



Boxted Bridge ECC Bridge No. 0059

CS451 – Structural Review Report 17.10.2023





Document Control Sheet

Document prepared by:



Seax House, 2nd Floor, Victoria Road South, Chelmsford, Essex Highways CM1 1QH



Report Title	CS451 Structural Review Report of Boxted Bridge	
Document Number	2023.10.17 - BR0059 – Boxted – CS451 – Revision 02	
Project Number	ECC No. 0059	
Status	For Issue	
Revision	02	
Control Date	February 2024	

Record of Issue

Issue	Status	Author	Date	Check	Date	Review	Date
0	For		10.22		12.22		12.22
	Issue		10.25		12.25		12.25
01	For		01.24		01 24		01.24
	Issue		01.24		01.24		01.24
02	For		02.24		02.24		02.24
	Issue		02.24		02.24		02.24

Approved for Issue By	Date
	12/02/2024

Distribution

Organisation	Contact	Number of Copies
Essex Highways		1- Electronic
Essex Highways		1- Electronic

Executive summary

Boxted Bridge, constructed in 1897, carries Wick Road over the River Stour. Located at TM 01244 34419 approximately 1.1 miles northeast of Boxted village. The ECC road classification is Local. The bridge is located immediately north of the junction of Wick Road, Sky Hall Hill and Lower Farm Road.

The superstructure is comprised of a simply supported single span half-through steel deck. The deck is trapezoidal in plan, being wider at the south abutment than the north, and has an effective square span of 12.50 m. The width of the structure varies from 4.77m on the north side to 6.75m on the south side dictated by the proximity to the junction. It comprises riveted plate primary edge girders and transverse secondary beams, with tertiary longitudinal rolled I-beam/channel sections and hogging plates.

Brick retaining walls (with brick pilasters and stone copings) are located on the approaches to (and departures from) the bridge which support the highway above the level of the adjoining riverbanks.

The substructure is comprised of brick abutments but the foundation type is unknown. The thickness of the abutments is approx. 1.0m in accordance with coring investigations undertaken in 2018.

This structural review has been undertaken in accordance with CS451 – Structural Review and Assessment of Highway Structures.

Boxted Bridge has recently been closed off to all road users, including pedestrian and cyclists, following the findings of a Principal Inspection undertaken in June 2023. A navigation closure under the structure has also been implemented. A CS470, Appendix 8 was prepared for the management of the immediate risk structure. In accordance with the risk assessment process set out in CS451 - Appendix A the available data for this structure returns a recommendation from the Decision Matrix Table A.12. of assessment recommended with very high priority.

The rotation of the edge girders seem to imply that lateral torsional buckling has taken place. This would seem to indicate that the U-frame action is not effective, if ever present. Due to the deteriorating condition of the structure and the findings of the previous assessment when U-frame action is not considered, a rereview of the assessment is recommended.

1. CS451 – Record of Structural Review Form

RECORD OF STRUCTURAL REVIEW FORM

IN ACCORDANCE WITH ANNEX B CS451

1	Structure Details			
	Structure Name	Boxted Bridge		
	Structure Number	ECC Br. No. 0059		
	Structure Key	Not applicable		
	Date Commissioned	Boxted Bridge was constructed in 1897. This information comes from a newspaper article from the Evening Star advertising the opening of the Bridge on the 28th April 1897.		
	Obstacles Crossed	River Stour, a main river.		
	Bridge Carries	Wick Road, an unclassified road.		
	Brief Description of Structure			
	 Boxted Bridge carries Wick Road over the River Stour. Located at TM 01244 34419 approximately 1.1 miles northeast of Boxted village. The ECC road classification is Local. The bridge is located immediately north of the junction of Wick Road, Sky Hall Hill and Lower Farm Road. The superstructure is comprised of a simply supported single span half-through steel deck. The deck is trapezoidal in plan, being wider at the south abutment than the north, and has an effective square span of 12.50 m. The width of the structure varies from 4.77m on the north side to 6.75m on the south side, dictated by the proximity to the junction. It comprises riveted plate primary edge girders and transverse secondary beams, with tertiary longitudinal rolled I-beam/channel sections and hogging plates. Brick retaining walls (with brick pilasters and stone copings) are located on the approaches to (and departure from) the bridge which support the highway above the level of the adjoining riverbanks. The thickness of the abutments is approx. 1.0m in accordance with coring investigations undertaken in 2018. 			
	Elements to be Reviewed (where not the whole structure)			
	The deck and abutments.			
	Reason for Structural Review	Boxted Bridge has recently been closed off to all road users, including pedestrian and cyclists, following the findings of a Principal Inspection undertaken in June 2023, refer to section 3 for more details. A navigation closure under the structure has also been implemented. A CS470, Appendix 8 was prepared for the management of the immediate risk structure.		
2	Existing Assessment Details or Design Records			

	Inspection for	12.03.1992 undertaken	Recorded Condition	The main girders appeared to
	Assessment Date	by Taywood		be in reasonable condition,
		Engineering Limited		with localised severe corrosion
				and section loss of the bottom
				flanges. The connecting angles
				and webs of the girders
				appeared to have corroded but
				remained intact around the
				rivet connections. The girder
				webs, T-section stiffeners and
				channel top flanges appeared
				to be in good condition. The
				end plate stiffeners appeared
				damage causing buckling of
				the plates.
				The BSB's suffered severe
				hottom flanges have been
				reinforced with plates, the
				plates have buckled. The plates
				appear to be quite pitted and
				corrosion was visible at their
				edges. The hogging plates
				were in reasonable condition
				the junction with the flanges of
				the BSB's.
				The abutments appeared to be
				in a reasonable condition.
				There were slight vertical
				chacks at the ends of the
				the east end of the south
				abutment. All other cracks
				were hairline.
				The foundations were not
				inspected, however, a scour
				survey took place.
	AIP for Assessment	16.04.1992 (as	Status	Unknown as a record of the
		mentioned in the		AIP does not exist
		assessment report, a		
		not exist in our		
		records)		
ļ	• • •	1000	_	
	Assessment Date	May 1992 and was	Keport Number	1992-05-01 Assessment Report
		1995 undertaken hv		
L		1000 anacitation by	1	

CS451 Structural Review Report of Boxted Bridge

		Taywood Engineering Limited			
	Current Assessed/Design	Capacity (include Reserve	e Factors)		
	HA/ALL	3 Tonnes	SV/STGO/SO	Not calculated	
	Critical Elements	The capacity is limited by channels and the plate g	acity is limited by the capacity of the longitudinal BSB's, the longitudinal s and the plate girders, both in bending and shear.		
	Parapet	The plate girders act as t	e girders act as the parapet to the structure.		
	Pier Impact	Not applicable			
	Certification	Yes. Included in assessme Report Tile: Assess	ent report. ment Report for Box	ted Bridge	
		Report No: 1302C/	/92/2375/B59/5-A		
	Calculations	Yes. Included in assessme	ent report.		
		Report Tile:AssessReport No:1302C/	ment Report for Box /92/2375/B59/5-A	ted Bridge	
	As built drawings	Record drawings are incl	uded in the report. I	No as-built drawings exist.	
	Comments on Assessment or Design				
	 The 1992 assessment concluded that the calculated capacity of the structure was based on the tervalue for the steel yield stress. With the lower bound stress, 3 tonnes loading cannot be carried except possibly by limiting the bridge to a single lane; Assumptions were made in the 1992 assessment for the determination of the effective length of structure; U-frame action has been assumed for the structure in the 1992 assessment. Without the assump of U-frame action the bridge girders were inadequate for dead loading alone. Even though the connection was unknown no investigations were undertaken to determine this. Consideration sh be made to undertaking investigations to determine the connection; The abutments were not assessed as part of the assessment even though cracks existed since the 1992 inspection 			f the structure was based on the test tonnes loading cannot be carried mination of the effective length of the assessment. Without the assumption loading alone. Even though the o determine this. Consideration should ction; yen though cracks existed since the ural elements:	
	Structural Elem	ient	Condition	Factor	
	Plate Girders Transverse Bea	ms	0.9	n shear)	
	Longitudinal be	eams	0.9		
2	Longitudinal ch Evaluation	annel beams	0.5 (0.75 i	n shear)	
	Inspection Date	27.06.2023			
	Change In Condition	The condition of highlighted belo - The riv are ext	f the primary and se ow: reted plate girders (k nibiting significant co	condary elements has deteriorated as both primary and secondary elements) prrosion with section loss through the	
		- A rivet	 A rivet head has become detached to the secondary element. 		

		 Riveted plate sections in upper areas of the secondary deck elements have deteriorated further. Rivet heads within the secondary elements which are subject to expansive corrosion have deteriorated further and are at increased risk of failure. The east edge girder had rotated inwards by 65mm measured midspan. The west edge girder had rotated inwards by 30mm measured at the north end. 			
	Change In Standards	BA34/90 has been replaced by CS451 BD21/84 has been replaced by CS454 BS 5400 was used for the calculation of the capacities. The standard is still current when incorporating amendments listed in CS 456.			
	Change In Loading	ALL Model 1 is more conservative and should be used instead CS454 [5.5.2 (NOTE 1)] in addition to ALL Model 2. ALL Model 2 loading was the loading considered in the previous assessment. This could create a moderate increase in the operational load carrying requirements.			
	Required capacity	44T +SV 80 +SV 100 in accordance with CS 454 and CS 458.			
	Vulnerable details	The plate girders, acting as parapets, as they are subject to accidental impact loading.			
	Hidden critical details	The only visible part of all structural elements, with the exception of the plate girders, is the bottom flange. These members are encased in concrete so their condition can only be assumed. The connection between the structural members cannot be seen.			
	Interim measures	The structure has curren being monitored on a 6 r	tly been closed to all user nonth basis. This is a visua	s. The structure is also al inspection.	
	Condition	Overall the condition of the bridge has worsened in recent years with more defects becoming evident since 2019. The BCI critical score reduced from 55.48 to 22.12 between inspections undertaken in 2018 and 2019 respectively. The condition factors assumed in the previous assessment would not be valid based on the current condition of the structure.			
		Overall BCI Scores	BCI (Av)	BCI (Crit)	
		Boxted Bridge	52.64	22.12	
	Conclusion	Due to the rotation of the plate girders it is uncertain if U-frame action is still in place. For any further assessments the U-frame action should be ignored. The condition factors for all other elements should be updated as well.			
4	Recommendation	<u> </u>			

In accordance with the risk assessment process set out in CS451 - Appendix A the available data for this structure returns a recommendation from the Decision Matrix Table A.12. of assessment recommended with very high priority.

The rotation of the edge girders seems to imply that lateral torsional buckling has taken place. This would seem to indicate that the U-frame action is not effective, if ever present. Due to the deteriorating condition of the structure and the findings of the previous assessment when U-frame action is not considered, a re-review of the assessment is recommended.

5. THE ABOVE IS SUBMITTED FOR ACCEPTANCE

Signed:	
Name:	
Position Held	Principal Engineer / Team Leader
Engineering Qualifications:	BEng(Hons), CEng, MIStructE
Name of Organisation:	Ringway Jacobs
Date:	

6. THE ABOVE IS RECOMMENDED FOR ACCEPTANCE BY THE TAA

Signed:	
Name:	
Position Held	
Engineering Qualifications:	BEng CEng MICE
Name of Organisation:	On behalf of Ringway Jacobs
Date:	

7. THE ABOVE IS REJECTED / AGREED (1) SUBJECT TO THE AMENDMENTS AND CONDITIONS

SHOWN BELOW (3)	
Signed:	
Name:	
Position Held	Structures Manager
	Essex County Council
ТАА	Structures, Design Services, Essex Highways
Date:	

<u>Notes</u>:

(1) Delete as appropriate

(2) CEng, MICE, MIStructE or equivalent

(3) Agreement is valid for three years after the date of agreement by the TAA. If the recommendation has not been implemented within this period, the Record of Structural Review Form must be re-submitted to the TAA for review

Appendix A. CS451 – Risk Assessment

The width of Boxted Bridge is 6.75m

The structure length of Boxted Bridge is 12.50m

The maximum span of Boxted Bridge is 12.50m

Boxted Bridge was constructed during the following period Pre-1950 or unknown.

Scenario B1 is applicable to this structure.

Boxted Bridge has had an assessment dated **May 1992** and the documentation indicates an assessed load capacity of **3 Tonnes** for the part of the structure which supports the running lanes.

Using Table A.1 and the above date and capacity information the value for variable 'D' (B1) has been determined as **1.00E-04**.

As variable 'D' as been determined from Table A.1, Tables A.2 and A.3 are not required.

Using Table A.4 Interim measures, the value for variable 'E' has been determined as 0.001

Using Table A.5 the current condition poor returns a variable 'F' value of 1000

Inspectability of critical elements using Table A.6 returns a variable 'G' value of 10

Monitoring using Table A.7 returns a variable 'H' value of 0.1

Change in condition since design/assessment using Table A.8 this returns a variable 'J' value of 500

There has been since design/assessment using Table A.9 returns a variable 'K' value of 5

The route supported is **a local road** using Table A.10 returns values for the variables 'R1' and 'R3' of **0.2** and **10000** respectively.

The route crossed is other - a river using Table A.11 returns a value for variable 'R2' of 0.1

Using Equation A.1 Consequences 1 (C1) returns a calculated value of 4.35E+05

Using Equation A.2 Consequences 2 (C2) returns a calculated value of 1.37E+05

Using Equation A.3 Consequences 2 (C3) returns a calculated value of 1.01E+05

Using Equation A.4 Consequences 2 (C4) returns a calculated value of 2.73E+05

Using Equation A.5 a Reliability value (C5) returns a calculated value of 68330.6

Using Equation A.6 a Risk value of (C6) returns a calculated value of 0.004

Using Table A.12 the Decision Matrix returns the Decision that Assessment is recommended with very high priority.

Rick Score	Reliability				
NISK SCOLE	00.00 to 13.20	13.30 to 25.00	25.10 to 83.00	83.00+	
00.00 to 01.00	Assessment recommended (low priority)	Assessment recommended (medium priority)	Assessment recommended (high priority)	Assessment recommended (very high priority)	
01.01 to 10.00	Review need for assessment at next structural review	Assessment recommended (low priority)	Assessment recommended (medium priority)	Assessment recommended (high priority)	
10.00+	Review need for assessment at next structural review	Review need for assessment at next structural review	Review need for assessment at next structural review	Assessment recommended (low priority)	