DIAS1/5

REPORT ON ASSESSMENT

For

EAST AYRSHIRE COUNCIL

Structure Reference No. : C127/010

Structure Name : LOW ASHYARD DISUSED RAIL BRIDGE

O.S. Reference 247402, 636124

East Ayrshire Council,
Department of Development Services,
Roads Division,
Greenholm Street,
Kilmarnock,
KA1 4DJ

Document Ref. : EAC / S/ 05 / 043

Date : JANUARY 2007

REPORT CONTROL SHEET

PROJECT	:	**East Ayrshire Council** **Bridge Assessment Programme**
DOCUMENT TITLE	:	**Report on Assessment** **Structure No. C127/010,** **Low Ashyard Disused Rail Bridge**
REPORT REFERENCE	:	**EAC / S / 05 / 043**

STATUS	DATE	AUTHOR	APPROVED
Final	January 2007	[redacted]	

REPORT ON [redacted]
Name
Qualification [redacted]
Title

Signature [redacted] 31/01/07

Authorised [redacted] **hire Council, Roads Division, Structures Section**

CONTENTS

C127/010 LOW ASHYARD DISUSED RAIL BRIDGE

1.0 SUMMARY

1.1 The conclusions of the assessment are:

(a) The main longitudinal cast iron beams are limited to 7.5 tonne assessment loading.

(b) The longitudinal cast iron edge/ parapet beams are limited to 7.5 tonne assessment loading.

(c) The cast iron hogging plates are limited to 7.5 tonne assessment loading.

1.2 The initial recommendation of the report is that a 7.5 tonne weight restriction should be placed on the bridge.

1.3 The bridge is weak, redundant and at the end of its serviceable lifespan. In addition the geometry of the bridge creates a significant hazard to road users. Therefore the report recommends the removal of the bridge. If this option is too expensive because of the cost of diverting services, then stowing the bridge should be considered.

2.0 INTRODUCTION

2.1 C127/010 Low Ashyard Disused Rail Bridge carries the C127 over a disused railway line about midway between Hurlford and Galston.

2.2 The assessment report provides details of the structure; Principal Inspection; site investigation, details of the structural assessment and load carrying capacity of the bridge; and the report makes recommendations relating to the assessment.

3.0 DESCRIPTION OF THE STRUCTURE

3.1 Low Ashyard Disused Rail Bridge is a single span cast iron deck. The deck consists of 6 longitudinal beams supporting arched cast iron deck plates off their bottom flanges backfilled with granular material and carrying a single lane, single carriageway with two grass verges. (Refer to the General Arrangement drawing in Appendix D) The superstructure is supported on two masonry full height abutments topped off with brick and the beams bear onto wooden sleepers. The bridge has a skew span between abutment faces of 8.3 metres and a square span of 8.115 metres. The skew angle of the deck is 12.1 degrees. The bridge has a total deck width between parapets of 7.9 metres and carries two grass verges of 2.1 metres width and a single lane single carriageway of 3.7 metres.

3.2 The Bridge Record Sheet from the bridge database, which provides a summary of the relevant features of the structure, and a location of the bridge are included overleaf.

3.3 General Arrangement Drawing No. C127/10/02, a copy of which is enclosed in Appendix D, provides details of the measured dimensions of the structure.

Structure Ref: **C127/10** | Route: C127 | North Area | Construction Date: | Grid: 247402 636124

Database Ref: C127/010 | Structure Type: Underbridge

Structure Name: **RAIL BRIDGE No. 5 [LOW ASHYARD]**

Obstacle: Dismantled Railway | Last GI Date: 02/06/2006 | M P R:

Structure Owner: Rail Property Limited

Maintenance Authority: Rail Property Limited

Listed: ( ) Yes (•) No ( ) Poss | Listed Cat:

Other Information:

7.5T weight limit signs installed in August 2006

Skew
Value: [ ] N/A

Arched
( ) Yes (•) No [ ] N/A
Arch Cover:

Decked
(•) Yes ( ) No [ ] N/A
Overall Deck Len: 9.940

Spans
No.: 1
Span 1: 8.100
Span 2:
Span 3:
Span 4:
Span 5:
Span 6:

Superstructure:	Cast Iron Beams & Jack Arches
Foundation:	Unknown
Abutments:	Coursed Masonry & Brick
Bearings:	Unknown
Waterproofing/Type:	Unknown
Expansion Joints:	Unknown

Wingwalls
Wingwalls Material: Coursed Masonry

Parapets
(•) Yes ( ) No [ ] N/A | Cast iron | Thickness:
Min Height: 1,300 | Protective System: | Ranking:

Piers
( ) Yes (•) No [ ] N/A

Screens
( ) Yes ( ) No [✓] N/A

	Left Verge	Carriageway	Right Verge
Maximum			
Minimum	2.100	3.600	2.100

No of CWs: 1

Min Deck width: 7.800
Min Soffit width: 8.100
Deck Area: 80.514

HeadRoom Restriction
( ) Yes ( ) No [✓] N/A
Headroom Ht:
Date Measured:

Assessment Status: Assessed, Failed, Weight Restriction
Comment: British Rail Prop.Board
Assessor: East Ayrshire Council
Year Strengthened: Wt. Restriction | Target Group: BRPB
Restrictions: 7.5 T Gross
Reported: Yes | Result: 7.5T | Copy of Report: Yes
HB Capacity: | Copy of Calculations: Yes

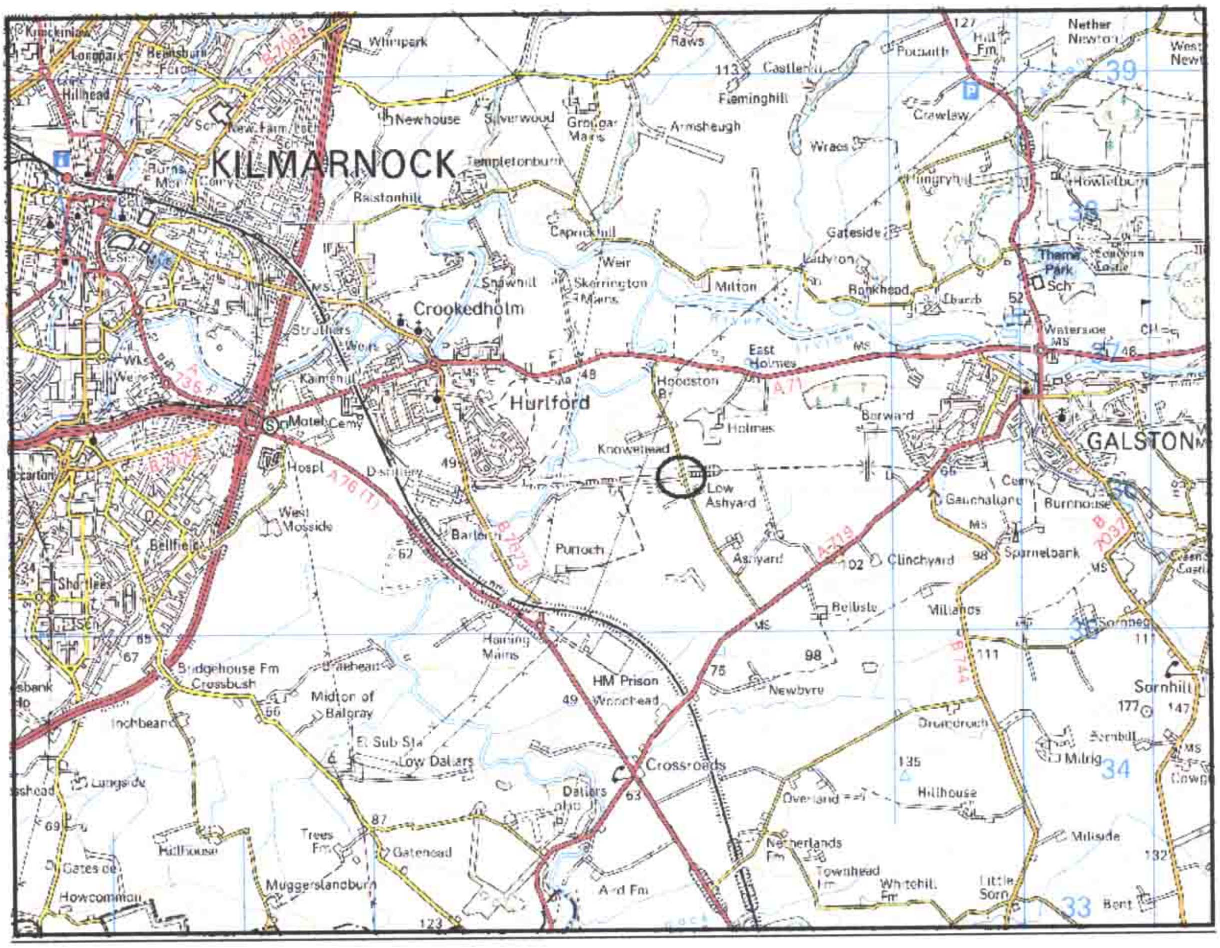
Weight Restriction
(•) Yes ( ) No [ ] N/A
Wt Restriction: 7.5 Tonnes

Diver Required
( ) Yes ( ) No [✓] N/A
Date inspected:

Under Bridge Inspection Vehicle
( ) Yes ( ) No [✓] N/A

Old Bridge Name: | Old Bridge No: C127/10
B.R. BRIDGE No. 5 [LOW ASHYARD]

Date of last PI:
Priority: | Next PI: 2007
File Reference. C127/10



LOCATION PLAN

C127/010 – LOW ASHYARD DISUSED RAIL BRIDGE

NOT TO SCALE

4.0 REVIEW OF EXISTING INFORMATION

4.1 Prior to undertaking the Assessment of the structure a desk study of all the existing information pertaining to the bridge was undertaken.

4.2 Previous Inspections

4.2.1 A General Inspection was carried out in June 2005. This report highlighted the problems with the breakdown of paint on all metal parts and the subsequent corrosion. The lack of safety fencing at wingwalls was also highlighted. Similar comments were noted in the previous Principal Inspection carried out in 1995.

4.3 Other Records

4.3.1 No drawings of the bridge were held in the office records. Enquiries to BRB (Residuary) Limited and Network Rail also provided no information. A General Arrangement drawing was produced based on site survey and investigation and a copy is reproduced in Appendix C.

4.3.2 The information on the Bridge Record Sheet was checked as part of the Assessment and was found to be correct.

4.4 Services

4.4.1 Enquiries to service providers indicated the presence of a water main in the bridge deck.

5.0 INSPECTION

5.1 An explanation of the process for determining defect ratings can be obtained in the Principal Inspection report contained in Appendix A. This Section provides a summary of that report.

5.2 Foundations

The foundations were not visible and therefore could not be inspected.

5.3 Embankments

The embankments on the approaches to the bridge are in good condition with no obvious signs of deterioration. The defect rating of the embankments is **2B.**

5.4 Abutments

5.4.1 The abutments are constructed on the lower part from ashlar sandstone masonry whilst the upper parts are constructed from brick. Whilst they appear to be in fairly good condition generally there is some cracking in the masonry blocks and some crumbling of the exterior surface of the brickwork. The defect rating of the abutments is **2C**. (Photos 1 and 3)

5.4.2 Wooden railway sleepers form a bearing ledge laid directly onto the upper brick abutment. The bearing ledge is clearly crushing in places and the defect rating is noted in paragraph 5.6 below.

5.5 Wingwalls

5.5.1 The wingwalls are constructed in ashlar sandstone masonry and appear to be in good condition generally with no obvious signs of tilting or bulging. However the pointing is poor in the upper half generally and a few masonry cope stones are loose or missing. Therefore the defect rating for these elements is **3C**. (Photos 1 and 2)

5.5.2 There are no fences at the top of the wingwalls to protect pedestrians from the drop to the disused track below which is about 5 metres. The defect rating for this defect is **4E**. (Photos 1, 7 and 8)

5.6 Bearings

The longitudinal bridge beams bear onto wooden railway sleepers. It was noted that there was obvious settlement at some locations where the sleepers have crushed. Settlement is estimated to be up to 50 mm. The defect rating of the bearing ledge is **4E**. (Photo 4)

5.7 Bridge Deck

5.7.1 The protective system to the cast iron beams and hogging plates of the bridge deck is in very poor condition and a fairly heavy build up of corrosion product has occurred. However cast iron sections are much thicker than steel or wrought iron and, although the inspection was limited by the presence of backfill, the corrosion effect is not considered likely to be particularly significant at this time. The defect rating of this element is **3E**. (Photos 1 and 5)

5.8 Joints

5.8.1 There are no visible joints in this bridge.

5.9 Parapets

5.9.1 The parapets on the structure are cast iron and the protective system to them has broken down leading to the onset of corrosion. The cast iron parapets have poor vehicle restraining properties and are likely to break off in the event of a collision. The defect rating of the parapets is **4E**. (Photos 1 and 7)

5.10 Surfacing

5.10.1 The bridge has an asphalt wearing course that is in fair condition and a grass verge either side. The surfacing is in **2B** condition. (Photo 7)

5.11 Drainage

5.11.1 The steep grades on approach to the bridge ensure that water on the pavement runs away from the bridge. However the nature of the bridge's construction means that water collected by the grass verges percolates through the backfill and drips off the bridge soffit, contributing to the corrosion process.

6.0 CONCLUSIONS

6.1 The assessed capacity of the internal longitudinal beams, the edge beams and the cast iron hogging plates was calculated at 7.5 tonnes and bending was determined to be the limiting condition.

6.2 The assessed capacity of the bridge is 7.5 tonnes.

6.3 The wooden bearing support has deteriorated significantly and will continue to do so. There does not appear to be an immediate problem with the relative movement of the deck elements. However there is clearly cause for concern that as differential settlement of the beams continues that undetermined stresses could be generated, or that so much movement will occur that the beams will fail to support the deck plates.

7.0 RECOMMENDATIONS

7.1 The initial recommendation of the report is that a 7.5 tonne weight restriction should be placed on the bridge and at the time of completion of this report this has been implemented.

7.2 The bridge is weak, redundant and at the end of its serviceable lifespan and there are relatively major maintenance issues which give cause for concern. In addition the hump back geometry of the bridge creates a significant visibility hazard to road users. Clearly the removal of the bridge would be a desirable option. However three possibilities have been costed as set out below.

7.3 Refurbish the existing bridge

Recommended refurbishment works without improvements to the capacity of the bridge would involve the following:

a) Lifting the superstructure and replacing the wooden bearing ledge.

b) Cleaning and repainting metal elements.

c) Repointing brick and masonry and replacing missing wingwall cope stones.

d) Reinstate broken fences at wingwalls.

The estimated cost of the above repairs is approximately £50,000 which excludes any allowance for scheme preparation and supervision costs.

7.4 Remove the bridge and embankments and reinstate the road

An alternative to the above would be to remove the bridge and embankments. This would have the advantages of removing the need for inspection and maintenance in the future with the added bonus that the vertical alignment on the road would be dramatically improved. However the cost of diverting the water main may be prohibitive if the bridge is removed.

The estimated whole project cost of removing the bridge and embankments (subject to confirmation of the cost of a water main diversion) is £95,000.

7.5 Remove the bridge deck, infill between the abutments and reinstate the road

A third option would be to lift out the deck, whilst supporting the water main, and infill between the remaining abutments to existing deck level and reinstate the carriageway. Given the size of the water main it may not be possible to carry out this scheme without a water main diversion.

The estimate of the cost of this proposal is £77,000 but if a diversion of the water main is required then this cost would increase.

APPENDIX A

PRINCIPAL INSPECTION REPORT

PRINCIPAL INSPECTION (PI) REPORT
for
EAST AYRSHIRE COUNCIL

Structure Reference No. : C127/010

Structure Name : LOW ASHYARD DISUSED RAIL BRIDGE

East Ayrshire Council,
Department of Development Services,
Roads Division,
Greenholm Street,
Kilmarnock,
KA1 4DJ

Document Ref. : EAC / S / 05 / 044

Date : November 2005

REPORT CONTROL SHEET

PROJECT : **East Ayrshire Council**
Principal Inspection Programme

DOCUMENT TITLE : **Principal Inspection Report (PI)**
Structure No. C127/010,
Low Ashyard Bridge

REPORT REFERENCE : **EAC / S / 05 / 044**

STATUS	DATE	AUTHOR	APPROVED
Final		[redacted]	

PRINCIPAL INSPECTION (PI) REPORT
for
EAST AYRSHIRE COUNCIL

STR. REF. No : C127/010 **STR NAME : LOW ASHYARD BRIDGE**

Downstream Elevation of Structure

DESIGNER	: UNKNOWN
YEAR OF COMPLETION	: UNKNOWN
LAST GENERAL INSPECTION DATE	: 27 June 2005
DATE OF PRINCIPAL INSPECTION ON SITE	: 8 November 2005
Date of Previous Principal Inspection	: 7 November 1995

PRINCIPAL IN[redacted] :
Name
Qualifications [redacted] MICE
Title : PI ENGINEER

Signature : ______________________ Date : ____________________

Authorised to submit this Report on behalf of East Ayrshire Council, Roads Division, Structures Section

CONTENTS

C127/010 LOW ASHYARD DISUSED RAIL BRIDGE

APPENDICES

1.0 SUMMARY

1.1 Recommended refurbishment works without improvements to the capacity of the bridge would involve the following:

a) Lifting the superstructure and replacing the wooden bearing ledge.

b) Cleaning and repainting metal elements.

c) Repointing brick and masonry and replacing missing wingwall cope stones.

d) Reinstate broken fences on embankment approaches.

1.2 The maintenance prioritisation ranking of this structure is **3 - unacceptable**. (see section 6.0 of this report)

1.4 Estimated cost of repairs is £50,000. However these repairs take no account of any strengthening required as indicated in the assessment carried out concurrently with this Principal Inspection.

2.0 INTRODUCTION

2.1 C127/010 Low Ashyard Disused Rail Bridge carries the C127 over a disused railway line between Hurlford and Galston.

2.2 A previous Principal Bridge inspection was carried out on this structure on 7 November 1995. A copy of that report is contained in Appendix A.

2.3 The inspection was carried out to the following design standards:-

a) BD63/94 'Inspection of Highway Structures'

b) HMSO 'Bridge Inspection Guide'

c) CSS 'Bridge Condition Indicators' Vol. 1,2 & 3, July 2002

2.4 The Principal Bridge Inspection was carried out on 8 November 2005 by East Ayrshire Council, Roads and Transportation Division staff. The weather preceding the inspection had been wet and on the day of the inspection there had been light rain.

3.0 DESCRIPTION OF THE STRUCTURE

3.1 Low Ashyard Bridge is a single span structure crossing a disused railway line. The bridge is constructed from masonry and brick abutments with a cast iron deck. The deck is formed of 6 cast iron longitudinal beams with cast iron arched plates spanning between bottom beam flanges. The beams and plates have been backfilled with a granular fill and a narrow single lane carriageway and two grass verges cross the bridge. The bridge parapets are also cast iron. The bridge has a clear square span of 8.30 metres and is 7.9 metres in width between parapets.

3.2 The Bridge Record Sheet from the bridge database is included overleaf and provides a summary of the relevant features of the structure. A location plan of the bridge is also included overleaf.

3.3 General Arrangement drawing No C127/10/02, which was produced for the assessment and a copy of which is enclosed in Appendix C, provides details of the principal dimensions of the structure.

Structure Ref: **C127/10** | Route: C127 | North Area | Construction Date: | Grid: 247402 636124

Database Ref: C127/010 | Structure Type: Underbridge

Structure Name: **RAIL BRIDGE No. 5 [LOW ASHYARD]**

Obstacle: Dismantled Railway | Last GI Date: 02/06/2006 | M P R:

Structure Owner: Rail Property Limited

Maintenance Authority: Rail Property Limited

Listed: ( ) Yes (•) No ( ) Poss | Listed Cat:

Other Information:

7.5T weight limit signs installed in August 2006

Skew — Value: | [ ] N/A

Arched — ( ) Yes (•) No [ ] N/A | Arch Cover:

Decked — (•) Yes ( ) No [ ] N/A | Overall Deck Len: 9.940

Spans — No.: 1 | Span 1: 8.100 | Span 2: | Span 3: | Span 4: | Span 5: | Span 6:

Superstructure:	Cast Iron Beams & Jack Arches
Foundation:	Unknown
Abutments:	Coursed Masonry & Brick
Bearings:	Unknown
Waterproofing/Type:	Unknown
Expansion Joints:	Unknown

Wingwalls

Wingwalls Material: Coursed Masonry

Parapets

(•) Yes ( ) No [ ] N/A | Cast iron | Thickness:

Min Height: 1,300 | Protective System: | Ranking:

Piers

( ) Yes (•) No [ ] N/A

Screens

( ) Yes ( ) No [x] N/A

	Left Verge	Carriageway	Right Verge
Maximum			
Minimum	2.100	3.600	2.100

No of CWs: 1

Min Deck width: 7.800

Min Soffit width: 8.100

Deck Area: 80.514

HeadRoom Restriction — ( ) Yes ( ) No [x] N/A | Headroom Ht: | Date Measured:

Weight Restriction — (•) Yes ( ) No [ ] N/A | Wt Restriction: 7.5 Tonnes

Diver Required — ( ) Yes ( ) No [x] N/A | Date inspected:

Under Bridge Inspection Vehicle — ( ) Yes ( ) No [x] N/A

Assessment Status: Assessed, Failed, Weight Restriction

Comment: British Rail Prop.Board

Assessor: East Ayrshire Council

Year Strengthened: Wt. Restriction | Target Group: BRPB

Restrictions: 7.5 T Gross

Reported: Yes | Result: 7.5T | Copy of Report: Yes

HB Capacity: | Copy of Calculations: Yes

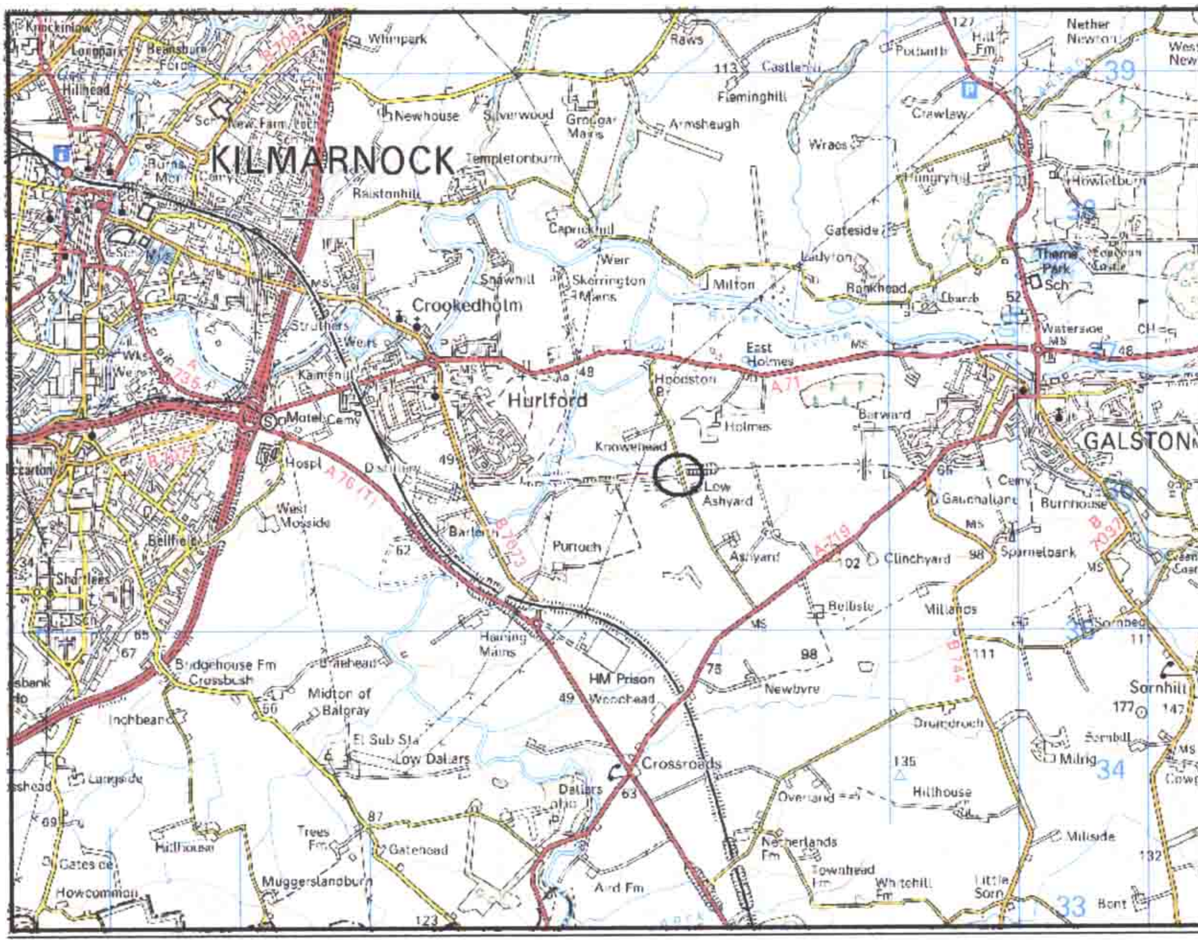
Date of last PI:

Priority: | Next PI: 2007

File Reference: C127/10

Old Bridge Name: B.R. BRIDGE No. 5 [LOW ASHYARD]

Old Bridge No: C127/10



LOCATION PLAN

C127/010 – LOW ASHYARD BRIDGE

NOT TO SCALE

4.0 REVIEW OF EXISTING INFORMATION

4.1 Prior to undertaking the Principal Inspection of the structure a desk study of all the existing information pertaining to the bridge was undertaken.

4.2 Previous Inspections

4.2.1 A General Inspection was carried out in June 2005. This report highlighted the problems with the breakdown of paint on all metal parts and the subsequent corrosion. The lack of safety fencing at wingwalls was also highlighted. Similar comments were noted in the previous Principal Inspection carried out in 1995.

4.3 Other Records

4.3.1 No drawings of the bridge were held in the office records. Enquiries to BRB (Residuary) Limited and Network Rail also provided no information. A General Arrangement drawing was produced based on site survey and investigation and a copy is reproduced in Appendix C.

4.3.2 The information on the Bridge Record Sheet was checked as part of the Assessment and was found to be correct.

4.4 Services

4.4.1 Enquiries to service providers indicated the presence of a water main in the bridge deck.

5.0 INSPECTION

5.1 General

5.1.1 The Principal Inspection must be carried out every six years. The inspection of the structure was carried out in accordance with:

i) BD 63/94 'Inspection of Highway Structures'

ii) BA 63/94 'Inspection of Highway Structures'

iii) HMSO 1983 'The Bridge Inspection Guide'

iv) CSS 'Bridge Condition Indicators' Vol. 1,2 & 3, July 2002

5.1.2 The objective of the inspection was to verify the form of construction, the dimensions of the structure and the nature and condition of the structural components.

5.1.3 In the following Sections 5.2 to 5.9 comments are made on constituent parts of the structure, adopting an overview of the inspection and highlighting the significant findings.

5.1.4 The following Table details the reporting criteria used in Sections 5.2 to 5.9.

Severity	**1**	As new condition, no significant defects	**Extent**	**A**	No Significant defects
	2	Early signs of deterioration, minor defect / damage, no reduction in functionality		**B**	Slight (< 5% affected)
	3	Moderate defect / damage, some loss of functionality could be expected.		**C**	Moderate (5% to 20% affected)
	4	Severe defect / damage, significant loss of functionality and / or is close to collapse		**D**	Wide (20% to 50% affected)
	5	The element is non-functional / failed		**E**	Extensive, more than 50%

Table 1 Assessment of Defects

5.2 Foundations

The foundations were not visible and therefore could not be inspected.

5.3 Embankments

The embankments on the approaches to the bridge are in good condition with no obvious signs of deterioration. The defect rating of the embankments is **2B.**

5.4 Abutments

5.4.1 The abutments are constructed on the lower part from ashlar sandstone masonry whilst the upper parts are constructed from brick. Whilst they appear to be in fairly good condition generally there is some cracking in the masonry blocks and some crumbling of the exterior surface of the brickwork. The defect rating of the abutments is **2C**. (Photos 1 and 3)

5.4.2 Wooden railway sleepers form a bearing ledge laid directly onto the upper brick abutment. The bearing ledge is clearly crushing in places and the defect rating is noted in paragraph 5.6 below.

5.5 Wingwalls

5.5.1 The wingwalls are constructed in ashlar sandstone masonry and appear to be in good condition generally with no obvious signs of tilting or bulging. However the pointing is poor in the upper half generally and a few masonry cope stones are loose or missing. Therefore the defect rating for these elements is **3C**. (Photos 1 and 2)

5.5.2 There are no fences at the top of the wingwalls to protect pedestrians from the drop to the disused track below which is about 5 metres. The defect rating for this defect is **4E**. (Photos 1, 7 and 8)

5.6 Bearings

The longitudinal bridge beams bear onto wooden railway sleepers. It was noted that there was obvious settlement at some locations where the sleepers have crushed. Settlement is estimated to be up to 50 mm. The defect rating of the bearing ledge is **4E**. (Photo 4)

5.7 Bridge Deck

5.7.1 The protective system to the cast iron beams and hogging plates of the bridge deck is in very poor condition and a fairly heavy build up of corrosion product has occurred. However cast iron sections are much thicker than steel or wrought iron and, although the inspection was limited by the presence of backfill, the corrosion effect is not considered likely to be particularly significant at this time. The defect rating of this element is **3E**. (Photos 1 and 5)

5.8 Joints

5.8.1 There are no visible joints in this bridge.

5.9 Parapets

5.9.1 The parapets on the structure are cast iron and the protective system to them has broken down leading to the onset of corrosion. The cast iron parapets have poor vehicle restraining properties and are likely to break off in the event of a collision. The defect rating of the parapets is **4E**. (Photos 1 and 7)

5.10 Surfacing

5.10.1 The bridge has an asphalt wearing course that is in fair condition and a grass verge either side. The surfacing is in **2B** condition. (Photo 7)

5.11 Drainage

5.11.1 The steep grades on approach to the bridge ensure that water on the pavement runs away from the bridge. However the nature of the bridge's construction means that water collected by the grass verges percolates through the backfill and drips off the bridge soffit, contributing to the corrosion process.

6.0 <u>CONCLUSIONS AND RECOMMENDATIONS</u>

6.1 MAINTENANCE PRIORITISATION RANKING

The maintenance prioritisation ranking is defined as follows:-

1- INSIGNIFICANT	Nothing to worry about. Leave for further examination at next PI. Not likely to deteriorate significantly within 6 years.
2 – MINOR	Nothing to worry about, but likely to deteriorate significantly within 6 years.
3 – UNACCEPTABLE	Should not be left for 6 years until next PI. Rapid deterioration and escalation of repair cost inevitable if left unrepaired. Could become severe to affect integrity of structure.
4 – SEVERE: ACTION NEEDED	Currently affecting the integrity of the structure. Essential to repair at an early date. Could become hazardous if left. Cost of repair/ damage to structure escalating rapidly.

The maintenance prioritisation ranking of this structure is 3 - unacceptable

6.2 Over all Low Ashyard Bridge is in poor condition. The cast iron elements have little or no protection against corrosion and this material is known to be brittle and weak; the parapets are substandard; fences at the bridge approaches are broken; and masonry and brickwork is in need of repair. Of particular concern, given that the main structural elements simply rest upon each other, were the wooden bearing sleepers which are rotten in places and allowing the main beams to sink. Clearly there is concern that as deterioration progresses enough movement could occur that would allow the deck plates to come free from the beam flanges supporting them leading to a collapse of the bridge.

6.3 This inspection has been carried out in conjunction with a bridge assessment, the results of which indicate that the deck is weak. The following recommendations will therefore compare proposals for refurbishing the bridge without strengthening with proposals for removing the weight restriction proposed by the assessment.

6.4 **Refurbish the existing bridge**

Recommended refurbishment works without improvements to the capacity of the bridge would involve the following:

a) Lifting the superstructure and replacing the wooden bearing ledge.

b) Cleaning and repainting metal elements.

c) Repointing brick and masonry and replacing missing wingwall cope stones.

d) Reinstate broken fences at wingwalls.

The estimated cost of the above repairs is approximately £50,000 which excludes any allowance for scheme preparation and supervision costs.

6.5 Remove the bridge and embankments and reinstate the road

An alternative to the above would be to remove the bridge and embankments. This would have the advantages of removing the need for inspection and maintenance in the future with the added bonus that the vertical alignment on the road would be dramatically improved. However the cost of diverting the water main may be prohibitive if the bridge is removed.

The estimated whole project cost of removing the bridge and embankments (subject to confirmation of the cost of a water main diversion) is £95,000.

6.6 Remove the bridge deck, infill between the abutments and reinstate the road

A third option would be to lift out the deck, whilst supporting the water main, and infill between the remaining abutments to existing deck level and reinstate the carriageway. Given the size of the water main it may not be possible to carry out this scheme without a water main diversion.

However an estimate of the cost of this proposal is £77,000 but if a diversion of the water main is required then this cost would increase.

APPENDIX A

PREVIOUS INSPECTION REPORTS

STRATHCLYDE REGIONAL COUNCIL

Principal Bridge Inspection Form

OS Map Ref 247400/636200

Road No C127 Bridge No 10 Bridge Name B.R. No 44

Type of Bridge C I Beams Spans [redacted]

Minimum Headroom/s ______ Inspected by [redacted]

CONDITION REPORT (Mark good, fair, poor; use description column for detail) Date of Inspection [redacted]

Item No	Item Description	Condition
1	Invert	GOOD
2	Aprons	
3	Foundations	
4	Cutwaters	
5	Piers/Columns	
6	Abutments	GOOD
7	Wing Walls	FAIR
8	Embankments	FAIR
9	Training Walls	
10	Drainage Substructure	
11	Parapets	FAIR
12	Bearings	
13	Expansion Joints	
14	Main Beams	FAIR
15	Encased Ends	
16	Troughing	
17	Jack Arches	FAIR
18	Transverse Beams and Diaphrams	–
19	Waterproofing	FAIR
20	Drainage Superstructure	
21	Concrete Deck	
22	Arch Springing	
23	Arch Ring	
24	Voussoirs/Archface	
25	Spandrel Walls	
26	Tie Rods	
27	Pointing	POOR
28	Condition of Masonry	FAIR
29	Surfacing	GOOD

Description of Condition and remedial Work rerquired referred to by Item No.

(1) The trackbed now carries a footpath

(6) The lower part of the north abutment leans forward noticeably but seems stable. Both abutments have vertical cracks near the midline. Some of the brickwork to the upper half is weathered and spalling. Some open joints.

(7) Many of the (wide) joints need repointing. All capstones to the newels (except the SW) are missing or displaced. Many capstones are loose and some have fallen from the SE W/W.

(8) Bank is eroding behind NE W/W. There are large bushes growing against the W/walls.

(11) Cast iron parapets are very rusty and lean out slightly. The adjacent roadside fences are poor or fallen (P&W, P&R). There is an unprotected drop of 6m from the back of the verge.

(14), (17) General rust with some scaling.

WAS REMEDIAL WORK RECOMMENDED AT PREVIOUS INSPECTION SATISFACTORILY COMPLETED? YES NO

COMMENTS IF ANSWER IS NO | RECOMMENDED PRIORITY FOR REMEDIAL WORK

East Ayrshire Council – Roads Division – General Bridge Inspection

Road No: **C 127**	Bridge No: **10**	O.S.E: **247402**	O.S.N: **636124**

Bridge Name: **Rail Bridge No: 5 (Low Ashyard)**	**Bridge Type Code**	
Bridge Type: **Cast iron Beams + Cast iron Jack Arches**	Primary deck element form(Table-2)	04
Number of spans: 1 | Span 1 of 1 | Span Length (m): **8.1**	Primary deck element material (Table-4)	F
Number of construction forms*: 1 (*delete as appropriate)	Secondary deck element form (Table-3)	23
All above ground elements inspected: **Yes** | Photographs? **No**	Secondary deck element material (Table-4)	F

S - Severity : 1, 2, 3, 4, 5 Ex - Extent : A, B, C, D, E	Date of this inspection: **27/6/05** Next inspection due (month/year):	Inspected By: **A. Malik**

Set	No	Element Description		S	Ex	Comments
Deck Elements	1	Primary deck element (Table-2)		2	D	Main beams are badly rusted.
	2	Secondary deck elements	Transverse beams			
	3		Elements from Table-3	2	D	Jack arches are badly rusted.
	4	Half joints				
	5	Tie beam / rod				
	6	Parapet beam or cantilever				
	7	Deck bracing				
Load Bearing Substructure	8	Foundation				
	9	Abutments (incl. Arch springing)		2	C	There is one vertical crack in each abutment, need filling/pointing. Spalled masonry and brickwork in both abutments need patching.
	10	Spandrel walls / Head walls				
	11	Piers / Columns				
	12	Cross head / Capping beam				
	13	Bearings				
	14	Bearing plinth / shelf				
Durability Elements	15	Superstructure drainage				
	16	Substructure drainage				
	17	Water proofing		1	A	
	18	Movement / Expansion joints				
	19	Painting: Deck elements		2	E	Paintwork on main beams and jack arches has completely broken down.
	20	Painting: Substructure elements				
	21	Painting: Parapets / Safety fences		2	E	Paintwork on parapets has completely broken down.
Safety Elements	22	Access / Walkways / Gantries				
	23	Parapets / Handrails /Safety fences		2	D	Parapets are badly rusted.
	24	Carriageway surfacing		1	A	
	25	Foot ways/ Footbridge surfacing				
Other Bridge Elements	26	Invert / River bed				
	27	Apron				
	28	Fenders / Cutwaters / Collision prot.				
	29	River training works				
	30	Revetment / batter paving				
	31	Wing walls		2	C	Safety fence over wing walls is non-existing. Several copes are missing from Southeast wing wall. Vegetation growing from joints needs to be removed and joints pointed.
	32	Retaining walls				
	33	Embankments		1	A	
Ancillary Elements	35	Approach rails / Barriers / Walls				
	36	Signs				
	37	Lighting				
	38	Services				
	39					
	40	Notes				

APPENDIX B

PHOTOGRAPHS

Photo 1- West Elevation of bridge

Photo2 – North East Wingwall

Photo 3 – South Abutment

Photo 4 - Abutment seating and wooden sleeper bearings

Photo 5 – Trial pit exposing West parapet, hogging plates and internal beam (note water main)

Photo 6 – Looking Northwards over the bridge

Photo 7 – East Verge and parapet

Photo 8 – Typical gap between parapet and approach fencing/ hedge.

APPENDIX C

DRAWINGS

FOR A COPY OF THE DRAWING REFER TO APPENDIX D OF THE ATTACHED ASSESSMENT REPORT

APPENDIX B

SUMMARY OF TESTING AND INVESTIGATION

Summary of Testing and investigation

Two trial holes were excavated to expose the cast iron beams. Both holes were in the verges with one at the line of the abutment which allowed measurements of end of the internal beam. The other hole was at mid-span and allowed measurements of the first internal beam and the parapet beam.

No material samples were taken. One 6 mm diameter holes was drilled through the web of one parapet beam and another through a hogging plate in order to confirm material thickness.

In addition to the above a cherry picker was used to gain access to the bridge soffit in order to measure beam flange sizes and to confirm beam spacings and other measurable dimensions.

The information gained from the site investigation has been used to create the General Arrangement Drawing No. C127/10/02 a copy of which is contained in Appendix D.

APPENDIX C

PHOTOGRAPHS

Photo 1- West Elevation of bridge

Photo2 – North East Wingwall

Photo 3 – South Abutment

Photo 4 - Abutment seating and wooden sleeper bearings

Photo 5 – Trial pit exposing West parapet, hogging plates and internal beam (note water main)

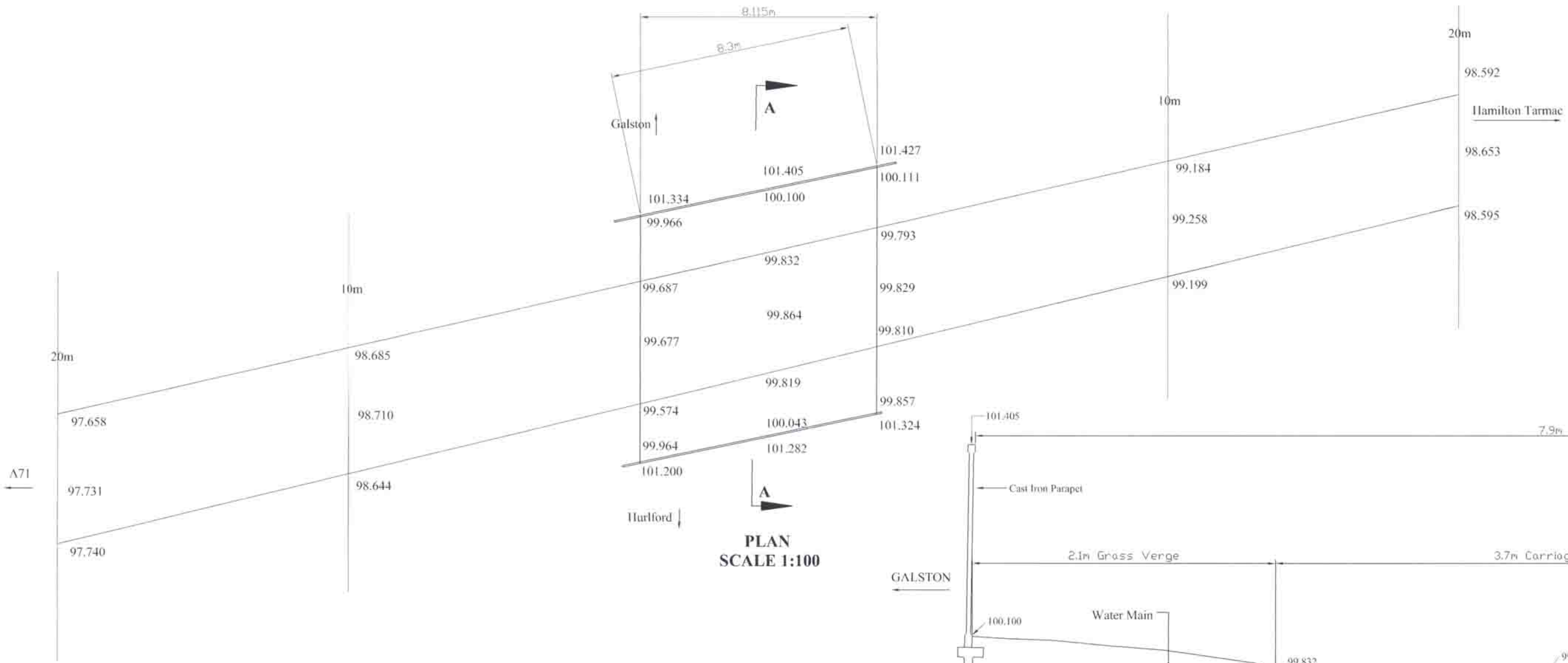
Photo 6 – Looking Northwards over the bridge

Photo 7 – East Verge and parapet

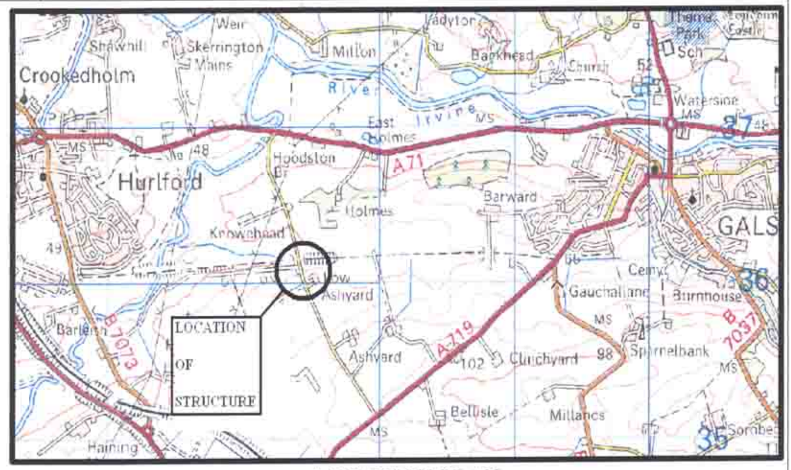
Photo 8 – Typical gap between parapet and approach fencing/ hedge.

APPENDIX D

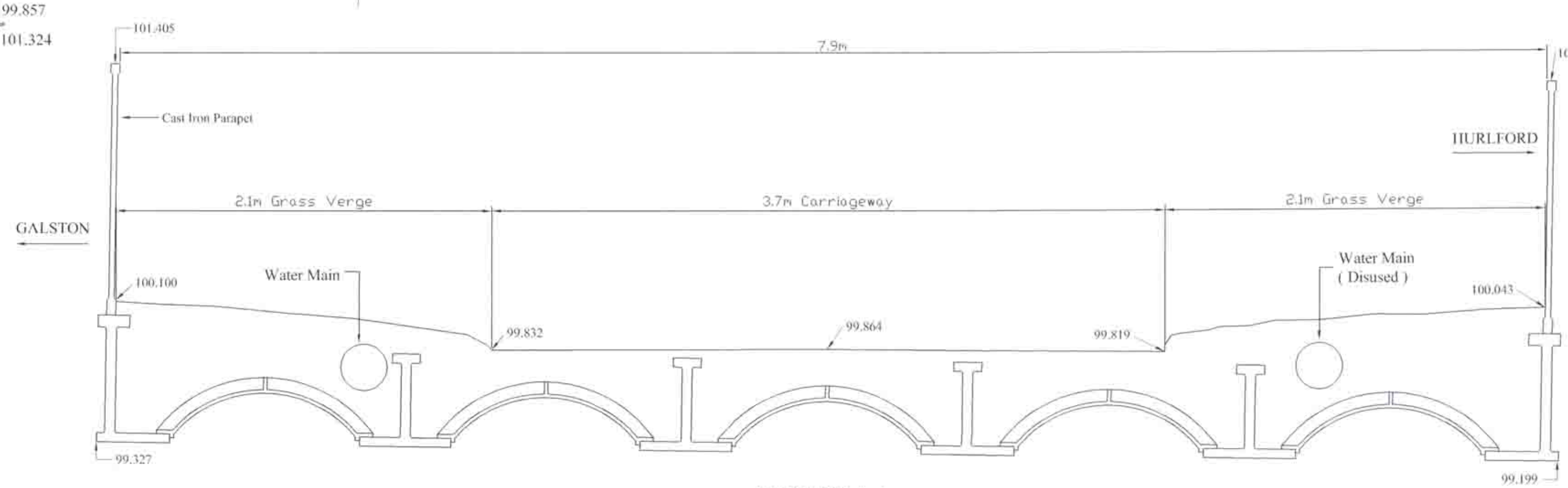
GENERAL ARRANGEMENT DRAWING



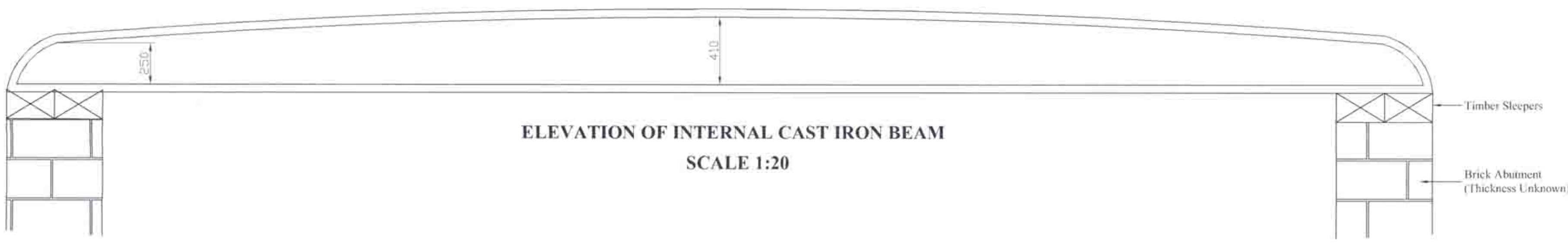
PLAN
SCALE 1:100



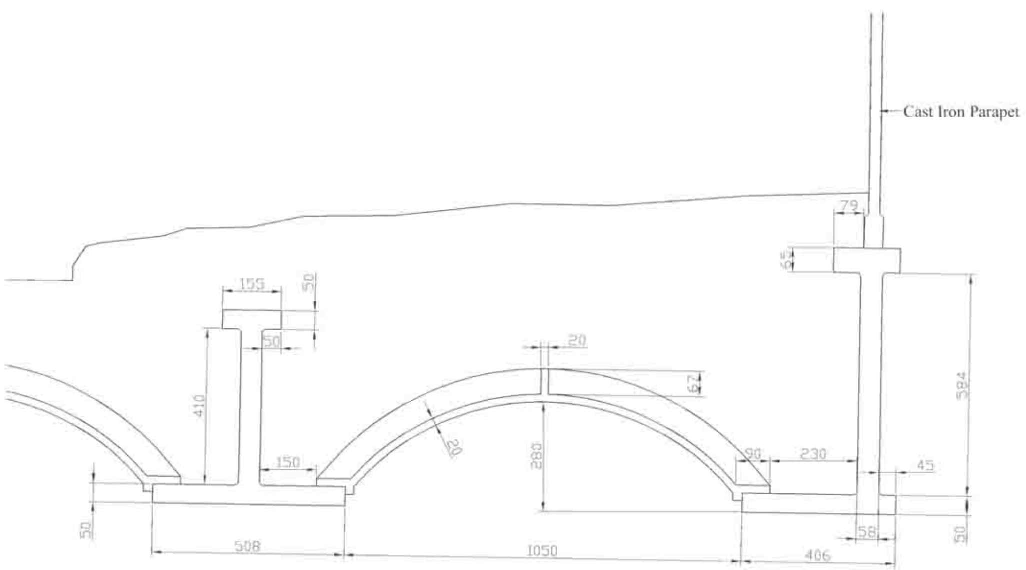
LOCATION PLAN
N.T.S



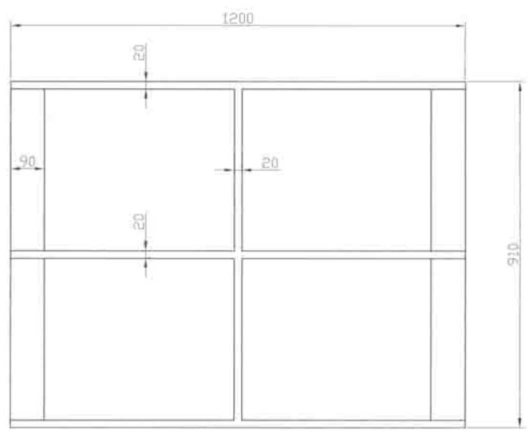
SECTION A-A
SCALE 1:20



ELEVATION OF INTERNAL CAST IRON BEAM
SCALE 1:20



SECTION THRO' CAST IRON DECK PLATES & CAST IRON BEAMS
SCALE 1:10



PLAN ON CAST IRON DECK ARCH PLATE
SCALE 1:10

Rev.	Date	Revisions	Check Date	Appv. Date

EAST AYRSHIRE COUNCIL
ROADS DIVISION

Head of Roads and Transportation :
James T. Kane BSc CEng FICE FIHT

Design Office :
Greenholm St., Kilmarnock, KA1 4DJ

Title :
ROUTE C127
LOW ASHYARD
DISUSED RAILWAY BRIDGE

GENERAL ARRANGEMENT

Scale :	As Shown	Date :	Aug 05
Prepared By :	A.Paxton	Checked By :	A.J.C
Traced By :	ACAD	Approved By :	

Drawing No :
C127/10/02

DRAWING STATUS	
Preliminary	Contract
Tender	Record

Rev.
File No :
C127/10

East Ayrshire COUNCIL

Drawing size : 841x594 (A1)

FILE DIRECTORY/NAME : I:design/struct/routes/c/class/c127/10

APPENDIX E

APPROVAL IN PRINCIPAL FORMS AND ASSESSMENT CERTIFICATION

Name of Project East Ayrshire Council – Bridge Assessment Programme

Name of Structure Low Ashyard Disused Rail Bridge

Structure Ref. No. **C127/010**
DAS 1/5

1. We certify that reasonable professional skill and care has been used in the preparation of the assessment and check of Low Ashyard Disused Rail Bridge with a view to securing that:

   i. It has been assessed and checked in accordance with:

      a. The Approval in Principle dated 3 October 2005 including the following:

      Not applicable

   ii. The assessed capa[redacted]

   Signed [redacted]

   Name [redacted]

   Engineering Qualifications C Eng. MICE

   Signed [redacted]

   Name [redacted]

   Date [redacted]

2. The certificate is accepte[redacted]

   Signed [redacted]

   Name [redacted]

   Engineering Qualifications [redacted]

   TAA [redacted]

   Date [redacted]

Name of Project	East Ayrshire Council – Bridge Assessment Programme
Name of Bridge or Structure	Low Ashyard Disused Rail Bridge
Structure Ref. No.	**C127/010** **DAS 1/5**

1. HIGHWAY DETAILS

1.1 Type of Highway – Single lane, single carriageway

1.2 Permitted traffic speed – 60 mph over bridge

1.3 Existing weight restrictions – none in place, visibility severely impaired and close to junction

2. **SITE DETAILS**

2.1 Obstacles crossed – Disused railway

3. PROPOSED STRUCTURE

3.1 Description of structure – Single span simply supported cast iron deck on brick and masonry abutments.

3.2 Structural type – 6 no. cast iron longitudinal beams with cast iron arched plates spanning between bottom flanges.

3.3 Foundation type - not known

3.4 Span arrangements – 8.3 metres on skew Single span, skew angle 12°

3.5 Articulation arrangements – simply supported cast iron beams resting on wooden sleepers

3.6 Road restraint system type – cast iron parapets on bridge, broken fence on approaches

3.7 Proposed arrangements for Inspection for Assessment
- 3.7.1 Traffic management – trial pits in verge, Chapter 8 signing
- 3.7.2 Access – underside accessed using cherry picker
- 3.7.3 Intrusive or further investigations proposed – 2 trial pits and two 6 mm diameter drilled holes to confirm metal thickness

3.8 Materials and Materials strengths assumed and basis of assumptions – From inspection it can be seen that the deck is constructed from cast iron. Material strengths have been assumed in compliance with BD21/01 Chapter 4.

3.9 Risks and hazards considered – Dealing with traffic & working at height

3.10 Year of Construction - unknown
3.11 Reason for assessment – to confirm load bearing capacity
3.12 Part of structure to be assessed – visual assessment of substructure, calculation of superstructure capacity

4 DESIGN CRITERIA

4.1 Live loading, Headroom

4..1 Loading relating to normal traffic under AW regulations and C&U regulations - HA loading and Appendix D BD21/01 Vehicle loading

4..2 Loading relating to General Order Traffic under STGO regulations – HB assessed if bridge can carry 40/44 tonnes

4..3 Footway or footbridge loading – not applicable

4..4 Loading relating to Special Order Traffic, provision for exceptional abnormal
4..4.1 indivisible loads including location of vehicle track on deck cross-section -none

4..5 Any special loading not covered above - none

4..6 Heavy or high load route requirements and arrangements being made to preserve the route, including any provision for future heavier loads or future widening - none

4.1.7 Minimum headroom provided – not applicable

4.1.8 Authorities consulted and any special conditions required – BRB (Residuary) Ltd. And utility providers.

4.2 List of relevant documents from the TAS :-
BD34/90 - Technical Requirements for the Assessment and Strengthening Programme for Highway Structures
BD21/01 - The Assessment of Highway Bridges and Structures
BA16/97 - The Assessment of Highway Bridges and Structures
BD37/01 - Loads for Highway Bridges
BA37/92 – Priority Ranking of Existing Parapets

4.2.1 Additional relevant Standards - none

4.3 Proposed departures from Standards given in 4.2 and 4.2.1 – none.

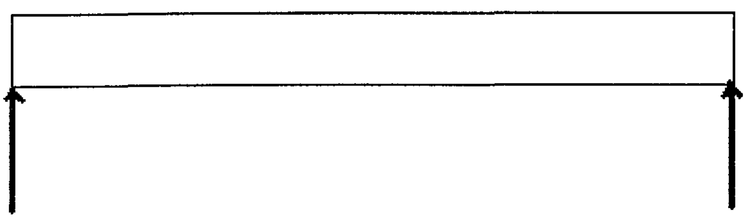
4.4 Proposed methods for dealing with aspects not covered by Standards in 4.2 and 4.2.1 – none

5 STRUCTURAL ANALYSIS

5.1 Methods of analysis proposed for superstructure, substructure and foundations – Simple distribution method

5.2 Description and diagram of idealised structure to be used for analysis -

The bridge is a series of simply supported beams connected by arched plates resting on the bottom flanges. The simple distribution method described in Chapter 2 of BD16/97 will be initially utilised to calculate the load on each beam. However because this structure has longitudinal members at centres of less than 2.5 metres and has low transverse distribution it will also be checked in accordance with BD21/01 Clause 5.2 using the vehicles in Annex D and E of BD21/01 as appropriate.



Simple Supports

5.3 Assumptions intended for calculation of structural element stiffness – material properties based on Chapter 4 of BD21/01

5.4 Proposed earth pressure coefficients (k_a, k_o or k_p) to be used in the assessment of earth retaining elements – Not applicable

6 GEOTECHNICAL CONDITIONS

6.1 Acceptance of recommendations of Section 8 of the Geotechnical Report to be used in the assessment and reasons for any proposed changes - not applicable
6.2 Geotechnical Report Highway Summary Information (Form C) - not applicable
6.3 Differential settlement to be allowed for in the assessment of the structure - not applicable
6.4 If the Geotechnical Report is not yet available, state when the results are expected and list the sources of information used to justify the preliminary choice of foundations - not applicable

7 CHECKING

7.1 Proposed Category - Category 1
7.2 If Category 3, name of proposed independent Checker - not applicable
7.3 Erection proposals or temporary works for which an independent check will be required, listing parts of the structure affected with reasons for recommending an independent check - not applicable

8 DRAWINGS AND DOCUMENTS

8.1 List of drawings (including numbers) and documents accompanying the submission -
Low Ashyard Disused Rail Bridge, General Arrangement – C127/10/02
8.2 List of construction and record drawings (including numbers) to be used in the assessment – none available
8.3 List of pile driving or other construction records – none available
8.4 List of previous inspection and assessment reports – none

9. THE ABOVE IS SU [redacted]

Signed [redacted]

Name [redacted]

Engineering Qualific [redacted]

Date [redacted]

10. THE ABOVE IS RE [redacted]
CONDITIONS SHO [redacted]

Signed [redacted]

Name [redacted]

Engineering Qualific [redacted]

TAA [redacted]

Date [redacted]

APPENDIX F

ASSESSMENT CALCULATIONS

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	1
		DATE	2/11/05
SECTION INDEX		CALC BY	[illegible]
		CHECK BY	
			Ref.

East Ayrshire Council Roads & Transportation Division

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	C127/10 Low Ashyard Bridge - Disused Rail Assessment	OFFICE	
		SHEET NO.	2
		DATE	27/10/05
SECTION	General Description	CALC BY	ASC
		CHECK BY	
			Ref.

Low Ashyard bridge is a disused rail bridge constructed from 6No. longitudinal cast iron girders with arched cast iron deck plates spaning transversely between bottom main beam flanges. There are 2 cast iron edge beams with cast iron parapets bolted onto them & 4 cast iron internal beams all spanning between brick & masonry abutments. The beam seating is formed from wooden railway sleepers and some settlement in a couple of the beams is visible due to deterioration / crushing of the beams. The deck carries a single lane of 3.7m and has 2No. 2.1 metre wide grass verges.

The bridge also carries a 200 mm diameter water main in the East verge.

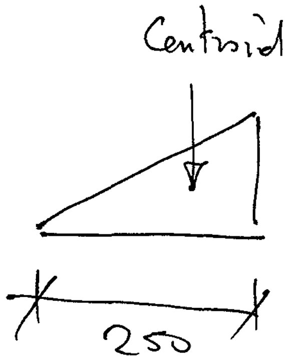
Clear Span - 8.3m.

Skew Angle - 12.12°

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 Low Ashyard Disused Rail Bridge Assessment		OFFICE	
		SHEET NO.	3
		DATE	27/10/05
SECTION Internal Beams		CALC BY	DSC
		CHECK BY	
			Ref.

Effective span - because the beams are bearing onto a soft material (wooden sleepers) allow a distance from face of abutment to the rear of of the bearing area of the depth of the beam (beam depth is 250mm at beam ends). Therefore:- BD21/01 Cl. 6.5

Drg. C127/10/02



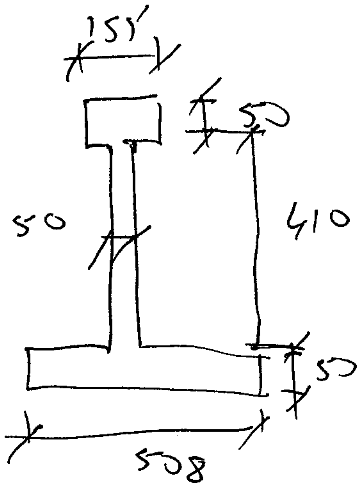
Dist to centroid is 250mm/3 = 83.33mm

Effective span = (2 x 83.33mm) + 8300mm
= 8467mm

ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME C127/10 Low Ashyard Disused Rail Bridge Assessment	OFFICE	
	SHEET NO.	4
	DATE	27/10/05
SECTION Internal Beams	CALC BY	GSC
	CHECK BY	
		Ref.

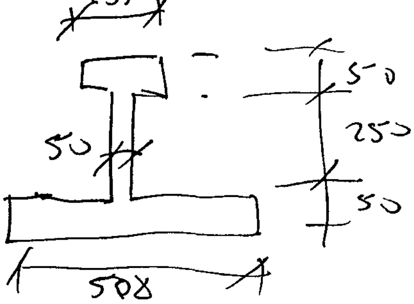
Beam Cross section at ℄ :-

Drg. C127/10/02



Area = 53,650 mm^2

Beam cross section at Ends :-



Area = 45,650 mm^2

The difference between the two areas is only about 17%
Therefore to simplify the calculations for beam dead loads
an averaged area of 49650 mm^2 will be utilised.

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.
SCHEME C127/10 Low Ashyard Disused Rail Bridge Assessment	OFFICE	
	SHEET NO.	5
	DATE	27/10/05
SECTION Internal Beams	CALC BY	GK
	CHECK BY	
		Ref.

Beam weight = 7200kg/m³ × ~~XXX~~ 49,650mm² (BD21/01 table 4.1)

= 3.5kN/m

Buckle plate load :-

Measurements from the drawing indicate that the arch plate has a radius of 690mm at its centre & covers an angle of 100 degrees. Therefore its curved length is:-

$\frac{100°}{360°} \times \pi \times 2(690mm) = 1204mm$

Total length of buckle plate (including support legs) =

1204mm + 2(90mm) = 1384mm

Buckle plate length = 910mm

wt/m = 1384mm × 20mm × 7200 kg/m³ / 910mm

= 219 kg/m

Add the weight of the ribs (20mm × 67mm)

Total rib length = 3 × 1204mm + 910mm = 4.522m

wt/m = 0.02m × 0.067m × 4.522m × 7200kg/m / 0.91m

= 48 kg/m

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 Low Ashyard Disused Rail Bridge Assessment		OFFICE	
		SHEET NO.	6
		DATE	28/10/05
SECTION Internal Beams		CALC BY	GC
		CHECK BY	
			Ref.

Total weight of arch plates/m = 219 kg/m + 48 kg/m
= 267 kg/m
≈ 2.6 kN/m

Wt. of surfacing :-

Assume surfacing depth = 100 mm @ 23 kN/m³ (BD21/01 table 6.1 & table 3.1)
= 2.3 kN/m²

Beam spacing = 1050 mm + 508 mm = 1558 mm

Surfacing load/m = 1.558 m × 2.3 kN/m² = 3.58 kN/m

Load from fill (C/W) :-

Depth at crown of arch plate = 99.819 m − 99.199 m − 0.28 m − 0.02 m
= 0.32 m

Deduct 100 mm surfacing & depth = 0.22 m at crown.

Depth at flange = 620 mm − 100 mm − 50 mm = 470 mm

Average = 395 mm

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 Low Ashyard Disused Rail Bridge Assessment		OFFICE	
		SHEET NO.	7
		DATE	~~GSC~~ 28/10/05
SECTION Internal Beams		CALC BY	GSC
		CHECK BY	
			Ref.

Average fill area (approx.) :–

fill area = (395mm × 1050mm) + (470mm × (508mm - 50mm))

= $0.63\,m^2$

Assume a fill density of $1900\,kg/m^3$

load/m = $0.63\,m^2 \times 1900\,kg/m^3$

= 11.74 kN/m

Dead load Moment

$\gamma f_3 = 1.0$ for cast iron — BD21/01

$\gamma f_1 = 1.0$ for cast iron for all dead loads — cl 3.10

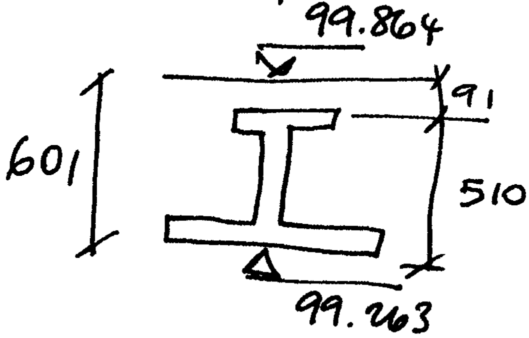
except surfacing where $\gamma f_1 = 1.5$ — table 3.1

$$DL\ mom = \frac{(3.5\,kN/m + 2.6\,kN/m + (1.5 \times 2.3\,kN/m) + 11.74\,kN/m) \times (8.467\,m)^2}{8}$$

= 190.78 kNm

<u>BD21/01 7.13</u>

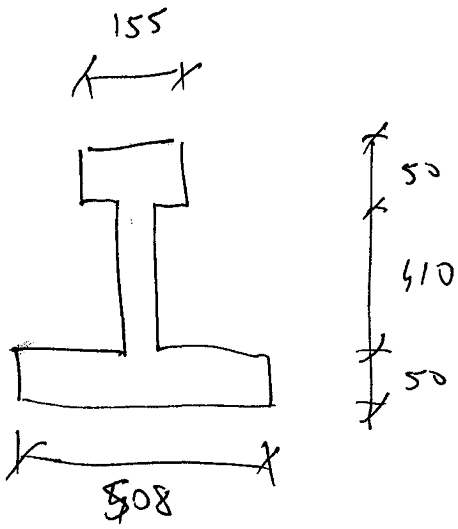
@ midspan



$$D/d = \frac{601-75}{510} = \underline{\underline{1.031}}$$

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
		SHEET NO.	8
		DATE	28/10/05
SECTION	Internal Beams	CALC BY	GSC
		CHECK BY	
			Ref.

Beam Properties



Depth to NA from soffit 2 –

$$y = (508\,mm \times 50\,mm \times 25\,mm) + (50\,mm \times 410\,mm \times 255\,mm) + (155\,mm \times 50\,mm \times 485\,mm) / 53650\,mm^2$$

$$= 179.3\,mm$$

Beam area at centre span = $53{,}650\,mm^2$

$$I_{xx} = \left(\frac{508\,mm \times (50\,mm)^3}{12}\right) + \left((154.3\,mm)^2 \times (50\,mm \times 508\,mm)\right) + \left(\frac{50\,mm \times (410\,mm)^3}{12}\right) +$$
$$\left((75.7\,mm)^2 \times (50\,mm \times 410\,mm)\right) + \left(\frac{155\,mm \times (50\,mm)^3}{12}\right) + \left((305.7\,mm)^2 \times (155\,mm \times 50\,mm)\right)$$

$$= \underline{\underline{1.74\,E9\ mm^4}}$$

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
		SHEET NO.	9
		DATE	28/10/05
SECTION	Internal Beams	CALC BY	GS
		CHECK BY	
			Ref.

Dead Load Stresses

Calculate maximum tension in beam soffit :-

$M = \frac{fI}{y}$ $f = \frac{My}{I}$

$DL_{mom} = 190.78 kNm$ — Page 7

$y = 179.3 mm$ — Page 8

$I_{xx} = 1.74\,E9\,mm^4$ — "

$f_{yt} = \frac{190.78 kNm \times 179.3 mm}{1.74 E9 mm^4}$

$= 19.66\ N/mm^2$

Max. compression in top flange :-

$f_{yc} = \frac{190.78 kNm \times 330.7 mm}{1.74 E9 mm^4}$

$= 36.26\ N/mm^2$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	10
		DATE	28/10/05
SECTION Internal Beams		CALC BY	GJR
		CHECK BY	
			Ref.

Live Load Moment

Loaded length = 8.467m — Page 3

$HA_{UDL} = W = 336 \left(\frac{1}{8.467m} \right)^{0.67}$ — BD21/01 Cl 5.18

$HA_{UDL} = 80.3\ kN/m$ per lane

$HA_{KEL} = 120kN$

Adjustment factor for UDL & KEL (AF) — 5.23

$AF = A_L / 2.5$ where $A_L = 3.65$

$= 1.46$

Therefore $HA_{UDL} / AF = \frac{1}{1.46} \times 80.3\ kN/m$ per lane

$= 55\ kN/m$ per lane

$HA_{KEL} / AF = \frac{1}{1.46} \times 120\ kN$ per lane

$= 82.2\ kN$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	11
		DATE	28/10/05
SECTION Internal Beams		CALC BY	GSC
		CHECK BY	
			Ref.

$$\text{L.L. moment/lane} = \frac{55\,kN/m \times (8.467m)^2}{8} + \frac{82.2kN \times 8.467m}{4}$$

$$= 666.9\,kNm/lane$$

BA16/97 allows for a simple moment distribution as described in chapter 2.

The load attributable to each beam for a lane of HA loading can be derived by multiplying the HA moment effects for a full lane by the proportion factor K_L derived from figure 2/2 of BA16/97. From the graph overleaf K_L is taken as 0.318

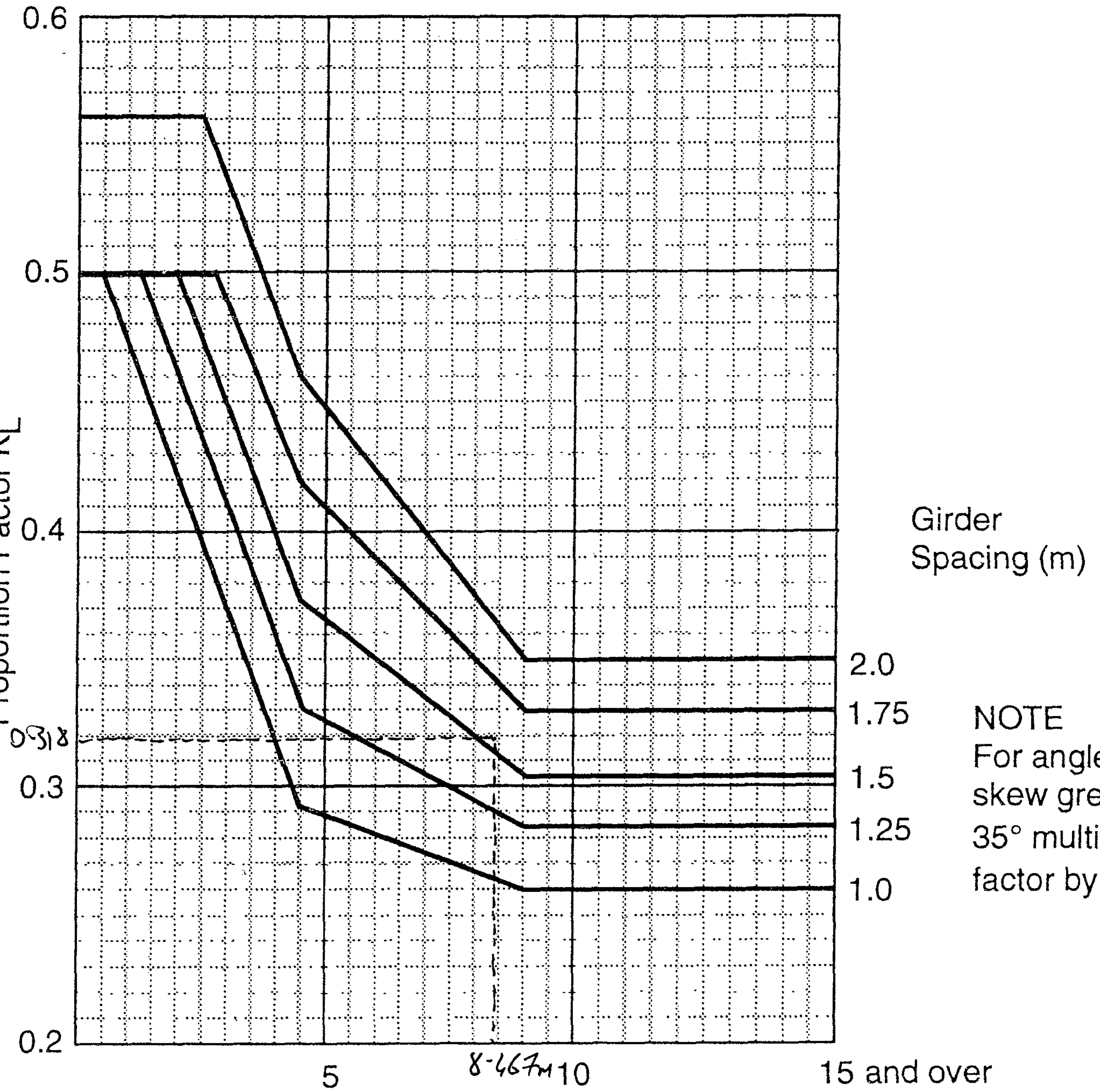
$$\text{L.L. Moment on beam} = 0.318 \times 666.9\,kNm$$

$$= 212.1\,kNm$$

This moment can be further reduced by the K factor derived in accordance with Cl.5.20 to 5.22 of BD21/01

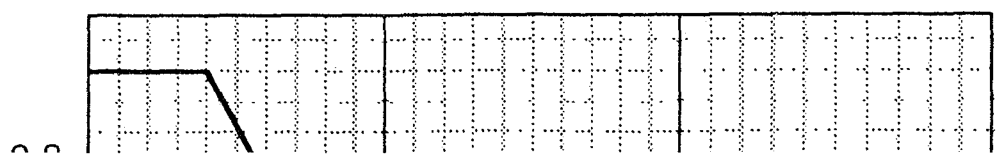
Page 12
28/10/05
ase

INTERNAL LONGITUDINAL GIRDER FIG 2/2



(a) Single Lane Loading

NOTE
For angles of skew greater than 35° multiply factor by 1.15



ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	13
	DATE	28/10/05
SECTION INTERNAL BEAMS	CALC BY	GSC
	CHECK BY	
		Ref.

Live load Moment (cont.)

K factor.

The road has a low traffic flow and is a poor quality surface. Therefore the K factor can be derived from fig 5.4 BD21/01 and has a value of K = 0.88

LL moment = 0.88 × 212.1 kNM

= 186.7 kNM

$$f_{yt} = \frac{186.7\,kNM \times 179.3\,mm}{1.74E9\,mm^4} = 19.24\,N/mm^2$$

$$f_{yc} = \frac{186.7\,kNM \times 330.7\,mm}{1.74E9\,mm^4} = 35.48\,N/mm^2$$

NOTE: The increase in beam live load capacity due to the composite effect of backfill & as described in Clauses 7.13 to 7.14 of BD21/01 is not applicable because the overall depth of the deck (including fill) is not sufficient to produce any gain in strength.

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	14
		DATE	28/10/01
SECTION INTERNAL BEAMS		CALC BY	QSE
		CHECK BY	
			Ref.

Allowable tensile strength :-

BD21/01 4.10 Page 9

$f_L = 24.6 - 0.44 f_d$ N/mm²

$= 24.6 - 0.44(19.66\,N/mm^2)$

$= 15.95\,N/mm^2 < 19.24\,N/mm^2$

Allowable compressive strength :- (from fig 4.1)

$f_L \doteq 120\,N/mm^2 \gg 35.38\,N/mm^2$

However because the tensile strength is exceeded recalculate allowable K value & derive a suitable weight restriction :-

K applied $= 0.88$ & $f_{yt} = 19.24\,N/mm^2$

full $f_{yt} = \dfrac{19.24\,N/mm^2}{0.88} = 21.86\,N/mm^2$

K allowable $= \dfrac{15.95\,N/mm^2}{21.86\,N/mm^2} = 0.7296 \doteq 0.73$

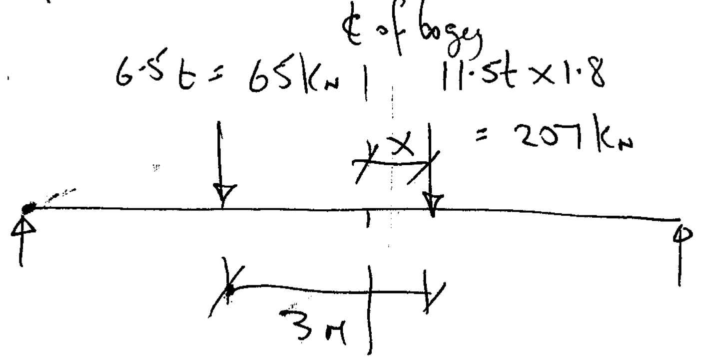
From fig 5.4 wt restriction = **18 tonnes**

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	15
		DATE	28/10/05
SECTION Internal Beam		CALC BY	GJC
		CHECK BY	
			Ref.

Because the deck has longitudinal members at ≤ 2.5m spacings and has low transverse distribution a check using vehicles in App D & E should be carried out. — BD21/01 Cl 5.2

By inspection it can be seen that the 18 tonne vehicle of 2 axles of 6.5t & 11.5t at a spacing of 3m will be the worst load case.

In addition an impact factor of 1.8 should be applied to the critical axle. Therefore where $\gamma f_3 = 1.0$ & $\gamma f_L = 1.0$ the loads are :- — App D; table 3.1 & cl 3.10



load per wheel = 32.5kN & 103.5kN

Centroid of bogey = $x \times 103.5 = y \times 32.5$

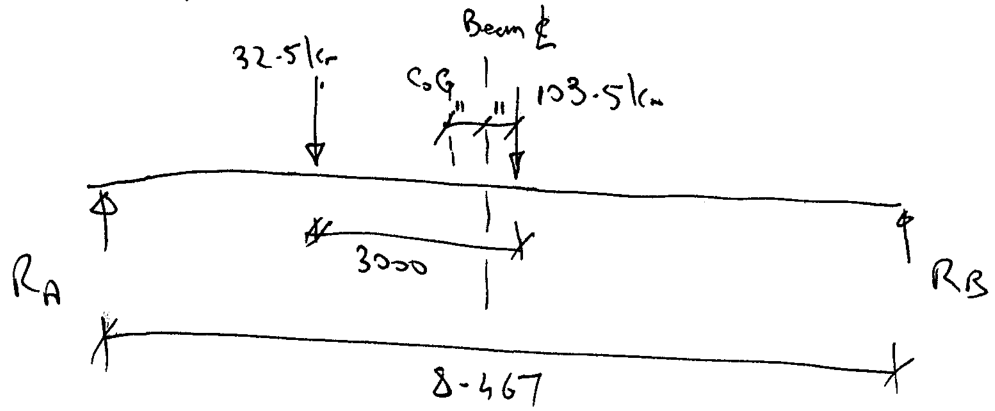
$x + y = 3 \quad \therefore \quad y = 3 - x$

$103.5x = 97.5 - 32.5x$

$x = 97.5/136 = 0.717\text{m}$

ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	16
	DATE	28/10/05
SECTION Internal Beam	CALC BY	GSC
	CHECK BY	
		Ref.

Maximum Moment will occur when :-



" = $717^{mm}/2$ = 358.5mm

lead wheel at :- $8467/2 + 358.5mm = 4592mm$

rear wheel at :- 1592mm

Max Moment below lead wheel :-

Max Mom. = $(8.467m - 4.592m) \times R_B$

$8.467m R_B = (1.592m \times 32.5kN) + (4.592m \times 103.5kN)$

$R_B = 62.24kN$

Max Mom = $3.875m \times 62.24kN$

= $241.2 kNm$

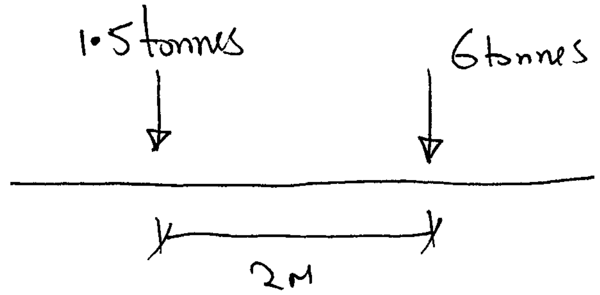
$f_{LG} = \frac{241.2kNm \times 177.3mm}{1.74E9mm^4} = 24.85 N/mm^2$ > allowable

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	17
		DATE	31/10/05
SECTION INTERNAL BEAM		CALC BY	QSC
		CHECK BY	
			Ref.

18 tonne vehicle load is too high. Therefore try 7.5 tonnes.

loads are :-

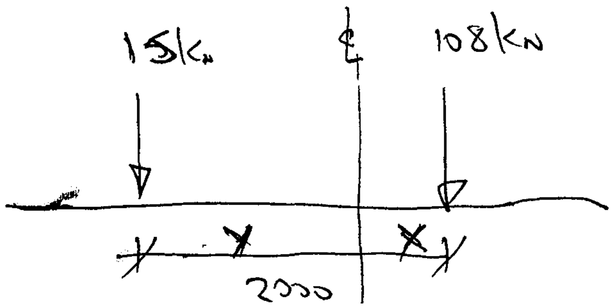
BD21/01 App D



load factor $\gamma_{fl} = 1.0$, $\gamma_{f3} = 1.0$

Impact factor for critical axle = 1.8

Therefore axle loads are :-



C.o.g. :-

$y \times 15kN = x \times 108kN$ where $x + y = 2000mm$

$\therefore x = 2000mm - y$

$15y = 216{,}000 - 108y$

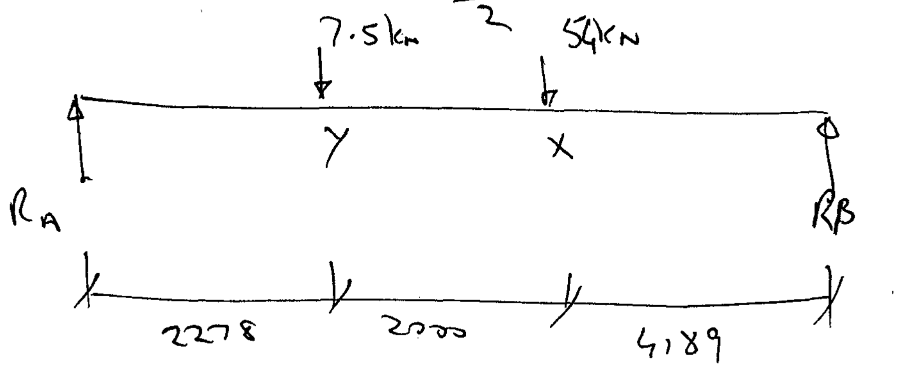
$113y = 216000$

$y = 1912 \text{ mm}$

ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	18
	DATE	31/10/05
SECTION INTERNAL BEAM	CALC BY	GSC
	CHECK BY	
		Ref.

Assume that 108kN/2 load applies at ½ span

+ ½(2000 − 1912) = $\frac{8.467\text{m}}{2}$ + 0.044m = 4.278m



$8.467 \times R_B = (2.278 \times 7.5\text{kN}) + (4.278 \times 54\text{kN})$

$R_B = \frac{248.11\text{kNM}}{8.467\text{M}}$

$R_B = 29.3\text{kN}$

M_x (Max moment on beam) :-

$M_x = 29.3\text{kN} \times 4.189\text{M}$

$= 122.74\text{kNM}$

$f_{Lt} = \frac{122.74\text{kNM} \times 179.3\text{mm}}{174E9\text{mm}^4} = 12.65\text{N/mm}^2 < 15.95\text{N/mm}^2$

∴ OK for 7.5tonnes in tension

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	19
		DATE	31/10/05
SECTION INTERNAL BEAM		CALC BY	GSC
		CHECK BY	
			Ref.

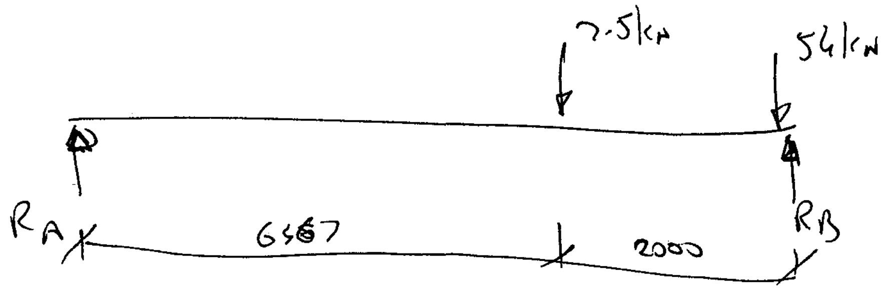
$$f_{Lc} = \frac{122.74\,kNm \times 330.7\,mm}{1.74\,E9\,mm^4}$$

$= 23.33\,N/mm^2 << 120\,N/mm^2$ allowable in compression.

Therefore the beams are ~~A~~ Okay for bending in both tension & compression.

Check shear load :-

Max 7.5 tonnes shear load will occur when max axle load is at support :-



$8.467\,R_B = (6.467 \times 7.5\,kN) + (8.467 \times 54\,kN)$

$R_B = 59.73\,kN$ - Live load shear.

Dead load Shear :- Page 7

$$R_A = R_B = \frac{8.467\,m\,(3.5\,kN/m + 2.6\,kN/m + (1.5 \times 2.3\,kN/m) + 11.74\,kN/m)}{2}$$

$= 90.13\,kN$

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	20
	DATE	1/11/05
SECTION INTERNAL BEAM	CALC BY	GSC
	CHECK BY	
		Ref.

DL shear stress :-

Shear is resisted by the beam ~~Q~~ web. Web area is

50mm x 350mm = 17,500mm²

DL shear stress = 90.13kN / 17,500mm² = 5.15 N/mm²

LL shear stress = 59.73kN / 17,500mm² = 3.413N/mm²

Allowable LL shear = 24.6 N/mm² − 0.449d N/mm²

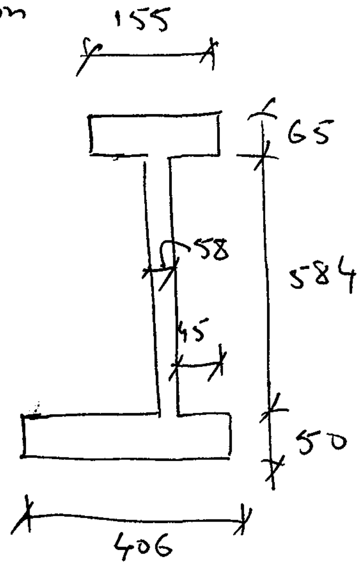
= 24.6 N/mm² − 0.44(5.15 N/mm²)

= 22.334 N/mm² >> 2.34 N/mm² ∴ Okay

for 7.5 tonnes in shear

ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	31
	DATE	1/11/05
SECTION	CALC BY	GSC
EDGE BEAM	CHECK BY	
		Ref.

Beam cross section



$$\text{Area} = 64{,}247\ mm^2$$

$$\text{Beam Wt} = 7200\ kg/m^3 \times 64{,}247\ mm^2 = 4.626\ kN/m$$

$$\text{Depth to NA from soffit} = \bar{y} = \frac{(406 \times 50 \times 25) + (58 \times 584 \times 342) + (155 \times 65 \times 666.5)}{64{,}247}$$

$$= 292.7\ mm$$

$$I_{xx} = \left(\frac{406 \times (50)^3}{12}\right) + \left((50 \times 406) \times (267.7)^2\right) + \left(\frac{58 \times (584)^3}{12}\right)$$

$$+ \left(58 \times 584 \times (49.3)^2\right) + \left(\frac{155 \times 65^3}{12}\right) + \left(65 \times 155 \times (373.8)^2\right)$$

$$= 3.835\ E9\ mm^4$$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	22
		DATE	1/11/05
SECTION		CALC BY	GSC
EDGE BEAM		CHECK BY	
			Ref.

DEAD LOADS

Beam self wt = 4.626 kN/m — Page 21

Parapet = 1.4m × 40mm × 7200 kg/m³

= 4.03 kN/m

½ Arch plate = 2.6 kN/m / 2 = 1.3 kN/m — Page 6

Fill = (600mm average depth × 1.05m/2 × 1900 kg/m³)

+ (720mm × 0.3m × 1900 kg/m²)

= 10.09 kN/m

Allow 50% extra for top 100mm (ie surfacing) — BD21/01 table 3.1

= + 0.5(100mm × (1.05m/2 + 0.3)) × 1900 kg/m³)

= + 0.78

Total surfacing = 10.87 kN/m

$$DL\ M_{bm} = \frac{(4.626kN/m + 4.03kN/m + 1.3kN/m + 10.87kN/m) \times (8.467m)^2}{8}$$

= **186.63 kNm**

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	23
		DATE	1/11/05
SECTION EDGE BEAM		CALC BY	GSC
		CHECK BY	
			Ref.

Live Loads :—

The live load for a 7.5 tonne accidental vehicle selected from App D of BD21/01 is the same load as that applied to the internal beams. Therefore the max deadload moment is 122.74 kNM — Page 18

TENSION STRESSES:—

$$f_{DE} = \frac{186.63\,kNM \times 292.7\,mm}{3.835\,E9\,mm^4}$$

$$= 14.24\ N/mm^2$$

$$f_{LE} = \frac{122.74\,kNM \times 292.7\,mm}{3.835\,E9\,mm^4}$$

$$= 9.36\ N/mm^2$$

$$f_{LE}\ \text{allowable} = 24.6 - 0.44 f_{DE} = 24.6\,N/mm^2 - 0.44(14.24\,N/mm^2)$$

$$= 18.33\ N/mm^2 \quad \therefore \text{OK in tension}$$

for 7.5 tonnes

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	24
		DATE	1/11/05
SECTION EDGE BEAM		CALC BY	[illegible]
		CHECK BY	
			Ref.

COMPRESSION STRESSES:—

$$f_{Dc} = \frac{186.63\text{kNm} \times 406.3\text{mm}}{3.835E9\text{mm}^2}$$

$= 19.8\ \text{N/mm}^2$

$$f_{Lc} = \frac{122.74\text{kNm} \times 406.3\text{mm}}{3.835E9\text{mm}^2}$$

$= 13.0\ \text{N/mm}^2$

f_{Lc} allowable ≑ $135\ \text{N/mm}^2$ ∴ Okay — BD21/01 Fig 4.1

Shear Stress:-

$$\text{DL shear} = \frac{8.467\text{m} \times (4.626\text{kN/m} + 4.03\text{kN/m} + 1.3\text{kN/m} + 10.87\text{kN/m})}{2}$$

$= 88.17\text{kN}$

LL shear $= 59.73\text{kN}$ — Page 19

web area $= (65+584+50)\times 58 = 40{,}542\ \text{mm}^2$

DL shear $= 88.17\text{kN}/40{,}542\text{mm}^2 = 2.17\ \text{N/mm}^2$

LL shear (7.5t) $= 59.73\text{kN}/40{,}542\text{mm}^2 = 1.47\ \text{N/mm}^2$

LL allowable $= 24.6 - 0.44\,(2.17\ \text{N/mm}^2) = 23.65\ \text{N/mm}^2$ ∴ Okay for 7.5 tonnes.

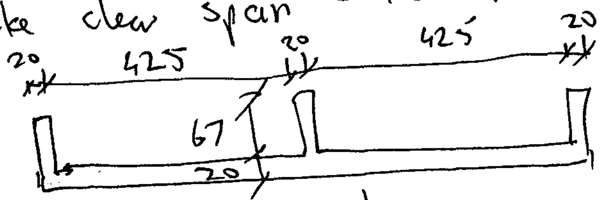
ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	25
	DATE	1/11/05
SECTION Metal Hogging Plate Capacity	CALC BY	GSC
	CHECK BY	
		Ref.

The metal (Cast Iron) hogging plates are supported from the bottom flanges of the CI longitudinal beams.

Network Rail Current Information Sheet No. 22 - 'Assessment of Jack Arches, Metal Arch Plates & Associated Ties in metal beam bridge decks' states that for a metal plate with no ties provided should be assessed as a plate in simple bending.

Plate dimensions :-

Plate clear span = 1050 mm



X-sect.

Assume that the plates will act as whole units under bending. That is a wheel will act (by distribution) of load over its full 910mm width.

X Sect. Plate area = (3 x 67 x 20) + 20 x 910 = 22,220 mm²

from bottom flange Y = $\frac{(20 \times 910 \times 10) + 3(20 \times 67 \times 53.5)}{22,220\ mm^2}$

= 17.87 mm

ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	26
	DATE	1/11/05
SECTION Cast Iron Hogging Plate	CALC BY	GSC
	CHECK BY	
		Ref.

$$I_{xx} = \left(\frac{20^3 \times 910}{12}\right) + \left(20 \times 910 \times (7.87)^2\right)$$

$$+ 3\left[\left(\frac{20 \times 67^3}{12}\right) + \left(20 \times 67 \times (35.63)^2\right)\right]$$

$$I_{xx} = 8.341\ E6\ mm^4$$

D.L. Moment. :-

CI plate :-

$$M = \frac{22,220\ mm^2 \times 7200\ kg/m^3 \times (1.05\ m)^2}{8}$$

$$= 0.22\ kNM$$

Fill :- (on verge)

$$M = \frac{0.6\ m \times 19\ kN/m^3 \times (1.05\ m)^2}{8}$$

$$= 1.57\ kNM$$

Live Load

Wheel load for 7.5 tonnes = 54 kN (including impact factor)

$$M = \frac{54\ kN \times 1.05\ m}{4} = 14.175\ kNM$$

ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	27
	DATE	2/11/05
SECTION Cast Iron Hogging Plate	CALC BY	gsc
	CHECK BY	
		Ref.

TENSION LOADS

DL Stress $f_{Dt} = \frac{1.57\,kNm \times 17.87\,mm}{8.341\,E6\,mm^4}$

$= 3.36\,N/mm^2$

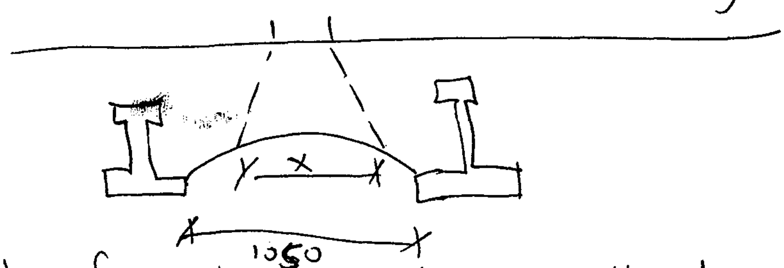
Allowable Liveload Stress $= 24.6 - 0.44(3.36\,N/mm^2)$ BD21/01 4.10

$= 23.12\,N/mm^2$

LL Stress $f_{Lt} = \frac{14.175\,kNm \times 17.87\,mm}{8.341\,E6\,mm^4}$

$= 30.37\,N/mm^2 >$ allowable

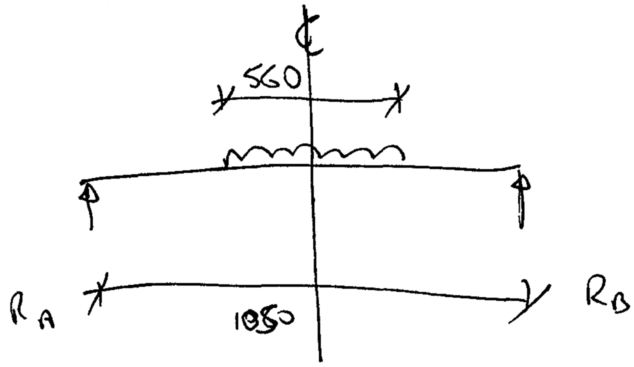
Therefore consider the wheel load as a patchload distributed through the fill & recalculate the applied live load moment. Consider wheel on carriageway - this is worst case.



By scaling from the drawing the UDL will act over a length x of 560 mm with its centre coinciding with the ℄ of the arch plate for maximum load effect.

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	28
	DATE	2/11/05
SECTION Cast Iron Hogging Plate	CALC BY	GSC
	CHECK BY	
		Ref.

Liveload moment:-



$$UDL = \frac{54\,kN}{560mm \times 910mm} = 105\,kN/m^2$$

$R_A = R_B = 27\,kN$

$$M_{℄} = \frac{1.05m}{2} \times 27\,kN - \left(\frac{0.28m^2}{2} \times 106\,kN/m^2 \times 0.91m\right)$$

$= 10.393\,kNm$

L.L. Stress $$f_{LL} = \frac{10.393\,kNm \times 17.87mm}{8.341\,mm^4\,E6}$$

$= 22.27\,N/mm^2 < 23.12\,N/mm^2$ ∴ Okay for 7.5 tonnes — Page 27

check Compression loading:-

DL Stress $$f_{DL} = \frac{1.57\,kNm \times 69.13\,mm}{8.341\,E6\,mm^4}$$

$= 13\,N/mm^2$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	29
		DATE	2/11/05
SECTION CAST IRON HOGGING PLATE		CALC BY	GSC
		CHECK BY	
			Ref.

Allowable compression for live load:- BD21/01

from fig 4.1 allowable stress ÷ 125 N/mm² 4.10 fig 4.1

Actual compression due to live load:-

$$f_{LC} = \frac{10.393\,kNm \times 69.13\,mm}{8.341\,E6\,mm^4}$$

$$= 86.13\,N/mm^2 < 125\,N/mm^2 \therefore \text{Okay}$$

Check shear force

Considering point loads in the first instance for the live load the maximum load in the plate from the wheel load is 54kN

The dead load shear is 0.94 kN

$$DL\ shear = \frac{0.94\,kN}{22,220\,mm^2} = 0.042\,N/mm^2$$

$$L.L.\ shear = \frac{54\,kN}{22,220\,mm^2} = 2.43\,N/mm^2$$

Max. allowable live load shear :- BD21/01 4.11

$$q_{L\ allowable} = 24.6 - 0.44(0.042\,N/mm^2)$$

$$= 24.58\,N/mm^2 \gg 2.43\,N/mm^2 \therefore \text{Okay}$$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT		OFFICE	
		SHEET NO.	39
		DATE	2/11/05
SECTION PARAPET PRIORITY RANKING		CALC BY	GSC
		CHECK BY	
			Ref.

Priority ranking of existing parapets :- — BA37/92

		Ranking
Containment ranking :-	Remnant strength 0-33%	5

Overall risk ranking

		Risk Ranking
Hazard Groups	- low traffic/non sensitive environment	1
Type of highway	- Single carriageway	1
Road & Structure layout	- Very poor vertical layout & close to junction	4
Containment features	- Parapet not part of structural member	0
	Total	6

App.A

The Priority Ranking is obtained by multiplying the Containment ranking by the Overall Risk Ranking. — 6.1

Priority Ranking = 5 × 6

= 30

ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME C127/10 LOW ASHYARD DISUSED RAIL BRIDGE ASSESSMENT	OFFICE	
	SHEET NO.	31
	DATE	2/11/05
SECTION SUMMARY OF ASSESSMENT	CALC BY	GSC
	CHECK BY	
		Ref.

ASSESSMENT CAPACITY

	BENDING	SHEAR	Ref.
MAIN LONGITUDINAL BEAMS	7.5 T	+ 7.5 tonnes	Pages 18, 19 & 20
PARAPET BEAMS	7.5 T	+ 7.5 tonnes	Pages 23 & 24
CAST IRON HOGGING PLATES	7.5 T	+ 7.5 tonnes	Pages 28 & 29

Parapet Priority Ranking = 30

CONCLUSION

As an interim measure (that is; prior to strengthening or removal of the bridge) a weight restriction of 7.5 tonnes should be imposed.

APPENDIX G

ASSESSMENT CHECK CALCULATIONS

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	1
		DATE	DEC 2005
SECTION	CONTENTS	CALC BY	DJM
		CHECK BY	
			Ref.

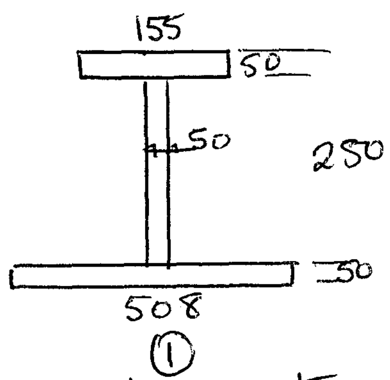
CONTENTS

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	–
		SHEET NO.	2
		DATE	DEC 2005
SECTION	BASICS	CALC BY	DJM
		CHECK BY	
			Ref.

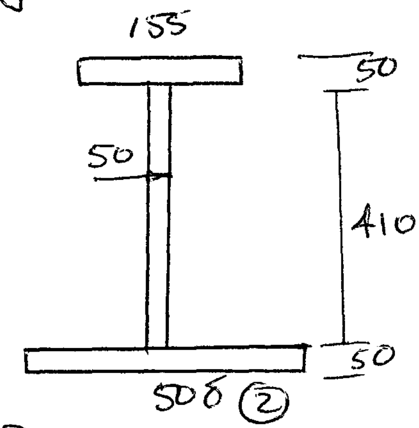
Layout 2 Edge Beams
4 Internal Beams

Clear Span 8·3 metres
Skew 12·12°
Bearings – Timber

Internal Beams have varying depth.



Beam end cross section



Beam midspan cross section

area section ① = 45,650 mm^2

area section ② = 53,650 mm^2

Average area of cross section = 49,650 mm^2

Bearing length 250mm.

Clear span 8·3m

Effective span $8.3 + 2(0.25 \times 1/3) = 8.47m$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	3
		DATE	DEC05
SECTION	LOADINGS - INTERNAL BEAMS	CALC BY	DJM
		CHECK BY	
			Ref.

Dead Loads

Beams Internal beam area = 49,650 mm^2

Unit weight cast iron = 7,200 kg/m^3 (Ref: BD21/1 Table 4.1)

Weight of beam per metre = 7,200 kg/m^3 × 49,650 × 10^{-6}

= 357.48 kg/m

Weight of beam = 3.51 kN/m length

Arch plates

Radius 690 mm

Angle of chord 100°

length of arch $\pi d \times \frac{100}{360}$

$= \frac{\pi \times 690 \times 2 \times 100}{360}$

l_1 = 1204 mm

length including lugs = 1204 + 90 × 2

l_2 = 1384 mm

Width 910 mm, thickness 20 mm

Weight per metre = 7,200 kg/m^3 × 1384 × 20 × $\frac{1000}{910}$ × 10^{-6}

= 219 kg/m

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	4
		DATE	DEC05
SECTION	LOADINGS - Internal Beams	CALC BY	DJM
		CHECK BY	
			Ref.

Dead loads

Transverse ribs (3 No) = 3 × 1.204 = 3.6 m

longitudinal ribs (1 No) = 1 × 0.91 = 0.9 m

4.5 m

Rib thickness 20 mm

Rib height 67 mm

Weight of ribs (per metre span length) = 7,200 kg/m³ × 4.5 × 0.020 × 0.067

= 44 kg / metre

Total weight of buckle plates per metre

= 219 + 44

= 263 kg/m

= 2.58 kN/m

Superimposed Dead loads

Surfacing Nominal depth 100 mm

Density 2400 kg/m³

Load per m² = 2400 × 9.81/1000 × 0.1

= 2.35 kN/m²

Beam spacing = 1.558

Surfacing load per beam = 1.558 × 2.35

= 3.6 kN/m length of beam

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	5
		DATE	DEC 05
SECTION	LOADINGS - INTERNAL BEAMS	CALC BY	DJM
		CHECK BY	
			Ref.

Fillon beams

Depth of fill to top of flange (bottom) = 620 - 50 = 570mm

Depth of fill to crown of arch = 320mm

Average depth of fill = 345mm

Area of fill = 0·345 × 1·050 + 0·48 × 0·458

= $0 \cdot 6 m^2$

Density of backfill = $1950 kg/m^2$

Load per beam per metre = $0 \cdot 6 \times 1950 \times \frac{9 \cdot 81}{1000}$

= 11.5kN/metre

ROADS AND TRANSPORTATION CALCULATION SHEET	JOB NO.	
SCHEME LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
	SHEET NO.	6
	DATE	DEC05
SECTION INTERNAL BEAM - Design	CALC BY	DJM
	CHECK BY	
		Ref.

Dead Load Moments γ Factors

Cast Iron $\gamma_{fe} = 1$

Surfacing $\gamma_{fl} = 1.5$

Fill $\gamma_{fl} = 1.0$

Moments

Self Weight $= \gamma_{fl} \frac{WL^2}{8} = \frac{1 \times (3.51 + 2.58) \times 8.47^2}{8}$

$= 54.6 \text{ kNm}$

Surfacing $= \gamma_{fl} \frac{WL^2}{8} = \frac{1.5 \times 3.6 \times 8.47^2}{8}$

$= 48.4 \text{ kNm}$

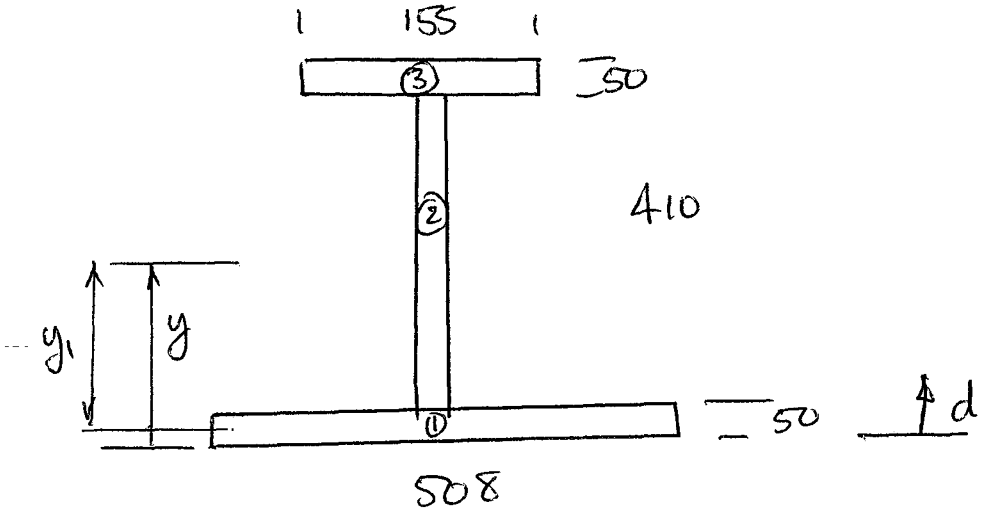
Fill $= \gamma_{fl} \frac{WL^2}{8} = \frac{1 \times 11.5 \times 8.47^2}{8}$

$= 103 \text{ kNm}$

Total Dead Load Moments $= 206 \text{ kNm}$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	7
		DATE	DEC 05
SECTION	INTERNAL BEAM – DESIGN	CALC BY	DJM
		CHECK BY	
			Ref.

Beam Section Properties



d_1 25
d_2 255
d_3 485

		A		d_1	Ad
①	508×50 =	25,400	×	25	= 635,000
②	50×410 =	20,500	×	255	= 5,227,500
③	155×50 =	7,750	×	485	= 3,758,750
		ΣA = 53,650		ΣAd	9,621,250

$$y = \frac{9,621,250}{53,650}$$

$$y = 179.3\,mm$$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	8
		DATE	DEC 05
SECTION	INTERNAL BEAM - Design	CALC BY	DJM
		CHECK BY	
			Ref.

$$I_{xx}① = \frac{bd_1^3}{12} + y_1^2 A_1 = \frac{508 \times 50^3}{12} + 154.3^2 \times 25{,}400$$

$$= 5 \times 10^6 + 604 \times 10^6$$

$$= \underline{609 \times 10^6}$$

$$I_{xx}② = \frac{b_2 d_2^3}{12} + y_2^2 A_2 = \frac{50 \times 410^3}{12} \times 75.7^2 \times 20{,}500$$

$$= 287 \times 10^6 + 117 \times 10^6$$

$$= \underline{404 \times 10^6}$$

$$I_{xx}③ = \frac{bd^3}{12} + y^2 A_3$$

$$= \frac{155 \times 50^3}{12} + (305.7)^2 \times 7{,}750$$

$$= 2 \times 10^6 + 724 \times 10^6$$

$$= \underline{726 \times 10^6}$$

$$\text{Total } I_{xx} = (609 + 404 + 726) \times 10^6$$

$$= \underline{1739 \times 10^6 \text{ mm}^4}$$

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	9
		DATE	DEC05
SECTION	INTERNAL BEAM - Design	CALC BY	DJM
		CHECK BY	
			Ref.

Dead Load Stress

$M = \frac{f_y I}{y}$ $y = 179.3$

$I_{xx} = 1739 \times 10^6 mm^4$

$f_{y_T} = \frac{My}{I}$ Dead load Moment $M = 206kNm$

$f_{y_T} = \frac{206 \times 10^6 \times 179.3}{1739 \times 10^6}$ $\frac{Nmm\ mm}{mm^4}$

$f_{y_T} = 21.2 N/mm^2$ bottom flange

$f_{y_c} = \frac{206 \times 10^6 \times 330.7}{1739 \times 10^6}$ N/mm^2

$f_{y_c} = 39.2 N/mm^2$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	10
		DATE	DEC 05
SECTION	Internal Beam – Design	CALC BY	DJM
		CHECK BY	
			Ref.

Calculation of Live Load Moment

Loaded length 8.47m. — BD21/1 Cl 5.18

$$HA\ UDL = 336\left(\frac{1}{8.47}\right)^{0.67}$$

$$= \underline{80.29\ kN/m}$$

$KEL = 120\ kN$

Adjustment Factor — Cl 5.23

Span 8.47 $AF = a_L/2.5$

$a_L = 3.65$

$$AF = \frac{3.65}{2.5} = \underline{1.46}$$

$$\text{Adjusted HA UDL} = \frac{80.29}{1.46} = 55\ kN/m$$

$$HA\ KEL = \frac{120}{1.46} = 82.2\ kN$$

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	11
		DATE	DEC05
SECTION	Internal Beams – Design	CALC BY	DJM
		CHECK BY	
			Ref.

Live Load Moments (UDL + KEL) $= \frac{55 \times 8.47^2}{8} + \frac{82.2 \times 8.47}{4}$

$= 493 + 174$

$= \underline{667 \text{ kNm}}$

Reduction Factor
From BA 16/97 Chapter 2

Distribution Para 2.5 – 2.7

Multiply live load bending moment by Factor obtained from Figure 2/7

Proportion Factor $K_L = 0.32$

Revised LL Moment per beam $= 0.32 \times 667$

$= \underline{213 \text{ kNm}}$

Further Reduction Factor
From BD 21/01 Section 5
Figure 5.4 (Low traffic – poor surface)

K from graph 0.88

Further revised LL Moment $= 0.88 \times 213$

$= \underline{187 \text{ kN/m}}$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	12
		DATE	DEC 05
SECTION	Internal Beams – Design	CALC BY	DJM
		CHECK BY	
			Ref.

LL Stress Calculations

$$f_{yt} = \frac{187 \times 10^6 \times 179.3}{1739 \times 10^6} = 19.28\ N/mm^2$$

$$f_{yc} = \frac{187 \times 10^6 \times 330.7}{1739 \times 10^6} = 35.56\ N/mm^2$$

Allowable compressive stress = $120\ N/mm^2$
Actual = $35.56\ N/mm^2$

Allowable Stresses BA 21/01 Chapter 4
Para 4.10

Allowable tensile stress

either ① $F_L = 24.6 - 0.44\ Fd\ \ N/mm^2$
or ② $F_L = 19.6 - 0.76\ Fd\ \ N/mm^2$
whichever is greater

① $F_L = 24.6 - (0.44 \times 21.2)$
$= 24.6 - 9.33$
$= 15.27\ N/mm^2$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	13
		DATE	DEC05
SECTION	Internal Beam - Design	CALC BY	DJM
		CHECK BY	
			Ref.

(2) $f_L = 19.6 - (0.76 \times 21.2)$

$= 19.6 - (0.76 \times 21.2)$

$= 19.6 - 16.11$

$= 3.49 \text{ N/mm}^2$

Allowable tensile stress = 15.27 or 3.49

ie = 15.27 N/mm²

Actual tensile stress f_{yt} = 19.28 N/mm²

Actual tensile stress > Allowable tensile stress

Tensile strength exceeded

ie allowable 15.27 > 19.28 N/mm²

in BA 21/01 Section 5

Reduction Factor K 0.88 gave f_{yt} = 19.28

If no reduction Factor

Full f_{yt} without reduction would be $= \frac{19.28}{0.88}$ N/mm²

$= 22.5 \text{ N/mm}^2$

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	14
		DATE	Dec 05
SECTION	Internal Beam - Design	CALC BY	DJM
		CHECK BY	
			Ref.

If allowable tensile stress is 15.2 N/mm^2

Reduction factor K would have to be $\frac{15.27}{22.5} = 0.68$

From figure 5.4

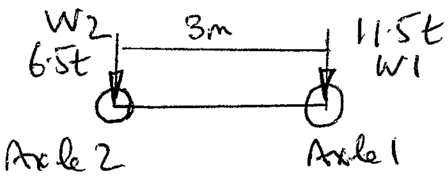
Factor 0.67 gives a weight restriction of 18 tonnes

BD21/01

Clause 5.2

For structures with long beams at less than 2.5 metres with low transverse distribution a check is to be made for vehicles in Annex D & E BD21/01

18 tonne vehicle



D4 a) A single vehicle an impact factor of 1.8 to be applied to critical axle ie 11.5 tonne

Axle load 1 is 6.5t

Axle load 2 is $11.5 \times 1.8 = 20.7t$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	15
		DATE	DEC05
SECTION	Internal Beams - Design	CALC BY	DJM
		CHECK BY	
			Ref.

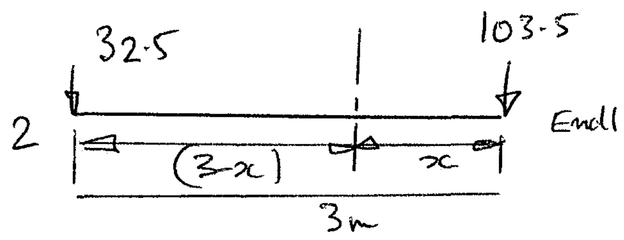
Load per wheel is: axle 1 $6.5/2 = 3.25t$

axle 2 $20.7/2 = 10.35t$

Axle 1 3.25t or 32.5kN

2 10.35t or 103.5kN

Centroid of bogey



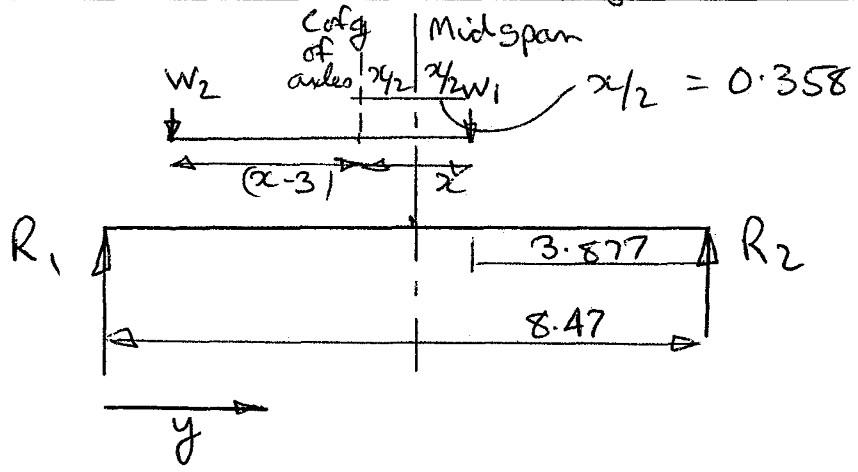
$$103.5x = 32.5(3-x)$$

$$103.5x = 97.5 - 32.5x$$

$$136x = 97.5$$

$$\underline{x = 0.717\ m}$$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	16
		DATE	Dec05
SECTION		CALC BY	DJM
Internal Beams – Design		CHECK BY	
			Ref.



$W_1 \quad y = 8.47 - 3.877 = \underline{4.593 \text{ mm}}$

$W_2 \quad y = 4.593 - 3.00 = \underline{1.593 \text{ mm}}$

<u>Moments about R1</u>

$(32.5 \times 1.593) + (103.5 \times 4.593) = 8.47R_2$

($W_2 \times y_2$) + ($W_1 \times y_1$) = y

$51.8 + 475.4 = 8.47R_2$

$\underline{R_2 = 62.24}$

Max Moment at W1 $= 3.877 \times 62.24$

$= \underline{241.3 \text{kNm}}$

Max Stress = f $= \dfrac{241.3 \times 10^6 \times 179.3}{1739 \times 10^6}$

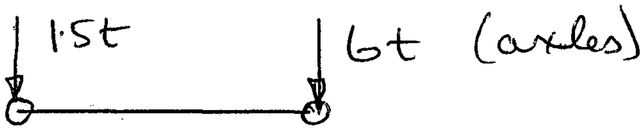
$= 24.88 \text{ N/mm} > 15.27 \text{ N/mm}$ Allowable

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	17
		DATE	Dec05
SECTION	Internal Beams - Design	CALC BY	DJM
		CHECK BY	
			Ref.

18 tonne 2axle vehicle gives too high stresses.

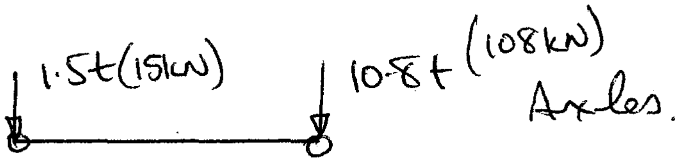
Next vehicle down in Appendix D is 7.5 tonne with 1.5t and 6t axles

Calculate stresses due to this vehicle



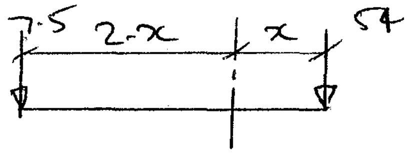
1.8 impact factor to be applied to critical axle (6t) $6 \text{ tonne} \times 1.8 = 10.8 \text{ tonne}$

Resultant loads



loads per wheel

Centroid of boegey



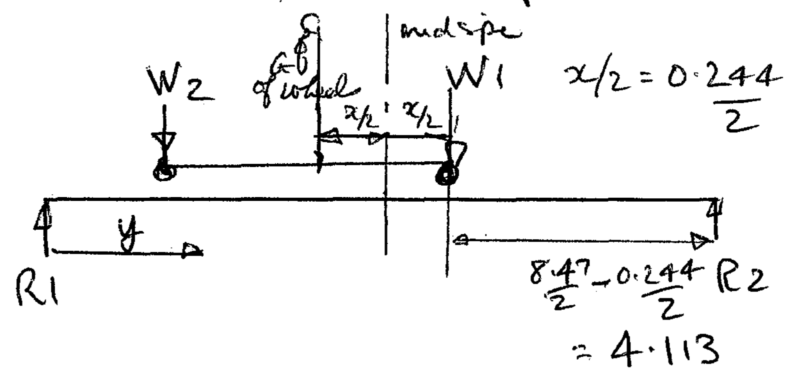
$$54x = 7.5(2-x)$$

$$54x = 15.0 - 7.5x$$

$$61.5x = 15$$

$$\underline{x = 0.244 \text{ m}}$$

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	18
		DATE	DEC05
SECTION	Internal Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.



$W_1 \quad y_1 = 8.47 - 4.113$

$= \underline{4.357\,m}$

$W_2 \quad y_2 = 4.357 - 2.00$

$= \underline{2.357\,m}$

Take Moments about R1

$W_2 y_2 + W_1 y_1 = y R_2$

$2.357 \times 7.5 + 54 \times 4.357 = 8.47 R_2$

$\underline{R_2 = 29.9\,kN}$

Max Moment $= 29.9 \times 4.113$

$= \underline{122.8\,kNm}$

$f_t = \dfrac{122.8 \times 179.3 \times 10^6}{1739 \times 10^6} = 12.66\,N/mm^2$

$f_t = 12.66\,N/mm < 15.27\,N/mm$ (Allowable)

Result 7.5 tonne vehicle acceptable

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	19
		DATE	DEC05
SECTION	Internal Beam - Design	CALC BY	DJM
		CHECK BY	
			Ref.

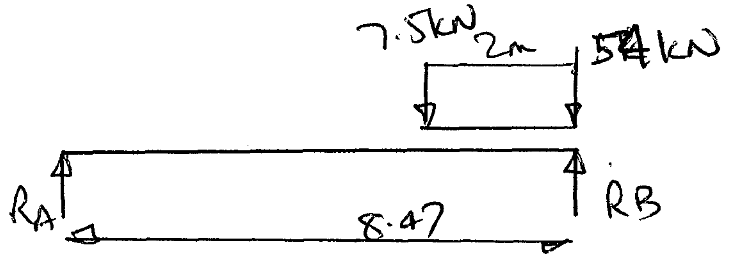
Compressive Stresses

$M = 122.8\ kNm$

$$f_{yc} = \frac{122.8 \times 330.7 \times 10^6}{1739 \times 10^6}$$

$$= 23.35\ N/mm < 120\ N/mm^2 \text{ Allowable}$$

Shear Check 7.5 tonne vehicle



54kN wheel at RB

Moments about RA

$$8.47 R_B = (54 \times 8.47) + (6.47 \times 7.5)$$

$$8.47 R_B = 457.4 + 48.52$$

Max Live Load Shear = 59.73kN

Dead Load Shear.

Beam + Arclplate + surf + fill

$$R_A = R_B = \frac{8.47}{2}\left(3.51 + 2.58 + (1.5 \times 2.35) + 11.5\right)$$

$$R_A = R_B = \frac{8.47}{2}(21.115)$$

Dead Load Shear = 89.4 kN

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	20
		DATE	DEC05
SECTION	Internal Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.

Shear forces resisted by web

Area of web $= 350 \times 50\ mm^2$

Dead load shear stress $= \dfrac{89.4 \times 10^3}{350 \times 50}$

$= 5.11\ N/mm^2$

Live load shear stress $= \dfrac{59.73 \times 10^3}{350 \times 50}$

$= 3.41\ N/mm^2$

Shear Resistance Max $46\ N/mm^2$

i) $q_L < 24.6 - 0.44 q_d\ N/mm^2$

live load shear $q_L < 24.6 - (0.44 \times 5.11)$

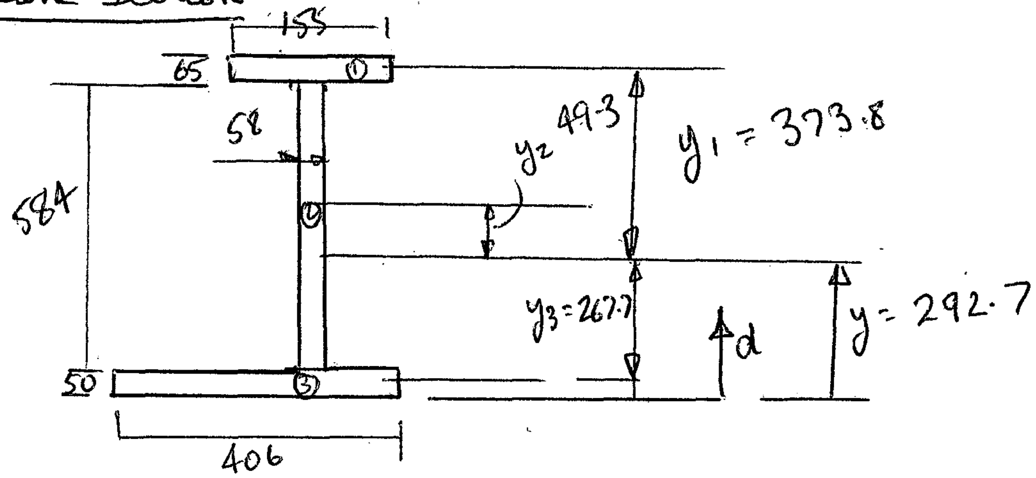
$22.35\ N/mm^2$

This is greater than actual shear stress (LL) of $3.4\ N/mm^2$

7.5 tonne vehicle is OK for shear

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	21
		DATE	DEC05
SECTION	Parapet / Edge Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.

Beam Section



Section Area

$$A = \underset{①}{155 \times 65} + \underset{②}{584 \times 58} + \underset{③}{406 \times 50}$$

$$A = 64,247 \text{ mm}^2$$

$$\text{Wt of beam} = 7,200 \text{ kg/m}^3 \times 64,247 \text{ mm}^2 \times 10^{-6}$$

$$= 462.6 \text{ kg/m}$$

$$= 4.54 \text{ kN/metre length}$$

Section Properties

		A		d	
①	155 × 65	= 10,075	×	666.5	= 6,714,987
②	58 × 584	= 33,872	×	342	= 11,584,224
③	406 × 50	= 20,300	×	25	= 507,500

$$\Sigma A = 64,247 \text{ mm}^2 \qquad \Sigma Ad = 18,806,711$$

$$y = \frac{18,806,711}{64,247} = 292.7 \text{ mm}$$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	22
		DATE	DEC05
SECTION	Parapet / Edge Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.

I_{xx}

① $I_{xx_1} = \frac{bd^3}{12} + y_1^2 A_1 = \frac{155 \times 65^3}{12} + 373.8^2 \times 10{,}075$

$= 1411.29 \times 10^6 \ mm^4$

② $I_{xx_2} = \frac{bd^3}{12} + y_2^2 A_2 = \frac{58 \times 584^2}{12} + 49.3^2 \times 338.72$

$= 1045.01 \times 10^6 \ mm^4$

③ $I_{xx_3} = \frac{bd^3}{12} + y_3^2 A_3 = \frac{406 \times 50^3}{12} + 267.7^2 \times 20{,}300$

$= 1458.99 \times 10^6 \ mm^4$

$I_{xx} = I_{xx_1} + I_{xx_2} + I_{xx_3}$

$= 3915.3 \times 10^6 \ mm^4$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	23
		DATE	DEC05
SECTION	Parapet / Edge Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.

Dead Loads

1 Beam S.W. — 4.54 kN/m

2 ½ of Arch Plate — $2.6/2 = 1.3$ kN/m

3 Parapet $= 1.4 \times 0.040 \times 7{,}200$ kg/m³

$= 403.2$ kg/m³

$= 3.96$ kN/m

4 Fill (SIDL) $= (0.6 \times \frac{1.05}{2} \times 1900) + (0.72 \times 0.3 \times 1900)$ kg/m

$= 5.87 + 4.03$ kg/m

$= 9.9$ kN/m

5 SIDL Surfacing — BD21/01 Table 3.1

$\gamma_{fL} = 1.5$ for top 100mm

Load $= 0.5 \left(100 + \frac{1.05}{2} + 0.3\right) \times 1900$

$= 0.77$ kN/m

Total SI Dead Load including factors = 10.67 kN/m

Total DL $= 4.54 + 1.3 + 3.96 + 10.67$

$= 20.47$ kN/m

Dead load Moment $= \frac{20.47 \times 8.47^2}{8}$

DL Moment = 183.6 kNm

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	24
		DATE	DEC05
SECTION	Parapet / Edge Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.

Live Loads

BD21/01

Appendix D Table D2 7.5 tonne accidental vehicle

from p 18 (Internal Beam Calcs)

Max Moment is 122.8 kN from 7.5t vehicle

Tensile Stresses

DL $f_{DL} = \dfrac{183.6 \times 292.7}{3915.3 \times 10^6}$

$f_{DL} = 13.73\ N/mm^2$

LL $f_{LL} = \dfrac{122.8 \times 292.7}{3915.3 \times 10^6}$

$f_{LL} = 9.18\ N/mm^2$

BD21/01 4.10

Allowable Stress $= 24.6 - 0.44(f_{DL})$

$= 24.6 - (0.44 \times 13.73)$

$= 18.5\ N/mm^2 > 9.18\ f_{LL}$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	25
		DATE	DEC05
SECTION	Parapet / Edge Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.

Compressive Stresses

$$f_c^{DL} = \frac{183.6 \times 406.3 \times 10^6}{3915.3 \times 10^6}$$

$$= \underline{19.05\ N/mm^2}$$

$$f_{LL} = \frac{122.8 \times 406 \times 10^6}{3915.3 \times 10^6}$$

$$= \underline{12.74\ N/mm^2}$$

Combined $f_{c\,LL} + f_{c\,DL} = 31.8\ N/mm^2 < 154\ N/mm^2$ BD21/01

OK

or $F_L = -43.9 + 0.79\,fd = -28.8\ N/mm^2$

or $F_L = -81.3 + 3.15\,fd = -21.3\ N/mm^2$

−ve is compression

Actual $f_{c\,LL} = 12.74 < 28.8\ N/mm^2$

OK

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	26
		DATE	DEC05
SECTION	Parapet / Edge Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.

Compressive Stresses

$$f_{DLc} = \frac{183.6 \times 406.3 \times 10^6}{3915.3 \times 10^6}$$

$$= 19.05 \ N/mm^2$$

$$f_{LLc} = \frac{122.8 \times 406.3 \times 10^6}{3915.3 \times 10^6}$$

$$= 12.74 \ N/mm^2$$

Combined $f_{LLc} + f_{DLc} = 31.8 < 154 \ N/mm^2$ Permissable — BD21/01

or $F_L = -43.9 + 0.79 \ f_{dLc} = -28.8 \ N/mm^2$

$F_L = -81.3 + 3.15 \ f_{dLc} = -21.3 \ N/mm^2$

Actual $f_{LLc} = 12.74 < 28.8 \ N/mm^2$ Permissable

OK

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	27
		DATE	DEC05
SECTION	Parapet / Edge Beam Design	CALC BY	DJM
		CHECK BY	
			Ref.

Shear Stresses

Dead Load Shear Force = $\frac{8.47}{2}(4.54+1.3+3.96+10.67)$

= 86.7 kN

Live Load Shear

See page 19

Liveload Shear = 59.73 kN

Area of web = 699 × 58 = 40,452 mm²

DL shear Stress = $\frac{86.7 \times 10^3}{40,452}$

= 2.143 N/mm²

LL shear Stress = $\frac{59.73 \times 10^3}{40,452}$

= 1.48 N/mm²

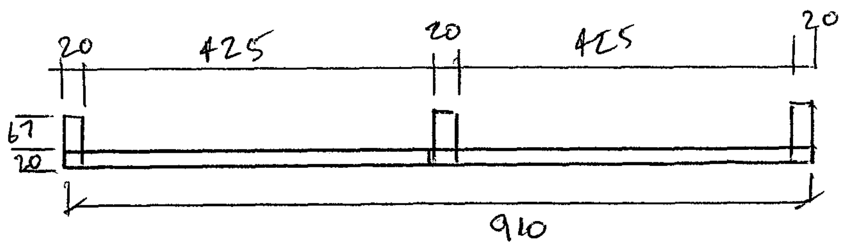
Allowable shear stress $q_L \leq 24.6 - 0.44 q_d$

= 24.6 − (0.44 × 2.143)

= 23.7 > q_L shear (1.48 N/mm²)

OK for shear.

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	28
		DATE	Dec 05
SECTION	Hogging plates	CALC BY	DJM
		CHECK BY	
			Ref.



Area of plate $= 910 \times 20 + 3(67 \times 20)$

$= \underline{22,220 \text{ mm}^2}$

Height of Neutral Axis

$$= \frac{\overset{A_1}{(910 \times 20)} \times \overset{y_1}{10} + 3\,\overset{A_2}{(67 \times 20)} \times \overset{y_2}{53.5}}{22,220}$$

$$= \frac{397,070}{22,220}$$

$y_{na} = \underline{17.87 \text{ mm}}$

① $I_{xx_1} = \dfrac{bd^3}{12} + A_1 y_1^2 = \dfrac{910 \times 20^3}{12} + (910 \times 20)(17.87 - 10)^2$

$= 606.7 \times 10^3 + 1127.3 \times 10^3$

$I_{xx_1} = \underline{1734 \times 10^3}$

② $I_{xx_2} = 3\left[\dfrac{bd^3}{12} + A_2 y_2^2\right] = 3\left[\dfrac{20 \times 67^3}{12} + 20 \times 67(53.5 - 17.87)^2\right]$

$= 3\left[501.3 \times 10^3 + 1701.1 \times 10^3\right]$

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	29
		DATE	DEC 05
SECTION	Hogging plates	CALC BY	DJM
		CHECK BY	
			Ref.

$$I_{xx(2)} = 3 \cdot [2202.4] \times 10^3$$

$$= 6607 \cdot 10^3$$

$$I_{xx} = I_{xx1} + I_{xx2} = 1734 \times 10^3 + 6607 \times 10^3$$

$$I_{xx} = 8341 \times 10^3$$

LOADS ON HOGGING PLATES

Moments

(1) Self Weight $M = \frac{wL^2}{8} = \frac{22,220}{10^6} \times \frac{7200 \times 1.05^2}{8} \quad m^2 \frac{kg}{m^3} m^2$

$$M_{sw} = 0.216 \text{ kNm}$$

(2) Fill $M = \frac{wL^2}{8} = \frac{1 \times 0.6 \times 1900 \times 1.05^2}{8}$

$$M_{fill} = 1.54 \text{ kNm}$$

(3) Live load One wheel from 7.5 tonne vehicle max wheel is 54 kN as a point load

$$M_{max} = \frac{PL}{4} = \frac{54 \times 1.05}{4}$$

$$= 14.2 \text{ kNm}$$

ROADS AND TRANSPORTATION CALCULATION SHEET		JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	30
		DATE	DEC05
SECTION	Hogging plates	CALC BY	DJM
		CHECK BY	
			Ref.

Stresses

Tensile Stress $f_{DL} = \frac{1.76 \times 10^6 \times 17.87}{8341 \times 10^3}$

$f_{DL} = 3.77\ N/mm^2$

Live load stress $f_{LL} = \frac{14.2 \times 10^6 \times 17.87}{8341 \times 10^3}$

$f_{LL} = 30.37\ N/mm^2$

Allowable LL stress $= 24.6 - 0.44 \times (3.77)$

$= 24.6 - 1.66$

$= 22.94\ N/mm^2$

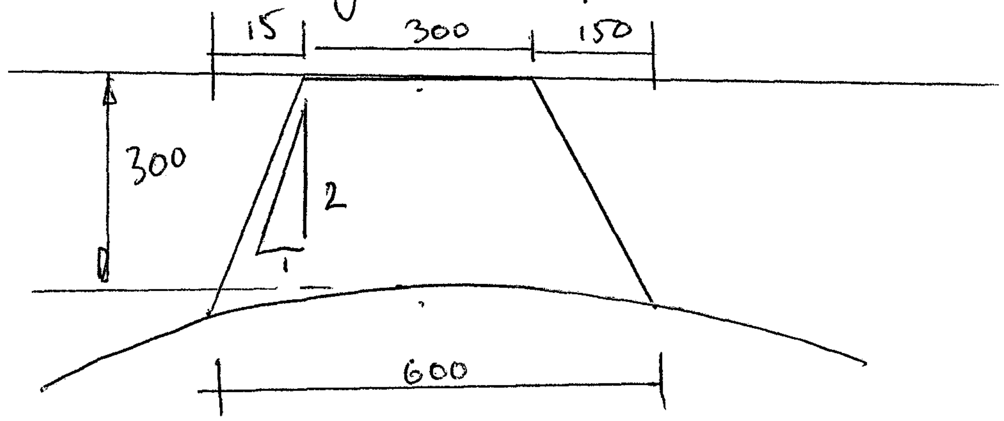
Actual 30.37 > Allowable 22.94

Not OK

when wheel load is considered as a point load.

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	31
		DATE	DEC05
SECTION	Hogging plates	CALC BY	DJM
		CHECK BY	
			Ref.

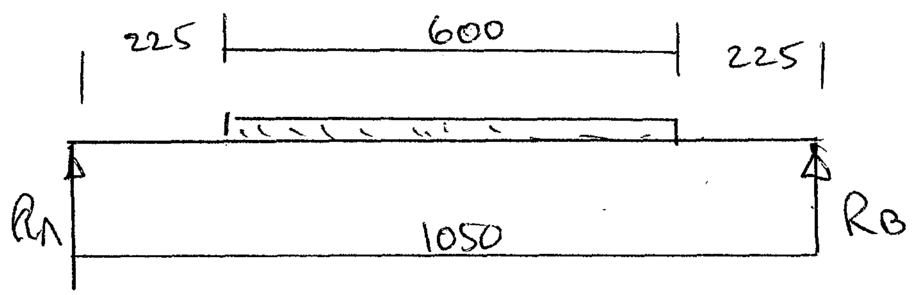
Try the wheel load being dispersed through the fill to give a patch load



Minimum depth of fill 300 mm

length of patch $= 300 + 2 \times \left(\frac{300}{2}\right)$

$= \underline{600\text{mm}}$



$$UDL = \frac{54\text{ kN}}{0.6 \times 0.911} = \underline{99\text{ kN/m}^2}$$

$$R_A = R_B = \frac{54}{2} = 27$$

ROADS AND TRANSPORTATION		CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS		OFFICE	
			SHEET NO.	32
			DATE	DEC05
SECTION	Hogging plates		CALC BY	DJM
			CHECK BY	
				Ref.

Moment about ℄ $= R_b \times \frac{L}{2} - \left(0.3 \times \frac{0.3}{2} \times 9 \times 0.9\right)$

$M_{max} = 27 \times \frac{1.05}{2} - 0.405$

$\underline{M_{max} = 10.12\,kNm}$

Live Load Stress $f_{LL} = \frac{10.12 \times 17.87}{8341 \times 10^3}$

$= \underline{21.68\,N/mm^2}$

This is less than allowable of $22.94\,N/mm^2$ page 30

∴ 7.5 tonne vehicle OK

Compressive Stress

DL Stress $f_{DC} = \frac{1.76 \times 69.13}{8341 \times 10^3}$

$\underline{f_{DC} = 14.6\,N/mm^2}$

Allowable Stress due to compression $= -125\,N/mm^2$

Actual Stress (LL) $f_{LL} = \frac{10.12 \times 69.13}{8341 \times 10^3}$

$= 83.9\,N/mm^2$

$< 125\,N/mm^2$

Allowable

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	33
		DATE	DEC 05
SECTION	Hogging plates	CALC BY	DJM
		CHECK BY	
			Ref.

Shear Force

Dead load 1·76 kN/m

$DL = 1.76 \times 1.05$ kN

$DL = 1.848$ kN

DL Max shear force = 0·93 kN

Max LL shear from wheel load

Max P = 54 kN

Shear Stress

Dead Load $= \frac{0.93 \times 10^3}{22{,}000} = 0.04 \, N/mm^2$

Live Load $= \frac{54 \times 10^3}{22{,}000} = 2.44 \, N/mm^2$

Max permissable shear force (LL)

$q = 24.6 - (0.44 q_a)$

$= 24.6 - (0.44 \times 0.04)$

$q = 24.58 \, N/mm^2$

Actual shear stress < permissable shear stress

Shear OK

ROADS AND TRANSPORTATION	CALCULATION SHEET	JOB NO.	
SCHEME	LOW ASHYARD BRIDGE ASSESSMENT CHECK CALCULATIONS	OFFICE	
		SHEET NO.	34
		DATE	DEC05
SECTION	PARAPETS	CALC BY	DJM
		CHECK BY	
			Ref.

Priority Ranking of Existing Parapets

BA 37/92

Risk Ranking Hazard Groups — ANNEX A

Group 1 Features below ______ 1

Group 2 Type of highway single carriageway ______ 1

Group 3 Road Structure layout
Inferior alignment + junction ______ 4

Group 4 Containment features
Not part structure ______ 0

Risk Ranking Total ______ 6 — BA37/92

Section 5

Containment Evaluation — Containment Ranking

Remnant strength 0-33%
of design strength — 5

Section 6
Para 6.1 — Priority Ranking = 6 x 5
= 30 — BA37/92