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Essex Highways



TECHNICAL NOTE

Boxted Bridge ECC Br. No. 0059

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RINGWAY JACOBS | Essex County Council

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EXECUTIVE SUMMARY

Boxted Bridge is a historic steel girder bridge constructed in 1897 which spans the River Stour on Wick Road at the Essex/Suffolk border. Following a 2023 Principal Inspection, the bridge was closed to all users due to significant deterioration including extensive corrosion, section loss, detached rivets and noticeable girder rotation. These defects raised concerns regarding the U-frame action that had previously been relied upon to provide stability against lateral buckling.

A Proving Load Test was subsequently undertaken in September 2025 to determine whether the structure could safely accommodate non-motorised users. The Proving Load Test, carried out in accordance with CS 463, simulated pedestrian loading using a water filled bag loading system and demonstrated satisfactory structural behaviour under loads exceeding the equivalent ultimate pedestrian loading. Measured deflections were acceptable, recovery was observed following unloading, and no evidence of distress or damage was identified during testing. On this basis, the bridge was considered suitable for use by pedestrians and cyclists along a restricted 2 m wide route through the centre of the bridge, leading to its reopening to non-motorised users in January 2026.

A detailed reassessment completed in September 2026 used a three-dimensional finite element model and current assessment standards to evaluate the bridge's structural capacity. The capacity of the superstructure was governed by bending resistance of the plate girder which was found to be just about adequate for the bending moment arising from permanent actions only.

Following the 2026 reassessment, a sensitivity review has been undertaken to determine if the structure is of an immediate risk in accordance with CS 470 3.2.1.1. The additional analysis considered unfactored load effects as well as the load effects applied during the Proving Load Test. The result of the sensitivity analysis is consistent with the satisfactory performance observed during testing, explaining why the bridge successfully carried the applied test load despite its low factored assessment rating. The successful Proving Load Test is therefore considered as evidence that the continued use of the bridge by non-motorised users is justified, subject to ongoing monitoring.

1. Introduction

1.1. Purpose of Technical Note

This Technical Note is prepared to explain the difference between the results of the Proving Load Test carried out in 2025, which supported the reopening of the bridge to non-motorised users, and the subsequent analytical reassessment completed in September 2026, which indicated that the factored bending resistance was just about adequate for the effects of permanent loads only.

1.2. Bridge Description

Boxted Bridge (OS grid reference: TM 01251 34422) is located on Wick Road within the Dedham Vale National Landscape and crosses the River Stour. The bridge is located on the north side of the junction of Wick Road, Skye Hall Hill and Lower Farm Road. The bridge straddles the Essex/Suffolk border and is located approximately 750m northeast of Boxted and 900m south of Thorington Street.

The structure is a steel girder bridge, constructed in 1897 by local Engineer George Double. It is trapezoidal in form and consists of a single span steel deck supported by two substantial brick abutments at either side of the waterway. The deck comprises jack arch construction, with transverse built-up girders in the middle of the bridge and longitudinal rolled beams near the abutments. The main edge girders act as parapets and are painted dark green, and the approaches to the bridge are flanked by red brick pilasters with granite stone coping on top. It is oriented approximately north/south and used to carry road traffic over the River Stour. The south side is slightly wider (6.75m) than the north side (4.77m).

1.3. Previous Assessments and Traffic Restrictions

The structure was assessed in 1992 in accordance with BD 21/84. The assessment found the superstructure to have a live load capacity of 3 tonnes, assuming that there is sufficient 'U-frame' action providing beneficial restraint for the edge girders against buckling and using a characteristic yield strength of 300MPa based on a test result from a steel sample taken from the plate girder. The structure was monitored regularly following the assessment as no weight restriction (structural or environmental) was implemented.

A full bridge closure was implemented on the 30th of June 2023 following the 2023 Principal Inspection which found the structure to be in poor condition, with significant section loss, detached rivets and significant girder rotation. The observed defects were considered as evidence of the 'U-frame' action being ineffective and the structure was classified as an Immediate Risk Structure and therefore closed to all users pending further investigation.

Subsequently, a Proving Load Test was carried out in September 2025, in accordance with CS 463 to check if the structure could safely carry non-motorised users. The pedestrian live load was simulated using a 3.4m x 3.4m water bag infilled with a prescribed volume of water to cover 1 tonne, 7.4 tonnes and 16 tonnes, each followed by full unloading to check for recovery of displacement. The 7.4 tonnes load was equivalent to the characteristic pedestrian load, while 12.2 tonnes is equivalent to the factored ultimate limit state pedestrian load (16 tonnes were applied for additional margin). Based on the measurements from the Proving Load Test, it was concluded that there was sufficient justification to reopen the bridge to pedestrian and cyclist traffic over a 2m wide path through the centre of the bridge. The bridge was reopened to pedestrians and cyclists in January 2026, subject to use of a 2 m wide route located through the centre of the carriageway.

In 2026, the structure was reassessed in accordance with CS 454. The superstructure has been analysed using a 3D linear elastic finite element model using a combination of plate and beam (line) elements. The main edge girders have been modelled using plate elements, including the stiffeners. The secondary longitudinal and transverse beams have been modelled using beam (line elements). The mass concrete jack arches have been modelled using plate elements with orthotropic properties.

The assessment found the capacity of the bridge to be governed by the resistance of the plate girders to lateral-torsional buckling. The plate girders were found to be just about adequate for permanent loads only.

The north-east bearing stiffener has been found to be inadequate for the required end-restraint force in accordance with BS 5400-3 cl. 9.12.5.2. Therefore, a factor has been applied in accordance with CS 456 cl. 9.6.1, which increases the slenderness of the plate girder and thus reduces resistance against lateral-torsional buckling.

To ensure accurate assessment of lateral-torsional buckling resistance, an elastic buckling analysis was performed in accordance with BS 5400-3 cl. 9.7.5. The results indicated that the girders are just about adequate for permanent loads only.

2. Sensitivity Analysis and Discussion

The difference between the 2025 Proving Load Test and the 2026 reassessment arises from the fundamentally different objectives of the two approaches. The reassessment evaluates compliance with modern assessment standards using prescribed partial safety factors and condition reductions, whereas the Proving Load Test directly demonstrated the behaviour of the existing structure under a known factored applied load.

In order to compare the assessment results with the observed performance during the Proving Load Test, a sensitivity analysis was undertaken in which partial safety factors on loads were removed. With the factors removed, the plate girder was found to be adequate for the bending moment arising from permanent loads and a pedestrian live load applied over a 2m wide footpath. The factored bending resistance of the girder was calculated as 1,058kNm, and the unfactored bending moment arising from permanent loads and the pedestrian live load was calculated as 949kNm.

In accordance with the provisions of CS 463, the Proving Load Test included a 16t water bag load which represented a factored pedestrian live load, including a factor to allow for the fact that a simplified model load is used to represent the complete live load and a partial safety factor for the ultimate limit state to obtain the nominal assessment load level. The maximum bending moment applied during the Proving Load Test has been calculated as 1,041kNm.

The sensitivity assessment therefore provides a rational explanation for the satisfactory performance observed during the Proving Load Test. The calculated factored bending resistance of 1,058kNm exceeds the estimated applied bending moment of 1,041kNm during the maximum test load, consistent with the acceptable deflections and recovery measured during testing.

3. Conclusion

Notwithstanding the above, the removal of partial safety factors is not appropriate for determining the load rating of the bridge, as this would not provide the level of reliability required for a structure carrying public traffic. The application of partial safety factors remains essential when assessing bridge capacity, as they account for uncertainties associated with loading, material properties, structural behaviour and modelling assumptions. The sensitivity analysis presented in this note is therefore not intended to establish a revised load rating, but rather to assist in understanding the correlation between the analytical assessment results and the observed behaviour of the structure during the Proving Load Test.

The results of the 2026 reassessment do not contradict the results of the 2025 Proving Load Test, which demonstrated satisfactory structural behaviour under loads exceeding the required pedestrian loading. The sensitivity analysis indicates that the observed performance of the bridge during testing is consistent with the calculated unfactored structural response, thereby providing a rational explanation for the apparent discrepancy between the load test and the factored assessment. In accordance with CS 463, a successful Proving Load Test may be used as an assessment of the structure and therefore provides a robust basis for permitting the continued use of the bridge by non-motorised users, subject to ongoing monitoring and management.

4. Recommendation

It is recommended that Boxted Bridge remains open to pedestrians and cyclists in accordance with the restrictions established following the 2025 Proving Load Test, subject to continued monitoring and management measures being implemented in accordance with CS 470.

5. THE ABOVE IS SUBMITTED FOR ACCEPTANCE

Signed	[redacted]
Name	
Engineering Qualifications	BEng(Hons), CEng, MIStructE
Name of Organisation	Ringway Jacobs
Date	As Above

THE ABOVE IS ~~REJECTED~~ / ACCEPTED AND RECOMMENDED FOR ACCEPTANCE

Signed	[redacted]
Name	
Engineering Qualifications	BEng, CEng, MICE
Name of Organisation	Ringway Jacobs
Date	As Above

THE ABOVE IS ~~REJECTED~~ / AGREED ~~SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW~~

Signed	[redacted]
Name	
TAA	Essex County Council
Date	As Above