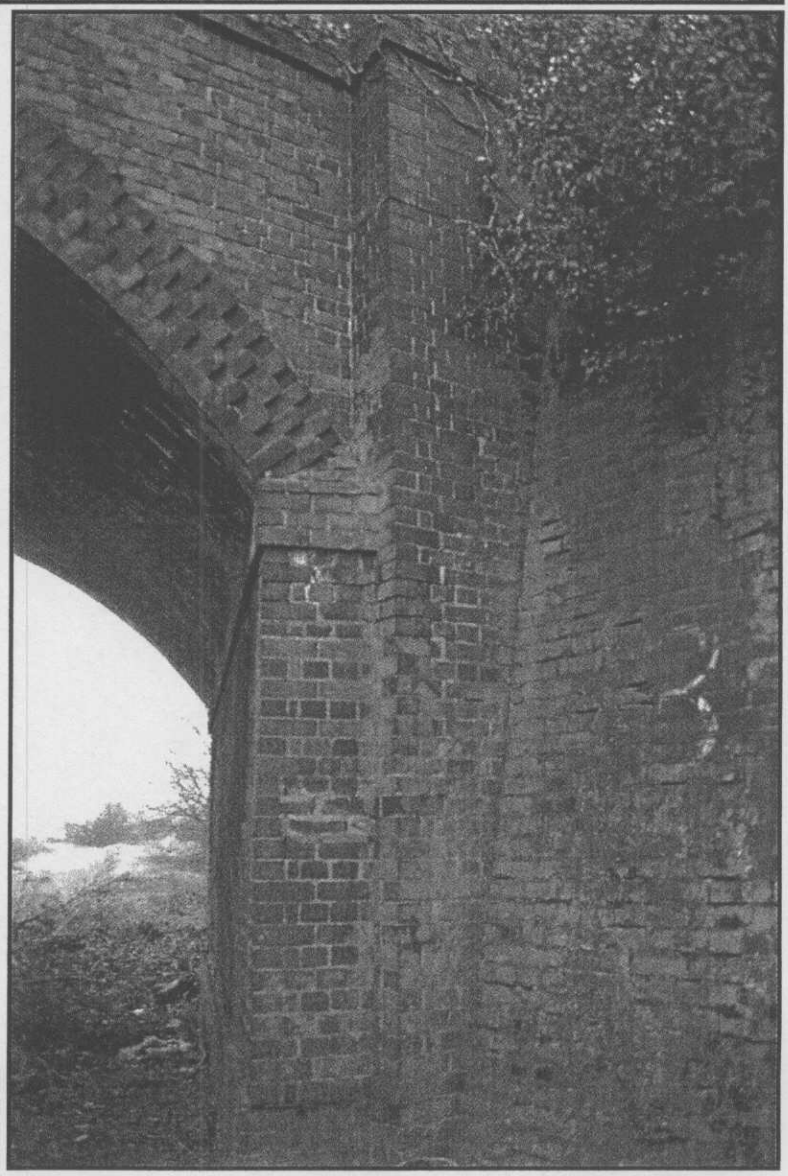


Plate 4
South abutment west end

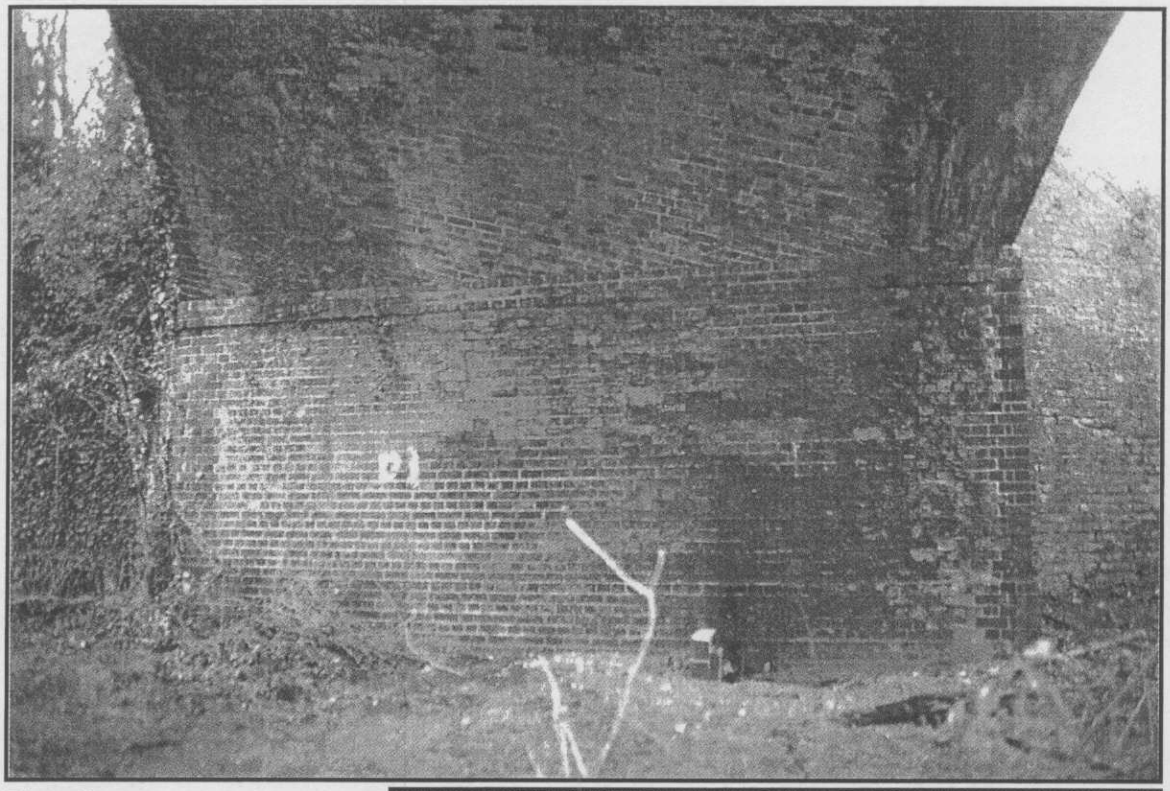


Plate 5
North abutment

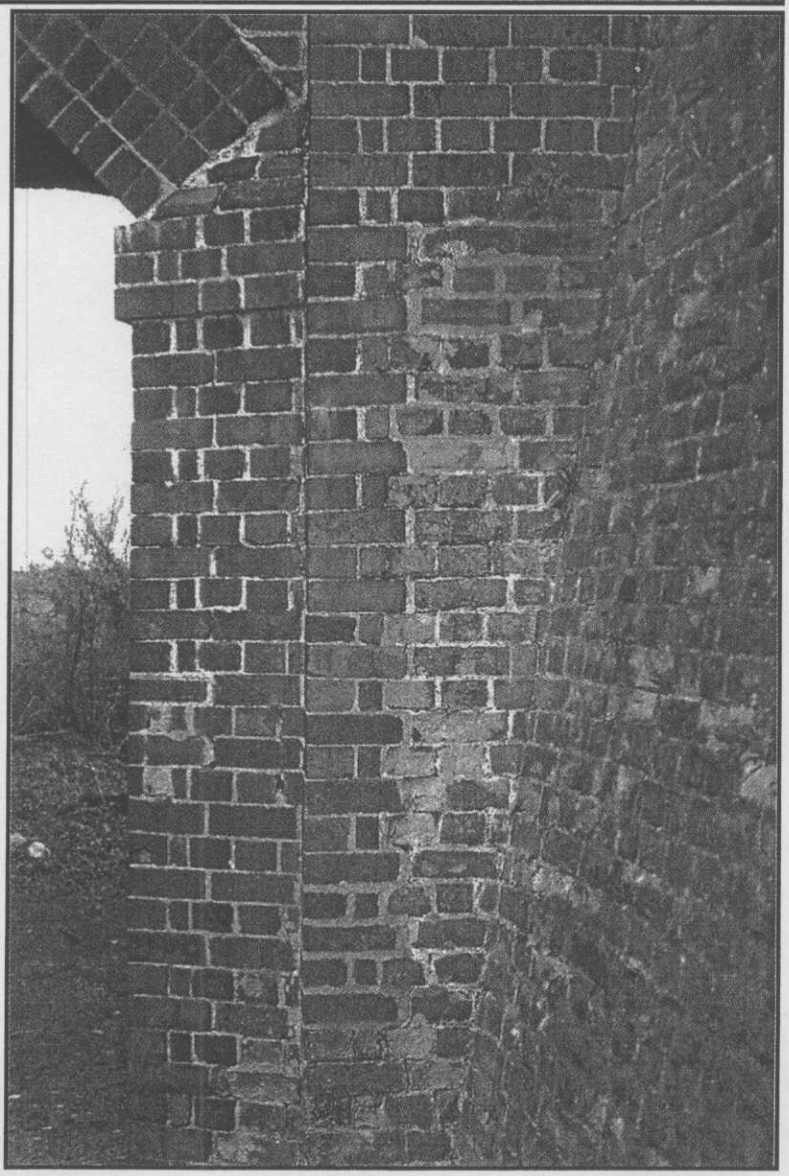


Plate 6
North abutment east end

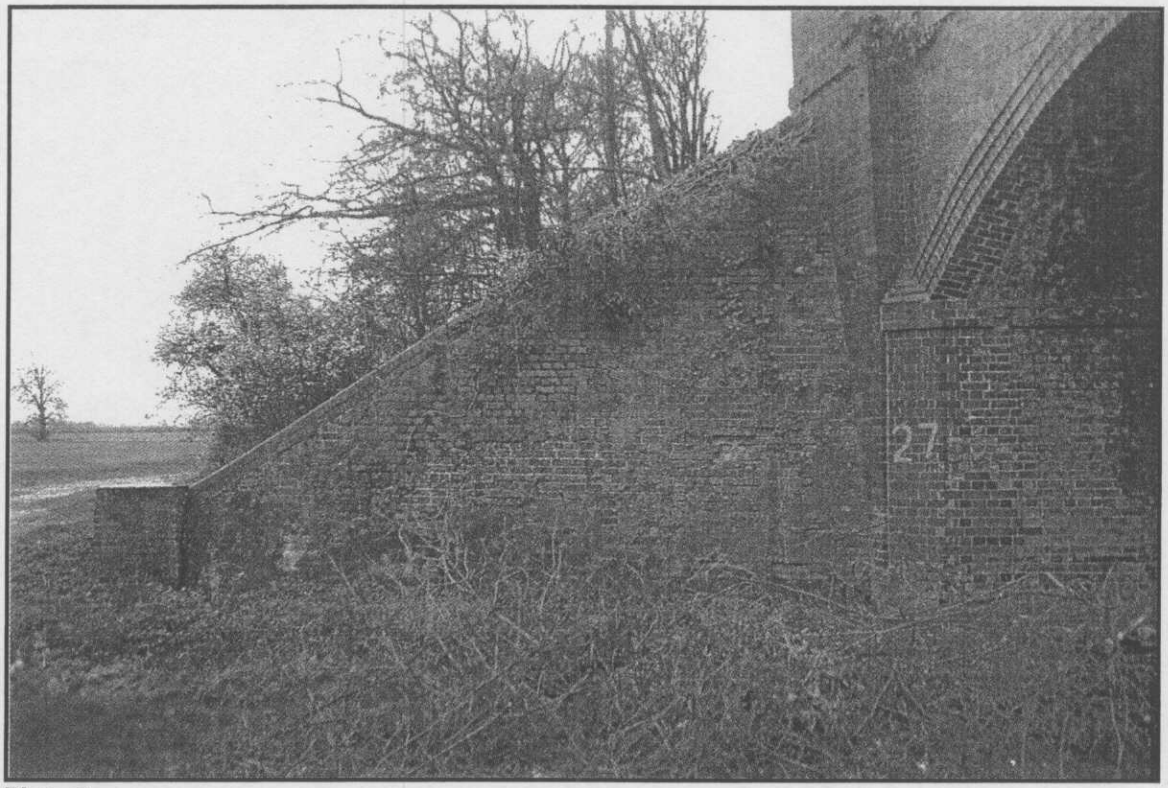


Plate 7
Southeast wingwall

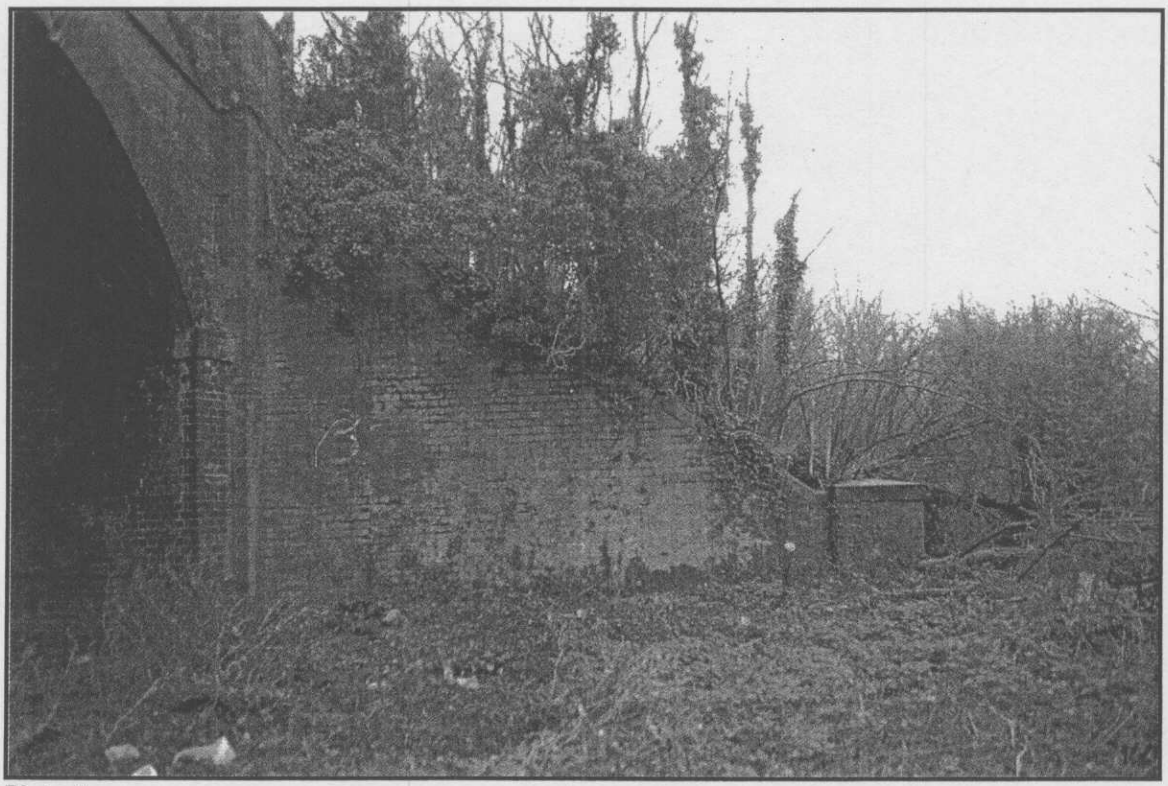


Plate 8
Southwest wingwall

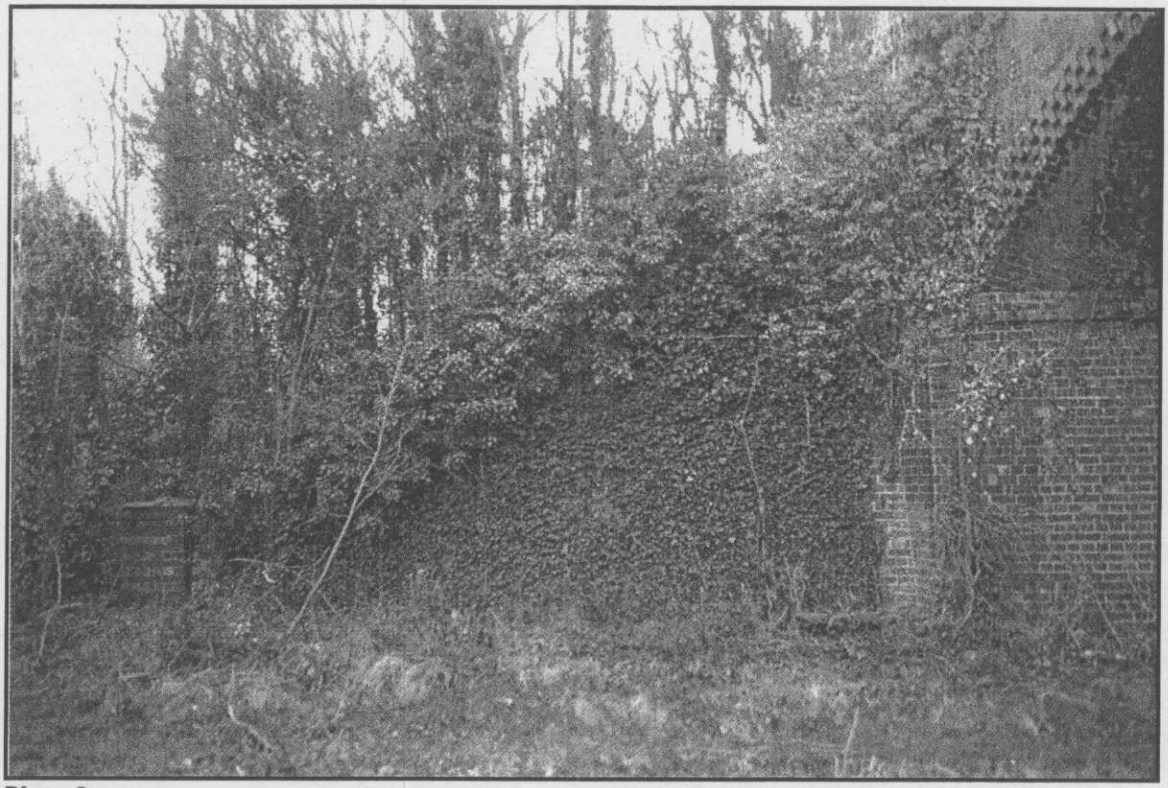


Plate 9
Northwest wingwall

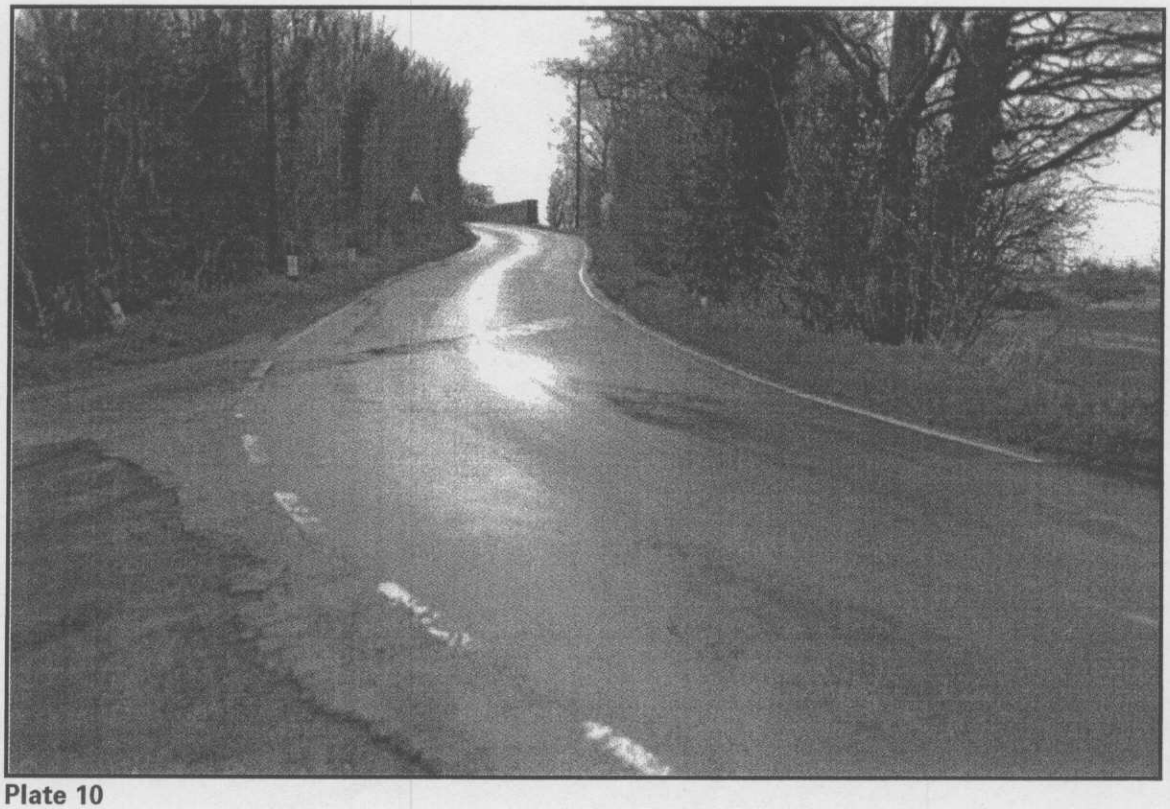


Plate 10
South approach embankment

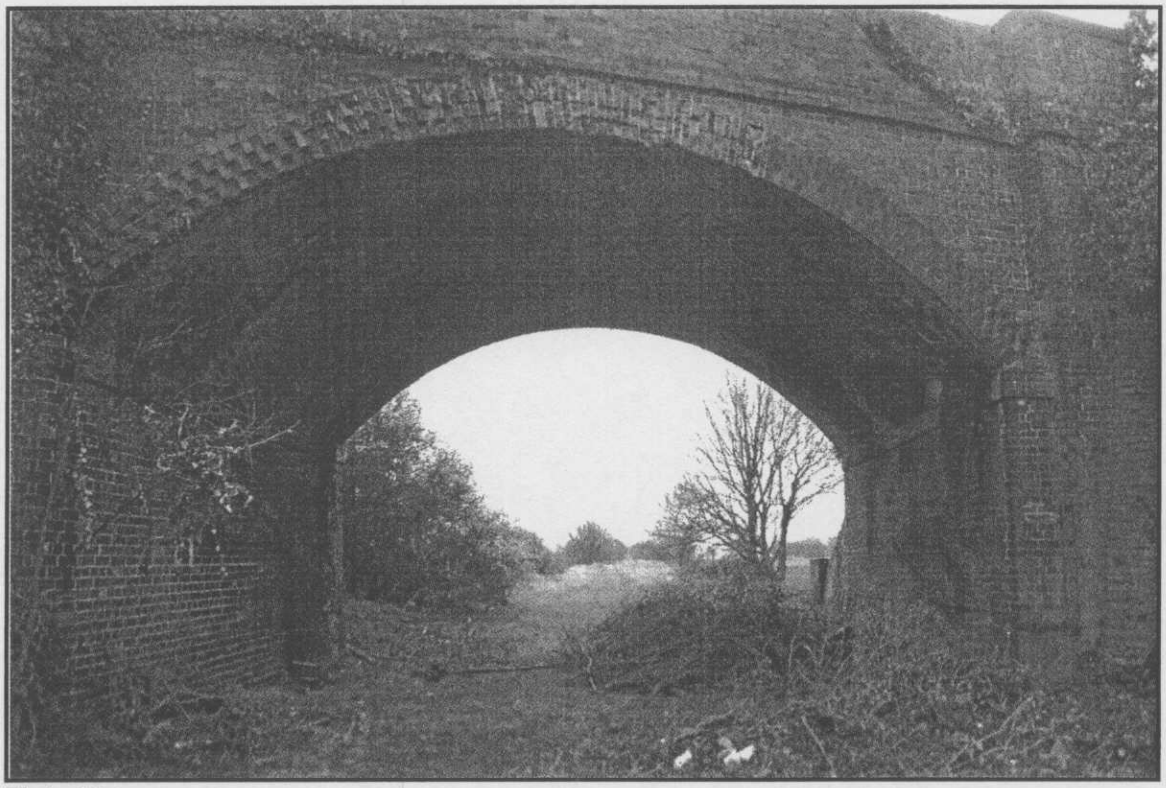


Plate 11
Elevation through arch from the west side

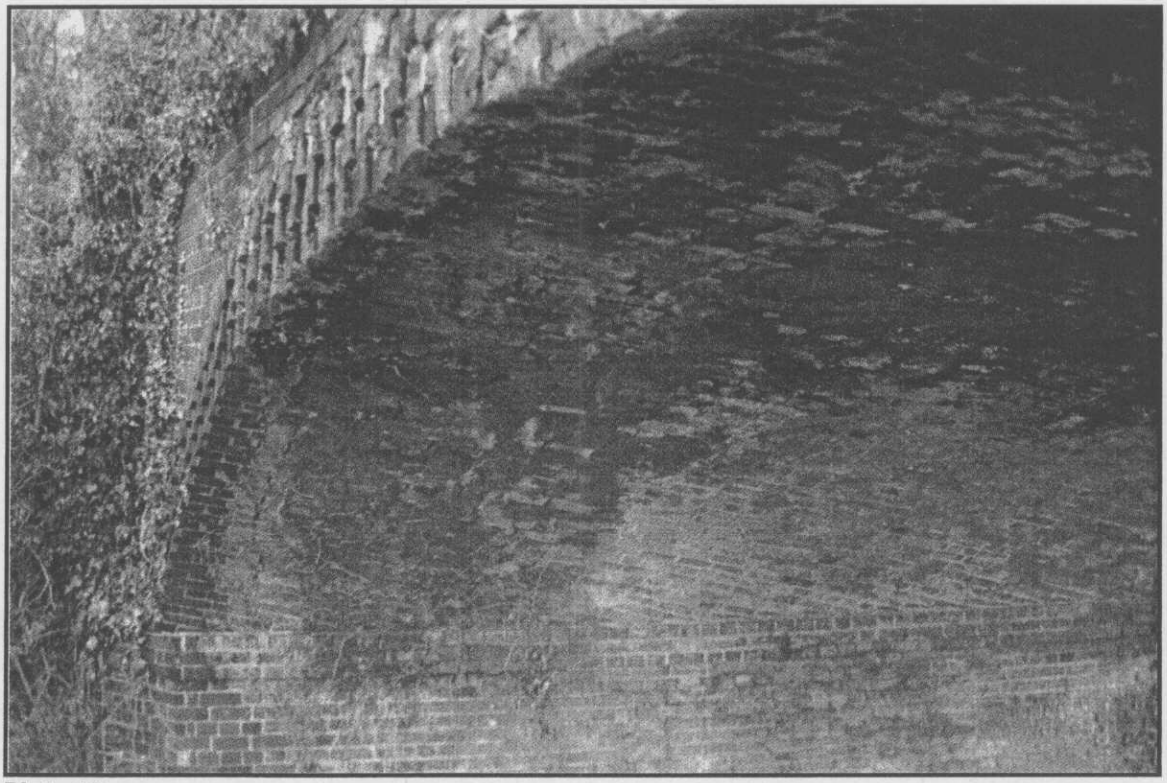


Plate 12
Arch and north abutment west end

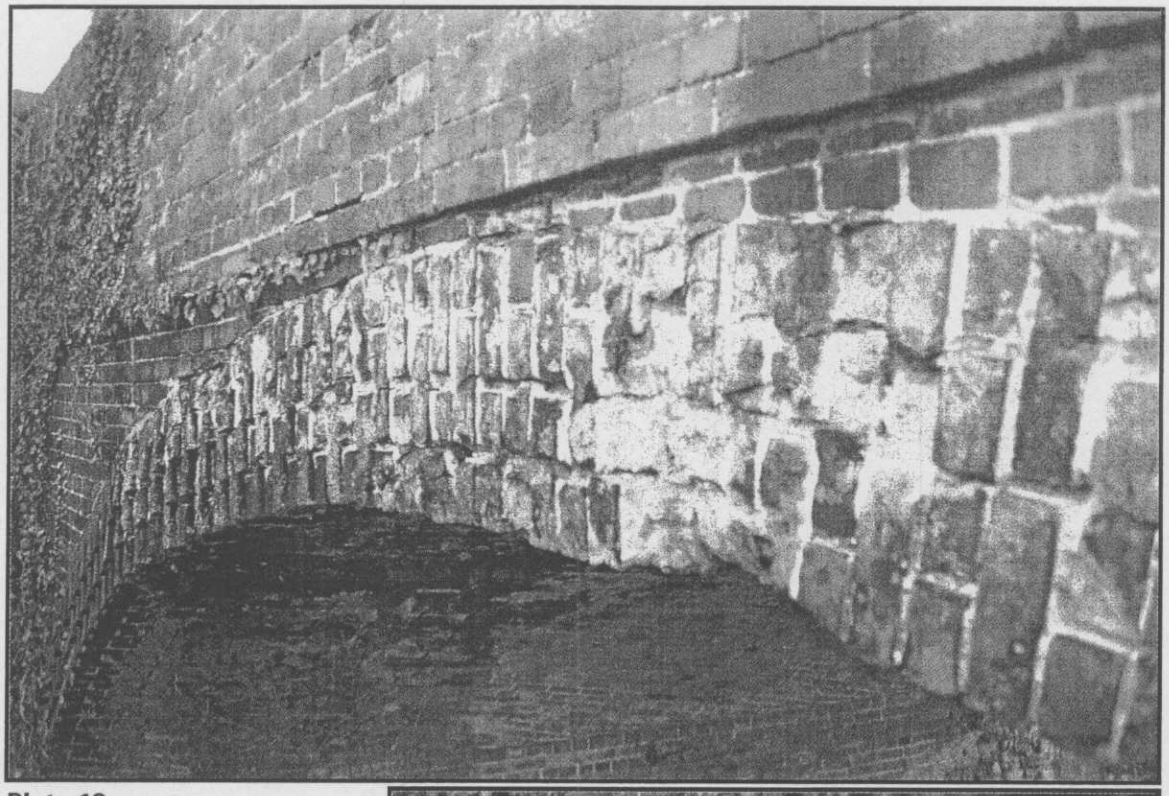


Plate 13
Arch west face north side

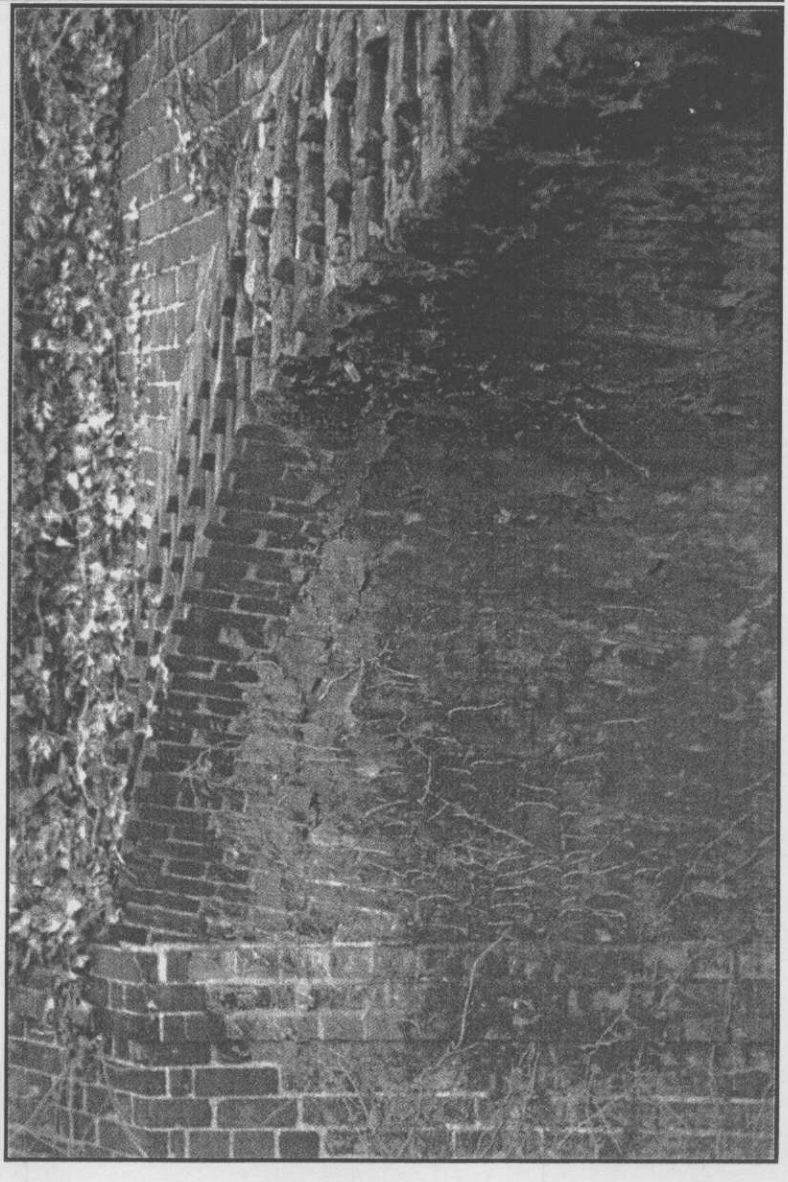


Plate 14
Arch west end over north abutment

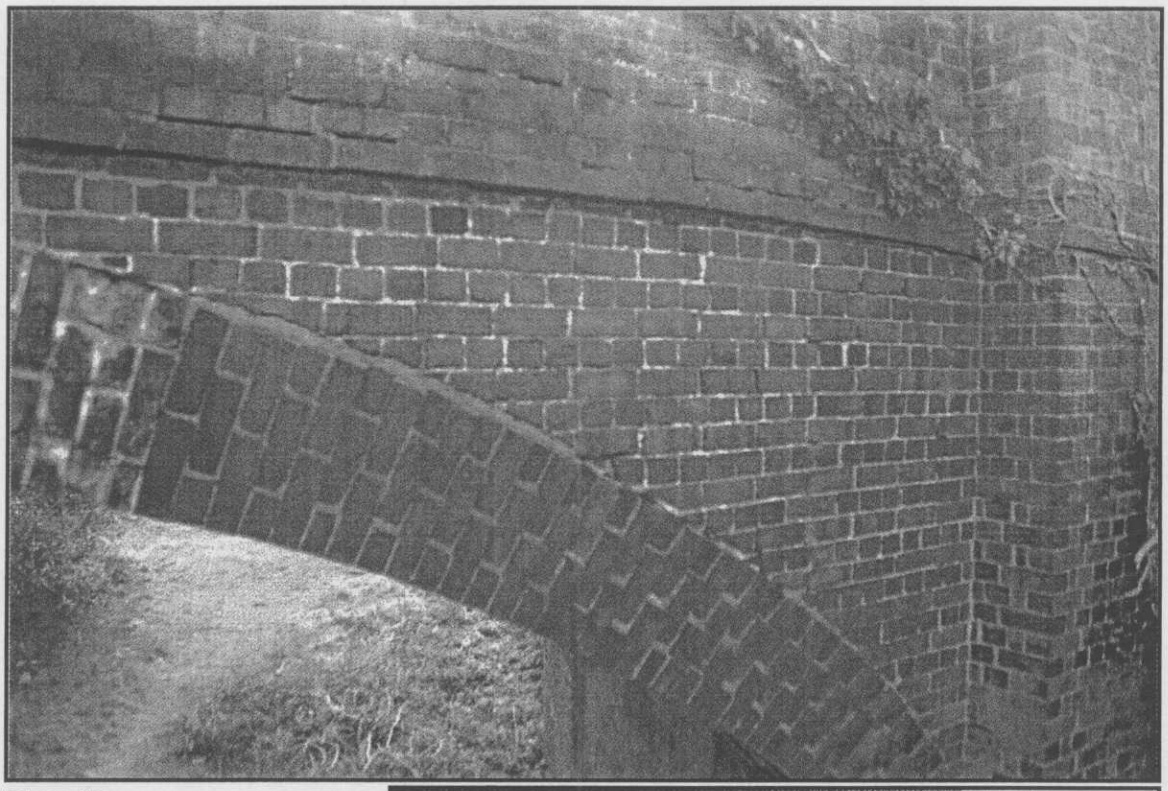


Plate 15
Arch west face and spandrel south side

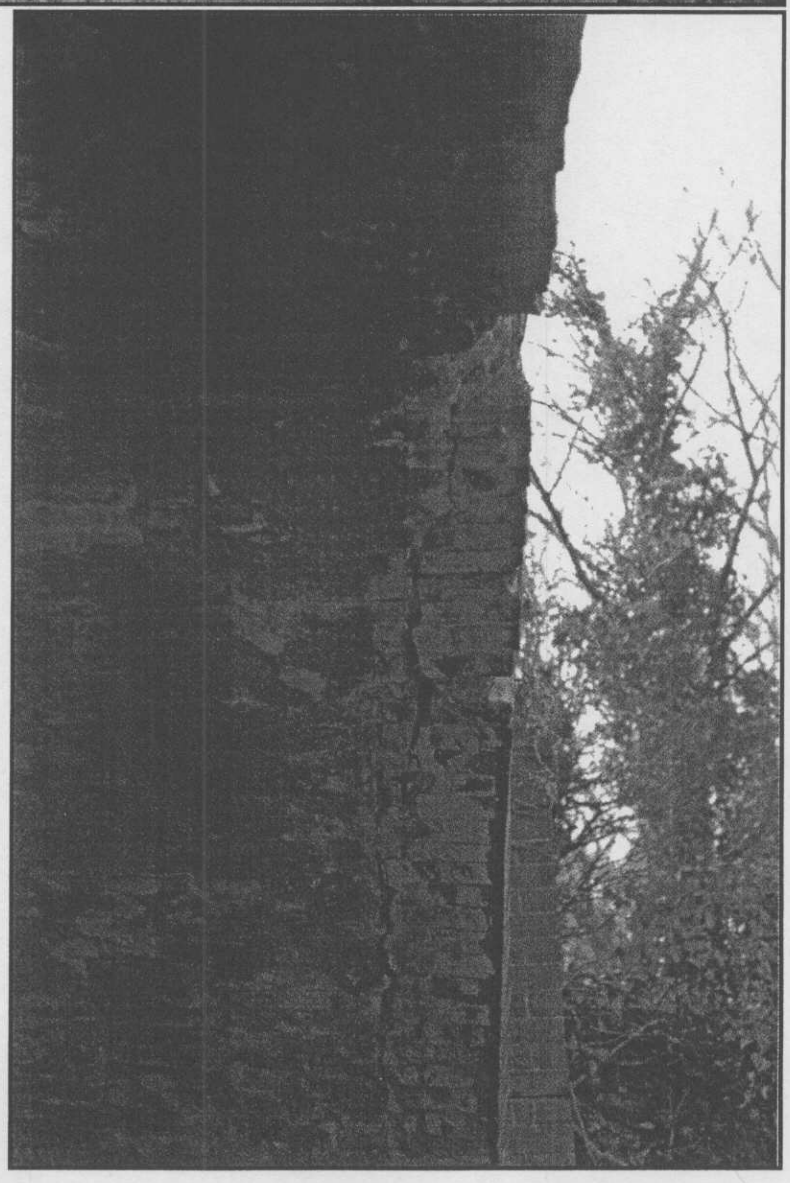


Plate 16
Arch west end over south abutment

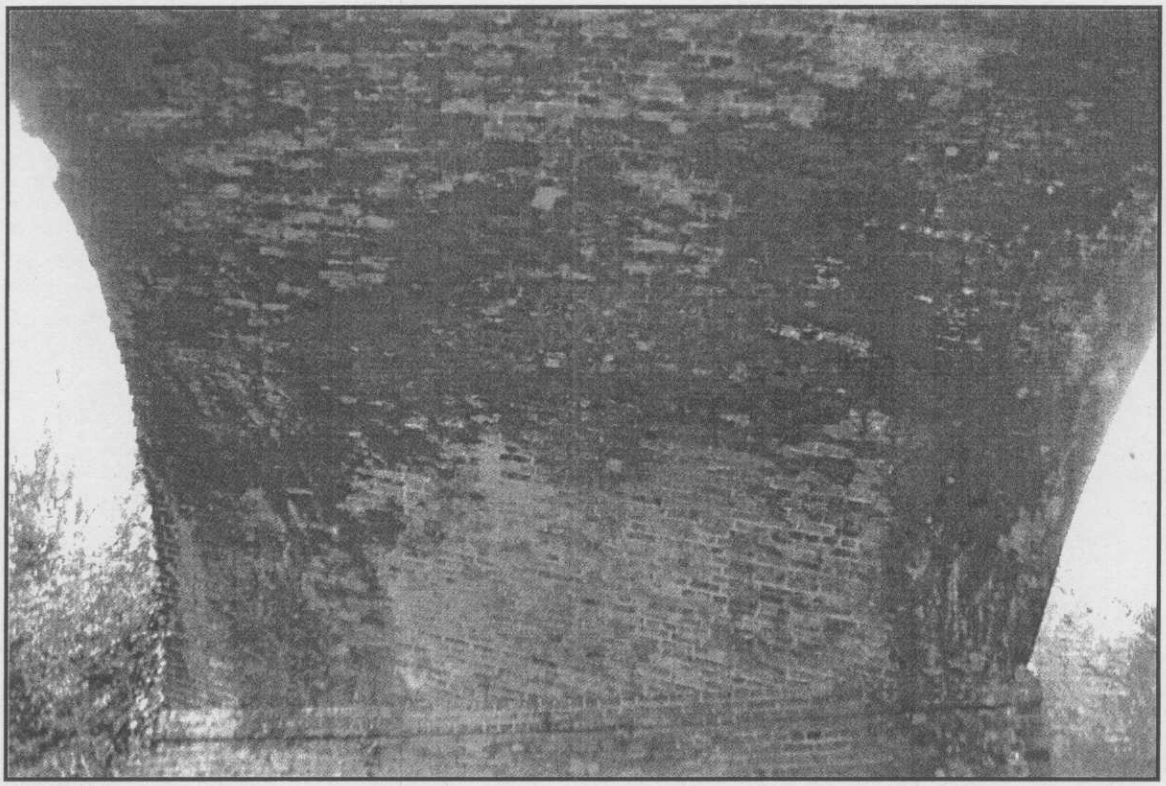


Plate 17
Arch north side

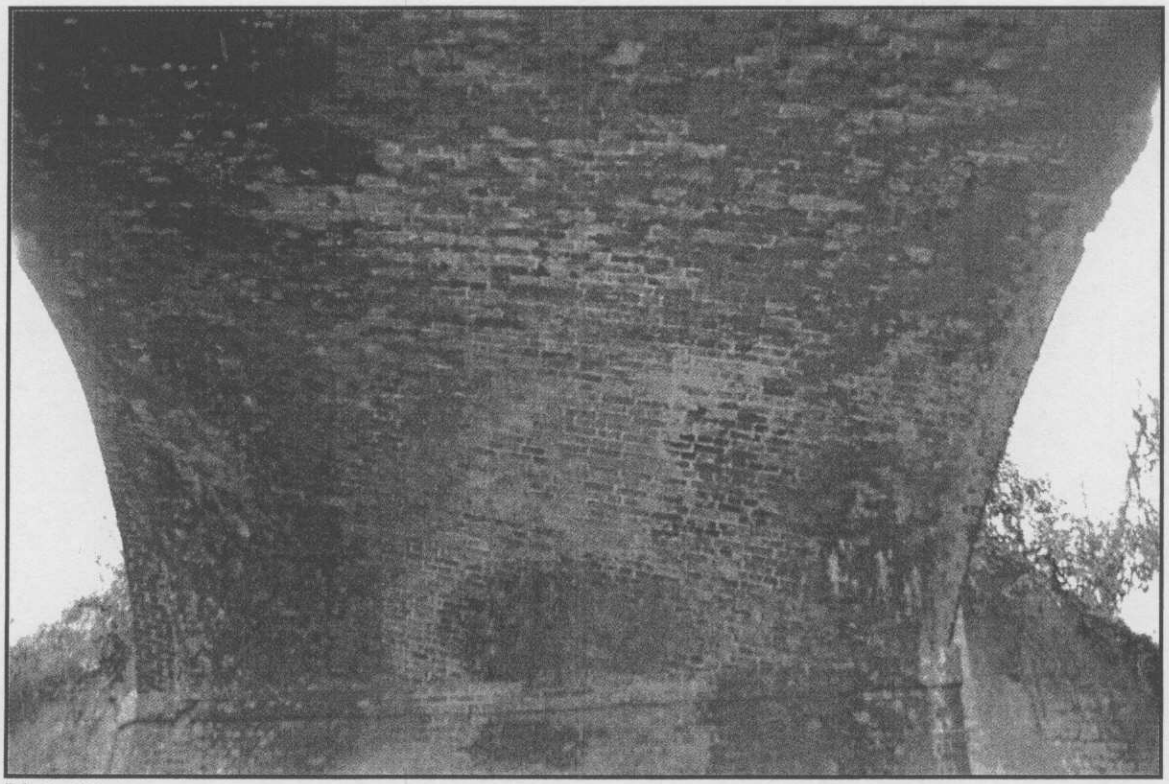


Plate 18
Arch south side

Plate 19
Elevation through arch from the east side

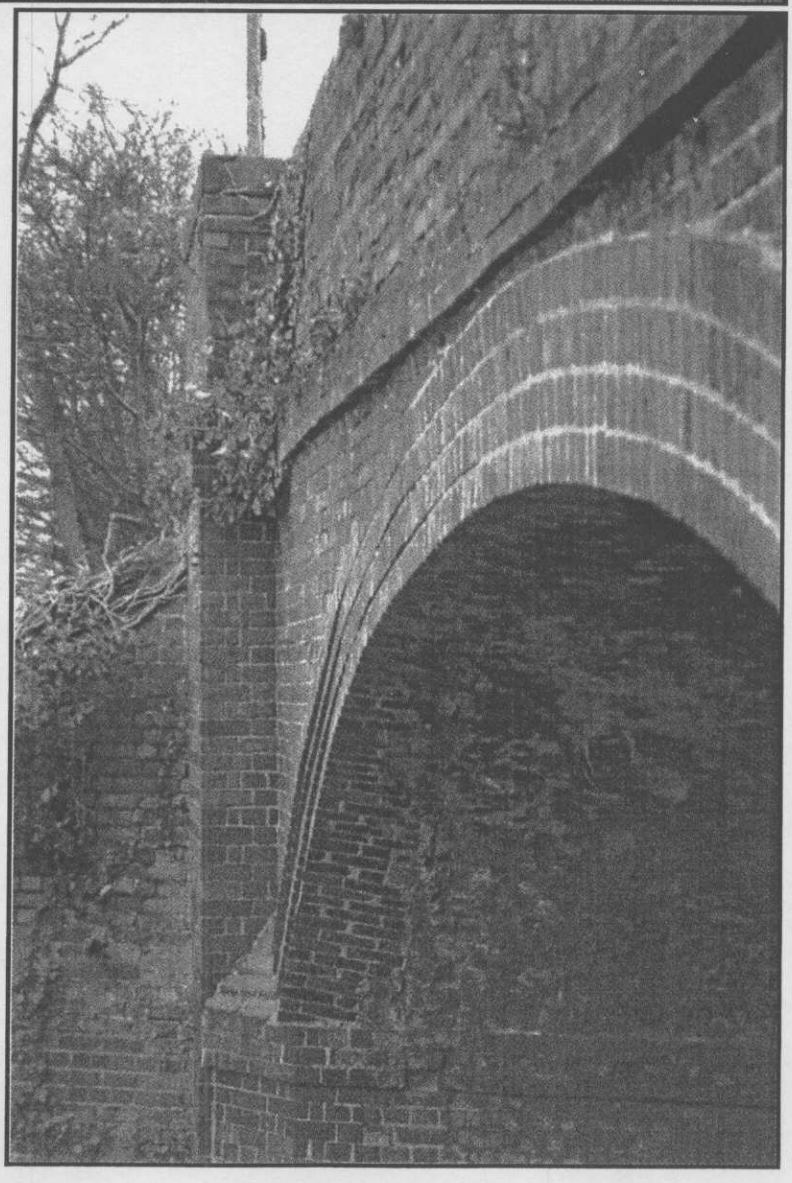


Plate 20
Arch east face and spandrel south side

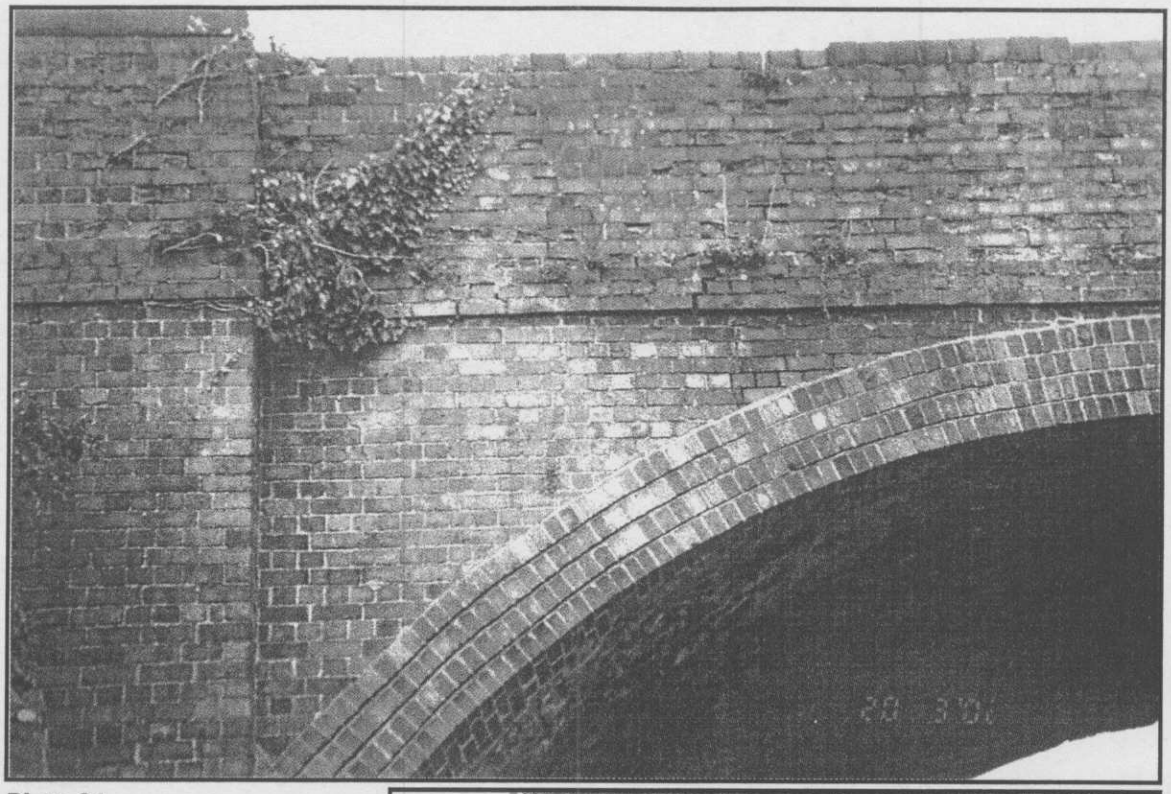


Plate 21
Arch east face, spandrel and parapet south side

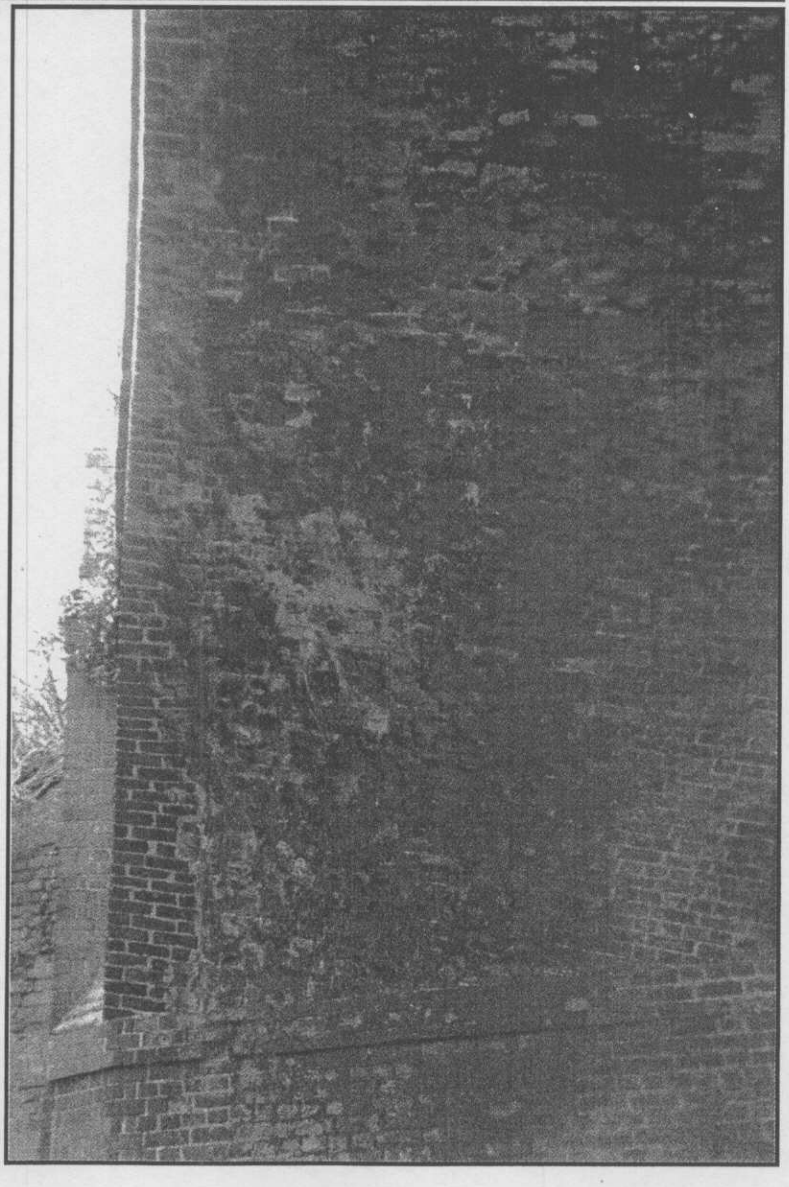


Plate 22
Arch and south abutment east end

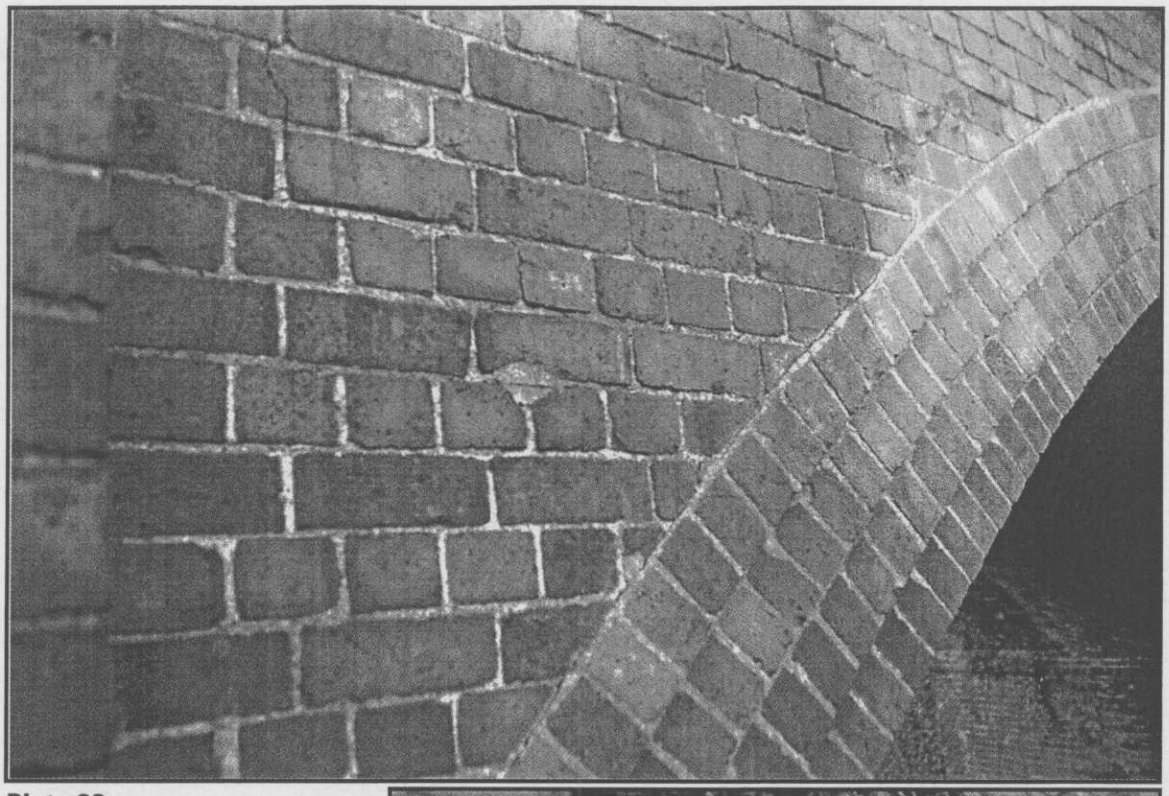


Plate 23
Arch east face and spandrel south side

Plate 24
East spandrel south end

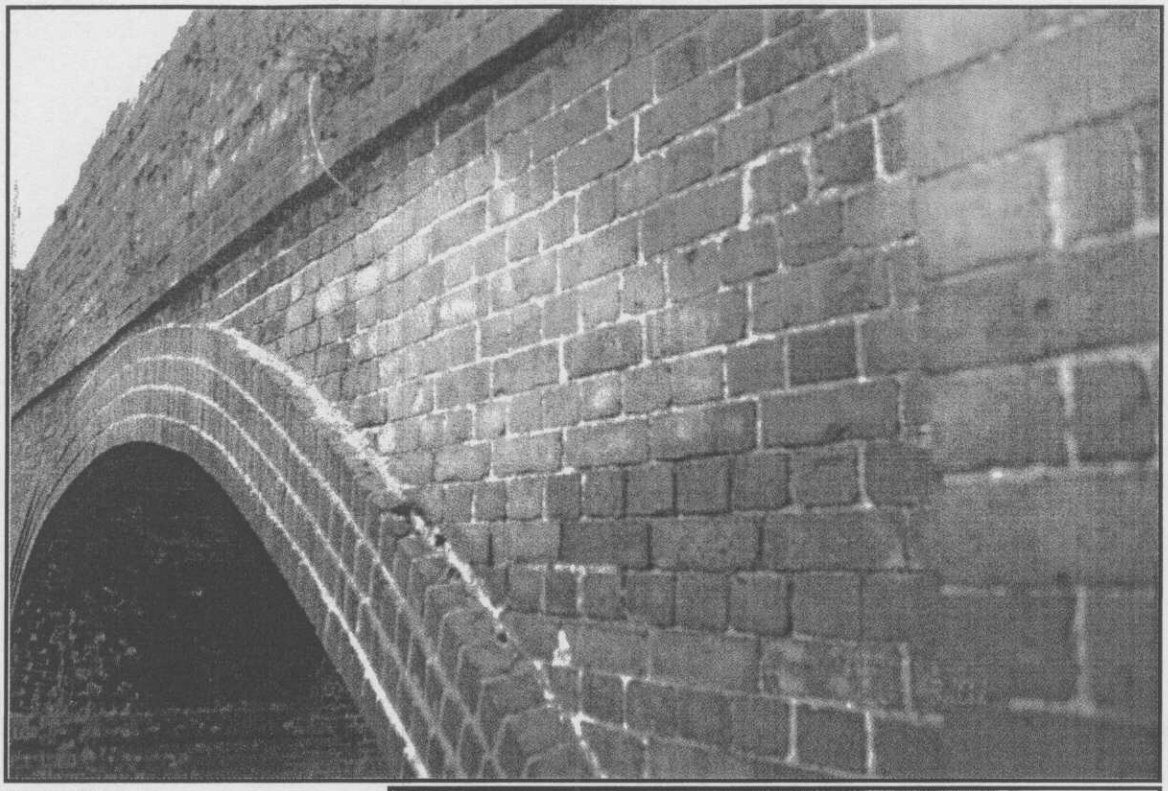


Plate 25
Arch east face and spandrel north side.

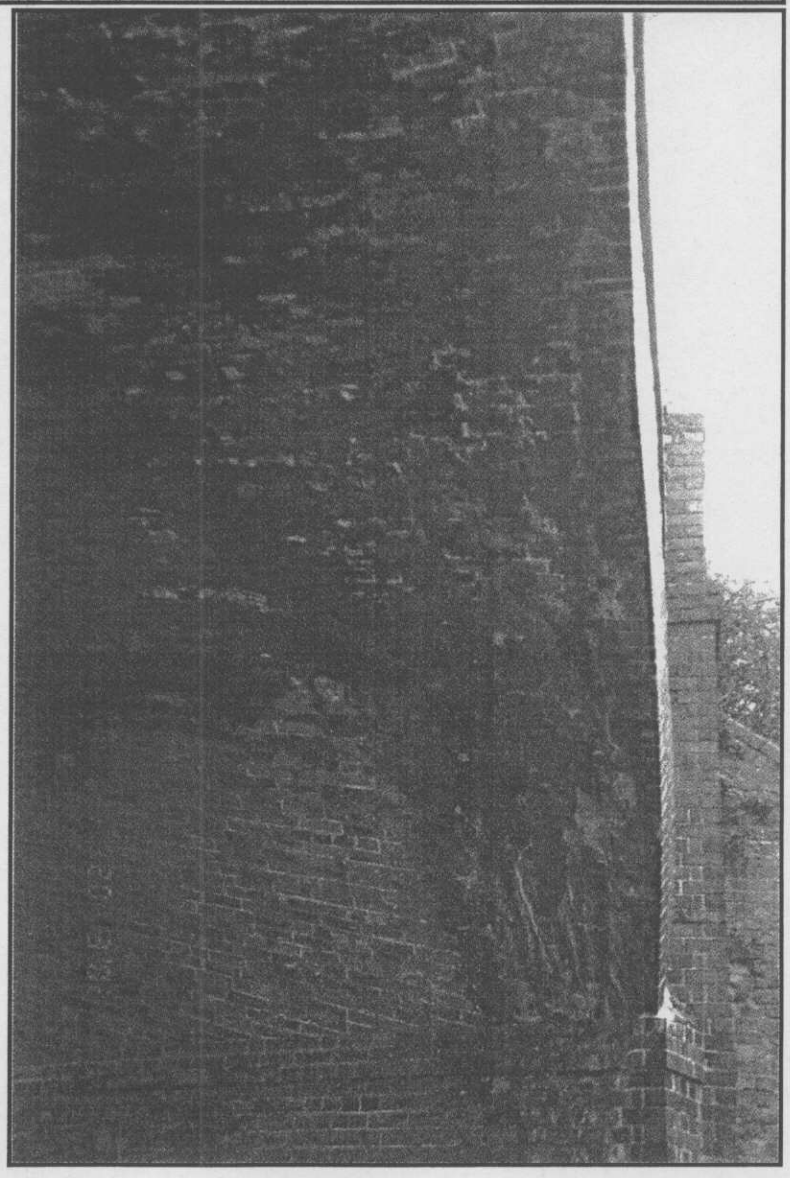


Plate 26
Arch and north abutment east end

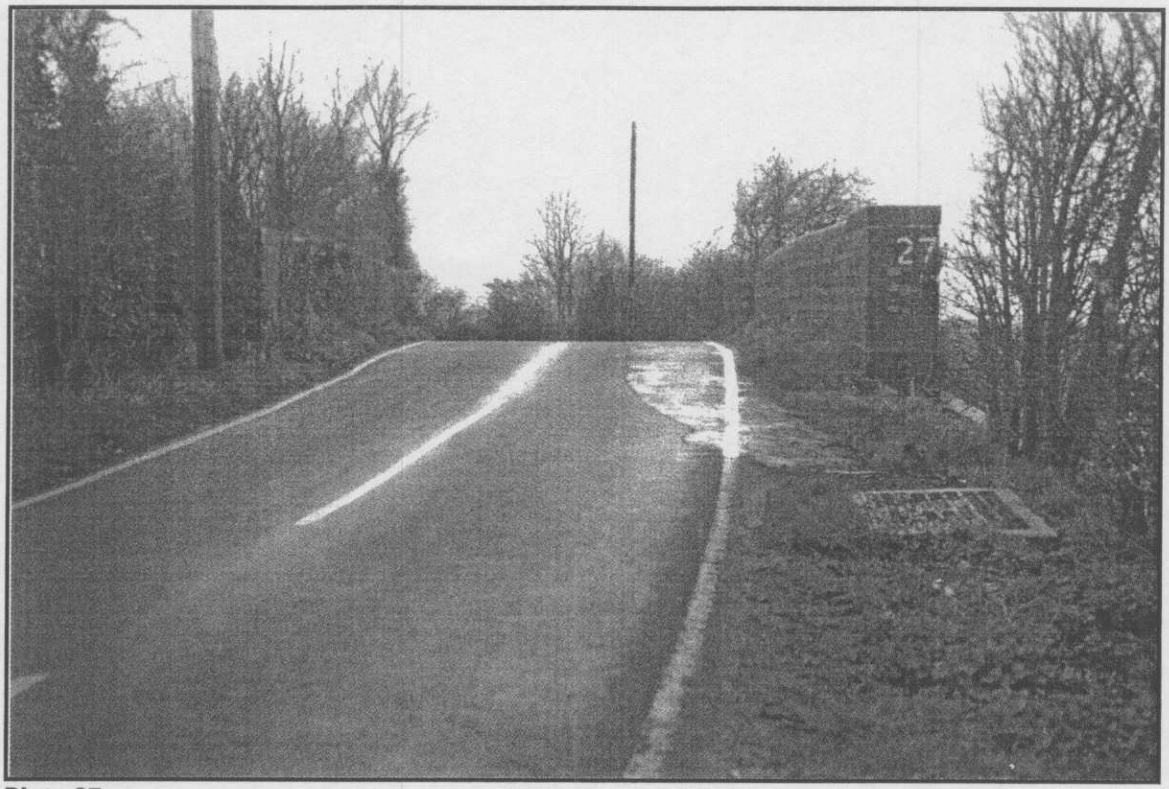


Plate 27
Carriageway elevation from the south

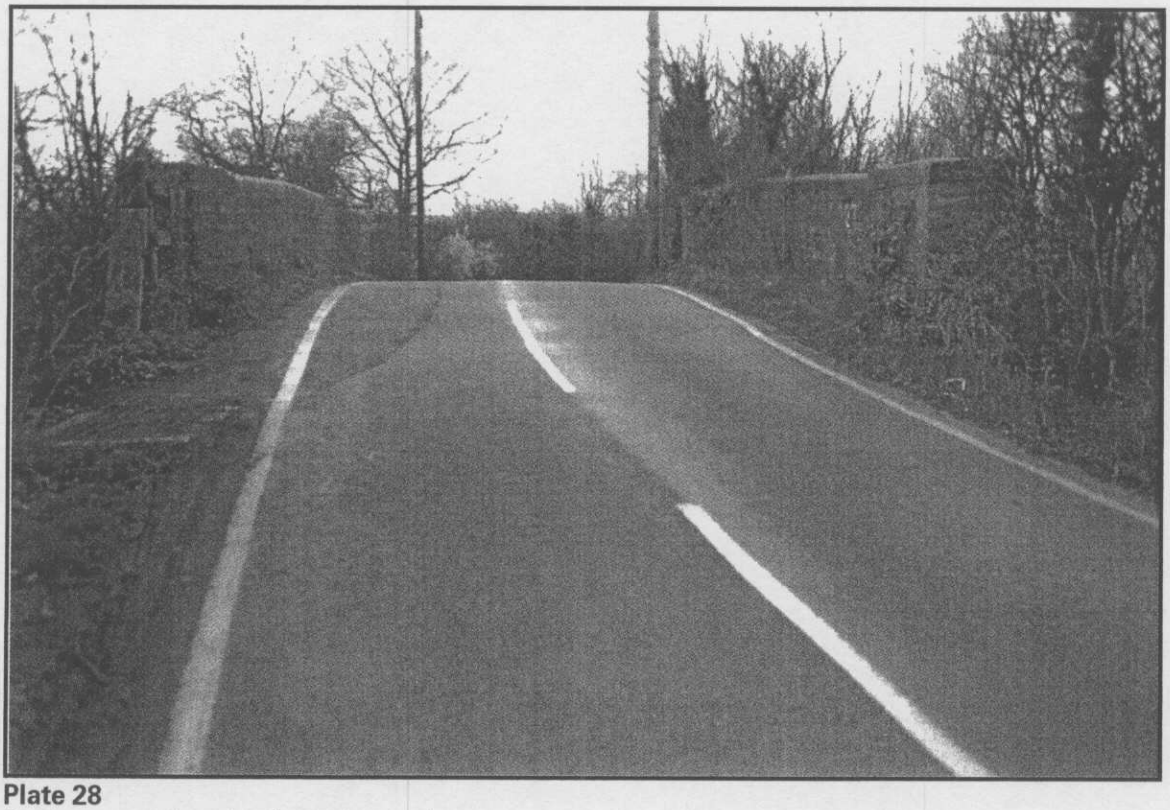


Plate 28
Carriageway elevation from the north

Plate 29
West parapet north end

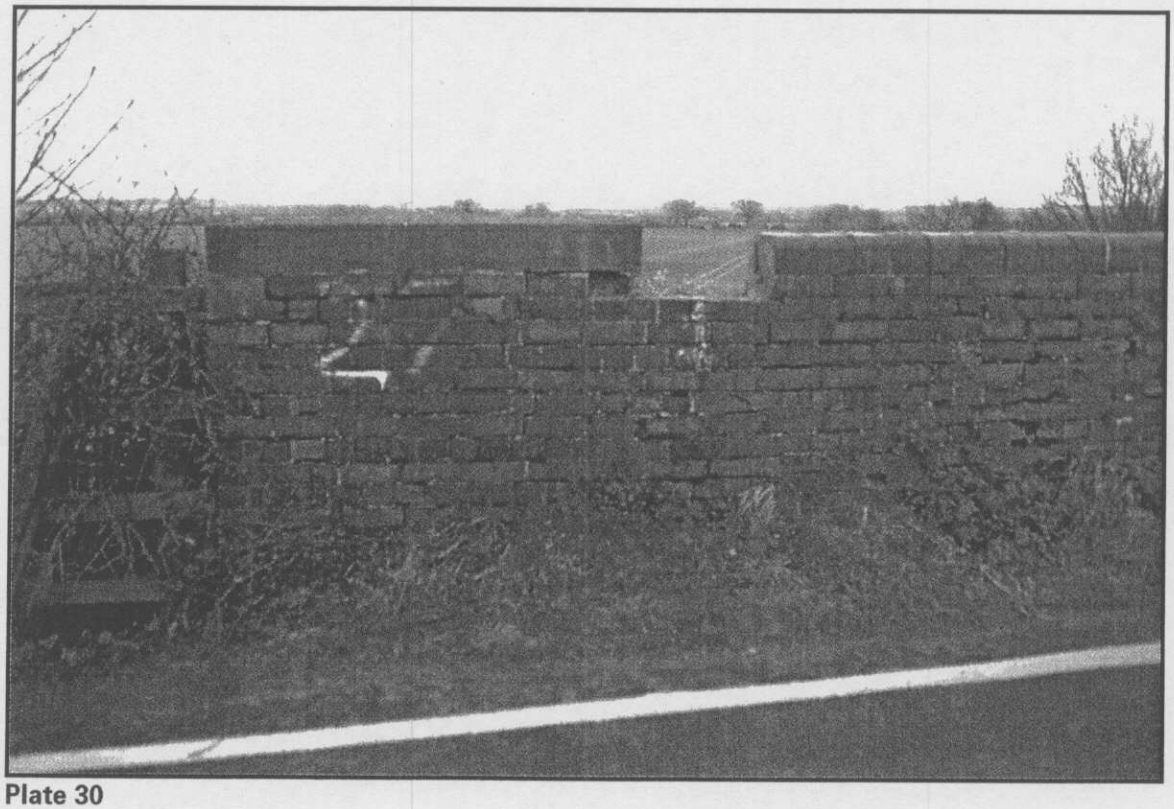
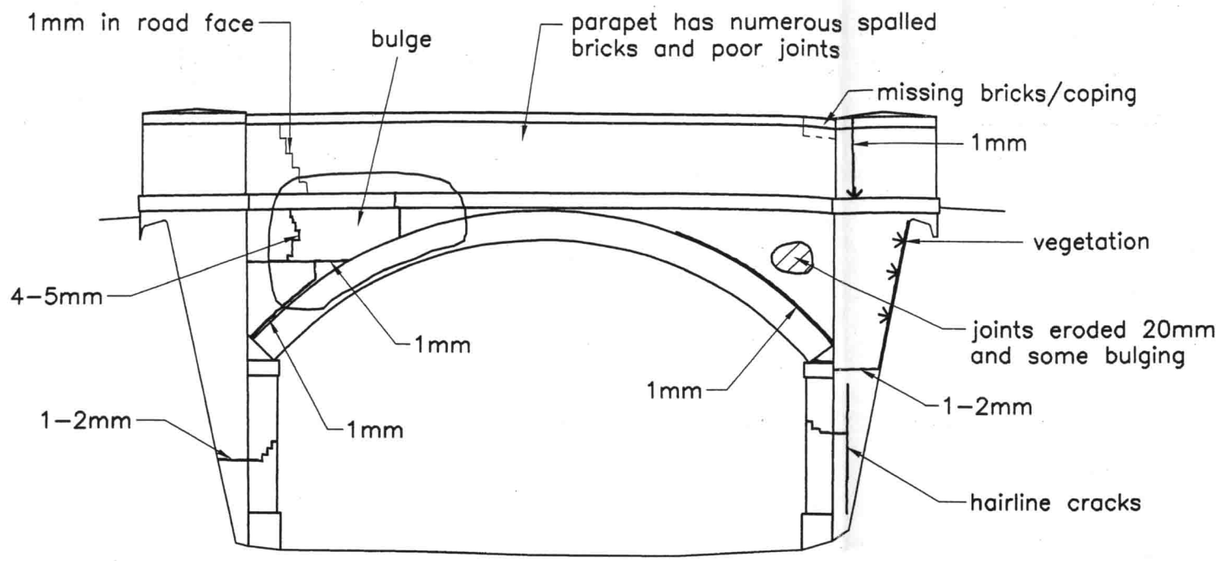


Plate 30
East parapet north end

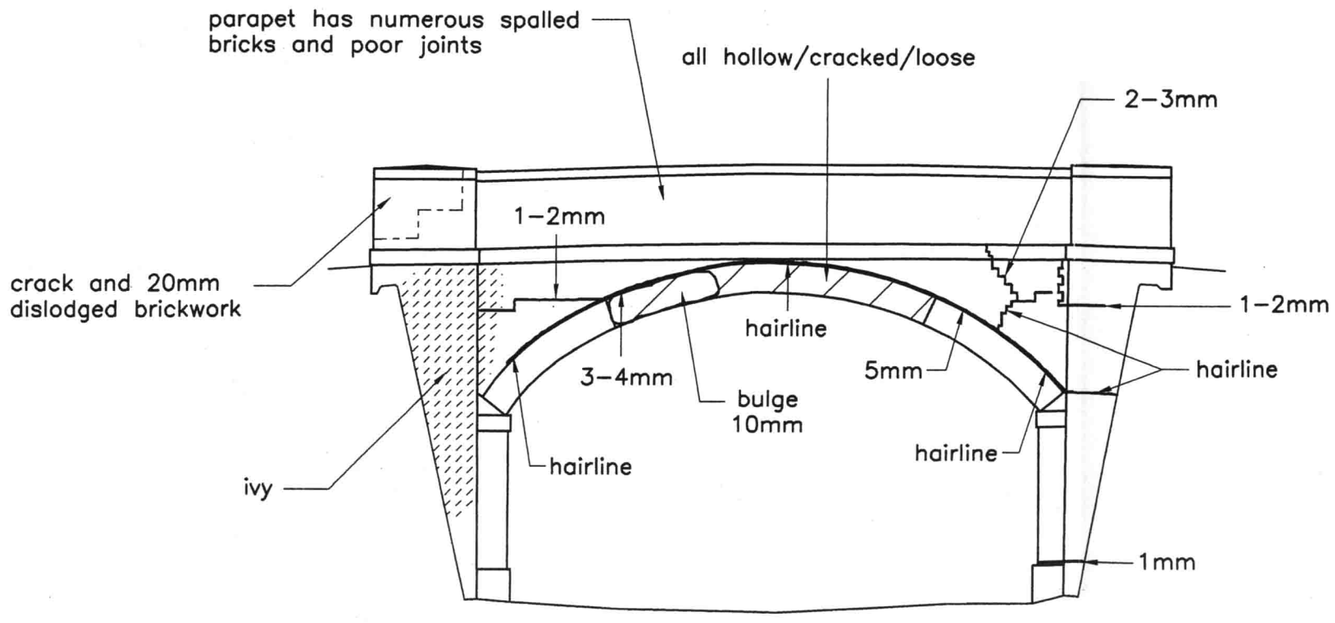
Appendix B

Defects Drawings

Drawing Number	Title
HIB27/6	Elevations Defects
HIB27/7	Arch Defects
HIB27/8	Abutment Defects
HIB27/9	Carriageway Defects



EAST ELEVATION



WEST ELEVATION

Drawing Number

HIB27/06

Notes

hollow

eroded joints

ivy

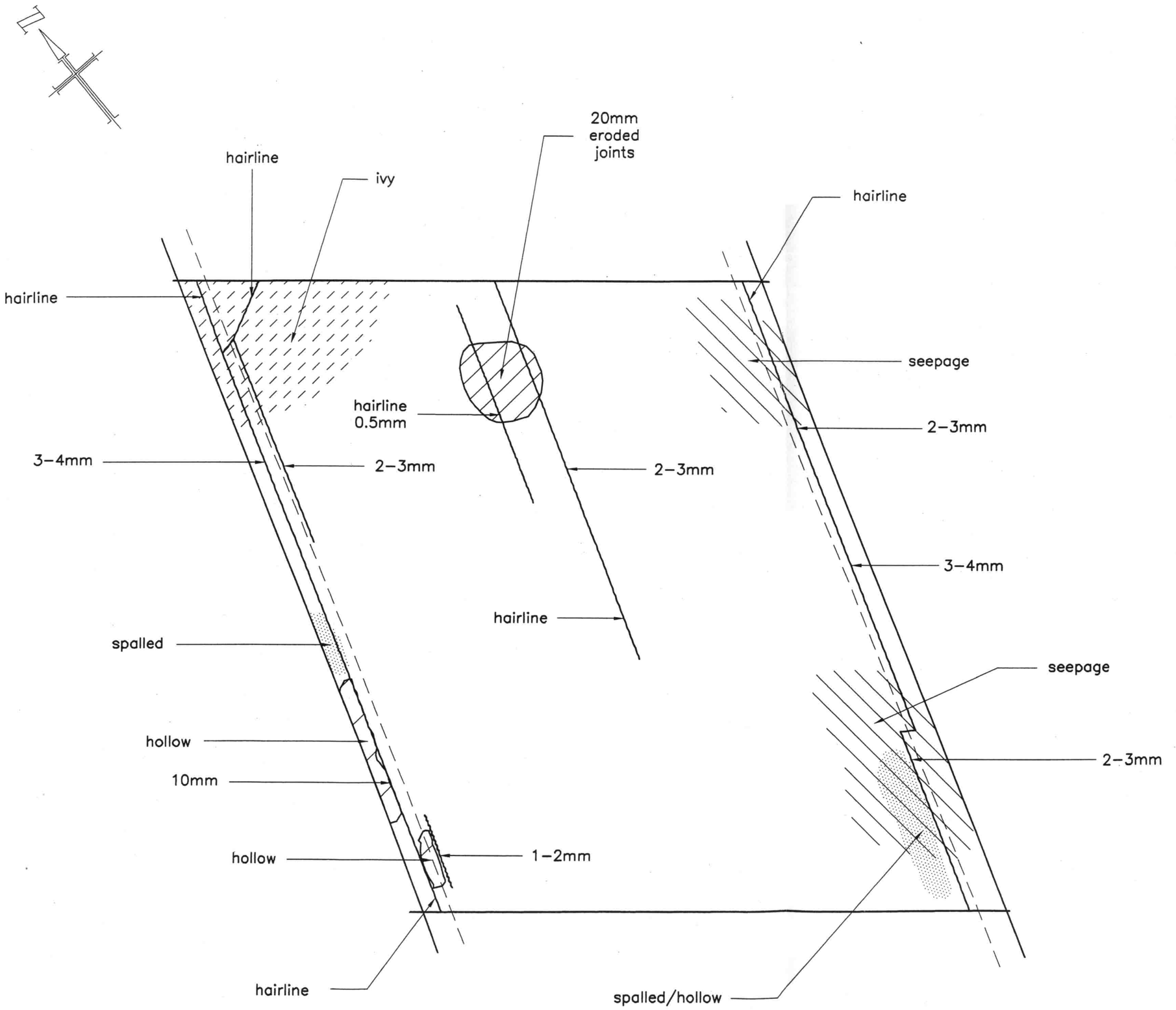
Do not scale this drawing

Rev	Date		Checked

Babtie

Client	**BEDFORDSHIRE COUNTY COUNCIL**
Project	**ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES**
Title	**SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON EAST & WEST ELEVATION DEFECTS**
Drawing No.	**HIB27/06**
Scale	**1:100** Date **APRIL 2002**
	Drawn **SR** Checked PDB Approved

Box 272, The Merton Centre, 45 St.Peters Street, Bedford MK40 2ZY



Drawing Number

HIB27/07

Notes

seepage

hollow

spalled

eroded joints

ivy

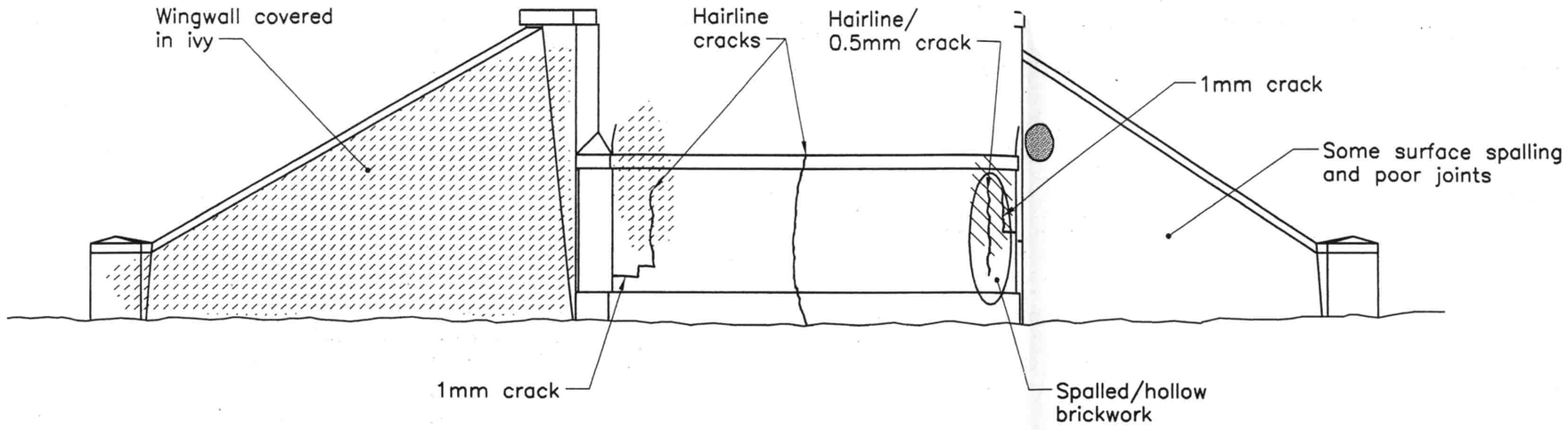
Do not scale this drawing

Rev	Date		Checked

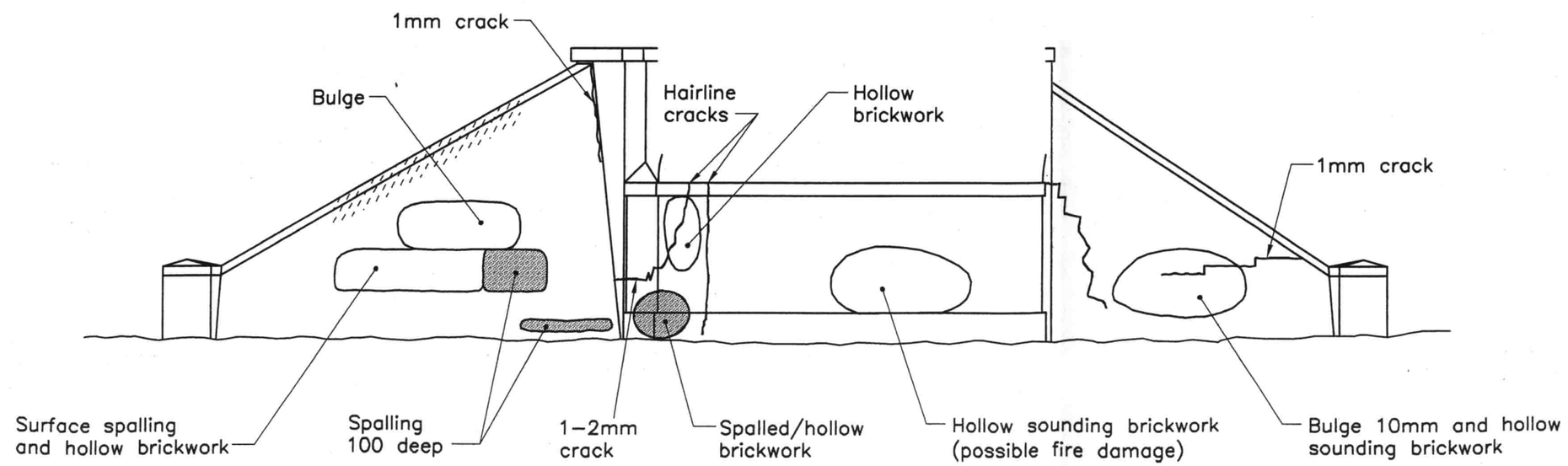
Babtie

Client	**BEDFORDSHIRE COUNTY COUNCIL**
Project	**ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES**
Title	**SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON ARCH DEFECTS**
Drawing No.	HIB27/07
Scale	1:50
Date	APRIL 2002
Drawn	SR
Checked	PDB
Approved	

Box 272, The Merton Centre, 45 St.Peters Street, Bedford MK40 2ZY



NORTH ABUTMENT



SOUTH ABUTMENT

Drawing Number

HIB27/08

Notes

Seepage

Spalling

Ivy

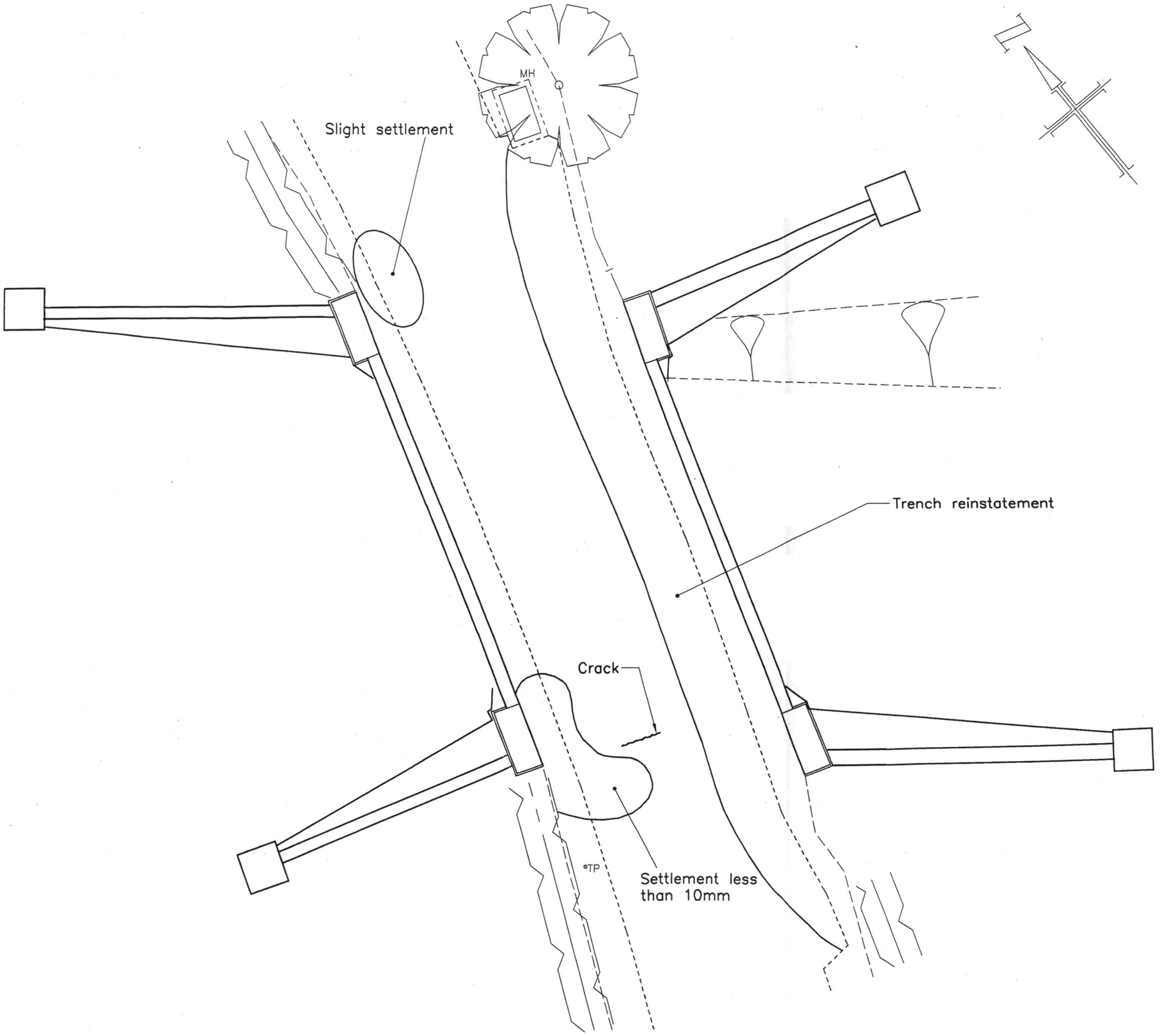
Do not scale this drawing

Rev	Date		Checked

Babtie

Client	**BEDFORDSHIRE COUNTY COUNCIL**
Project	**ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES**
Title	**SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON ABUTMENT DEFECTS**
Drawing No.	HIB27/08
Scale	1:100
Date	APRIL 2002
Drawn	SR
Checked	PDB
Approved	

Box 272, The Merton Centre, 45 St.Peters Street, Bedford MK40 2ZY



Drawing Number

HIB27/09

Notes

Do not scale this drawing

Rev	Date		Checked

Babtie

Client	**BEDFORDSHIRE COUNTY COUNCIL**
Project	**ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES**
Title	**SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON CARRIAGEWAY DEFECTS**
Drawing No.	**HIB27/09**
Scale	**1:100**
Drawn	**SR** Checked PDB
Date	**APRIL 2002**
Approved	

Box 272, The Merton Centre, 45 St.Peters Street, Bedford MK40 2ZY

Appendix C

Statutory Undertakers Apparatus Information

There is no information regarding Statutory Undertakers Apparatus.

Appendix D

Survey Drawings

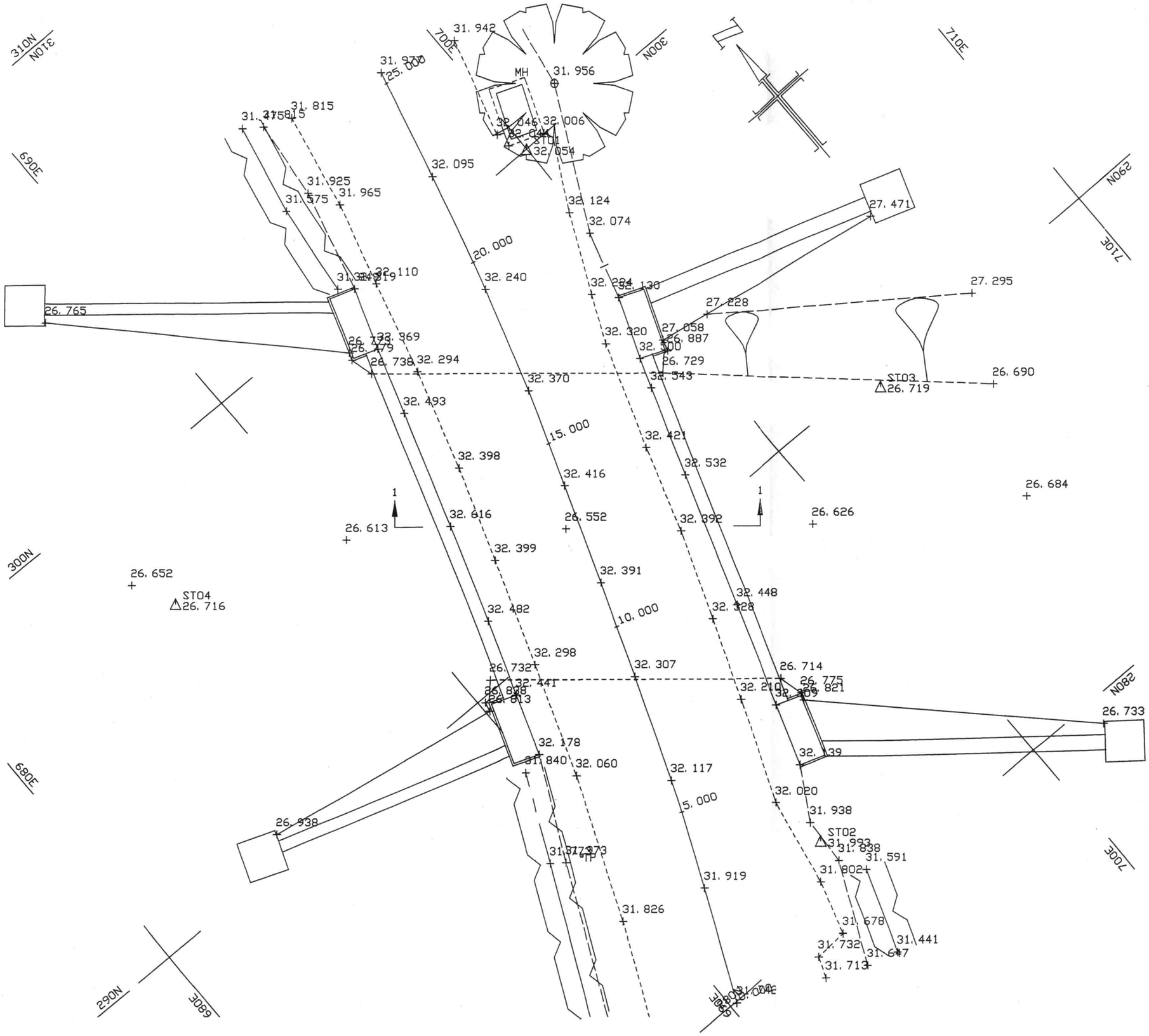
Sheet 1	Structure Dimensions
Drawing Number	Title
HIB27/1	Plan and Levels
HIB27/2	East Elevation
HIB27/3	West Elevation
HIB27/4	Cross section 1

Appendix D

Sheet 1

Structure Dimensions

Structural Element	Surveyed Dimension
Skew Span	8.49
Skew	21°
Ring Thickness	0.46
Width between parapets	6.03
Carriageway width	Varies - approx. 4.65
West verge	Varies - approx. 0.73
East verge	Varies - approx. 0.65
Parapet Width	0.34



Drawing Number

HIB27/1

Notes

1.
Coordinates are based on a local grid

2.
This drawing is based on a topo survey carried out Feb 2002

3.

STATION COORDINATES

NAME	TYPE	EASTINGS	NORTHINGS	LEVEL
ST01	PIN	700.000	300.000	32.054
ST02	PEG	694.409	281.712	31.993
ST03	PEG	703.029	289.602	26.719
ST04	PEG	685.826	296.792	26.716

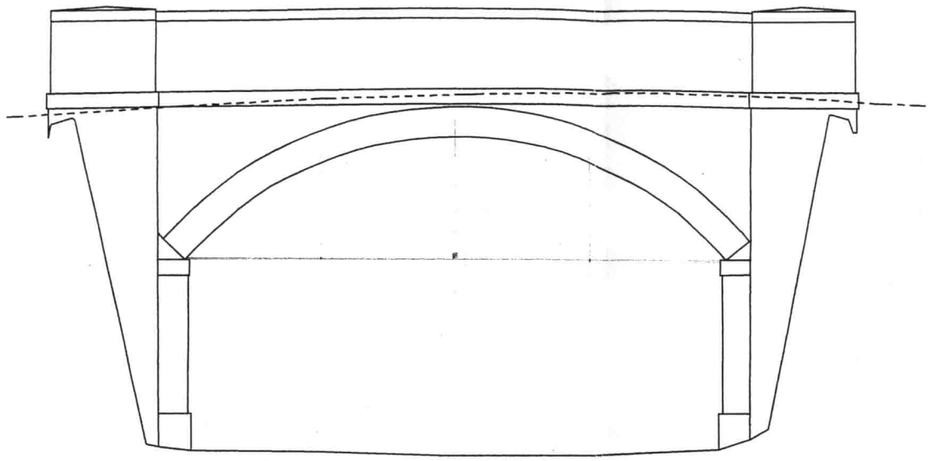
4.
All levels are related to the OSBM on Southill Road Railway Bridge Value 33.710m

Do not scale this drawing

Rev	Date		Checked

Babtie

Client	BEDFORDSHIRE COUNTY COUNCIL
Project	ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES
Title	SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON PLAN AND LEVELS
Drawing No.	HIB27/1
Scale	1:100
Drawn DMS	Checked
Date FEB 2002	Approved



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CHAINAGE	5.000	6.000	7.000	8.000	9.000	10.000	11.000	12.000	13.000	14.000	15.000	16.000	17.000	18.000
GROUND	31.728 31.909 32.021		26.821 26.775	26.714		26.701		26.642		26.635		26.729	26.887 27.058	32.060 31.765
ARCH				29.764	30.269	30.947	31.227	31.541	31.712	31.705	31.618	31.510	31.289	30.996 30.832 30.655 30.112 29.860
EDGE OF CARRIAGEWAY	32.020			32.210		32.328		32.392		32.421			32.320	32.224 32.188
PARAPET	33.708	33.779	33.698		33.730	33.741	33.749			33.725		33.682	33.752	33.681

Drawing Number

HIB27/2

Notes

1.
All levels are related to the □SBM
on Southill Road Railway Bridge
Value 33.710m

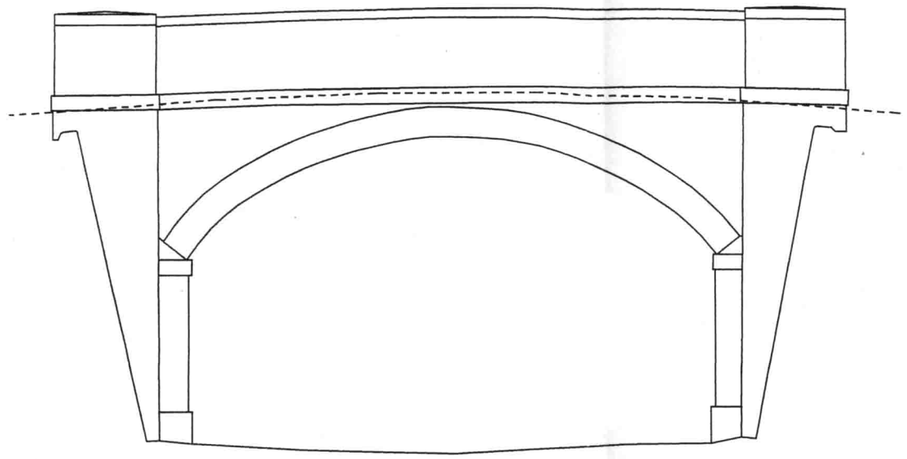
2.
Direction of elevation is perpendicular to
the face of the structure

Do not scale this drawing

Rev	Date		Checked

Babtie

Client	BEDFORDSHIRE COUNTY COUNCIL
Project	ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES
Title	SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON EAST ELEVATION
Drawing No.	HIB27/2
Scale	HS=1:100 VS=1:100
Date	FEB 2002
Drawn	DMS
Checked	
Approved	



DATUM=26.000

CHAINAGE	21.000	20.000	19.000	18.000	17.000	16.000	15.000	14.000	13.000	12.000	11.000	10.000	9.000	8.000
GROUND	31.656	31.807	26.773	26.779	26.738	26.630	26.573	26.718	26.732	26.838	26.813	31.847	31.763	
ARCH				29.736	30.201	31.002	31.303	31.535	31.684	31.682	31.611	31.484	31.267	30.996	30.611	30.366	29.853			
EDGE OF CARRIAGEWAY	32.056	32.110			32.294			32.398			32.399			32.298						32.060
PARAPET	33.673	33.718	33.627			33.712			33.757			33.752					33.695	33.757	33.726	

Drawing Number

HIB27/3

Notes

1.
All levels are related to the □SBM
on Southill Road Railway Bridge
Value 33.710m

2.
Direction of elevation is perpendicular to
the face of the structure

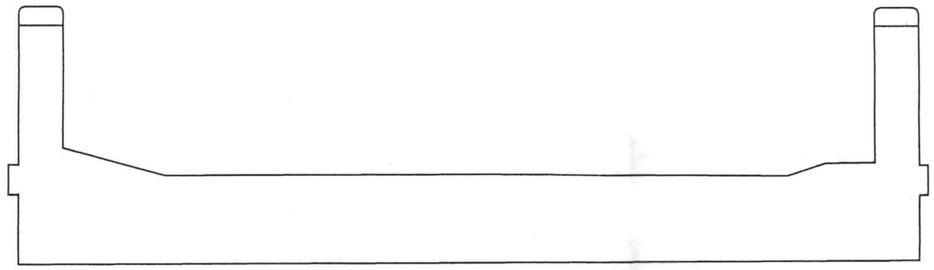
Do not scale this drawing

Rev	Date		Checked

Babtie

Client	BEDFORDSHIRE COUNTY COUNCIL
Project	ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES
Title	SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON WEST ELEVATION
Drawing No.	HIB27/3
Scale	HS=1:100 VS=1:100
Drawn DMS	Checked
Date FEB 2002	Approved

Babtie Group Ltd 95 Bothwell Street, Glasgow G2 7HX



DATUM=31.000

CHAINAGE	-3.612	-3.282	-2.741	-2.492	0.000	2.511	2.817	3.184	3.519 / 3.638
SECTION 1	33.756	32.615	32.468	32.398	32.406	32.394	32.493	32.499	33.743 / 32.479
SOFFIT	31.683								31.711

Drawing Number

HIB27/4

Notes

1.
All levels are related to the □SBM
on Southill Road Railway Bridge
Value 33.710m

Do not scale this drawing

Rev	Date		Checked

Babtie

Client	BEDFORDSHIRE COUNTY COUNCIL
Project	ASSESSMENT OF BRITISH RAIL PROPERTY BOARD STRUCTURES
Title	SOUTHILL ROAD RAILWAY BRIDGE U147 CARDINGTON CROSS SECTION 1
Drawing No.	HIB27/4
Scale	HS=1:50 VS=1:50
	Drawn DMS Checked
Date	FEB 2003
Approved	

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Appendix E

List of Record Drawings

None

Appendix F

Site Factors Affecting Assessment

Arch Profiles and Assessment Data

Sheet 1 Parameters for Assessment

Sheet 2 Carriageway Profile and Statutory Undertakers Plant

Appendix F

Sheet 1 Parameters for Assessment

Arch Barrel Material and Condition	
Arch Barrel Material Brick 4-ring (460mm). Not engineering bricks but appear of good quality.	
Arch Barrel Material Condition Good condition generally but has some spalled bricks.	
Arch Barrel General Condition Longitudinal crack at centre. Large longitudinal cracks at both ends. Intrados brickwork in sound condition apart from ends and arch appears to have a good shape.	
Fill Material	
Well compacted. Minor settlement.	
Mortar Joints	
Joint Width Less than 10mm	
Joint Condition Generally good condition but has some patches of eroded joints up to 20mm deep. Some ivy growth to northwest corner.	
Depth missing 20mm	
Factors for assessment	
Barrel Factor F_b	1.0
Fill Factor F_f	0.7
Joint Width Factor F_w	0.9
Mortar Factor F_{mo}	1.0
Joint Depth Factor F_d	0.9
Condition Factor F_{cm}	0.6
Arch Profile	
The arch elevation surveys show that the arch appears to have a uniform circular profile.	

Appendix F

Sheet 2 Carriageway Profile and Statutory Undertakers Plant

Affect of Carriageway Profile

Lift-off: Lift-off will be considered in the assessment, as the carriageway over the structure is curved.

Centrifugal Effects: Centrifugal effects are not considered in the assessment. The carriageway over the structure is nearly straight.

Affect of Statutory Undertakers Apparatus

No information is available on existing services.

Appendix G

AIP Form