Rail Accident Investigation Branch

Rail Accident Report

Train striking debris at Yarnton near Hanborough, Oxfordshire
10 February 2023

Report 01/2024
February 2024

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC
- the Railways and Transport Safety Act 2003
- the Railways (Accident Investigation and Reporting) Regulations 2005.

Any enquiries about this publication should be sent to:

RAIB
The Wharf
Stores Road
Derby UK
DE21 4BA

Email: enquiries@raib.gov.uk
Telephone: 01332 253300
Website: www.raib.gov.uk

This report is published by the Rail Accident Investigation Branch, Department for Transport.

Preface

The purpose of a Rail Accident Investigation Branch (RAIB) investigation is to improve railway safety by preventing future railway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability. Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

RAIB's findings are based on its own evaluation of the evidence that was available at the time of the investigation and are intended to explain what happened, and why, in a fair and unbiased manner.

Where RAIB has described a factor as being linked to cause and the term is unqualified, this means that RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident or incident that is being investigated. However, where RAIB is less confident about the existence of a factor, or its role in the causation of the accident or incident, RAIB will qualify its findings by use of words such as 'probable' or 'possible', as appropriate. Where there is more than one potential explanation RAIB may describe one factor as being 'more' or 'less' likely than the other.

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident or incident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, words such as 'probable' or 'possible' can also be used to qualify 'underlying factor'.

Use of the word 'probable' means that, although it is considered highly likely that the factor applied, some small element of uncertainty remains. Use of the word 'possible' means that, although there is some evidence that supports this factor, there remains a more significant degree of uncertainty.

An 'observation' is a safety issue discovered as part of the investigation that is not considered to be causal or underlying to the accident or incident being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

The above terms are intended to assist readers' interpretation of the report, and to provide suitable explanations where uncertainty remains. The report should therefore be interpreted as the view of RAIB, expressed with the sole purpose of improving railway safety.

Any information about casualties is based on figures provided to RAIB from various sources. Considerations of personal privacy may mean that not all of the actual effects of the event are recorded in the report. RAIB recognises that sudden unexpected events can have both short- and long-term consequences for the physical and/or mental health of people who were involved, both directly and indirectly, in what happened.

RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of any inquest or fatal accident inquiry, and all other investigations, including those carried out by the safety authority, police or railway industry.

This page is intentionally left blank

Train striking debris at Yarnton near Hanborough, Oxfordshire, 10 February 2023

Contents

Preface 3

Summary 7

Introduction 8

Definitions 8

The accident 9

Summary of the accident 9

Context 11

The sequence of events 15

Events preceding the accident 15

Events during the accident 15

Events following the accident 17

Analysis 18

Identification of the immediate cause 18

Identification of causal factors 18

Other factor considered 29

Identification of an underlying factor 30

Observations 31

Previous occurrences of a similar character 34

Summary of conclusions 35

Immediate cause 35

Causal factors 35

Underlying factor 35

Additional observations 35

Actions reported as already taken or in progress relevant to this report 36

Recommendations and learning points 37

Recommendations 37

Learning points 39

Appendices 40

Appendix A - Glossary of abbreviations and acronyms 40

Appendix B - Glossary of terms 41

Appendix C - Investigation details 43

This page is intentionally left blank

Summary

Just after 18:35 hrs on Friday 10 February 2023, the driver of the 17:34 hrs Great Western Railway service from London Paddington to Hereford reported striking an object on the single line at Yarnton, between Oxford and Hanborough. The train had struck brick rubble from a collapsed wing wall, part of a bridge carrying a local road over the railway. The train was travelling at around 58 mph (93 km/h) when the collision occurred and sustained damage but did not derail. There were no injuries to the traincrew or passengers on the service.

The wing wall, adjacent to the railway, was known to be in poor condition and collapsed when it was no longer able to carry the load imposed by the embankment it was supporting. Action had not been taken to address risks associated with the wing wall's deteriorating condition because effective control measures had not been put in place.

RAIB has made four recommendations to Network Rail regarding improvements in the specification of repair work and the quality of information available for making safety-critical decisions relating to the stability of structural defects. They also address the need to improve the process of evaluating defects and improve asset knowledge of wing walls. RAIB has also identified four learning points for infrastructure managers and examination contractors regarding the ability to monitor structural movement, risk mitigation measures when remedial work is deferred, the importance of clearing vegetation to allow structural examinations to take place, and the value of including comparable photographs in examination reports.

Introduction

Definitions

1 Metric units are used in this report, except when it is normal railway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.

2 The report contains abbreviations and technical terms (shown in *italics* the first time they appear in the report) which are explained in appendices A and B. Sources of evidence used in the investigation are listed in appendix C.

The accident

Summary of the accident

3 At 18:35 hrs on Friday 10 February 2023, train 1W03, the 17:34 hrs Great Western Railway service from London Paddington to Hereford, struck brick rubble debris on the single line at Yarnton, between Oxford and Hanborough (figure 1).

4 The debris was from a collapsed *wing wall*, which had been part of a bridge (referred to as Yarnton Road bridge in this report) carrying a local road over the railway (figure 2 and figure 3). The wing wall acted as a retaining wall supporting an embankment beside the railway.

5 The train was travelling at around 58 mph (93 km/h) when the collision occurred. The train did not derail, but the leading three vehicles sustained damage. The driver made an emergency brake application just after the collision and, once the train had stopped, reported the collision to the signaller using the train's *GSM-R* radio. There were no injuries to the staff or passengers on the train. However, the damage sustained meant that the train was unable to move, requiring passengers to be evacuated onto another train that was sent to assist.

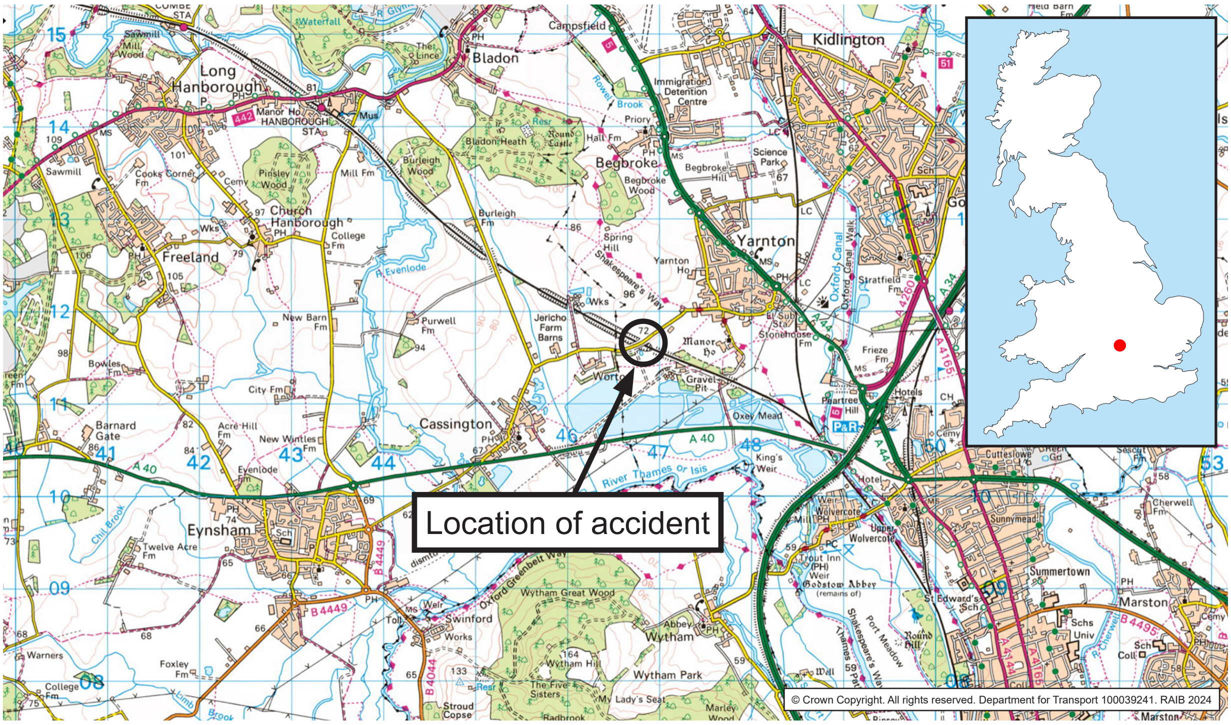

Figure 1: Extract from Ordnance Survey map showing location of the accident near Hanborough.

Figure 2: Debris and rear of stationary train soon after the accident (courtesy of Network Rail).

Figure 3: Overview on the morning after the accident showing the collapsed wing wall and rear vehicle of train 1W03 which stopped after passing under the bridge. The train was travelling from left to right.

Context

Location

6 Yarnton Road bridge is located at 67 miles 63 chains[1] between Oxford and Hanborough on the single-track Cotswold line. It is 1.4 miles (2.2 km) north-west of Wolvercot North Junction and 4.3 miles (6.9 km) from Oxford. It carries the B4449, a two-lane local road, between the villages of Yarnton and Cassington in west Oxfordshire.

7 The Cotswold line is a non-electrified, bi-directional line with a maximum permitted speed of 100 mph (161 km/h) at the point where the collision occurred. Signalling is controlled from the Thames Valley signalling centre in Didcot.

Organisations involved

8 Network Rail owns and maintains the infrastructure at this location, which lies in its Western route, part of the Wales and Western region which was established in 2019. Network Rail's infrastructure includes the bridge structure and the road approach embankments on either side of the bridge but excludes the road surface. Asset engineers worked within the respective regional asset manager (RAM) teams for structures and geotechnics, the latter being more commonly termed earthworks.

9 Amey OWR Ltd (Amey) was contracted to undertake examinations of structures and earthworks on behalf of Network Rail between 2009 and 2021. It employed the staff who undertook the planned visual and detailed examinations of the bridge and approach embankment earthworks during this period.

10 XEIAD Ltd (XEIAD) was contracted to undertake examinations for structures on Network Rail's Western route from July 2021. It employed the staff who undertook structures examinations, including the planned visual examinations of Yarnton Road bridge in April 2022 and January 2023. Some experienced staff had transferred to XEIAD from Amey as the responsibility for examining structures was transferred between the two organisations.

11 GeoAccess Ltd (GeoAccess) was contracted to undertake earthworks inspections on Network Rail's Western route from October 2021. It employed the staff who undertook a planned earthworks inspection in January 2022, and a rapid response inspection immediately after the accident. Some experienced staff also transferred to GeoAccess from Amey as the responsibility for examining earthworks was transferred between the two organisations.

12 Great Western Railway (GWR) was the operator of the train involved and employer of the train driver and conductor.

13 QTS Group Ltd (QTS) held a Network Rail framework contract and undertook minor repairs to Yarnton Road bridge wing walls in 2013. This contract is now held by a different company.

14 Sisk Rail, a division of John Sisk & Son, was contracted by Network Rail in 2022 to undertake major refurbishment work to Yarnton Road bridge and other structures. At the time of the accident this work had not started.

15 Tony Gee & Partners was contracted by Sisk Rail to prepare designs and specifications for the planned bridge refurbishment.

[1] Mileage is measured from a datum at London Paddington. There are 80 chains in one mile.

16 Oxfordshire County Council is the local highway authority responsible for maintaining and repairing the road surface over Yarnton Road bridge.

17 The above organisations freely co-operated with the investigation.

Train involved

18 Train 1W03 formed the 17:34 hrs Great Western Railway service from London Paddington to Hereford. It was formed of unit 800318, a nine-coach, bi-mode intercity express train travelling using diesel power.

The bridge involved

19 Yarnton Road bridge was built for the opening of the Oxford, Worcester and Wolverhampton railway in 1853 (*engineer's line reference* OWW). It carries Yarnton Road (which becomes Cassington Road) over the railway at an angle, and has a single arch built at a *skew* of 50° to the railway. The bridge spans a two-track railway formation, located in a shallow cutting. The track on the north side of the formation was taken out of use in 1971 and later removed.

20 The bridge does not have a conventional railway structure number in common with some other bridges on the same line. A sign attached to the bridge at road level states '*This bridge is OWW 67m 63ch Yarnton Rd aka Cassington Rd-Single*'. In examination reports, it is named either 'Cassington Road' or 'Yarnton Rd aka Cassington Rd-Single Span'. In other documents, it is called 'Worton bridge', after a nearby settlement.

21 The bridge is of brick construction throughout, with a wing wall at each corner supporting the road and *parapets* at road level (figure 4).

22 It was part of the wing wall at the south-west corner of the bridge that collapsed (figures 5, 6a and 6b). This wall (referred to as the 'downside high mileage wing wall'[2] in examination reports, but the 'south-west wing wall' in this report) was 13 metres long and up to 5.3 metres high. The lateral clearance between the wall and the railway was about 2.3 metres, making it almost inevitable that debris would fall onto the track if part of the wall collapsed. The south-west wing wall had been reported as being in poor condition, with *drummy*, or hollow-sounding, brickwork and a large bulge (see paragraph 48).

Staff involved

23 The driver of train 1W03 had more than seven years' experience as a train driver and had been driving the Paddington to Worcester route for more than five years. The driver's actions played no part in the accident.

External circumstances

24 The accident occurred in darkness, about an hour after sunset, and in an area with no external lighting. Weather records show that the temperature was just above 7°C, with a light northerly wind.

[2] Down side refers to bring located on the same side of the railway as the down line (on the left-hand side of the railway when looking in the down direction away from London), and high mileage refers to the side of the bridge with the highest mileage (usually furthest from London).

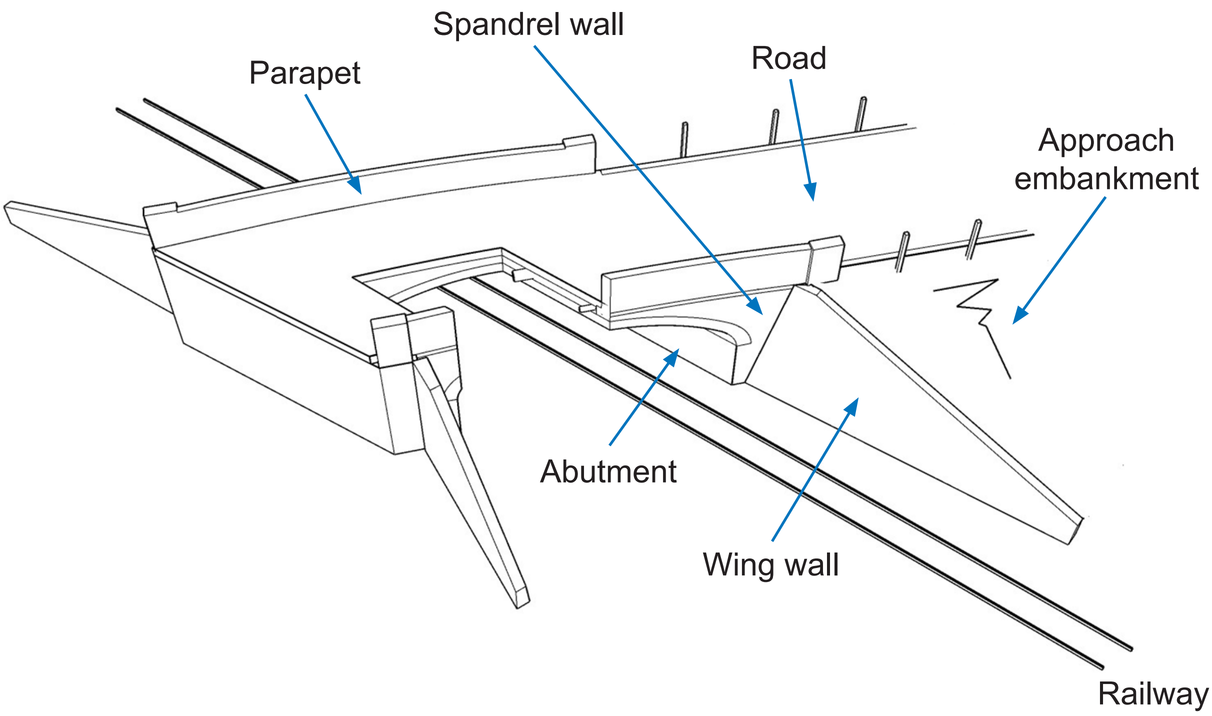

Figure 4: Diagram showing components of the bridge.

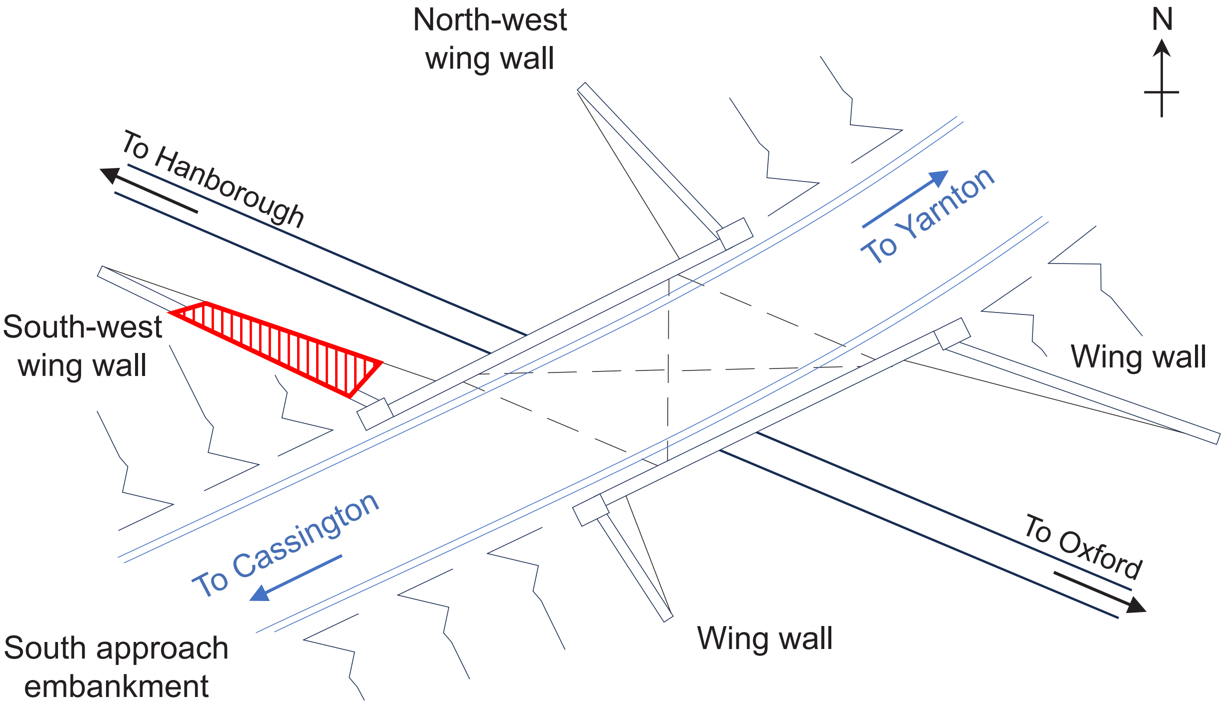

Figure 5: Bridge layout sketch showing the wing walls and south approach embankment. The section of the south-west wing wall that collapsed is highlighted in red.

Figures 6a and 6b: Collapsed south-west wing wall on 11 February 2023.

The sequence of events

Events preceding the accident

25 During the afternoon of 10 February, the line between Oxford and Hanborough was operating normally. Forward-facing CCTV recordings have been obtained from trains which passed under Yarnton Road bridge at around 16:29 hrs and 17:35 hrs. The images do not show any visible sign of an issue with the south-west wing wall at this point (figures 7a and 7b).

Figures 7a and 7b: Forward-facing CCTV images from passing trains at 16:29 hrs and 17:35 hrs. The section which later collapsed is outlined in red (courtesy of Great Western Railway).

26 At around 18:17 hrs, 19 minutes before the collision, train 1P38, the 16:31 hrs Great Western Railway service from Great Malvern to Paddington, passed under Yarnton Road bridge without incident. It was travelling in the up direction towards Oxford and it was already dark. No CCTV data was available from this train. Train running data indicates that train 1P38 departed from Hanborough on time at 18:14 hrs and arrived at Oxford four minutes early at 18:22 hrs.

27 Train 1W03, the incident train, departed Oxford at 18:29 hrs. It was carrying 365 passengers plus 2 crew. It passed Wolvercot North Junction where it joined the Cotswold line at 18:34 hrs, after which the driver accelerated under green signals. It was next due to call at Hanborough.

Events during the accident

28 At 18:35 hrs, train 1W03 approached Yarnton Road bridge in darkness, travelling in the down direction at 57.6 mph (92.7 km/h). The train passed under the bridge and struck debris on the track (figure 8). The driver, in a statement to their employer, reported seeing what they thought was the shadow of a tree branch close to the track as the train went under the bridge followed by a heavy strike against the train. The on-train data recorder fitted to the train shows that the driver applied the emergency brake around one second after the impact. The train stopped 19 seconds later, after travelling approximately 290 metres beyond the bridge.

Figure 8: Forward-facing CCTV image from train 1W03 at 18:35 hrs, immediately before striking debris (courtesy of Great Western Railway).

29 Damage to the train included a broken fibreglass panel located under the nose cone above the left-hand rail (in the direction of travel), displacement of safety equipment on the leading bogie and impact marks on the obstacle deflector, lifeguard, and leading wheelset (figure 9a and figure 9b). There were no injuries.

Figures 9a and 9b showing damage to the front of the train.

30 The driver immediately reported the incident to the signaller by radio and asked them to block the line. After investigating, the driver informed GWR control that the train had hit part of a bridge. The driver described a pile of bricks 10 metres long by 2.5 metres high.

Events following the accident

31 The train was assessed on site by a technical representative from the train's maintenance company, and at 21:17 hrs GWR was advised that train 1W03 was not fit to proceed. A rescue train was sent to assist and arrived via Hanborough. The evacuation started at 22:15 hrs, assisted by Oxfordshire Fire and Rescue Service. It was completed at 23:57 hrs.

32 The Cotswold line was reopened on 12 February 2023 with a temporary speed restriction in place. This occurred after some of the exposed cutting slope behind the failed wing wall had been removed and a watchperson had been put in place to observe elements of the bridge which Network Rail was concerned about. Later the same day, the watchperson reported further ground movement of the slope which had caused earth to spill over a concrete barrier placed to protect the track. In response to this movement, and concern from the RAM (structures) team about the stability of part of the parapet, the line was blocked again. It reopened again on 22 February after extensive work to stabilise the slope, the road and utility pipes under the road surface. The road reopened with single lane running under traffic light control on 28 February 2023.

Analysis

Identification of the immediate cause

33 The south-west wing wall from Yarnton Road bridge collapsed onto the track, leaving debris which could be struck by passing trains.

34 The collapse of the south-west wing wall occurred after an earlier train had passed the site 19 minutes before the collision without incident (paragraph 26). The collapse was not detected in the short intervening period and the driver of train 1W03 did not have time to take any action before the collision occurred (paragraph 28).

Identification of causal factors

35 The accident occurred due to a combination of the following causal factors:

a. The south-west wing wall was no longer able to carry the load imposed by the embankment because it had insufficient structural capacity to do so (paragraph 36).

b. The risk assessment process did not lead to effective control measures being put in place to address risks associated with the south-west wing wall's deterioration (paragraph 67).

These factors are now considered in turn.

Wing wall loading

36 The south-west wing wall was no longer able to carry the load imposed by the embankment because it had insufficient structural capacity to do so.

37 The south approach embankment supports the road formation and is formed of a stiff clay core overlaid with sandy clay, gravel and ash. The most recent planned earthworks examination was undertaken in January 2022 (paragraph 11). The examination report gave this embankment an earthworks hazard category of 'A' in accordance with Network Rail company standard NR/L2/CIV/086, 'Management of earthworks manual', issue 10 published June 2021. This category can be related to the statistical likelihood that the asset may fail, with A being the least likely.

38 Following the accident, GeoAccess staff were deployed to site and undertook a rapid response inspection (paragraph 11). Its post-accident report states:

> '*The fill material appeared to comprise of a mixture of poorly sorted bricks, ash, granular and cohesive soil. A slump feature approximately 2m wide, 1.5m high and 1m deep had formed in the fill likely during or just after structural failure.*'

39 Although the clay core did not collapse, the slump feature reported by GeoAccess (a small part of the embankment that collapsed) indicates that the embankment was imposing a load onto the wing wall at the point of failure. The ground movement probably occurred during, or just after, the structural failure of the wing wall when the support was lost.

40 RAIB has considered the relevance of any embankment movement before the accident, and whether this may have increased the loading on the wing wall or reduced support to the road. Although this factor cannot be entirely discounted, RAIB has concluded, based on the lack of any supporting evidence, that it was unlikely to have been a factor in the causation of the accident.

41 XEIAD staff were also deployed to site following the accident to examine the structure. They recorded that the wing wall had collapsed, and a passing train had struck the debris. Their report states '*the wing wall is not keyed into the spandrel and [is] not affecting the safety of the remainder of the structure*.'

42 The wing wall acted as a retaining wall supporting the approach embankment for the road, which was at a higher level than the railway. The retained soil naturally imposed a lateral pressure which exceeded the wall's capacity to resist it. This occurred because:

a. The wing wall was described as being in poor condition in examination reports and had deteriorated over time (paragraph 43).

b. The wing wall had a hidden defect which meant that brickwork repairs undertaken in 2013 were ineffective (paragraph 52).

These factors are considered in turn.

Wing wall condition

43 The wing wall was described as being in poor condition in examination reports and had deteriorated over time.

44 Yarnton Road bridge was constructed in 1853 using relatively low-quality bricks, and it has needed numerous repairs over its lifetime. There are no records of repair work undertaken before 2013, but examination reports and photographs show areas where brickwork has previously been removed and replaced, a process known as *recasing,* at both abutments, all four wing walls, both parapets and around the arch.

45 Network Rail company standard NR/L3/CIV/006/1B, 'Structures, Tunnels and Operational Property Examinations', Part 1B, 'Undertake examinations', issue 3 dated September 2019, specifies the requirements for visual and detailed examinations of structures. Visual examinations are carried out from multiple safe observation locations with no access equipment to reach those areas of a structure which are elevated or close to the railway line, whereas detailed examinations are carried out within touching distance of the asset. Examiners are required to report on the asset location, properties and condition, severity and extent of defects and include photographs. The examining engineer receives examiners' reports and is responsible for identifying aspects that could affect the operational safety of the structure, using their judgement to assign a defect risk score to each defect and making recommendations for any required remedial works. Completed reports are issued to Network Rail where asset engineers are responsible for reviewing all examination reports where recommendations have been made.

46 Network Rail company standard NR/L3/CIV/006 Part 2A, ‘Detailed examination requirements’, issue 3 dated September 2019, sets out the requirements for condition marking; this is undertaken by the examiner and is separate from defect risk scoring. It requires examiners to confirm that all elements subject to condition marking are viewed during a detailed examination. This enables the Bridge Condition Marking Index (BCMI or CMI) from Network Rail company standard NR/L3/CIV/006 Part 1E, ‘Structures defects’, issue 1 dated September 2019, to be used to grade the condition of a structure and give each structure a unique measurable score. A condition marking score of 100 indicates that a structure is in perfect condition. A structure scoring 40 or below is deemed to be at a heightened risk and would normally trigger detailed examinations at a more frequent interval in accordance with Network Rail company standard NR/L3/CIV/006 Part 1A, ‘Management of Examinations’, issue 4 dated 7 September 2019.

47 Yarnton Road bridge had an overall BCMI score of 28. The south-west wing wall element had a BCMI score of 20.

48 Since 2014, the interval between detailed examinations has been scheduled as three years, plus or minus three months. The required frequency was largely achieved. Detailed examination reports of the bridge are available for 2002, 2006, 2011, 2014, 2018 and 2021. These are interspersed with visual examination reports on an approximately annual basis, available from 2009 onwards. Each examination report identified that the wing walls were in poor condition. The south-west wing wall had a longstanding bulge (see paragraph 70), but little or no change was identified between successive reports.

49 In January 2023, the examiner undertaking a planned visual examination noted that the bulging appeared to have increased and the fractures had opened up. They looked up the previous report electronically while on site to compare the photographs. Photographs in the 2023 visual report (figures 10 and 11) were captioned:

‘*Appears to have increased bulging’* and *‘Deterioration throughout wing wall’*.

50 The failure occurred less than three weeks after the 2023 examination, while the report was still under review by the EXIAD examining engineer. There is a process for an examiner to directly notify the Network Rail asset engineer if they identify a serious issue that requires urgent attention, but the issue was not felt to be of a serious enough nature to require an immediate response.

51 RAIB has not identified a specific trigger event which caused the south-west wing wall to fail at the time it did. There is no evidence of unusual vibrations from road or rail traffic preceding the event. Although the temperature was above freezing when the failure occurred (paragraph 24), sub-zero temperatures had been recorded during the previous five consecutive nights without causing a failure. However, there had been very little rainfall during this period and the ground was relatively dry, reducing the effect of *freeze-thaw* ground movement.

Figure 10: Image showing part of the south-west wing wall from the 2023 visual examination report captioned 'Appears to have increased bulging' (courtesy of XEIAD/Network Rail).

Figure 11: Image showing part of the south-west wing wall from the 2023 visual examination report captioned 'Deterioration throughout wall' (courtesy of XEIAD/Network Rail).

Hidden defect

52 The wing wall had a hidden defect which meant that brickwork repairs undertaken in 2013 were ineffective.

53 Examiners and asset engineers assumed that the wing wall was a contiguous structure as this is the normal form of construction for a retaining wall. Its thickness and foundation details were not known due to the absence of records. At an unknown date in the past, work had been undertaken to repair and possibly strengthen the wing wall. This could have been achieved either by adding additional brickwork to increase the wall's thickness or by recasing.

54 The repair should have created a stronger structure, interlocking new and older brickwork. However, a post-accident inspection of the partly collapsed wing wall showed that it comprised the original structural wall hidden behind a 'skin wall' just over 100 mm thick, leaving an internal cavity or void of a similar width. Bricks laid perpendicular to the face of the wall had been broken in half, and these half-bricks known as *snap headers* used in place of standard-length bricks (figures 12a and 12b). This would have saved on materials and disguised the fact that the new brickwork was not connected to the structural wall.

Figures 12a and 12b: View of partly collapsed wing wall and clay embankment core, and detailed view of skin wall showing short 'snap header' bricks and void around 100 mm wide.

55 As built, the construction of the outer skin wall was detrimental to the structural safety of the wing wall. This was because it concealed the inner structural wall, so its condition was unknown, and because it reduced the efficacy of the 2013 repair (see paragraph 58). It also added to the volume of debris which collapsed onto the track.

56 When the wing wall partially collapsed, a large part of the skin wall also failed. The remaining section of the skin wall was removed shortly afterwards, exposing this part of the structural wall for the first time in many years. This showed that the structural wall behind the skin wall was connected (that is, linked structurally) to the abutment (figure 4). However, the skin wall was not connected to the abutment leading to the development of a vertical fracture (figure 13a), a defect identified in examination reports from 2006 onwards and described as a 'mitre fracture' (see paragraph 71).

Figures 13a and 13b: Vertical fracture between skin wall and south abutment, and structural wall exposed after removal of skin wall (courtesy of Network Rail). Both images February 2023.

57 Exposure of the structural wall (figure 13b) revealed a bracket believed to be part of an early railway telegraph system. This suggests that the railway was already in operation before the skin wall was constructed.

The 2013 repair

58 In 2011, a detailed examination report identified deterioration of the south-west and north-west wing walls. The examining engineer included the following recommendation:

> '*Take down and reconstruct bulging & severely fractured wing wall or drill & anchor bulging areas, and pin & grout brickwork fractures to hold rate of deterioration*'.

They assigned the defect a severity factor of 3 and a likelihood factor of 4 (see paragraph 79), which when multiplied together resulted in a defect risk score of 12. This met the normal threshold for taking action (see paragraph 82). The examining engineer estimated the cost of the required work at £5,000 for both wing walls.

59 The Network Rail asset engineer who reviewed the report accepted the recommendation. They recorded the following note in a database used to manage structure repairs:

> '*De-vegging* [devegetation and] *wingwall repairs have been accepted as minor works. Other recommendations* [to other parts of the bridge] *have been rejected.*'

60 Guidance was available to asset engineers within Network Rail document NR/CIV/SD/TUM/101, 'Technical user manual for brickwork and masonry repair', revision B dated May 2006. This suggests that either drummy brickwork or bulging should have been subject to further inspection, including trial drilling or coring. The guidance was not followed on this occasion, either because the repairs were treated as minor works or because the bulging was in an area not regarded as the primary load bearing element for the bridge.

61 The instruction was passed to Network Rail's minor works project team, which issued a work instruction to its then framework contractor, QTS. The instruction included the full recommendation from the examination report (paragraph 58). As the description of work required contained an 'or' statement, the intended scope of work for QTS was unclear. Neither taking down and reconstructing the wall nor anchoring bulging areas, which would have involved drilling through the wall and installing substantial ground anchors into the embankment behind, could be considered minor works. QTS has stated that the remit was varied by Network Rail to limit the work to the pinning and grouting of certain areas, and that this would have been agreed with a Network Rail representative on site.

62 In early November 2013, QTS undertook pin and grout repairs to brickwork fractures affecting the two wing walls. This type of repair is detailed on Network Rail drawing NR/CIV/SD/109, 'Stitching of shear cracks', rev A dated 22 June 2006. It involved drilling a series of holes at an angle of 45 degrees on either side of a fracture and inserting, then grouting, a 6 mm diameter stainless steel bar into each hole. Pin and grout repairs of this nature can be used as a first intervention to try and stabilise a masonry fracture.

63 When the work was complete, QTS submitted a completion certificate valuing the work at £1,383.45, together with photographs of the work being undertaken (figures 14a and 14b). The completion certificate included text that had been prepopulated by Network Rail's minor works management system 'Monitor' with the full text of the original recommendation (paragraph 58). This was not amended by either QTS or Network Rail to make it clear that only the final part, '*pin & grout brickwork fractures to hold rate of deterioration*' had been done, although QTS stated that they felt that the photographs of the work would have made this clear. There is no report of a void being encountered while drilling into the wall or any other record of the work. The project did not meet the threshold for requiring a Health & Safety File, under the 'The Construction (Design and Management) Regulations 2007', to be submitted, so QTS was not required to provide as-built information.

Figures 14a and 14b: Drill and grout repair in November 2013 (courtesy of QTS).

64 Successful pin and grout repairs rely on stronger masonry being present behind the fracture to tie the damaged area in to. If there had been no void present behind the outer skin of the south-west wing wall, then this type of repair would have worked more effectively to stabilise it.

65 The detailed examination report in 2014, which followed this repair, included a photograph indicating the extent of the pin and grout work to the south-west wing wall (figure 15). Although the precise extent of the void is not known, it is likely that some or all of the holes drilled in November 2013 passed through it. Pins installed through the void would not have been effectively anchored into the structural wall as some of the grout pumped into the hole from the exterior face of the wall would have been lost into the internal void or loose fill material, and likely to have left most of the pin's length ungrouted. There are no records, or other evidence, to indicate whether the presence of the void was apparent to staff on site.

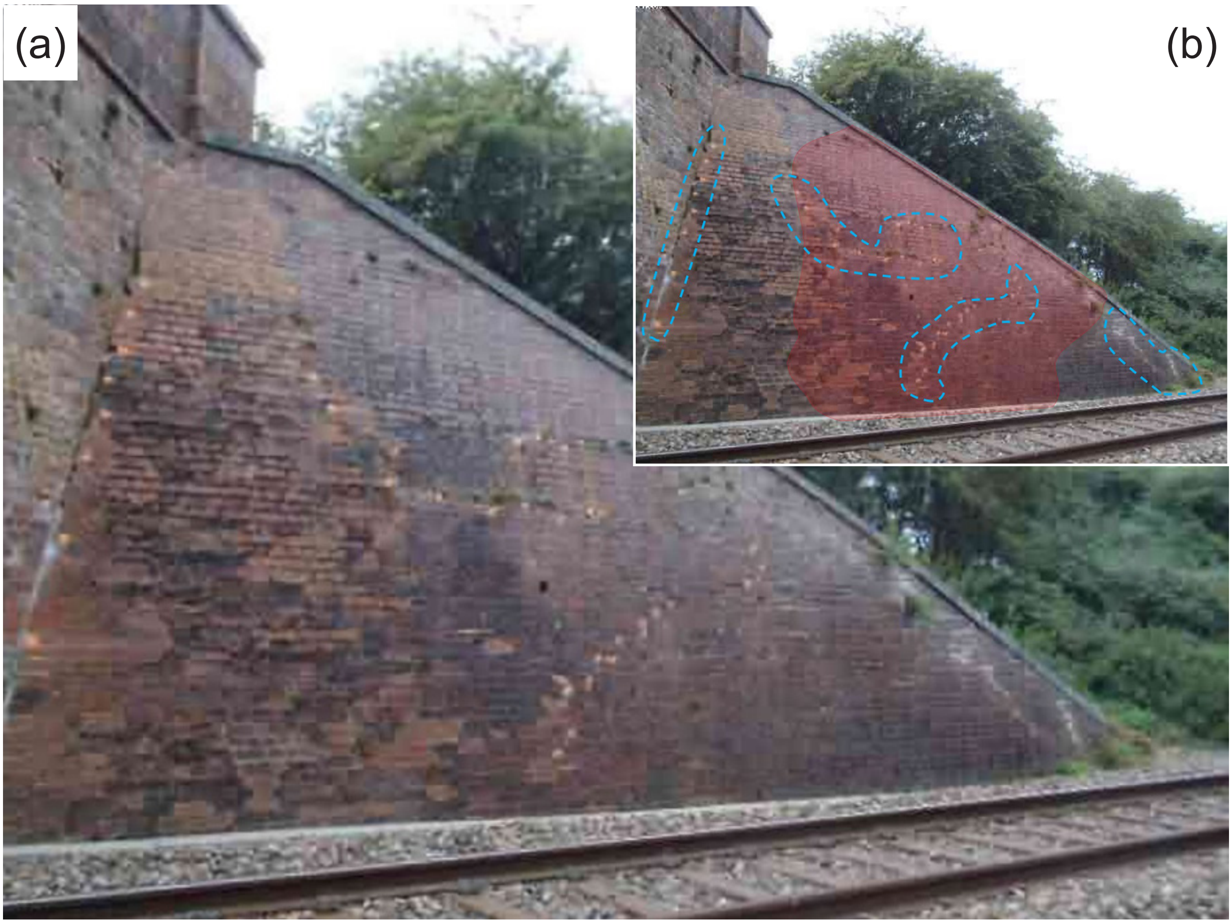

Figure 15: Image from the 2014 detailed examination report showing south-west wing wall and location of pin and grout repairs indicated by yellow paint marks (a), and with areas of repair outlined and area of collapse indicated by shading (b) (courtesy of Amey/Network Rail)

66 Examination reports show that defect risk scores dropped significantly (see paragraph 80) following the instruction of repair work. RAIB considers that this was almost certainly due to the examining engineers having misplaced confidence in the extent of the repair undertaken, and its effect on the stability of the wing wall, and them being unaware of the large void. Amey stated to RAIB that examining engineers do not normally have information on any repairs or interventions carried out, although some consideration will be given by the examining engineers to visible repairs and interventions.

Defect risk assessments

67 The risk assessment process did not lead to effective control measures being put in place to address risks associated with the south-west wing wall's deterioration.

68 This causal factor arose due to a combination of the following:

a. Examiners did not have an effective method for monitoring deformation (paragraph 69).

b. The defect risk scores assigned in examination reports did not reflect the actual risk (paragraph 77).

Monitoring of bulging masonry

69 Examiners did not have an effective method for monitoring deformation. This is a probable factor.

70 The earliest available examination report for Yarnton Road bridge is dated January 2002. In this report, the south-west wing wall is recorded as being in poor condition. The report states:

> *'Approximately 8sq/m total and bulging by 60 mm, but wing wall looks to have been built with slight curve in.*
>
> *'All of the repointing is lifting and cracking due to the deterioration of the mortar content behind and root action. Wing wall is drummy to hammer to 70% of total area.'*

71 Subsequent examination reports contain similar observations and sketches of defects (figure 16). Those issued between 2011 and 2023 describe the significant defects affecting the south-west wing wall as:

> '*Bulging up to 70mm, 8m^2. Full height mitre fracture up to 12mm wide.'*

72 This indicates that the shape (protuberance) of the bulge had apparently increased by 10 mm over a period of about 20 years. However, the difference between a 60 mm and 70 mm outstand over a large area cannot be seen or reliably quantified without using electronic distance measuring equipment. The examiners did not have access to this type of equipment and, in the absence of an established or practical alternative method, used a string line or a spirit level for this purpose. In the absence of any identified change, they reported the previous value. The 2011 report made the only reference to the measurement issue. It stated:

> '*Unable to take accurate measurement but appears to be no visual change'.*

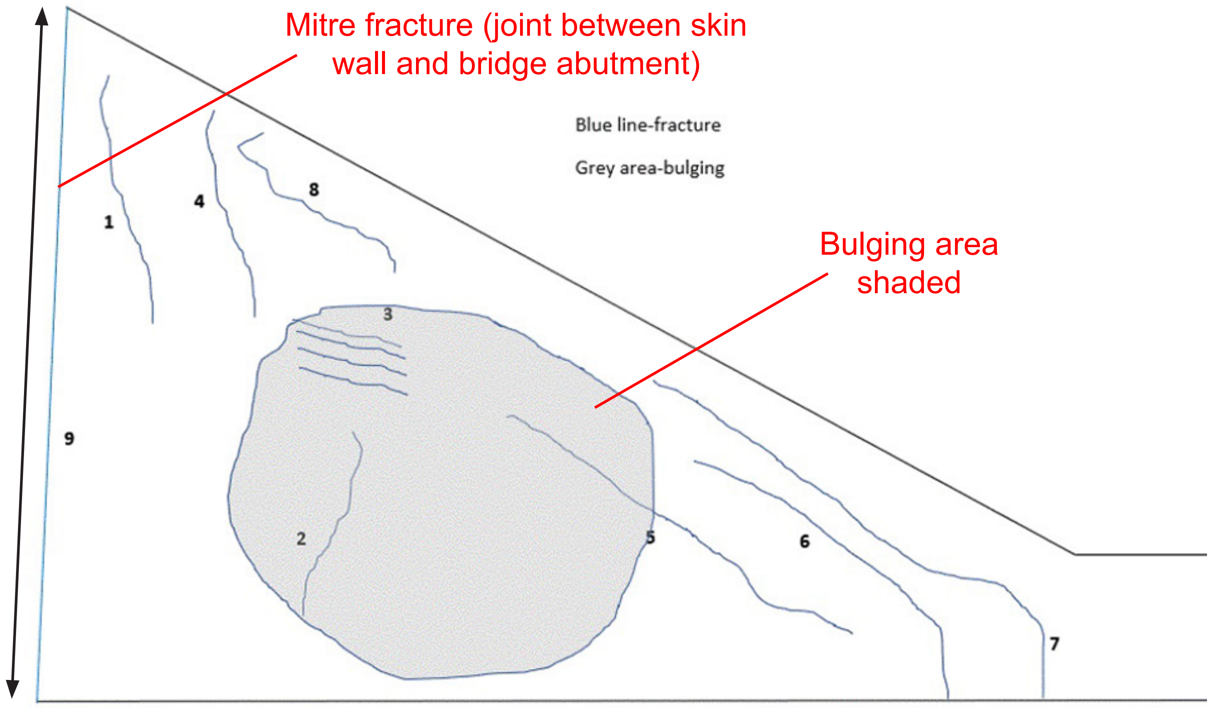

Figure 16: Sketch from 2021 detailed examination report showing defects affecting the south-west wing wall, with RAIB annotations (courtesy of Amey/Network Rail).

73 The 2018 detailed exam report stated:

‘*The bridge is in a similar condition to the last exam. There are no new major defects and no worsening of existing defects*.’

74 The limited variance of measurements and commentary in the exam reports potentially gave a false assurance to Network Rail’s asset engineers that the wing wall remained stable. It is possible that more accurate measurements taken during detailed examinations would have given an earlier indication that movement was occurring. This might have led to different decisions being made, possibly including a recommendation to investigate the bulge in more detail which could have led to the discovery of the void between the structural wall and the skin wall.

75 While the examiner who undertook the planned visual examination in January 2023 observed and reported a change (paragraph 49), this was a visual examination and their conclusion was based on their observations and experience, rather than measurements.

76 The role performed by an examining engineer is dependent on the examiner's observations, measurements, and photographs. An examining engineer will often compare the most recent report with earlier reports as part of the review process, but this is made more difficult when photographs are taken from a range of locations and at different angles. Some recent reports include low-resolution photographs which can make fractures difficult to see and interpret. Previous guidance was given in Network Rail company standard NR/L3/CIV/006 Part 11A, 'Reporting and recording examinations of Structures in CARRS', issue 4 dated June 2017. This required a photograph file size of approximately 100 kB to 150 kB per photo to avoid creating a large file size. Figure 15 is an example of a low-resolution image provided of the Yarnton Road bridge in an examination report. This guidance has been superseded by standard NR/L3/CIV/006/2A.

Risk scoring of masonry defects

77 The defect risk scores assigned in examination reports did not reflect the actual risk. This is a probable factor.

78 When a defect is identified by an examiner, the examining engineer reviews the evidence and assigns a risk score (paragraph 45). This is tracked in each examination report until the defect is repaired. The risk score is defined in standard NR/L3/CIV/006/1B, appendix A, as the examining engineer's judgement of the consequences if the defect is not rectified within one year from the date of examination.

79 The risk score is derived using a severity factor, which ranges from 1 (onset of accelerated degradation) to 5 (structure unsafe). A defect for which a foreseeable consequence of failure is 'line and/or road closure' would score 4. This is then multiplied using a 5 x 5 risk matrix by the likelihood factor, which ranges from 1 (very unlikely) to 5 (certain). A defect where failure is considered 'possible' would score 3. The result of multiplying the two factors is a defect risk score, which ranges from 1 to 25.

80 From the 2014 detailed examination report onwards, a list of recommendations was included on the front page above the list of significant defects. In 2014, the examining engineer made a recommendation which applied to the south-west wing wall, north-west wing wall, south-east wing wall and east parapet. It stated:

> '*Rake out fractures to sound material, point in and apply tabs*[3] *to monitor for movement at future examinations*.'

The examining engineer assigned a severity factor of 2 '*Cost increase due to further deterioration',* and a likelihood factor of 3 '*Possible*', giving a defect risk score of 6 for the group of defects. The estimated cost was £3,000.

81 As this repair was not done, the recommendation was repeated in the 2018 and 2021 detailed examination reports. In these reports, the examining engineers assigned a severity factor of 2 with a likelihood factor of 4 '*Likely*', giving an increased defect risk score of 8. The 2018 report also included the following comment which probably led to the increased likelihood factor:

> *'The previous* [2014] *report states that fractures to wingwalls have been pinned and grouted, but no evidence of this could be found and the majority of fractures were open.'*

[3] This refers to a small patch of mortar placed across a fracture to act as an indicator of movement.

82 Recommendations for existing and emerging defects with a risk score of 12 or more would normally have been actioned under Network Rail's intervention policy. The response to recommendations with a lower risk score is dependent on the asset engineer's professional judgement and available funding. The lack of action in response to the 2014 and 2018 recommendations can be explained by the relatively low defect risk scores of 6 and 8 respectively.

83 These scores did not reflect the actual risk associated with the south-west wing wall because it was repeatedly assigned a severity factor of 2 which signified '*Cost increase due to further deterioration*'. However, the foreseeable consequence of the wall's collapse was line and/or road closure because of its height and proximity to the railway (paragraph 22). On this basis, the severity factor should not have been less than 4.

84 This underestimate of the risk may have arisen because of the practice of aggregating the scores for defects from different parts of the structure into a single recommendation. As the severity of a failure will vary depending on which part of the structure is affected and its location in relation to a road or railway, this can lead to higher risk issues being given too low a value unless the highest severity factor is applied.

85 With a severity factor of 4, and a likelihood factor of 3 or 4 already established, a defect risk score of 12 would have resulted from the 2014 detailed examination report, and a defect risk score of 16 would have resulted from the 2018 and 2021 detailed examination reports. This higher score should have resulted in action being taken in response to any recommendations under Network Rail's intervention policy. However, for Yarnton Road bridge, the asset engineers who reviewed the detailed examination reports in 2014, 2018 and 2021 identified the recommendations as 'duplicate'. They recorded that renewal works intended to improve the condition of the structure were planned (see paragraph 96).

Other factor considered

Road defects

86 The local highway authority, Oxfordshire County Council, has had a longstanding concern about the stability of the approach embankments at this bridge. In 1987, following settlement of the road in the north-east corner of the bridge (that is to say remote from the 2023 failure), it commissioned a study from a consultant which was jointly funded by British Rail. The consultant's report found inherent weakness in the north and south embankments immediately adjacent to the wing walls, but no evidence of general instability of the embankments. There is no record of any significant issues affecting the embankment or road surface between 1987 and November 2022.

87 In November 2022, a representative from Oxfordshire County Council's highways team contacted Network Rail and reported that cracks were appearing in the road surface on the embankment of the bridge. The information, including photographs, was forwarded to the RAM (structures) and RAM (geotechnics) teams for Wales and Western region for consideration. Network Rail subsequently informed the council's representative that the bridge was due to have major work to its structure in 2023 (see paragraph 100) and confirmed that it was undertaking inspections of the embankment.

88 Although Network Rail did not undertake any specific actions which might have prevented the wall failure following these reports, RAIB considers that the cracks in the road surface were not indicative of pre-accident embankment movement behind the wing wall for the following reasons:

a. The cracks are near the centre of the road, and too far from the edge of the carriageway to indicate a classic rotational slope failure mechanism. There was no evidence of bulging, movement, or other visual signs of instability on the embankment slope that would indicate if the cracks were being caused by slope movement.

b. The cracks did not widen following the wall's collapse, or when a large piling machine stood on the carriageway during later slope stabilisation works.

c. The longitudinal cracks in the road extend beyond the end of the embankment. They may be associated with a water main known to run beneath the carriageway.

d. The embankment slump observed after the failure was confined to a section of embankment which had been directly supported by the wing wall.

As such, there was no reason why Network Rail would have undertaken repairs that would have prevented the accident as a result of the cracks in the road surface.

Identification of an underlying factor

89 Network Rail's Wales and Western RAM (structures) team did not understand the internal condition of the wall or the potential implications of the wall's deterioration so could not effectively manage the risk associated with the wing wall.

90 There are no record drawings for this bridge or many other similar bridges, which are of a largely generic and historic design. The bridge had been extensively repaired during its lifetime, but it remained in poor condition as described in examination reports. Any records of repair work have been lost or destroyed during the long period of the bridge's operational service. The lack of drawings and details of historical repairs can affect the safe management of a structure.

91 Network Rail had also not carried out an investigation to establish the cause or condition of the bulge in the south-west wing wall despite it being relatively large, located low in the wall and in an area where there were also fractures in the brickwork. This lack of an investigation, and the lack of historical records, meant that asset engineers did not understand the internal condition of the wall and the potential implications of its deterioration. The method of assessing changes to the bulge dimensions were left to the examiner (paragraph 72), and a recommendation to install tabs to enable examiners to detect movement (paragraph 80) was not actioned.

92 Network Rail's asset engineers were possibly unaware of the limited extent of repair works undertaken in 2013 (paragraph 63). In addition, their lack of knowledge of the wall's construction may have led to them assuming that any stabilising effect from the repair was more significant than it was.

Wing wall monitoring

93 Bridges passing over or under the railway often have a wing wall at each corner of the structure to support approach embankments. These walls are managed as sub-components of the bridge, which is the primary asset. Bridge assessments focus on the main load carrying components (the arch, spandrel walls and abutments). Although wing walls are managed as part of the asset, there is no targeted focus on them.

94 As the internal condition of wing walls is often unknown, they are qualitatively assessed. This process needs to consider the way the load from the retained embankment acts on the wall, referred to as the load path, and establish what a failure would affect.

95 Network Rail uses a retaining wall risk tool described in Network Rail company standard NR/L2/CIV/032 Module 02A, 'Retaining walls risk-based prioritisation procedures', issue 1 dated December 2021, to establish the risk of derailment associated with a retaining wall failure. This tool is not applied to wing walls that are managed as part of a bridge, tunnel or culvert, meaning that this risk assessment was not undertaken for the Yarnton Road bridge. In addition, retaining walls are typically rectangular, whereas wing walls are typically triangular, so a different calculation is required to return a result that accurately reflects the risk.

Observations

Major repair

96 Major repair work to improve the condition of the bridge had been deferred without additional risk mitigation measures being taken.

97 Yarnton Road bridge was in poor condition as indicated by its low BCMI score (paragraph 47). This put it at the lowest end of the condition profile for 2,402 masonry bridges which are BCMI scored on Network Rail's Wales & Western region.

98 In 2014, the bridge was proposed for 'renewal', a term that means major repair work. The overall condition of the bridge was the driver for the scheme, which was given a provisional start date of 2019/2020. This would have coincided with the start of Network Rail's *control period* 6 (CP6).

99 In May 2019, the project was listed as part of Network Rail's CP6 Year 4 Package 1 Remediation scheme, with a proposed year of 2022/2023. This was later changed to 2023/2024 due to resourcing limitations, but the intention remained to complete the work before the end of CP6 in March 2024. These changes were regarded as part of normal planning and did not constitute a *deferred renewal* (see paragraph 108).

100 In May 2022, Network Rail appointed Sisk Rail, a civil engineering contractor experienced in rail projects, to undertake masonry repairs for 16 structures including Yarnton Road bridge. These structures were a mix of *underbridges*, *overbridges* and retaining walls. Sisk Rail appointed Tony Gee & Partners (TGP) to undertake the design of the works on its behalf.

101 The scope of works was defined in a route requirements document[4] prepared by the Wales & Western RAM (structures) team and issued as part of the contract. The work was to include:

- *'Significant repairs to brickwork throughout including but not limited to re-casing, repointing, stitch and grout, etc.'*
- *'Works to include rectification of any defects noted in most recent visual and detailed examination reports*.'[5]

Network Rail intended that the work would mainly involve condition-led repairs based on standard designs (for example, tying brickwork back together within the wall) rather than structural repairs (such as anchoring brickwork back into the surrounding ground).

102 Between July and October 2022, structural engineers from TGP made three visits to Yarnton Road bridge to examine the structure and determine what work was required. TGP developed its proposals and submitted its completed report and proposals to Sisk Rail.

103 In December 2022, Sisk Rail issued the TGP report to Network Rail. Some work was planned to improve the condition of the wing walls, but this would not significantly improve the BCMI as the scoring applies a lower factor to wing walls compared with the main load carrying elements such as the arch and abutments. The TGP report states:

'The wingwalls were in poor condition throughout with bulging, numerous fractures, spalled bricks and drummy areas present in all cases.

'*The proposed works achieve a theoretical BCMI score of 58 on the basis that bulging or overriding areas will be tied back to sound material to aid load distribution*.'

104 Under the heading 'Envisaged repairs' it states:

'Condition-led repairs to the wingwalls will consist of stitching across fractures to increase robustness and aid in load distribution. Recasing large sections is considered impractical due to the risk of collapse from the low structural integrity in the wall caused by the cracking.

'Rebuilding the wingwalls fully or providing significant structural strengthening are outside the scope of this package of works. It is suggested that monitoring points are installed on the wingwalls post-repair to confirm if ongoing movement is occurring. If so, structural repairs may be required such as ground anchors or a reinforced concrete facing.'

105 The part of TGP's report covering the south-west wing wall found:

'*The wing wall has numerous fractures, a bulging area, and large drummy sounding areas. This wall appeared to have drainage issues as the surface of the wall was found to be a lot wetter than others at the time of inspection.*'

---

[4] OWW 067 1386 Cassington Road aka Yarnton Road Route Requirement Document, issue 1, March 2020.

[5] The 2018 detailed examination report.

106 Referring to the causes of defects to the wing walls it states:

‘*The bulging could be a result of poor drainage leading to increased water pressures along with general deterioration of the walls over time or differential settlement along the length of the wall.*’

Project deferred

107 In January 2023, Network Rail rescoped the renewal programme as there was insufficient budget available in Year 5 of CP6 to complete all the projects within the Sisk Rail contract. The Wales and Western RAM (structures) team was involved in selecting schemes which were to be deferred. Projects that were in progress, had possessions booked, or were assessment driven were prioritised for completion. Yarnton Road bridge was identified as ‘medium’ priority based on the overall condition of the bridge.

108 In early February 2023, shortly before the collapse occurred, Network Rail instructed Sisk Rail that work at Yarnton Road bridge was not to be progressed due to project rescoping. Some other projects from the original group were also affected by this change. The start date for the Yarnton Road project was provisionally moved to 2029 at the start of control period 8 (CP8). This was a holding date pending completion of a deferred renewal risk assessment under Network Rail company standard NR/L2/HAM/02201, ‘Management of the risk arising from deferred renewals’, issue 6 dated September 2022. This is a process that is required to justify decisions on deferrals and to manage the risks arising based on an established *‘need’ date*. A deferral decision needs to consider potential failure modes and not just high-level condition information. It also needs to consider whether sufficient asset information is available to allow a decision to be reached. A deferred renewal risk assessment had not been undertaken for Yarnton Road bridge due to a backlog of deferred renewal risk assessments that developed in Wales and Western region during 2023.

109 Although the renewal project at Yarnton Road bridge had not started, RAIB considers it unlikely that the work proposed by the renewal project would have strengthened the south-west wing wall sufficiently to mitigate the risk of the failure that occurred. This would only have happened if the internal construction or the condition of the hidden part of the wing wall was established, leading to additional remedial work being undertaken.

Vegetation management

110 The most recent detailed examination could not be completed because part of the structure was hidden by vegetation.

111 The 2021 detailed examination was recorded as incomplete. A different wing wall could not be fully examined due to extensive vegetation growth (figure 17). The examining engineer recommended:

‘*Remove vegetation from face of wingwall, make good stonework as required, treat to prevent re-growth and clear from site, to complete a compliant detailed examination.*’

Figure 17: Image from 2021 detailed examination report showing vegetation growth obscuring the north-west wing wall (courtesy of Amey/Network Rail).

Previous occurrences of a similar character

112 Network Rail's report[6] into the collapse of an abutment at Lochburn footbridge in Scotland in April 2017 found failures in the management of the structure. The abutment that collapsed was a facing wall protecting a natural rock outcrop, also known as a 'dentition wall'. The investigation found that:

a. The severity of the defects was not recognised or understood.

b. Too much reliance was put on the slow rate of deterioration.

c. Tools to monitor deformation were inadequate.

d. There were issues with the risk scoring of defects and the interpretation of their significance.

113 RAIB's report into the failure of a parapet wall above the vertical-sided Edge Hill cutting near Liverpool Lime Street in February 2017 (RAIB report 17/2017) found that the wall had been loaded by fill placed against the wall by a third party. The investigation found that:

a. The lease holder had built an earthwork against the retaining wall without assessing the effect of the additional surcharge.

b. Network Rail took no action because it was unaware that the wall had been additionally surcharged, and it had not identified the infringement of its land adjacent to the retaining wall.

[6] Collapse of Abutment at Lochburn Footbridge, 4th April 2017. SMIS reference SMIS25212.

Summary of conclusions

Immediate cause

114 The south-west wing wall from Yarnton Road bridge collapsed onto the track, leaving debris which could be struck by passing trains (paragraph 33).

Causal factors

115 The causal factors were:

a. The south-west wing wall was no longer able to carry the load imposed by the embankment because it had insufficient structural capacity to do so (paragraph 36). This was because:

   i. The wing wall was described as being in poor condition in examination reports and had deteriorated over time (paragraph 43, **Recommendation 1**).

   ii. The wing wall had a hidden defect which meant that brickwork repairs undertaken in 2013 were ineffective (paragraph 52, **Recommendation 1**).

b. The risk assessment process did not lead to effective control measures being put in place to address risks associated with the south-west wing wall's deterioration (paragraph 67).

   This factor arose due to a combination of the following:

   i. Examiners did not have an effective method for monitoring deformation. This is a probable factor (paragraph 69, **Recommendation 2**).

   ii. The defect risk scores assigned in examination reports did not reflect the actual risk. This is a probable factor (paragraph 77, **Recommendation 3, Learning point 4**).

Underlying factor

116 Network Rail's Wales and Western RAM (structures) team did not understand the internal condition of the wall or the potential implications of the wall's deterioration so could not effectively manage the risk associated with the wing wall (paragraph 89, **Recommendations 1, 2 and 4, Learning point 1**).

Additional observations

117 Although not linked to the accident on 10 February 2023, RAIB observes that:

a. Major repair work to improve the condition of the bridge had been deferred without additional risk mitigation measures being taken (paragraph 96, **Learning point 2**).

b. The most recent detailed examination could not be completed because part of the structure was hidden by vegetation (paragraph 110, **Learning point 3**).

Actions reported as already taken or in progress relevant to this report

118 Following the collapse of the wing wall, core holes were drilled in the other three wing walls at Yarnton Road bridge. No other voids were found, but the thickness of the wing walls varied between 0.35 metres and 0.85 metres.

119 The RAM (structures) team also identified a small number of other bridges across Network Rail's Wales and Western region with similar bulges. One bridge spanning the same line as Yarnton Road bridge (OWW) had bulges and fractures, and core holes have been drilled. This investigation identified voids in all four of its wing walls. A temporary speed restriction on rail traffic was immediately imposed until remedial works were completed.

Recommendations and learning points

Recommendations

120 The following recommendations are made:[7]

1 *The intent of this recommendation is to ensure that effective standards and processes are in place which will reduce the likelihood of ineffective repair work being undertaken to masonry.*

Network Rail should review the relevant standards and procedures that deal with the specifying of repairs to fractured masonry to ensure that complex defects, such as bulging with fractures, are subject to appropriate review and further investigation to ensure that suitable repairs are undertaken. This review should specifically consider how the repair of masonry which is already in a poor condition is undertaken.

Network Rail should develop a timebound programme to make any appropriate changes identified to standards and processes (paragraphs 115a.i, 115a.ii and 116).

2 *The intent of this recommendation is to improve the quality of information available to staff responsible for making safety-critical decisions on the stability of structural defects.*

Network Rail should develop and implement improved methods for managing defects in masonry structures, such as wing walls, to gain a better understanding of the asset. This should include consideration of:

a) Introducing a standardised and repeatable method for accurately measuring the shape of bulges in masonry walls that is suitable for use by structures examiners, where the routine examination regime is insufficient. This method should be available for use where bulges exist or the need for monitoring has been identified through the examination review process. This method should enable the likelihood of failure to be assessed with greater confidence and should define the actions to be taken in specific circumstances, such as identifying the trigger for additional monitoring.

---

[7] Those identified in the recommendations have a general and ongoing obligation to comply with health and safety legislation, and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail and Road to enable it to carry out its duties under regulation 12(2) to:

(a) ensure that recommendations are duly considered and where appropriate acted upon; and

(b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on RAIB's website www.gov.uk/raib.

b) Reviewing the guidance for structures examiners so that photographs of masonry fractures included in examination reports are taken from a location perpendicular to the surface and that bulges are photographed at an oblique angle and from both sides where it is practical and safe to do so.

Network Rail should develop a timebound programme to make any appropriate changes identified to standards, guidance and processes (paragraphs 115b.i, 116).

3 *The intent of this recommendation is to improve the risk scoring of structures defects and the interpretation of their significance.*

Network Rail should review the training and working practices associated with allocating risk scores and the examination report review process to ensure that defects affecting parts of structures which could present a direct risk to the railway in the event of collapse are given an appropriate defect risk matrix severity factor in accordance with Network Rail standard NR/L3/CIV/006, 'Structures, Tunnels and Operational Property Examinations', Part 1B, 'Undertake examinations'.

This review should specifically consider if, when defects from different parts of a structure are aggregated into a single recommendation, the recommendation's risk score reflects the highest risk item.

Network Rail should develop a timebound plan to make any appropriate changes identified to training, working practices and processes (paragraph 115b.ii).

4 *The intent of this recommendation is to improve asset knowledge of wing walls which are not fully encompassed by existing processes to enable asset engineers to make better informed, consequence-based decisions.*

Network Rail should review its bridge assets and establish if it has clearly identified those wing walls which may fail with a potentially high safety consequence. Network Rail should also consider the benefits of introducing a wing wall risk tool to assess load paths and consequences of failure to improve its knowledge of these assets (paragraph 116).

Learning points

121 RAIB has identified the following important learning points:[8]

1 Infrastructure managers and examination contractors are reminded of the value of understanding whether a masonry fracture is stable. This requires a mechanism to accurately determine whether movement is occurring, for example, by installing tabs (paragraph 116).

2 Railway undertakings should re-examine interim risk mitigation measures if the timing of large-scale remedial work changes and a known risk will exist for longer than planned (paragraph 117a).

3 It is important to clear vegetation from a structure in advance of a detailed examination, where such vegetation may reduce the effectiveness of the examination concerned (paragraph 117b).

4 It is important that examiners follow the requirement in Network Rail standard NR/L3/CIV/006/2A, 'Structures, Tunnels and Operational Property Examinations' Part 2A, 'Detailed examination requirements'. This is to ensure that photographs that are taken close enough so the detail of the defect can be distinguished, and from the same positions as in previous examinations so that a comparison can be made between successive reports (paragraph 115b.ii).

[8] 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where RAIB has not identified management issues that justify a recommendation) and the consequences of failing to do so. They also record good practice and actions already taken by industry bodies that may have a wider application.

Appendices

Appendix A - Glossary of abbreviations and acronyms

Amey	Amey OWR Ltd
BCMI	Bridge condition marking index
CCTV	Closed-circuit television
CP	Control period
GeoAccess	GeoAccess Ltd
GSM-R	Global System for Communications – Railways
GWR	Great Western Railway
QTS	QTS Group Ltd
RAM	Regional asset manager
SMIS	Safety management intelligence system (RSSB)
TGP	Tony Gee & Partners
XEIAD	XEIAD Ltd

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis's British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com.

Abutment	Structure which supports the deck (or arch) at the extreme ends of a bridge.*
Control period	A five-year period during which access charges, Network performance and Network Rail's (NR) fiscal allowances for enhancement works are set.* Control period 6 ran from April 2019 until March 2024. Control period 8 will start in April 2029.
Deferred renewal	A renewal planned to be carried out after the 'need' date (see definition below).
Drummy	Brickwork than sounds hollow when tapped with a hammer.
Engineer's line reference	A three or four character identification code used to specify a route or section of a route.*
Freeze-thaw	The effect of water seeping into cracks in the ground and expanding when it freezes.
GSM-R	A national radio system which provides secure voice mobile communications between trains and signallers, relaying calls via radio base stations built alongside the railway or on suitable vantage points.
'Need' date	A date defined in standard NR/L2/HAM/02201 as '*The date a validated renewal should be carried out based purely on asset condition, without reference to budget, resource, access or other constraints*.'
Overbridge	A bridge that allows passage over the railway. Also referred to as an overline bridge.*
Parapet	The wall or railing built along the edges of a bridge deck or arch to prevent ballast, pedestrians or vehicles straying over the edge.*
Recasing	Replacement of the outer layer of brickwork.
Skew	Describing something crossing a railway at an angle other than 90°.*
Snap header	A brick cut to approximately half its length or 100 mm long that is positioned in a wall with its uncut header exposed, giving the impression that the header brick penetrates fully into the wall.
Spandrel	A wall carried on the outer edge (extrados) of an arch filling the space below the deck (road surface).

Underbridge	A bridge that allows passage under the railway. Also referred to as an underline bridge.*
Wing wall	Retaining wall on either side of a bridge abutment, supporting an embankment.

Appendix C - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from the train's on-train data recorder
- CCTV recordings taken from trains
- site photographs and measurements
- weather reports and observations at the site
- examination reports
- a review of previous RAIB investigations that had relevance to this accident.

This page is intentionally left blank

This report is published by the Rail Accident Investigation Branch,
Department for Transport.

Any enquiries about this publication should be sent to:

RAIB
The Wharf
Stores Road
Derby UK
DE21 4BA

Email: enquiries@raib.gov.uk
Telephone: 01332 253300
Website: www.raib.gov.uk