SMB/2062 BE4 Assessment Check of Southeast Edge Girder

Braughing, Puckeridge, East Hertfordshire

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National Highways – Historical Railways Estate
VAR9/7070

HRE Assessment Programme
1 October 2025

SMB/2062 BE4 Assessment Check of Southeast Edge Girder

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Project name:	HRE Assessment Programme		
Client reference:	VAR9/7070	**Project no:**	[redacted]
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Document history and status

Revision	Date	Description	[redacted]			ved
Form AA/BA/BAA	Oct-25	SMB/2062 BE4 Check	[redacted]			

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments

Jacobs U.K. Limited

20, George Hudson Street
York YO1 6WR
United Kingdom

T +44 (0)190 455 9900
www.jacobs.com

Executive summary

Structure Type: Single span overbridge

Superstructure Form: Double joist compound girders with jack arches

Substructure Form: Brick wingwalls, abutments and parapets

Span: 9.14m (30' – 0")

Assessment Code: BE4

Live Load Capacity: Dead Loads Only

Capacity Critical Element: South Edge Girders (Midspan bending)

Condition: Poor

Local Authority: Hertfordshire

OS Reference: TL 390 241

This report presents the load carrying capacity for the assessed element (southeast edge girder) and identifies the data used to derive the assessment. The load carrying capacity of the bridge is based only on the assessment of visible span that were amenable to inspection as part of the inspection for assessment completed for the purpose of a CS 454 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 the site visits described.

Identification of defects was 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 CS 454 assessment:

- Topside and internal faces of the girders covered by the jack arch construction were not exposed.
- No investigation was made of the internal condition of the pseudo-box girders apart from where visible through existing holes.

Contents

Appendices

1. Introduction

Jacobs was appointed by National Highways – Historical Railways Estate (HRE) to undertake a CS454 assessment of structure SMB/2062. Following the failure of the southeast edge girder and a rating of 'dead loads only', HRE remitted Jacobs to complete a check of the girder to BE4. The dimensions and condition of the girder have been taken from the CS 454 assessment and as such, the following should be read in conjunction with the report: SMB/2062 CS 454 Assessment and Inspection report (Revision Form BA): May 2025.

2. Assessment to BE4

2.1 Methodology

The capacity of the girder was calculated using estimates of reduced sections sizes where corrosion is present. A general condition factor was not applied. Section sizes have been taken from the CS 454 assessment.

The outer joist of the pair forming the compound girder is corroded to the extent that it is considered to be ineffective in providing any bending capacity. Hence the assessment is based on the capacity of the inner joist and its attached top and bottom plates

Southeast edge girder at midspan showing severe corrosion

The girders are mild steel. The capacity of the steel girder was derived using the permissible stress from BS 153: Part 3B: 1958 assuming BS 15 steel with a yield stress of 15 ton/in^2, adjusted as prescribed in BE4 Part I Clause 304(a).

The girder was to be checked for live loads in accordance with BE4 Part I Clause 202 (a) using the simple distribution method in BE4 Part II Clause 301.

The assessed bending resistance is dependent on the rotational restraint to the compound girder at its supports. This is difficult to judge in the case of a highly corroded girder. Thus, results are presented over the normal range of values for girders with no intermediate lateral restraint in accordance with BS 153: Part 4 Clause 21a.

2.2 Results

Element: Southeast Edge Girder

Action	Effective length	Location	DL & SDL Effects	Assessed Resistance	Live Load Capacity
Bending	= Span	Midspan	111.8 ton.ft	87.6 ton.ft	Fails dead loads
	=0.85 x span		111.8 ton.ft	97.2 ton.ft	Fails dead loads
	=0.7 x span		111.8 ton.ft	112.1 ton.ft	Dead load only

A check of the live loads which would be imposed on the edge girder was not undertaken as the girder has only marginal live load capacity in the most optimistic restraint state when assessed to BE4.

3. Conclusions and Recommendations

As demonstrated by this check of the southeast edge girder to BE4, the girder has only marginal live load capacity in the most optimistic restraint state and is therefore not adequate for any live loads. With no intervening member between the position of the near side wheels of a BE4 vehicle train and the edge girder, there will be some, albeit small, live load effect on the edge girder.

The CS 454 assessment was able to demonstrate a similar capacity, marginally in excess of dead load, but insufficient for any live load, albeit by considering the girder to have compact plastic properties. This assumption may be doubtful in the case of a highly corroded girder. BS 153 considers only the elastic sections when determining the resistance of a girder.

The effective length of the girder greatly affects the capacity. A satisfactory double web compound girder might be expected to have a high degree of restraint to rotation in plan at the point of support, thus reducing effective length. The effects of corrosion on the system are difficult to determine.

As a priority, the carriageway should be narrowed and barriers put in place to prevent any vehicle loading on the edge girder. Longer term solutions that should be considered are complete replacement of the edge girders or full deck, infill or the installation of a multiplate arch or similar.

Appendix A. Form AA

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Bridge/Line Name: **Braughing Station / Buntingford branch**

ELR/Bridge No. **SMB/2062**

Brief Description of Existing Bridge:

Dimensions and condition factors are obtained from site measurements and inspection completed for CS 454 assessment. (See Jacobs report "VAR9-7070 Assessment Programme – Assessment and Inspection Report – Bridge Ref.: SMB/2062 – May 2025)

(a) Span Arrangement

The structure is a heavily skewed (40º) single-span bridge. The skewed span of the structure is 9.14m.

(b) Superstructure Type

The superstructure comprises six longitudinally spanning double joist compound girders at 1.665m centres with brick jack arches spanning between them. The internal and edge girders are of a similar construction.

(c) Substructure Type

The wingwalls, parapets, and abutment are constructed from brindle brick.

(d) Planned highway works/modifications at this site

None

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

The structure carries the B1368 over the former trackbed. The B1368 has a carriageway width of 5.97m over the structure. A footpath runs along the north side and there is a grass verge on the southern side. The north footpath has a width of 1.38m, the south verge has a width of 0.79m. The overall width between the parapets is 8.13m.

(f) Any other requirements

None

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

Appendix: 4

ELR / Bridge No: SMB/2062 Issue: 1

Revision: B (Nov 2000)

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Assessment Criteria

(a) Loadings and Speed

The southeast edge girder is to be assessed for standard BE4 loading representative of 24 ton vehicle, with reduced loading being determined where this capacity is not reached.

(b) Codes to be used

BE4 – The Assessment of Highways Bridges for Construction and Use Vehicles, Ministry of Transport 1967 (with amendments to 1969)

BS 153: Parts 3B & 4: 1958 – Steel Girder Bridges, British Standards Institution (with amendments to 12 Sept. 1968)

(c) Proposed Method of Structural Analysis

Capacity of the girder will be calculated using estimates of reduced section sizes where corrosion is present. A general condition factor will not be applied. Section sizes have been taken from the CS 454 assessment. The outer joist of the pair forming the compound girder is corroded to the extent that it is considered to be ineffective in providing any bending capacity. The assessment will therefore be based on the capacity of the inner joist and its attached top and bottom plates only.

The girders are mild steel. The capacity of the steel girder will be checked using the permissible stress from BS 153 Part 3B: 1958 assuming BS 15 steel with a yield stress of 15 ton/in^2, adjusted as prescribed in BE4 Part I Clause 304(a).

The girder will be checked for live loads applied in accordance with BE4 Part I Clause 202 (a) using the simple distribution method in BE4 Part II Clause 301.

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

Appendix: 4
Issue: 1
Revision: B (Nov 2000)

ELR / Bridge No: SMB/2062

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]

Signed

Title

Date 06/11/2025

Category 2 and 3

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

Signed

Title

Date

Signed

Title

Date

Appendix B. Form BA/BAA

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

Appendix: 4

ELR/ Bridge No SMB/2062 Issue: 1

Revision: A (Dec 2005)

CERTIFICATION FOR ASSESSMENT CHECK

Assessment Group: **Jacobs UK Ltd**

Bridge/Line Name: **Braughing Station / Buntingford Branch**

Category of Check: **1**

ELR/ Bridge No: **SMB/2062**

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:

- BE4 – The Assessment of Highway Bridges for Construction and Use Vehicles 1967 (with amendments to 1969)
- BS153: Parts 3B and 4 – Steel Girder Bridges (with amendments to 12th September 1968)

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

None

Category 1

Na[redacted] Date

…[redacted]……………… Assessor

…[redacted]……………… Assessment Checker

…[redacted]……………… Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible.

FORM 'BA' (BRIDGES) **GC/TP0356**
Appendix: 4
ELR/ Bridge No SMB/2062 Issue: 1
Revision: A (Dec 2005)

CERTIFICATION FOR ASSESSMENT CHECK

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

(a) Assessment

Name	Signature	Date	
………	………	………	Assessor
………	………	………	Assessment Checker
………	………	………	Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible.

(b) Check

Name	Signature	Date	
………	………	………	Assessor
………	………	………	Assessment Checker
………	………	………	Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible.

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

FORM 'BAA' (BRIDGES) **GC/TP0356**
Appendix: 4
ELR/ Bridge No SMB/2062 Issue: 1
Revision: A (Dec 2005)

CERTIFICATION FOR ASSESSMENT CHECK

Notification of Assessment Check

Assessment Group	Jacobs UK Ltd
Bridge Name/Road No.	Braughing Station / B1368
Line Name	Buntingford Branch
ELR Code/Structure No.	SMB/2062

The above structure 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 are as follows:-

STATEMENT OF CAPACITY

Southeast Edge Girder	Insufficient for any live loads

Recommended Loading Restrictions
Prevent all live loads on the edge girder.

Description of Structural Deficiencies and Recommended Strengthening
Due to the severe corrosion on the southeast edge girder it does not have sufficient capacity for any live loads. Solutions to fully support/replace the girder should be considered and temporary traffic management and barriers to prevent vehicle loading on the girder should be implemented as a priority.

Name Signature Date

….[redacted]ssessor

….[redacted]ssessment Checker

….[redacted]thorised signatory of the
[redacted]n of Consulting
[redacted]gineers to whom
[redacted]sessor/Checker is
[redacted]sponsible.

Thi[redacted]……………………………

Appendix C. Calculations

CALCULATION COVER SHEET

Jacobs
York

Project Title: HRE Assessment Programme		Calc. No.:	0452080
Job No:	B38380BA	File:	VAR9-7070
Project Manager	[redacted]	Subject:	**SMB/2062**
Assessor	[redacted]		Braughing, Puckeridge, East Hertfordshire
Project Group	31200		BE4 Assessment Check of Southeast Edge Girder

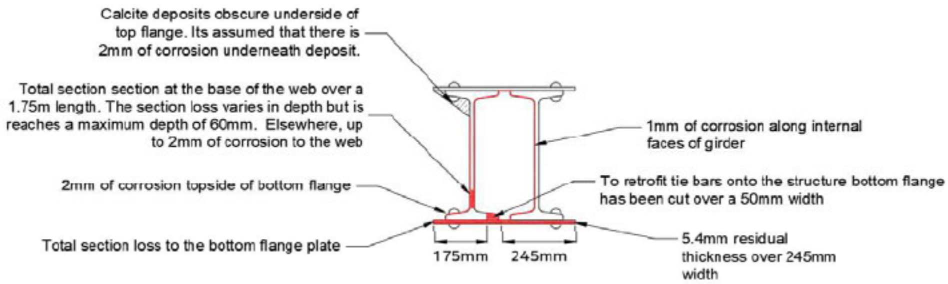
	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	7	[redacted]	Oct-25	[redacted]	Oct-25	JR	Oct-25		
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

Section properties for south edge girder

As stated in the CS 454, due to the pattern of corrosion the external RSJ is assumed to not contribute to the section properties of the double-joist compound girder.



Section properties about x-x

Section	b	d	A	y	A·y	$A(y-y_t)^2$	I_{xx}
	in	in	in²	in	in³	in³	in⁴
Flange Plate	9.25	0.44	4.05	0.22	0.89	267.99	0.06
RSJ Flange	7.00	0.88	6.13	0.88	5.36	342.82	0.39
Web	0.56	16.25	9.14	9.44	86.26	10.68	201.14
RSJ Flange	7.00	0.88	6.13	18.00	110.25	569.63	0.39
Flange Plate*	9.25	0.21	1.97	18.54	36.47	204.10	0.01
Rivet hole	-0.89	1.09	-0.97	18.11	-17.50	-91.87	-0.10
SL top flange	-0.75	0.04	-0.03	0.42	-0.01	-1.86	0.00
SL RSJ	-0.04	0.88	-0.03	0.88	-0.03	-1.93	0.00
SL RSJ	-3.22	0.04	-0.13	1.29	-0.16	-6.32	0.00
SL RSJ	-0.04	16.25	-0.64	9.44	-6.04	-0.75	-14.08
SL RSJ	-3.22	0.04	-0.13	17.58	-2.23	-10.79	0.00
SL RSJ	-0.04	0.88	-0.03	18.00	-0.62	-3.20	0.00
		Net Area	25.45		212.64	1278.50	187.82

Depth of full section	D	=	18.7	in
Depth of web panel	d_w	=	18.0	in
Depth of web between flanges	d_{we}	=	16.3	in
Distance to NA from top of section	y_t	=	8.4	in
Distance to NA from bottom of section	y_b	=	10.3	in
Second moment of area of section	I_{xx}	=	1466.31	in⁴
Elastic section modulus (compression flange)	Z_{xc}	=	175.47	in³
Elastic section modulus (tension flange)	Z_{xt}	=	142.45	in³
Radius of Gyration	R_x	=	7.6	in

*Section loss included

Jacobs	**CALCULATION SHEET**				
Office	York Office	**Page No.**	2	**Calc No.**	0452080
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Section	Section Properties	**Checker**	[redacted]	**Date**	Sep-25

Section properties about y-y (axis at centreline of RSJ web being considered)

Section	**b**	**d**	**A**	**x**	**A·x**	**A(x-xt)²**	**Iyy**
	in	**in**	**in²**	**in**	**in³**	**in³**	**in⁴**
Flange Plate	0.44	9.25	4.05	0.38	1.52	0.26	28.86
RSJ Flange	0.88	7.00	6.13	0.00	0.00	0.09	25.01
Web	16.25	0.56	9.14	0.00	0.00	0.14	0.24
RSJ Flange	0.88	7.00	6.13	0.00	0.00	0.09	25.01
Flange Plate*	0.21	9.25	1.97	0.38	0.75	0.13	14.02
SL top flange	0.04	-0.75	-0.03	-3.88	0.11	-0.47	0.00
SL RSJ	0.88	-0.04	-0.03	-3.48	0.12	-0.45	0.00
SL RSJ	0.04	-3.22	-0.13	-1.85	0.23	-0.49	-0.11
SL RSJ	16.25	-0.04	-0.64	-0.26	0.17	-0.09	0.00
SL RSJ	0.04	-3.22	-0.13	-1.85	0.23	-0.49	-0.11
SL RSJ	0.88	-0.04	-0.03	-3.48	0.12	-0.45	0.00
		Net Area	26.41		3.26	-1.74	92.92

Width of full section	B	=	9.25	in
Distance to NA	xt	=	0.12	in
Second moment of area of section	Iyy	=	91.18	in⁴
Radius of Gyration	Ry	=	1.86	in

Effective Span

From CS 454 assessmet

Effective span = 9379.9 mm
= 369.29 in
= 30.774 ft

Dead Loads

Unit Weights of Materials

BE4

Material	lb/cu.ft
Steel	490
Concrete	150
Brickwork	140
Miscellaneous Fill	135
Macadam (tar)	144

1 ton	=	2240	lb
1 ft	=	12	in
1 sq.ft	=	144	sq.in
1 cu.ft	=	1728	cu.in

Areas of dead loads have been taken from CS 454 assessment

Self Weight

Gross area of compound girder = 37047 mm^2
= 57.42 in^2

Self weight of girder (57.42/144) x 490 = 195.4 lb/ft
= 0.087 ton/ft

Jack Arch

Area of jack arch = 0.173 m^2
= 268.15 in^2

Jack Arch UDL (268.15/144) x 140 = 260.70 lb/ft
= 0.116 ton/ft

Jack Arch Backing

Area of concrete backing = 0.097 m^2
= 149.58 in^2

Jack Backing Arch UDL (149.58/144) x 150 = 155.81 lb/ft
= 0.070 ton/ft

Miscellaneous Fill

Area of fill	=	0.384	m^2
	=	595.20	in^2
Miscellaeous fill UDL	(595.20/144) x 135 =	558.00	lb/ft
	=	0.249	ton/ft

Parapet

Area of parapet	=	0.628	m^2
	=	973.40	in^2
Parapet UDL	(973.40/144) x 140 =	946.36	lb/ft
	=	0.422	ton/ft
Total UDL on girder	=	0.945	ton/ft

Dead Load Effects

The maximum bending moment in a beam with a UDL are given by:

Maximum Bending Moment $M_{max} = \frac{wl^2}{8}$

MDL = 111.84 ton.ft

The girder passed in shear for Normal Traffic loading to CS 454 and therefore shear does not need to be checked for the purposes of this assessment.

Girder Capacity

The structure likely dates from the 1920s

BS153 Pt. 4
Cl. 21

The effective length of the compression flange shall be taken as the span

l = 30.774 ft
= 369.29 in

The basic permissible stress will be taken from Table 3

pbc = 9.5 ton/sq.in

From BE4, the stresses for mild steel will be as in BS 153, Part 3B Table 1 case II
The allowable stress will therefore be increased by 25%
Allowable stress = 11.88 ton/sq.in

BS 153 Pt 3B
Cl. 28b (i) A

Critical stress in Compression Flange

Due to the corrosion on the girder, the moment of inertia for the compression flange about the y-y axis exceeds that of the tension flange

$$C_s = \frac{170000}{(l/r_y)^2}\sqrt{\left[1+\frac{1}{20}\left(\frac{lT}{r_yD}\right)^2\right]} + K_2\frac{170000}{(l/r_y)^2}$$

Where:

l = effective length of the compressive flange

ry = radius of gyration about the y-y axis of the gross section of the whole girder at the point of maximum bending.
= 1.86 in

D = overall depth of the girder, at the point of the maximum bending moment.
= 18.65 in

T = effective thickness of the compression flange given by:
K1 x the mean thickness of the horizontal portion of the compression flange at the point of maximum bending moment.

K1 makes allowance for reduction of thickness or breadth of flanges between points of effective lateral restraint and depends on N, the ratio of the total area of both flanges at the point of least bending moment to the corresponding area at the point of greatest bending moment between such points of restraint.
As the cross section remains the same along the length of the girder
K1 = 1

Mean thickness = 1.10 in

T = 1.10 in

Jacobs	CALCULATION SHEET				
Office	York Office	Page No.	6	Calc No.	0452080
Job No. & Title	SMB/2062 South East Edge Girder BE4 Check	Calcs by	[redacted]	Date	Sep-25
Section	Girder Capacity	Checker	[redacted]	Date	Sep-25

K2 = a coefficient to allow for inequality of tension and compression flanges, and depends on M, the ratio of the moment of inertia of the compression flange alone to the that of the sum of the moments of inertia of the compression and tension flanges, each calculated about its own axis parallel to the y-y axis of the girder, at the point of maximum bending moment.

TABLE 6. VALUES OF K_2

M	1·0	0·9	0·8	0·7	0·6	0·5	0·4	0·3	0·2	0·1	0
K_2	0·5	0·4	0·3	0·2	0·1	0·0	−0·2	−0·4	−0·6	−0·8	−1·0

Top flange Iyy = 52.69 in^4

Bottom flange Iyy = 38.20 in^4

M = 0.58

K2 = 0.09

Cs = 12.47 ton/sq.in.

Allowable working stress from table 8 = 4.79 ton/sq.in.
Determined by linear interpolation
Increase by 25% = 5.99 ton/sq.in.

Elastic compression section modulus = 175.47 in^3
Bending Capacity, compression = 87.63 ton.ft

Elastic tension section modulus = 142.45 in^3
Bending Capacity, tension = 140.96 ton.ft

The girder does not have sufficient capacity for the imposed dead loads

Checking effective length = 0.85 x span

l = 26.158 ft
= 313.89 in

Cs = 15.09 ton/sq.in.

Allowable working stress from table 8 = 5.32 ton/sq.in.
Determined by linear interpolation
Increase by 25% = 6.65 ton/sq.in.

Elastic compression section modulus = 175.47 in^3
Bending Capacity, compression = 97.20 ton.ft

Checking effective length = 0.7 x span

l = 21.542 ft
= 258.5 in

Cs = 19.16 ton/sq.in.

Allowable working stress from table 8 = 6.13 ton/sq.in.
Determined by linear interpolation
Increase by 25% = 7.67 ton/sq.in.

Elastic compression section modulus = 175.47 in^3
Bending Capacity, compression = 112.08 ton.ft

A check of the imposed live loads has not been completed as even with the optimum effective span, the girder is only just sufficient for the imposed dead loads.