JACOBS

BRB (Residuary) Ltd
Major Works Programme 2004/2007

VAR9/2165 ASSESSMENT PROGRAMME

BE4 ASSESSMENT AND INSPECTION REPORT

Bonnington Road, Lanark

BRIDGE REF: DMB/5

March 2009

JACOBS

Document control sheet Form IP180/B

Client: BRB (Residuary) Ltd
Project: Major Works Programme 2004/2007 Job No: J24110NA – DMB/5
Title: VAR 9 /2165 Assessment Programme

	Prepared by	Reviewed by	Approved by
ORIGINAL Form AA stage	NAME [redacted]	NAME	NAME
DATE 14 Nov 2007	SIGNATURE	SIGNATURE	SIGNATURE
REVISION Final Report	NAME [redacted]	NAME	NAME
DATE 26 March 2009			
REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE
REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

JACOBS

Contents

1 General Description and Structural Details

1.1 Introduction

Jacobs was appointed by BRB(R) to conduct the site survey at DMB/5 in sufficient detail to provide data for BE4 assessment work.

1.2 Location and General Description

Bridge DMB/5 carries an unclassified road over the track bed of the former Douglas and Muirkirk branch and is located about 1 mile southeast of the town of Lanark. The road is used for access to farms and the "Falls of Clyde" conservation area. The carriageway is 3.32 wide.

The OS grid reference is NS 899424.

1.3 Construction type

The structure comprises four cast iron spandrel arch girders at approximately 1.613m centres. The girders consist of a horizontal beam and an arch beam both 24" (610mm) deep with three vertical spandrel columns at both ends of the girders where the arch and horizontal diverge. The full length of the horizontal girders is 15.76m. The clear span of the arches between the springings is 14.91m. The deck is skewed at 53° to the normal. See site survey sketches in Appendix F.

The bottom flanges of the horizontal beams are continuous in order to support the jack arches. However on the outside face of the edge beams the flanges of the horizontal beam merge into the arch to give a continuous arch fascia. There are blue brick jack arches spanning transversely between the bottom flanges of the horizontal beams.

The abutments and wingwalls consist of squared sandstone blocks brought to courses. The parapets are constructed of cast iron and are 1.422m high from the top of the edge girder.

The railway was opened in 1864 and the bridge was probably constructed at the same time. It is believed to be a Grade B listed structure.

2 Existing Information Search

2.1 Service Search

Documentation obtained by Structural Soils Ltd is included in Appendix B.

2.2 SI Results

One trial pit was dug. The top flange of the west internal girder was exposed at mid-span.

Data on the trial pit and a description of the investigation is included in Appendix C.

2.3 Existing Drawings

There is no information available for this bridge in the form of drawings or previous assessments.

3 Structure Condition

3.1 General

The inspection and investigation were carried out on Wednesday 11 September 2007. The weather was cloudy and dry and the temperature about 17C.

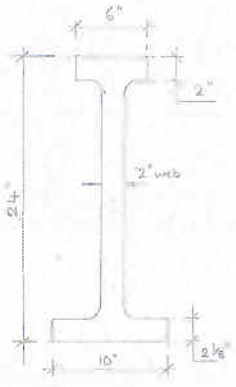
Parking was available on the grass verge about 30m south of the bridge where the carriageway widens. The widened area to the north west of the bridge is used by vehicles turning into the farm.

Access to the underside of the bridge was obtained by crossing the fence at the north west corner of the bridge and descending the steep cutting slope.

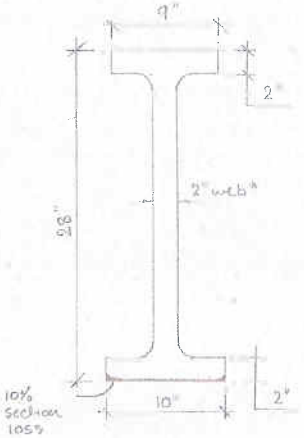
3.2 Main Superstructure

3.2.1 Main Girders

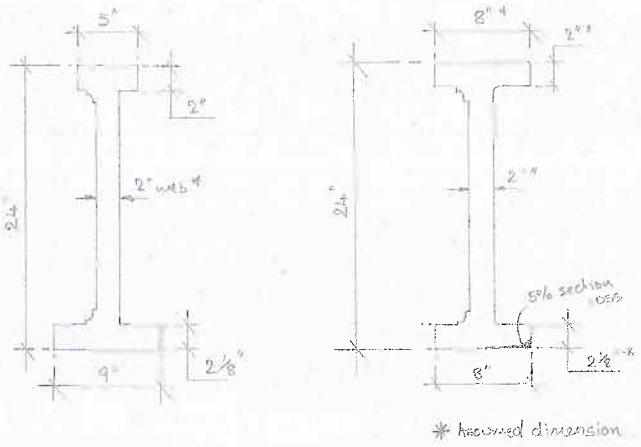
The outside face of the edge girders are in a good condition with most of the original paint system intact. The inside face and underside of the flanges of the edge girders show signs of surface corrosion which only amounts to a negligible loss of section. The bottom flanges of the horizontal beams of the internal girders have about 10% section loss over the entire length. There is some vegetation growth on the outside face of the top flange of the east edge girder and at mid span of the west edge girder.



Internal girder arch beam



Internal girder horizontal beam



Edge girder arch beam

Edge girder horizontal beam

3.2.2 Jack arches and tie-bars

The jack arches are in a good condition. There are no signs of seepage or distortion. The tie bars are encased in iron tubes about 3.5" in diameter. There appear to be 6 bars in-span and a further bar at each end. Bar size appears to be 1¼" or 1½" from observation of the nuts exposed on the outer girders.

3.3 Abutments

Both abutments are in a good condition with all the stonework intact. There is some seepage through the south abutment underneath the east internal girder. (Photographs 5 and 6.)

3.4 Wingwalls

The wingwalls are in a good condition. They are stone gravity type structures with squared off sandstone blocks brought to courses. (SE wingwall, photograph 8)

3.5 Parapets

The cast-iron parapets are in a poor condition. The top chord leans outwards up to 100mm (photograph 10). Some repair work has been done to the east parapet; steel plates have been added to the posts as reinforcement where the parapet has cracked. The height of the parapets is 0.80m above the verge which is well below the 1.15m value for normal pedestrian containment to modern standards.

3.6 Road Surface

The road surface is in reasonably good condition (Photograph 7). The road is level over the bridge. There are some minor repairs just off the span on the south side.

3.7 Formation

The formation is heavily overgrown with small trees bushes and ground cover. There is a degree of fly-tipping on the west side of the bridge.

4 Assessment to BE4 1967

4.1 Methodology

Distribution of live load onto the individual spandrel arch girders utilised previous work on four girder jack-arch structures with similar girder spacing whereby distribution factors were obtained from a simple grillage model simulating the degree of distribution obtained from the BE4 curves. For the purposes of this modelling, the ratio between longitudinal and transverse stiffness is taken as suggested in BE4 Part II Clause 202:

$$\frac{EI_T}{EI_L} = 0.0305$$

There is a slight difference in the road layout between the structure originally modelled and DMB/5 as the wheel track can approach 10" closer to the edge girder in DMB/5. While this does not affect the calculated proportion factor for the internal girders, the factor on the edge girder would be slightly underestimated. The factor was accordingly enhanced to allow for this.

As the bridge is on a skew of 37° the proportion factors were multiplied by 1.15 as would be the case when using the BE4 graphical factors.

Load effects in the spandrel arches were determined by applying the proportioned load as above onto a simple plane frame model considering the arches to be pinned at the springings. As the infill material over the jack arches is essentially soft, section modulus enhancement for live load on the internal horizontal girders was not considered.

Spandrel columns were considered using the Gordon-Rankine equation as outlined in BE4 clause 305 b ii 2.

The assessment was based on the current condition of the structure as determined by the inspection. Specific allowance for recorded section losses was made to the appropriate edges of the relevant elements.

Determination of the adequacy of the jack arches was based upon the empirical method described in Bridgeguard 3 Current Information Sheet No 22 (Pro-forma for the empirical assessment of brick, masonry and concrete jack arches and associated ties.)

The substructure was assessed qualitatively.

4.2 Results

The BE4 assessment for all members gives the following results:

Element: **Internal arches (combined bending and axial load)**

Compressive stress shown as positive

Action	Live load axial stress	Live load bending stress	Coexistent dead load axial stress	Coexistent dead load bending stress	Combined stress	Permissible stress	Live Load Capacity
Arched member top flange	1.59 t/in^2	0.65 t/in^2	3.94 t/in^2	1.42 t/in^2	7.60 t/in^2	10 t/in^2	**24 tons**
Arched member bottom flange	1.59 t/in^2	-0.56 t/in^2	3.94 t/in^2	-1.13 t/in^2	3.84 t/in^2	10 t/in^2	**24 tons**
Horizontal member bottom flange	0 t/in^2	-0.50 t/in^2	0 t/in^2	-0.66 t/in^2	-3.95 t/in^2	-8 t/in^2	**24 tons**
End struts	7.17 ton	0	13.74 ton		21.9 ton	79 tons	**24 tons**

Element: **External arches**

Action	Live load axial stress	Live load bending stress	Coexistent dead load axial stress	Coexistent dead load bending stress	Combined stress	Permissible stress	Live Load Capacity
Arched member top flange	1.07 t/in^2	0.52 t/in^2	2.38 t/in^2	0.89 t/in^2	4.76 t/in^2	10 t/in^2	**24 tons**
Arched member bottom flange	1.07t/in^2	-0.42 t/in^2	2.38 t/in^2	-0.71 t/in^2	3.84 t/in^2	10 t/in^2	**24 tons**
Horizontal member bottom flange	0 t/in^2	-0.47 t/in^2	0 t/in^2	-0.53 t/in^2	-3.52 t/in^2	-8 t/in^2	**24 tons**

Element: **Jack Arches**

There is no theoretical failure or none compliance in the empirical method. They are deemed capable of sustaining full C&U loading. The tie bars are encased in metal ducts and are therefore assumed to be in good condition.

Element: **Substructure**

The abutments show no signs of structural distress. By qualitative assessment, they appear to be satisfactory for Full C&U loading.

5 Conclusions and Recommendations

The bridge structure including the cast iron spandrel arches, the jack arches and tie bars appear to be in satisfactory condition.

The assessment even with allowance for some corrosion on the arches indicates the bridge has ample capacity for BE4 loadings.

The parapets are substandard being barely 800mm above verge height. Some panels are in poor condition being misaligned and vulnerable to traffic impact. It should be noted in considering any repairs that the structure is thought to be a Grade B listed structure.

The girders would benefit from repainting to arrest corrosion.

Appendix A - Photographs

1. West elevation

2. Bridge soffit – jack arches with encased tie-bars

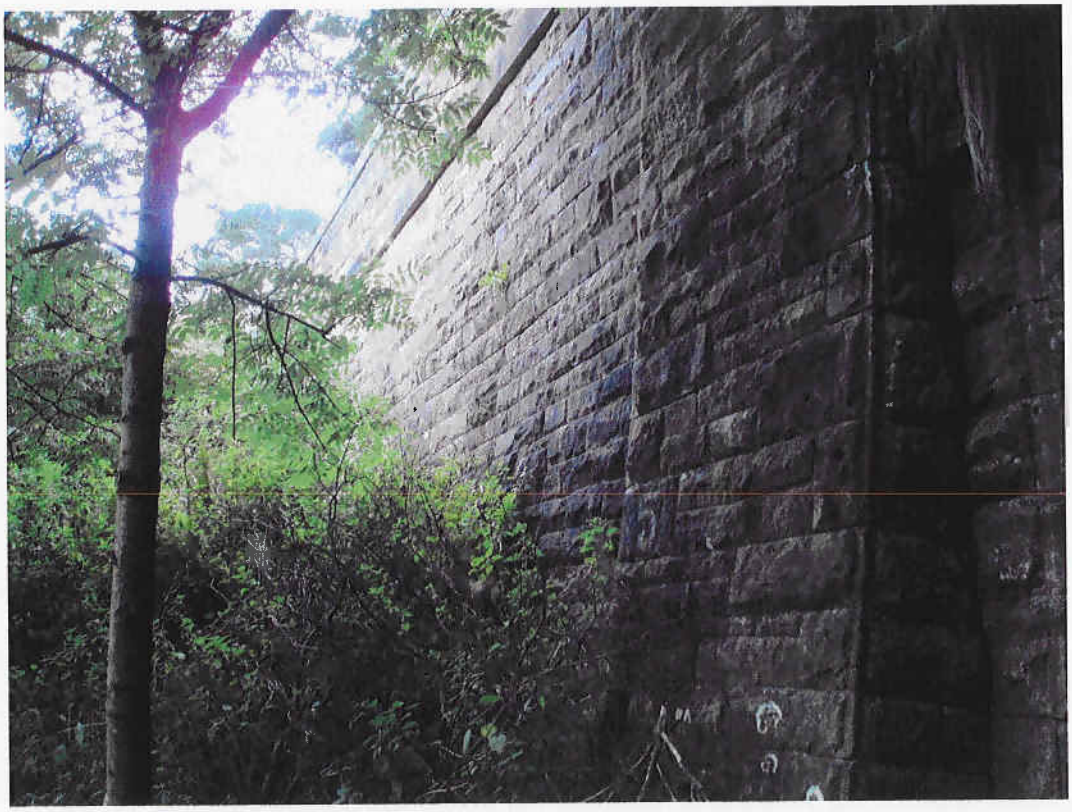
3. Arch springing and spandrel columns.

4. Trial Pit showing top of internal girder

5. North abutment

6. South Abutment.

7. Road over bridge – looking north



8. South East wingwall

9. South abutment springing

10. West parapet

Appendix B - Services Search

Search Results

Thank you for your enquiry: LS-1706179-332

This enquiry result is valid for 28 days only from the date of enquiry and is based on the confirmed information you entered. If the location of the work changes then a further enquiry must be made. Should the work not be undertaken within 28 days of the enquiry then a further enquiry must be made.

Enquirer details

Name:	Ms Gray
Company:	PlanToDig
Email:	retriever@plantodig.com

Enquiry details

Your Reference:	Hyndforg Rd, Lanark. SS618
Confirmed location:	OS grid reference (289908, 642488)
Estimated start date:	08-08-2007
Type of work:	Excavations non utility - Private services
Distance covered:	100 metres

This enquiry is not in the zone of interest for any of the following Operators:

Esso Petroleum Company Limited	NOT IN ZONE OF INTEREST
Mainline Pipelines Limited	NOT IN ZONE OF INTEREST
BPA	NOT IN ZONE OF INTEREST
Government Pipelines & Storage System	NOT IN ZONE OF INTEREST
Total Pipeline Operations	NOT IN ZONE OF INTEREST
ConocoPhillips (UK) Ltd	NOT IN ZONE OF INTEREST
Manchester Jetline Limited	NOT IN ZONE OF INTEREST
Shell UK Ltd	NOT IN ZONE OF INTEREST
Sabic UK Petrochemicals (formerly Huntsman)	NOT IN ZONE OF INTEREST
BP TSEP	NOT IN ZONE OF INTEREST
BT GEO Network	NOT IN ZONE OF INTEREST
E-on UK Plc	NOT IN ZONE OF INTEREST
BP Exploration Purbeck Southampton Pipeline	NOT IN ZONE OF INTEREST
ConocoPhillips Ltd Humber Refinery	NOT IN ZONE OF INTEREST
Scottish Power Generation Ltd	NOT IN ZONE OF INTEREST
NPower CHP Pipelines	NOT IN ZONE OF INTEREST

Thank you for your enquiry, there is no further action necessary.

*Please quote the Linesearch enquiry reference number in *all* correspondence*

SX111226L

Janette Gray

From: Lynda Willis [lynda.willis@uk.easynet.net]

Sent: 19 July 2007 14:08

To: retrievar@national-one-call.co.uk

Subject: Easynet NRSWA Department

Plant Enquiry
National One Call

[illegible]

Date	Our Ref	Your Ref
19 July 2007	FE07.07-1717	CA9LQLWW

Dear Sir/Madam,

RE: Bridge OMB/5 Hyndford Rd, Lanark

Thank you for your enquiry.

Pleased be advised that Easynet Telecom will not be effected by these works.

Best endeavours have been made to ensure accuracy, however if you require further information, please contact us.

If you would like to submit your plant enquiries electronically to Easynet, please send them to nrswa@uk.easynet.r

Please be advised that our fax number has changed to 0207 032 3160.

Kind regards

NRSWA Department
Network Maintenance & Planning Department

19/07/2007

Faxed Enquiry

National One Call Enquiry EQ/ADECY618

Fax to:Verizon Business	Fax Number: 01293 553871

Requests are made for the following documents.

Click the document to respond online	Use this section only for marking up to fax /Email		
Document	Affected	Action Taken / Required / Comments	Charge
Telecommunications Plan	Yes / No		£

If you prefer, you can print this form, mark it up and fax it back to us on 0845 280 2040
If you are faxing this form to us and are not affected, simply highlight 'No'. If you are affected, tell us what action you have taken, or that we should take to obtain the document and if there is a charge made for you providing the document. See our PlanBroker Service to see how we can help to ensure you receive all appropriate enquiries and apply your rules and prices to help protect plant and aid co-ordination.

VERIZON BUSINESS
We have reviewed your plans and have determined that Verizon (Formerly MCI) has **NO** apparatus in the areas concerned

Map data ©2007 Tele Atlas - Terms of Use

Required Date	08/08/2007	Response Deadline 07/08/2007
Organisation	Structural Soils Ltd	
Contact	Retriever from National One Call	
Email address	retriever@national-one-call.co.uk Click this address to respond by email.	
Postal Address	National One Call, 1 Mill Place, Mill Road Industrial Estate, Linlithgow Bridge, West Lothian, EH29 7TL	
Phone	0844 800 9957	Fax 0845 280 2040
Work Intention	Works Intended	
Created Date	18/07/2007	
Notice given	21 Days (15 Workdays)	
Location Address	Bridge Ref: DNB/5 Hyndford Road, , Lanark, South Lanarkshire, ML11	
Site Description	Bridge Works	
Comments		
Approximate OS Coordinates	NS 89827 42478 : Easting 289827 , Northing 642478 Easement: 25 Metres	

[redacted]

From: [redacted]k.com]
Sent: 20 July 2007 13:30
To: retriever@national-one-call.co.uk
Subject: plant enquiry

I can confirm that Energetics Design and Build have NO plant in the area of Hyndford Road, Lanark, South Lanarkshire

Ref Number; EQ/ADECT618

If you have any problems with this please do not hesitate to contact me on the details below.

Thankyou

[redacted]
Technical Support
Energetics Design and Build
Tel: 01698 404964
Fax: 01698 404940
[redacted]-uk.com

FAX

thus™
99 Berkeley Street
Glasgow

Date 20/07/07

Number of pages including cover sheet 1

To:

National One Call

Ref

Phone

Fax Phone **0845 280 2040**

CC:

From:

[redacted]

Ref 3651

Phone **0141 566 3955**

Fax Phone **0141 566 3954**

REMARKS:

☒ Urgent ☐ For your review ☐ Reply ASAP ☐ Please comment

RE:- HYNDFORD ROAD, LANARK, SOUTH LANARKSHIRE

With regard to the above, I am unaware of any Thus plant in the vicinity of your proposed works.

[redacted]

Janette Gray

From: plantenq@mailman.ftel.co.uk
Sent: 23 July 2007 13:51
To: retriever@national-one-call.co.uk
Cc: plantenq@mailman.ftel.co.uk
Subject: Plant Protection Search Result. Ref :- EQ/ADECY618

Your Ref EQ/ADECY618
Our Ref 32335\1
NATIONAL ONE CALL ENQUIRY
1 MILL PLACE
MILL ROAD INDUSTRIAL ESTATE
LINLITHGOW
WEST LOTHIAN
EH49 7RS

For the attention of TO WHOM IT MAY CONCERN

Location HYNDFORD ROAD, LANARK

Dated 23-JUL-07

With reference to your enquiry regarding the above noted location, we are unaware of any GLOBAL CROSSING (UK) LTD, GLOBAL CROSSING PEC, ORANGE PCS, plant or services supported by Fujitsu in the area indicated in your enquiry.
We bring your attention to the fact that whilst we try to ensure the information we provide is accurate, the information is provided Without Prejudice and Fujitsu accepts no liability for claims arising from any inaccuracy, omissions or errors contained herein.

If you require any further information, please do not hesitate to contact me.

Plant Protection Administrator

Fujitsu Telecommunications Europe Ltd
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YU. UK
E-Mail:- plantenq@mailman.ftel.co.uk
Phone :- +44(0) 121 717 6065
Fax :- +44(0) 845 8500115

www.uk.fujitsu.com

<IMG src="http://appsrv-dev-1.ftel.co.uk:7779/images/415x641.gif" alt="Fujitsu logo">

[redacted]

From: [redacted]@innovene.com]
Sent: 23 July 2007 10:30
To: retriever@national-one-call.co.uk
Subject: Ineos - EQ/ADECY618

With reference to your e-mail regarding the above works we can advise you that Ineos do not operate any pipelines within this area and are therefore unaffected by the proposed works.

Thank you for advising us of the above works and if you have any further queries regarding Ineos Pipelines in Scotland please do not hesitate to contact this office

Regards

[redacted]

www.innovene.com/pipelines

[redacted]

From: Streetworks [streetworks@gammatelecom.com]
Sent: 25 July 2007 19:37
To: retriever@national-one-call.co.uk
Subject: Gamma Telecom - EQ/ADECY618

Hi,

Having examined my records, I can confirm that Gamma Telecom has no apparatus within your search area enquiry.

Regards
[redacted]

S14252 CC

-->

National One Call Enquiry EQ/ADECY618

Documents / Responses Requested from

Cable & Wireless

Requests are made for the following documents.

Click the document to respond online	*Use this section only for marking up to fax /Email*		
Document	***Affected***	***Action Taken / Required / Comments***	***Charge***
Telecommunications Plan	*Yes / No*		*£*

If you prefer, you can print this form, mark it up and fax it back to us on 0845 280 2040
If you are faxing this form to us and are not affected, simply highlight 'No'. If you are affected, tell us what action you have taken, or that we should take to obtain the document and if there is a charge made for you providing the document. See our PlanBroker Service to see how we can help to ensure you receive all appropriate enquiries and apply your rules and prices to help protect plant and aid co-ordination.

NEW ROADS AND STREET WORKS ACT - 1991
PLANT ENQUIRY
CABLE AND WIRELESS PLANT IS
NOT AFFECTED
TEL: 01454 288808 FAX: 0870 240 3212

Required Date	08/08/2007	**Response Deadline 07/08/2007**
Organisation	Structural Soils Ltd	
Contact	Retriever from National One Call	
Email address	retriever@national-one-call.co.uk Click this address to respond by email.	
Postal Address	National One Call, 1 Mill Place, Mill Road Industrial Estate, Linlithgow Bridge, West Lothian, EH29 7TL	
Phone	0844 800 9957	**Fax 0845 280 2040**
Work Intention	Works Intended	
Created Date	18/07/2007	
Notice given	21 Days (15 Workdays)	
Location Address	**Bridge Ref: DNB/5 Hyndford Road, , Lanark, South Lanarkshire, ML11**	
Site Description	Bridge Works	
Comments	NS 8942	
Approximate OS Coordinates	NS 89827 42478 : Easting 289827 , Northing 642478 Easement: 25 Metres	

Virgin Media
National Plant Enquiries
Cablephone House
Small Heath Business Park
Talbot Way
Birmingham
B10 0HJ

Telephone: 0870 888 3116
Facsimile: 0121 694 2345

National One Call
1 Mill Place
Mill Road Industrial estate
Linlithgow Bridge
West Lothian
EH29 7TL

Our Ref:	TW/NatVii/041147
Our Drawing Ref:	41147 01/08/2007
Your Letter Date:	19 July 2007
Your Ref:	EQ/ADECY618
Your Contact:	
Date:	01-Aug-07

Dear Sirs

Location - Bridge Ref: DNB/5 Hyndford Road, Lanark South Lanarkshire ML11

Thank you for your Enquiry regarding work at the above location

Virgin Media and Viatel plant should not be affected by your proposed work and no strategic additions to our existing network are envisaged in the immediate future.

However you should be aware that elements of our network are built in response to customer orders so this situation can change.

Should your request be in relation to a new development and you require an estimate to be prepared, for Virgin Media to service your proposed development, please submit this request for costs along with site drawings (scale 1:500) to:

Access Network WIP, New Developments
Unit 7, Bothwell Park Industrial Estate
Uddingston
G71 6NZ

This information is only valid on the date of issue. If your start date is 3 months or more from the date of this letter, please re-apply for updated information.

Yours faithfully

National Plant Enquiries Team

email: plant.enquiries.team@telewest.co.uk

JA

Please note: National Plant Enquiries Team (Birmingham) cover and respond to plant enquiries for all ex ntl:Telewest franchise areas

SCOTTISH WATER

PROPERTY SEARCHES

24 July 2007

SCOTTISH WATER

Property Searches
Bullion House
Invergowrie
Dundee
DD2 5BB

Tel: 01382 563666
Fax: 01382 563275

Customer Helpline:
0845 601 8855

www.scottishwater.co.uk

National One Call
1 Mill Place
Mill Road Industrial Estate
Linlithgow Bridge
West Lothian
EH29 7TL

Dear Sirs

Location of Services at: EQ/ADECY618 Hyndford Road Lanark
Reference:- SWPP/07/10689

Further to your enquiry regarding location of Scottish Water infrastructure at the above property, I write to confirm that since April 2002, Scottish Water Property Searches has charged a fee of £40 + VAT for the provision of plans of this nature.

This charge goes some way to recovering the costs associated with the associated dedicated Property Searches Team, along with the administration and preparation of such plans.
This is distinct from your rights to seek access to and inspect infrastructure plans, traditionally via area offices, for which no charge is applied.

I enclose herewith copy coloured plans which indicate the approximate position of Scottish Water's existing services and would be obliged if you could forward a cheque payment for the sum of £47 made payable to Scottish Water to the above address.

Other plant such as water service / supply pipes and sewer tails to properties may also be present, but no official records of these are kept.

Should you have any further technical queries on new connections, Strategic Asset Capacity etc. please contact
Planning and Development Services Helpline: 0141 355 5511.
Email: connections@scottishwater.co.uk
General reference can also be made under the "Connections" title at www.scottishwater.co.uk

Yours faithfully

Property Searches Assistant
searches@scottishwater.co.uk

N

The representation of physical assets and the boundaries of areas in which Scottish Water and others have an interest does not necessarily imply their true positions. For further details contact the appropriate District Office.

Date Plotted: 24/07/2007

HYNDFORD ROAD LANARK
WATER ONLY – NO WASTEWATER

SCALE: 1:2500

Plotted by: MCILROGI

SCOTTISH WATER

CHIEF EXECUTIVE: JON HARGREAVES
Castle House, 6 Castle Drive, Dunfermline KY11 8GG

SMALLWORLD GIS – WATER LEGEND

SCOTTISH WATER

- Trunk Main (in use)
- Distribution Main
- Raw Water Main
- Mains (abandoned)
- Mains (proposed)
- Mains (isolated)
- Communication Pipe
- Supply Pipe
- Tunnel
- Open Course
- Aqueduct
- Logical Service Link
- Duct
- Air Valve Double
- Air Valve Single
- Anode
- Hydrant : Terminal
- Hydrant : Fire
- Dialysis Patient

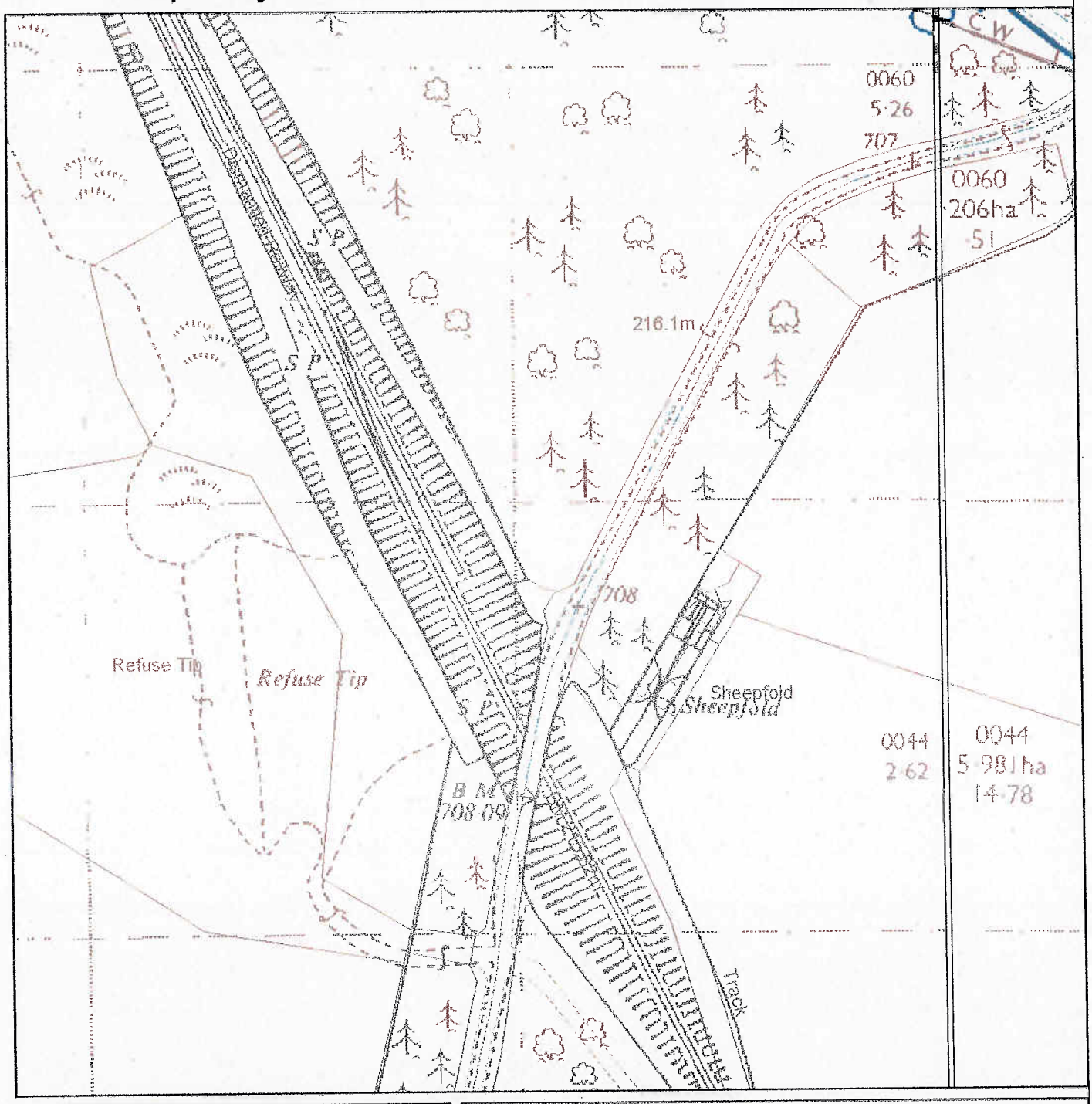
P

- Tapping
- Field trough
- Other fitting
- Orifice Plate
- Meter Point
- Cleansing Cock
- Coupling
- Flow Restrictor
- Taper
- Change Collar
- End Cap
- Stopcock
- Sample Point
- Service Point
- Hatchbox
- Chemical Dosing Point
- Break Pressure Tank

- Bulk Meter
- Revenue Meter
- Meter Cable
- Meter Display Unit
- Pumping Station
- Booster Station
- Pump Symbol
- River Intake
- Spring Intake
- Borehole Intake
- Other Company Intake
- Clear Water Tank
- Service Reservoir
- Impounding Reservoir
- Pumped Storage Reservoir
- Storage Tank
- Storage - Other
- Balancing Tank - Current

- Water Treatment Works
- Pressure Reducing Valve
- Pressure Sustaining Valve
- Reflux (Non-Return) Valve
- Washout (Scour) Valve
- Control Valve
- Pressure Relief Valve
- Altitude Valve
- Level Control Valve
- Valve - Other
- BC WSZ Valve
- BC DMA Valve
- BC WOA Valve
- BC PRA Valve
- BC PCC Valve
- BC PSA Valve
- Pipebridge

Maps by email Plant Information Reply



IMPORTANT WARNING

Information regarding the location of BT apparatus is given for your assistance and is intended for general guidance only. No guarantee is given of its accuracy. It should not be relied upon in the event of excavations or other works being made near to BT apparatus which may exist at various depths and may deviate from the marked route.

Dial Before You Dig - 0800 917 3993
Professional on-site assistance
prior to commencement of excavation works

KEY TO BT SYMBOLS

UNDERGROUND PLANT	POLE
OVERHEAD PLANT	CABINET
JOINT BOX	BURIED JOINT
DISTRIBUTION POINT	JOINTING POST
MANHOLE	PROPOSED U/G
DP BOUNDARY	PROPOSED O/H
OTHER BT BOUNDARY	PROPOSED BOX

Other proposed plant is shown using dashed lines. BT symbols not listed above may be disregarded. Existing BT plant may not be recorded. Information valid at the time of preparation.

openreach
a BT Group business

BT ref: SXI11226L

Map reference (centre): NS8990842488

Issued: 20/07/07 11:24:55

Scotland Gas Networks
A Scotia Gas Networks Company

95 Kilbirnie Street,
Glasgow G5 8JD.

Our Ref: SC/24.07.07/NA54942/82044

Your Ref: EQ/ADECY618

Date: 24 July 2007

Fax:

Email:

24 hour gas escape number 0800 111 999

Calls will be recorded and may be monitored.

, .
National One Call
1 Mill Place
Mill Road Industrial Estate
Linlithgow Bridge
West Lothian, EH29 7TL.

Dear Sir / Madam,

Re: Proposed Works Enquiry at: Hyndford Road, Lanark.

Scotland Gas Networks acknowledges receipt of your notice of your intention to carry out work at the above location.

We enclose an extract from our mains records in the location of the area covered by your proposals together with a comprehensive list of precautions for your guidance. This plan shows only those pipes owned by Scotland Gas Networks in its role as a Licensed Gas Transporter (GT). Gas pipes owned by other GT's and also privately owned may be present in this area. Information with regard to such pipes should be obtained from the owners. The information shown on this plan is given without obligation, or warranty, the accuracy thereof cannot be guaranteed. Service pipes, valves, siphons, stub connections, etc., are not shown but their presence should be anticipated. Your attention is drawn to the information and disclaimer on these plans. The information included on the enclosed plan should not be referred to beyond a period of 28 days from the date of issue.

You will note the presence of our Low/Medium/Intermediate Pressure gas main in the proximity to your site. NO mechanical excavations are to take place above or within 0.5 m of the Low pressure system, 2m of the medium pressure system and 3metres of the intermediate pressure system. You should where required CONFIRM THE POSITION of mains using HAND DUG TRIAL HOLES.

A colour copy of these plans and the gas safety advice card should be passed to the senior person on site in order to prevent damage to Scottish Gas Networks plant and potential direct or consequential costs to your organisation.

Safe digging practices, in accordance with HSE publication HSG47 "Avoiding Danger from Underground Services", must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that this information is provided to all persons (either direct labour or contractors) working for you on or near gas apparatus. In addition please follow the advice given on the gas safety card.

It must be stressed that both direct and consequential damage to gas plant can be dangerous both for your employees and the general public, repairs to any such damage will incur a charge. Your works should be carried out in such a manner that we are able to gain access to our apparatus throughout the duration of your operations.

If you have any further enquires please contact the Telephone number below

Yours faithfully,

[redacted]

SCOTLAND GAS NETWORKS (GAS APPARATUS)

copy of Both Sides of this document MUST be given to the On-site Operator Directly Responsible for the ctual or proposed works. Please take note that the reverse side of this sheet lists our 20 step guide to :-

'Measures To Be Taken To Protect Plant'

Gas Escape & Emergency Response Number
0800 111 999

All Scotland Gas Networks Plant Location Enquiries (for Scotland) should be addressed to :-

Scotland Gas Networks (Plant Location)
95 Kilbirnie Street, Tradeston
Glasgow, G5 8JD

Telephone no :- 0141 418 4093 (during office hours only)

Only limited information can be supplied by telephone. In general requests MUST be made in writing. For all enquiries the following information is required :-

1. **Is the enquiry in regard to Speculative or Actual works.**
2. **The full postal address of the Works Site and of the Main Company promoting the works.**
3. **A specific Contact Name and Telephone Number at EACH of these locations.**
4. **The full details of the nature of the works (Proposed or Actual).**
5. **The expected Start Date of the works and, if known, the Duration of the works.**
6. **For written enquiries a suitable scale map or drawing showing the Works Location and any Site Boundaries must be provided.**

Note : Due to the potentially poor quality reproduction of letters and drawings Scotland Gas Networks will not generally accept faxed enquiries or send fax replies.

SYMOLOGY

Symology can be contacted on 0800-0231-251. This facility is designed to be used by all excavators PRIOR to starting work on site. When requested, Symology will notify all Utilities, Pipeline Operators and the relevant Local Authority of your proposed works. Given sufficient notice they can supply you with drawings and enable you to comply with the New Roads And Street Works Act 1991 (HAUC 'Code of Practice for the Co-ordination of Streetworks and Works for Road Purposes and Related Matters') and the Health and Safety Executive document HS(G) 47 'Avoiding Danger from Underground Services'. Note that Symology are not connected to Scotland Gas Networks in any way and are an independent company.

Cemetery

PC

Riding Centre

Track

Dismantled Railway

0060

Refuse Tip

Sheepfold

Auction Mart

BM 216.74m

BM 215.82m

215.1m

315 PE M/P

180 PE M/P

90 PE M/P

63 PE M/P

SCALE: Not to scale	LP MAINS
USER ID: na54942	MP MAINS
DATE: 24/07/2007	IP MAINS
EXTRACT DATE: 26/03/2007	LHP MAINS
MAP REF: NS9042	NHP MAINS
CENTRE: 290035, 642571	HISTORY MAINS
	GTs SSSIs

Some examples of Plant Items:

Valve | Depth of Cover | Syphon | Diameter Change | Material Change

This plan shows those pipes owned by Scotia Gas Networks plc in their role as a Licensed Gas Transporter (GT). Gas pipes owned by other GTs, or otherwise privately owned, may be present in this area. Information with regard to such pipes should be obtained from the relevant owners. The information shown on this plan is given without warranty, the accuracy thereof cannot be guaranteed. Service pipes, valves, syphons, stub connections, etc. are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Scotia Gas Networks plc or their agents, servants or contractors for any error or omission. Safe digging practices, in accordance with HS(G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that this information is provided to all persons (either direct labour or contractors) working for you on or near gas apparatus. The information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

MAPS Viewer Version 5.3.0.0

Local Machine

ScottishPower
EnergyNetworks

Plan To Dig
1 Mill Place
Mill Road Industrial Estate
Linlithgow Bridge
West Lothian
EH49 7TL

Your Ref
EQ/ADECY618
Our Ref
DM/ 43107
Date
23 July 2007

Contact
Andrew Nicol

Dear Sir/Madam

NEW ROADS AND STREET WORKS ACT 1991

Re: Location of ScottishPower Equipment at Bridge DNB/5 Hyndford Road Lanark

Thank you for your enquiry of 19 July 2007 regarding your proposed works at the above location. Please find enclosed a copy of our relevant records showing approximate position of all known ScottishPower apparatus in the area specified.

As much information as possible has been given, however, it must be understood that locations of cables and pipes shown on the plans are indicative only as original depths and lines may have been changed by persons unknown.

I would draw your attention to the advice given in the Health and Safety Executive booklet HS (G) 47 - "Avoiding Danger from Underground Services", and their guidance note GS6 - "Avoidance of Danger from Overhead Lines". Please ensure all site operators have this information and if any apparatus is damaged, contact our fault desk immediately on 0845 2727 999.

Should you require any further information, please do not hesitate to contact me at the address below.

Yours faithfully,

[redacted]
For Elaine Stewart
Data Management
Enc. Underground 1:500 ☐ Overhead 1:2,500 ☐

On behalf of SP Distribution plc and SP Transmission plc

St Vincent Crescent, Glasgow G3 8LT
Telephone 0141 567 4155 Fax 0141 567 4262

LORRY
PARKING

PD

Fuses

ScottishPower

Telephone:
0141 567 4155

D.O.M.1.4.3
APPENDIX 2

Information about ScottishPower apparatus given on this drawing is indicative only as the original depths and lines of cables may have been changed by persons unknown. Normally electricity cables are laid in trenches between 450mm and 1m deep, but cellars or structures such as bridges may prevent cables being laid at these standard depths. Also, the depth may be above or below the standard due to regrading of the surface or other work after the cables are laid. Where known, non-standard depths are indicated. Any interference with or damage to ScottishPower apparatus may result in a serious accident. Health & Safety Executive booklet HS(G)47 provides information on the avoidance of danger from underground services. Authorities and Contractors will be held liable both for the full cost of repairs to ScottishPower apparatus and all claims made against ScottishPower by Third Parties as a result of any interference or damage. In the event of an emergency or for further assistance contact 0845 2727 999 (ScottishPower area) or 0845 272 2424 (SP Manweb area).

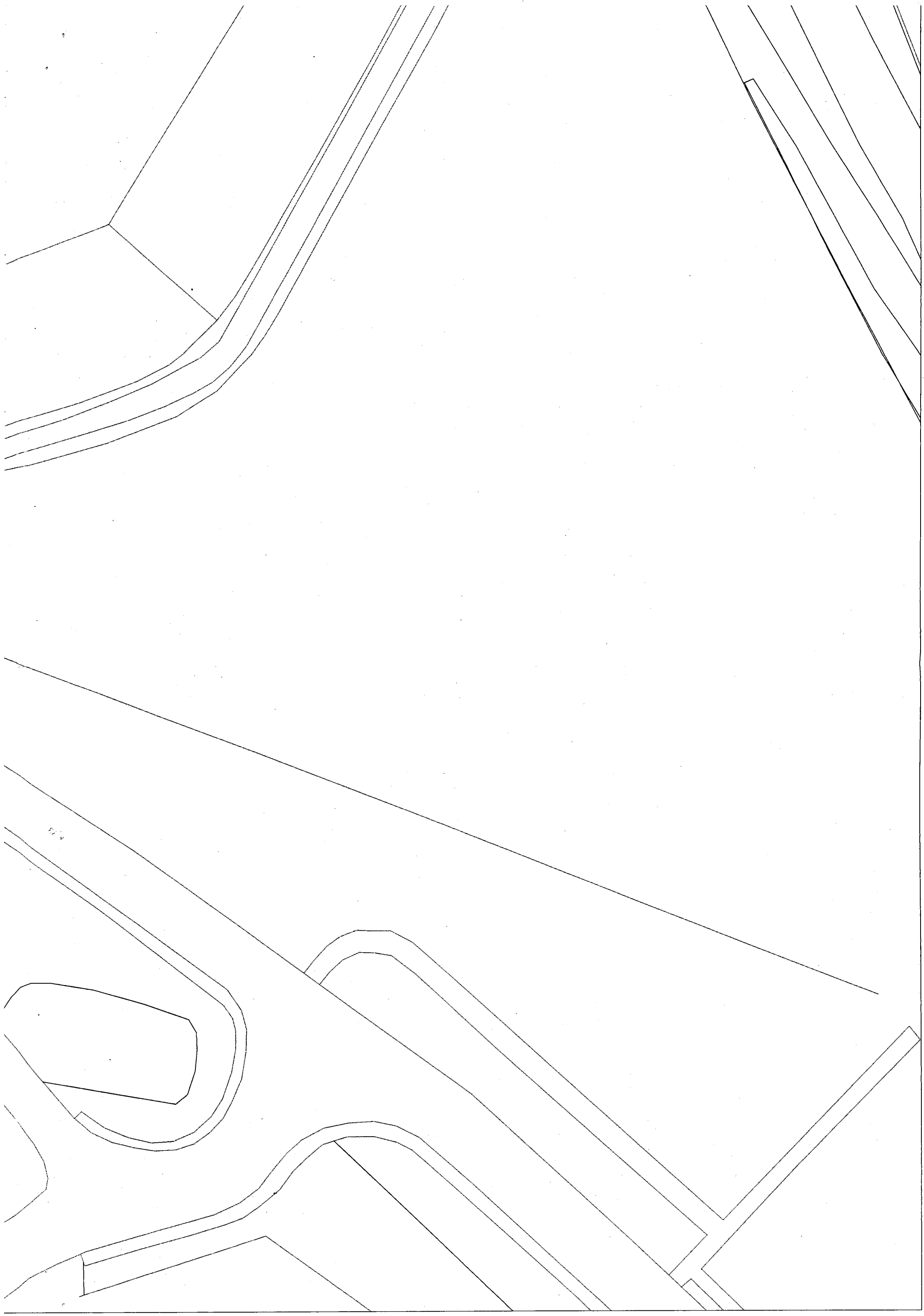
Map Reference:289996642510

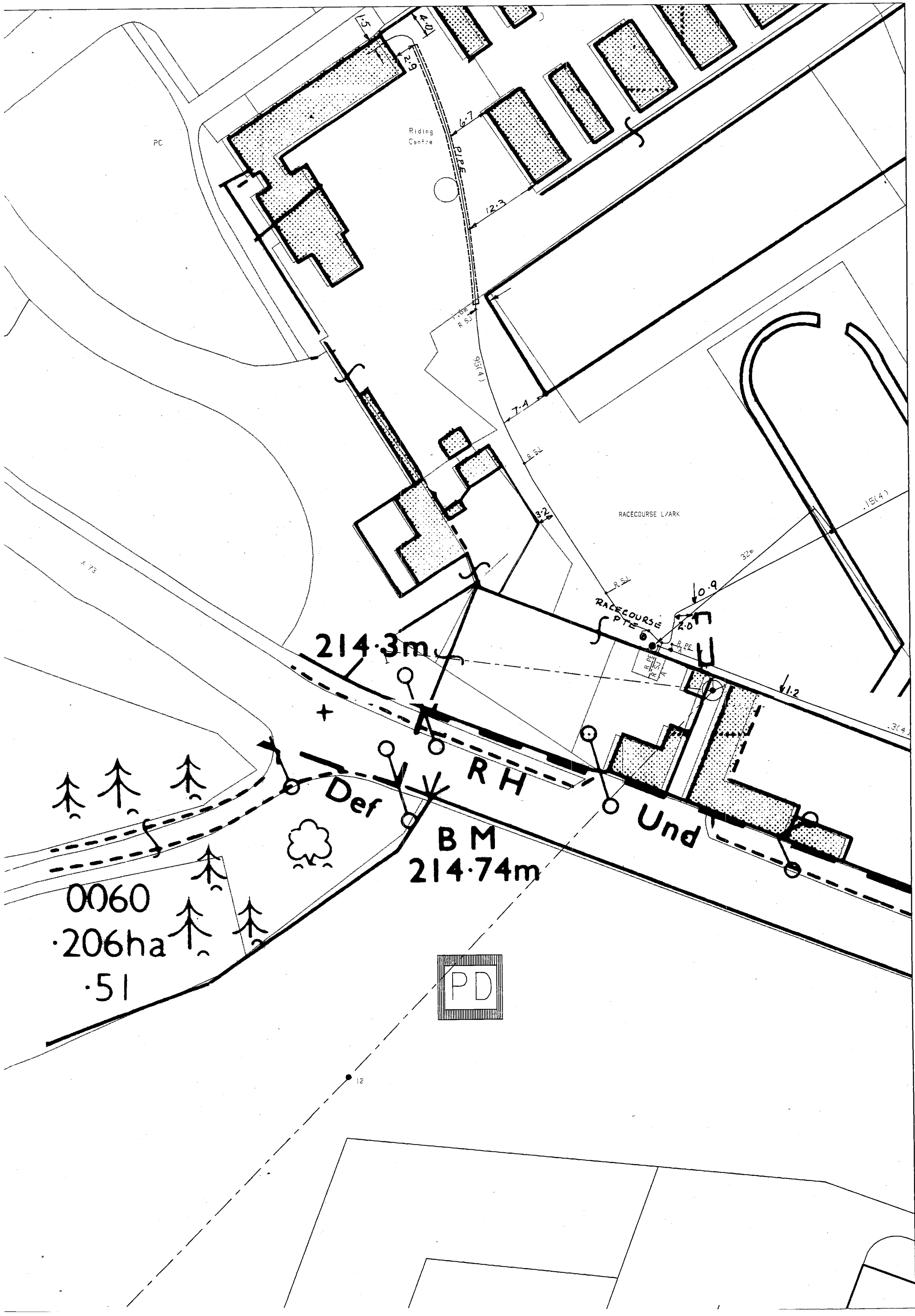
SCALE: 1/500

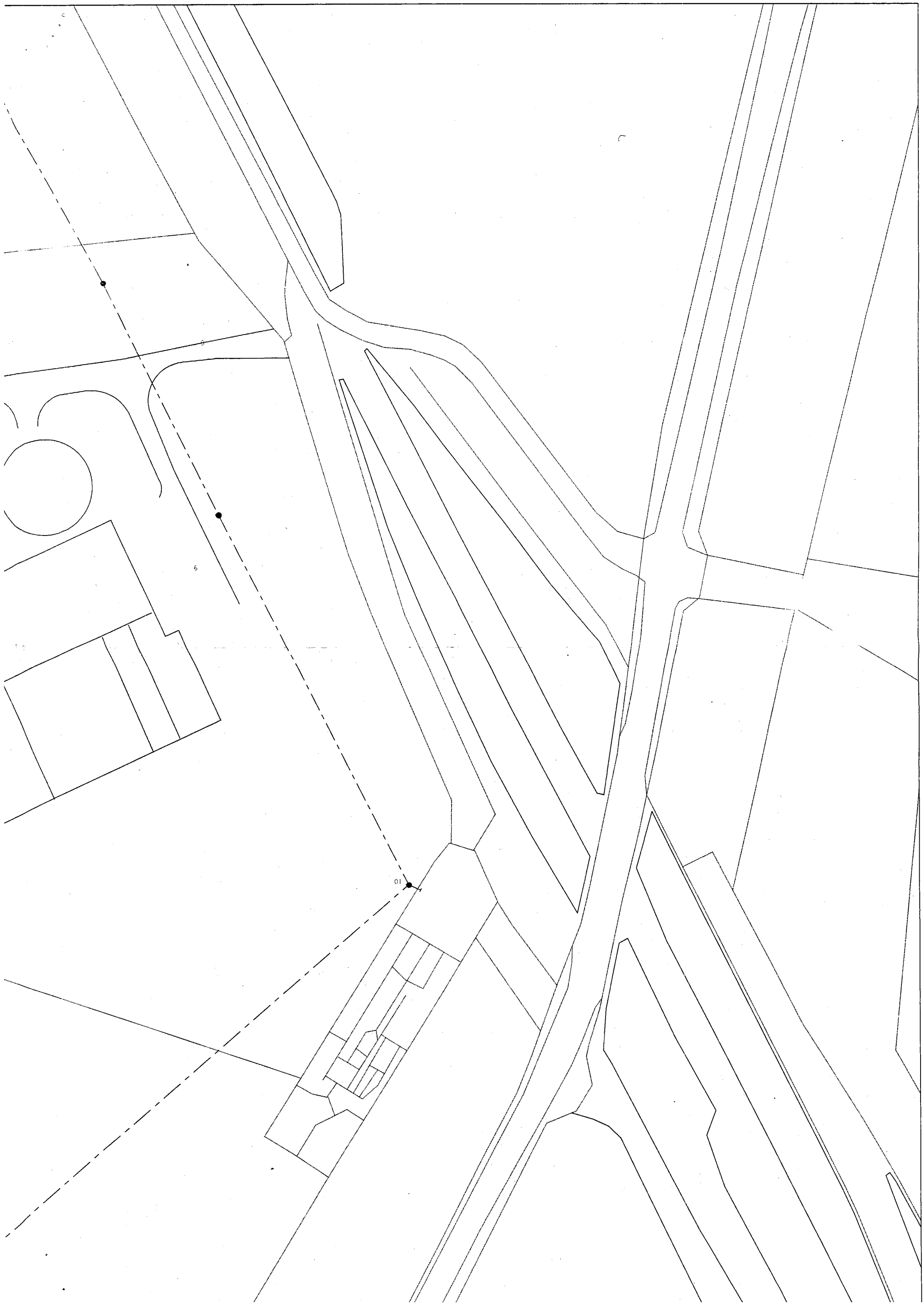
Date: 20Jul2007

Produced by:
View and Print User AN

Produced for:
43107




1·5
4·0
2·9
6·7
PIPE
12·3
PC
Riding
Centre
1·5
R SL
95(4)
7·4
RACECOURSE L/ARK
3·2
15(4)
32m
R SL
10·9
RACECOURSE
PTE
2·0
R PE
R PE
R PE
11·2
3(4)
214·3m
RH
Def
Und
BM
214·74m
0060
·206ha
·51
PD


01

Appendix C - Trial Pit Log

STRUCTURAL SOILS

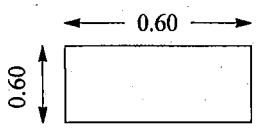
TRIAL PIT LOG

Contract	Client	Trialpit No
BD21/BE4 Bridge Assessments	**Jacobs**	**DMB/5**

Job No	Date	Ground Level	Local Grid Co-Ordinates	Sheet
760120	**12.9.07**	**---**	**---**	**1 of 1**

Samples and In-situ Tests				Water	Description of Strata	Depth (Thickness)	Legend
Depth	No	Type	Results				
					MADE GROUND: Tarmac	0.07	
					MADE GROUND: Brown slightly slightly gravelly fine to medium SAND of ash. Gravel is angular to subangular fine to coarse of ash and clinker.	0.47	
					Trail pit terminated on cast iron girder at 0.47m depth.		

Plan (Not to Scale)



No Bearing Taken

General Remarks

1. Prior to hand digging service plans were consulted
2. Cable aviodance tool was used to determine any underground services.
3. On completion Inspection pit was reinstated back to local authorities specification.

All dimensions in metres	Method	Logged By	Checked By
Scale **1:5**	**Hand Dug**	**ADAW**	

AGS

Appendix D - Form AA

FORM 'AA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: B (Nov 2000)

ELR/ Bridge No DMB/5

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Bridge/Line Name: Bonnington Road, Lanark / Douglas and Muirkirk Branch

ELR/Bridge No. DMB/5

Brief Description of Existing Bridge:

(a) Span Arrangement

This is a single span spandrel arch bridge with clear skew span between springings of 14.91m (48' – 11"). The full length of the horizontal girders is 15.76m. The deck is skewed at 53° to the normal.

(b) Superstructure Type

The structure comprises four cast iron spandrel arch girders at approximately 1.613m centres. The girders consist of a horizontal beam and an arch beam both 24" (610mm) deep with three vertical spandrel columns at both ends of the girders where the arch and horizontal diverge.

The bottom flanges of the internal horizontal beams and internal faces of the edge beams are continuous in order to support the jack arches. However, on the outside face of the edge beams the flanges of the horizontal beam merge into the arch to give a continuous arch fascia. There are blue brick jack arches spanning transversely between the bottom flanges of the horizontal beams.

The parapets are constructed of cast iron and are 1.422m high from the top of the edge girder.

The railway was opened in 1864 and the bridge was probably constructed at the same time. It is believed to be a Grade B listed structure.

(c) Substructure Type

The abutments and wingwalls consist of squared sandstone blocks brought to courses.

(d) Planned highway works/modifications at this site

None

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

The bridge carries an unclassified road used for access to farms and the "Falls of Clyde" conservation area. The carriageway is 3.32 wide. The west verge is 0.8m wide, east verge 0.72m wide.

APPROVAL IN PRINCIPLE FOR ASSESSMENT

(f) Any other requirements

None

Assessment Criteria

(a) Loadings and Speed

Section sizes used to calculate dead loads obtained from site measurements with reference to previous assessments. (See Jacobs report "VAR9-2165 BE4 Assessment Programme – Assessment and Inspection Report – Bridge Ref.: DMB/5"). Vehicle loading obtained from and applied in accordance with BE4. Standard BE4 loading representative of 24 ton vehicles will be assessed.

(b) Codes to be used

BE4 - "The Assessment of Highway Bridges for Construction and Use Vehicles" Ministry of Transport, 1967 (with amendments to 1969).

(c) Proposed Method of Structural Analysis

Distribution of live load onto the individual spandrel arch girders will utilise previous work on four girder jack-arch structures with similar girder spacing whereby distribution factors were obtained from a simple grillage model simulating the degree of distribution obtained from the BE4 curves. For the purposes of this modelling, the ratio between longitudinal and transverse stiffness is taken as suggested in BE4 Part II Clause 202:

$$\frac{EI_T}{EI_L} = 0.0305$$

Load effects in the spandrel arches will be determined by applying the proportioned load as above onto a simple plane frame model considering the arches to be pinned at the springings. As the infill material over the jack arches is essentially soft, section modulus enhancement for live load on the internal horizontal girders will not be considered initially. Sensitivity to this factor can be determined if the girders fail assessment.

Spandrel columns will be considered using the Gordon-Rankine equation as outlined in BE4 clause 305 b ii 2.

The assessment will be based on the current condition of the structure as determined by the inspection. Specific allowance for any recorded section losses will be made to the appropriate component of the relevant elements.

FORM 'AA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: B (Nov 2000)

ELR/ Bridge No DMB/5

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Determination of the adequacy of the jack arches will be based upon the empirical method described in Bridgeguard 3 Current Information Sheet No 22 (Pro-forma for the empirical assessment of brick, masonry and concrete jack arches and associated ties.)

The substructure will be assessed qualitatively.

FORM 'AA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: B (Nov 2000)

ELR/ Bridge No DMB/5

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Senior Civil Engineer's Comments

None

Proposed Category for Independent Check 1

Superstructure 1

Substructure 1

Name of Checker suggested if Cat 2 or 3 /

Category 1

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

Signed [redacted]

Title CIVIL ENGINEER

Date 7/12/07

Category 2 and 3

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

Signed .....

Title .....

Date .....

Signed .....

Title .....

Date .....

Appendix E - Form BA

FORM 'BA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Dec 2005)

ELR/ Bridge No DMB/5

CERTIFICATION FOR ASSESSMENT CHECK

Assessment Group: **Jacobs Engineering UK Ltd**

Bridge/Line Name: **Bonnington Road Bridge, Lanark / Douglas and Muirkirk Branch**

Category of Check: **1**

ELR/ Bridge No: **DMB/5**

We certify that reasonable professional skill and care have been used in the assessment of the above structure with a view to securing that:

(1) It has been assessed in accordance with the Approval in Principle as recorded on Form AA approved on 7 December 2007.

(2) It has been checked for compliance with the following principal British Standards, Codes of Practice, BRB (Residuary) Limited technical notes and Assessment standards:

BE4 - "The Assessment of Highway Bridges for Construction and Use Vehicles" Ministry of Transport, 1967 (with amendments to 1969).

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

None

Category 1

[redacted]

Date

6/3/09 Assessor

/3/09 Assessment Checker

/5/09

Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible.

FORM 'BA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Dec 2005)

ELR/ Bridge No DMB/5

CERTIFICATION FOR ASSESSMENT CHECK

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

(a) Assessment

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

(b) Check

Name	Signature	Date	
			Assessor
			Assessment Checker
			Authorised signatory of the firm of consulting engineers to whom Assessor/Checker is responsible.

This Certificate is accepted [redacted] 21).....

FORM 'BAA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Dec 2005)

ELR/ Bridge No DMB/5

CERTIFICATION FOR ASSESSMENT CHECK

Notification of Assessment Check

Assessment Group	Jacobs Engineering UK Ltd
Bridge Name/Road No.	Bonnington Road Bridge, Lanark / unclassified
Line Name	Douglas and Muirkirk Branch
ELR Code/Structure No.	DMB/5

The above bridge has been assessed and checked in accordance with Standards which are listed on the appended Form BA. A summary of the results of the assessment in terms of capacity and restrictions is as follows:-

STATEMENT OF CAPACITY

Internal girders: (No enhancement taken)	24 tons
Edge girders:	24 tons
Jack arches and ties	24 tons
Abutments (qualitative assessment)	Full C&U loading

Recommended Loading Restrictions

Full C&U (24 tons) gross vehicle weight

Description of Structural Deficiencies and Recommended Strengthening

The parapets are in need of attention, but it is noted the bridge is thought to be a Grade B listed structure..

The cast iron girders would benefit from repainting to arrest corrosion.

FORM 'BAA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Dec 2005)

ELR/ Bridge No DMB/5

CERTIFICATION FOR ASSESSMENT CHECK

[redacted]

Date

26/3/09 Assessor

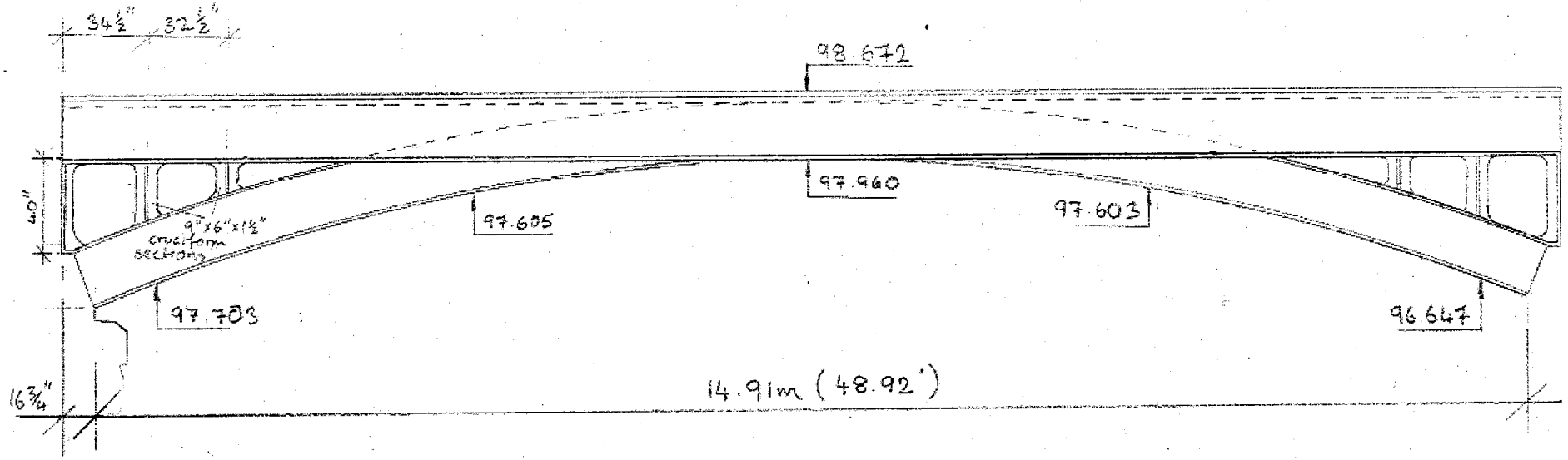
26/3/09 Assessment Checker

1/5/09

Authorised signatory of the firm of Consulting Engineers to whom [redacted]sor/Checker is [redacted]sible.

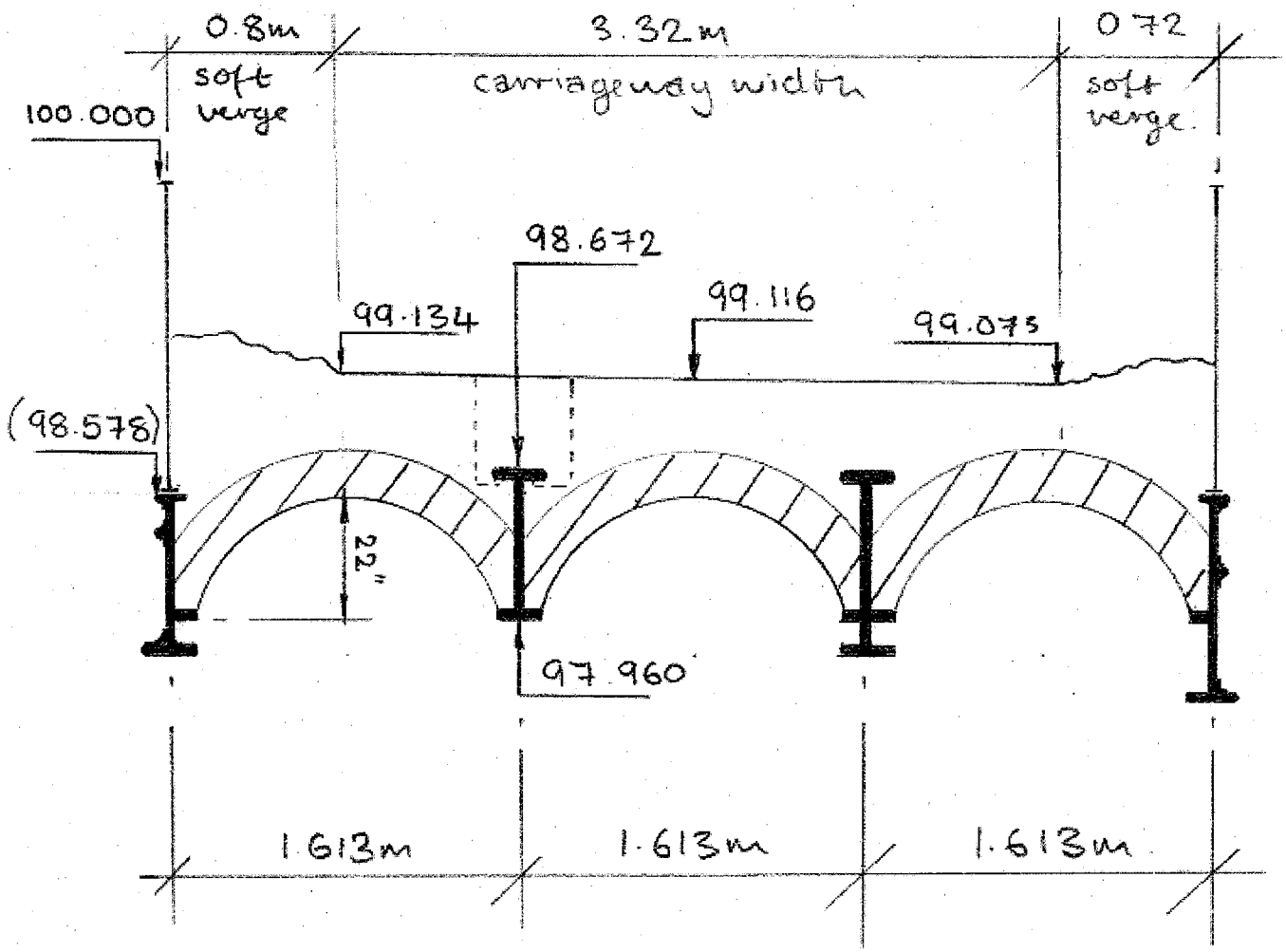
This Certificate is accepted [redacted] .....

Appendix F - Calculations



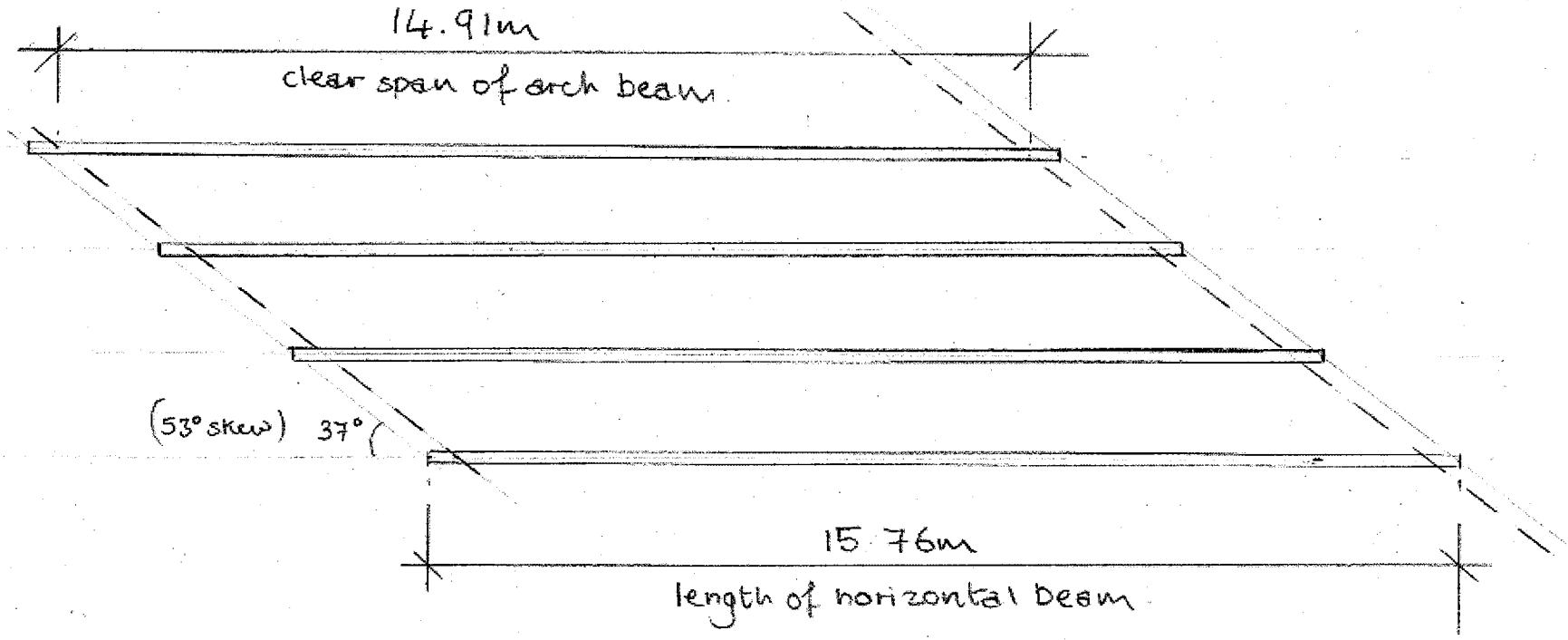
Elevation of girders

Ste survey – September 2007



Cross-section

Site survey – September 2007


14.91m
clear span of arch beam
(53° skew)
37°
15.76m
length of horizontal beam

Plan

CALCULATION COVER SHEET

Jacobs
Reading

Project Title:	BRB (Residuary) Ltd - Major Works 2004/2009		Calc. No.: 157.0
Job No: J24110NA			File: R14
Project Manager	[redacted]	Subject:	DMB/5
Designer			Bonnington Bridge, Lanark
Project Group	31400		BE4 Assessment

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	41	JR	Mar-09	ME	Mar-09				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

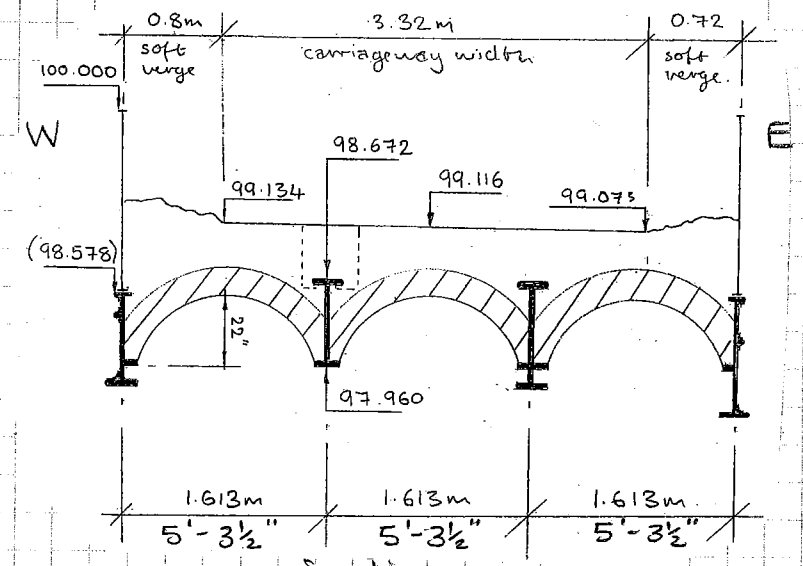
CALCULATION SHEET

JACOBS

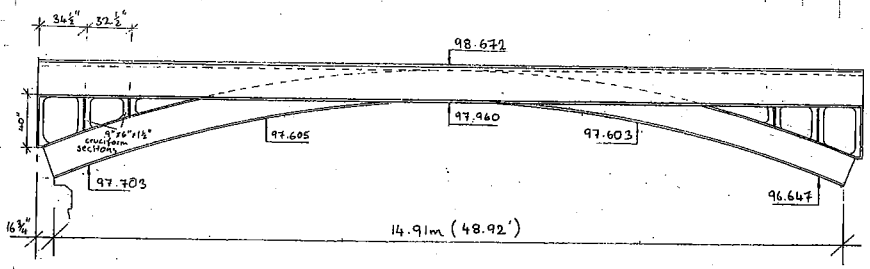
Project Title: BRB(R) MAJOR WORKS (2004 - 2009)			Sheet No: 1
Subject: VAR9|2165 : BE4 ASSESSMENTS			Calc No: 157
Job No: J24110NA	DMB/5		File: R14
Made By: JLR	Date: APR.08	Revised By:	Date:
Checked By: ME	Date: 03/09	Checked By:	Date:

BE4 assessment of DMB/5

Site survey by Jacobs - Sept. 2007



Section



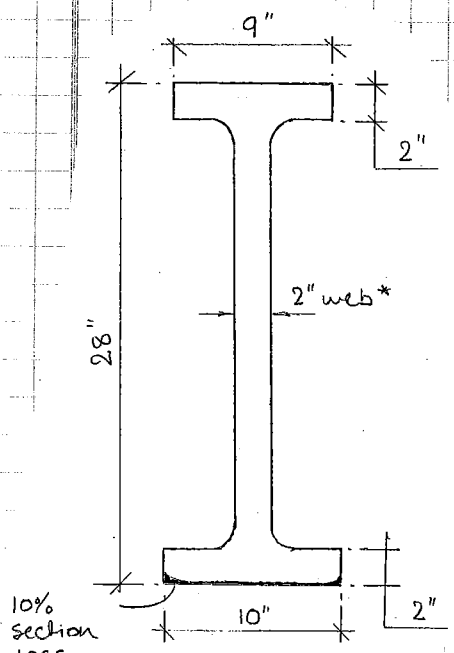
Elevation on west internal girder.

CALCULATION SHEET

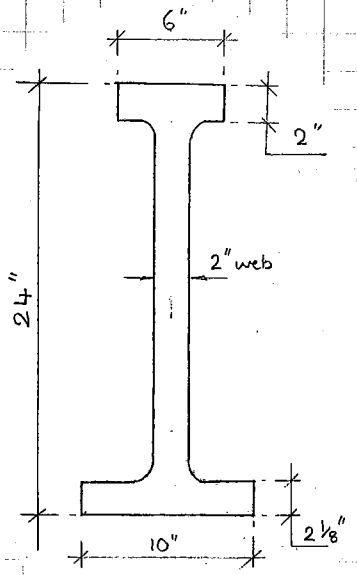
JACOBS

Project Title:		Sheet No: 2	
Subject: DMB | 5		Calc No: 157	
Job No: J24110NA		File:	
Made By: JLR	Date: 4/08	Revised By:	Date:
Checked By: ME	Date: 3/09	Checked By:	Date:

Internal girders: section properties



Horizontal leg



Arched girder

Element	Dimension b	Dimension d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	9	2	18.00	1	18.00	3031.98	6.00
Web	2	24	48.00	14	672.00	0.02	2304.00
Bottom flange	10	1.8	18.00	26.9	484.20	3005.34	4.86
NET AREA			84.00		1174.20		
GROSS AREA			84.00				
Depth to Neutral Axis y1		13.98					
					Sum	6037.34	2314.86
						Ixx=	8352.20
						Ztop	597.50
						Zbot	604.29

Horizontal leg

Element	Dimension b	Dimension d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	6	2	12.00	1	12.00	1827.78	4.00
Web	2	19.875	39.75	11.9375	474.52	78.37	1308.49
Bottom flange	10	2.125	21.25	22.9375	487.42	1956.72	8.00
NET AREA			73.00		973.94		
GROSS AREA			73.00				
Depth to Neutral Axis y1		13.34					
					Sum	3862.88	1320.49
						Ixx=	5183.36
						Ztop	388.51
						Zbot	486.32

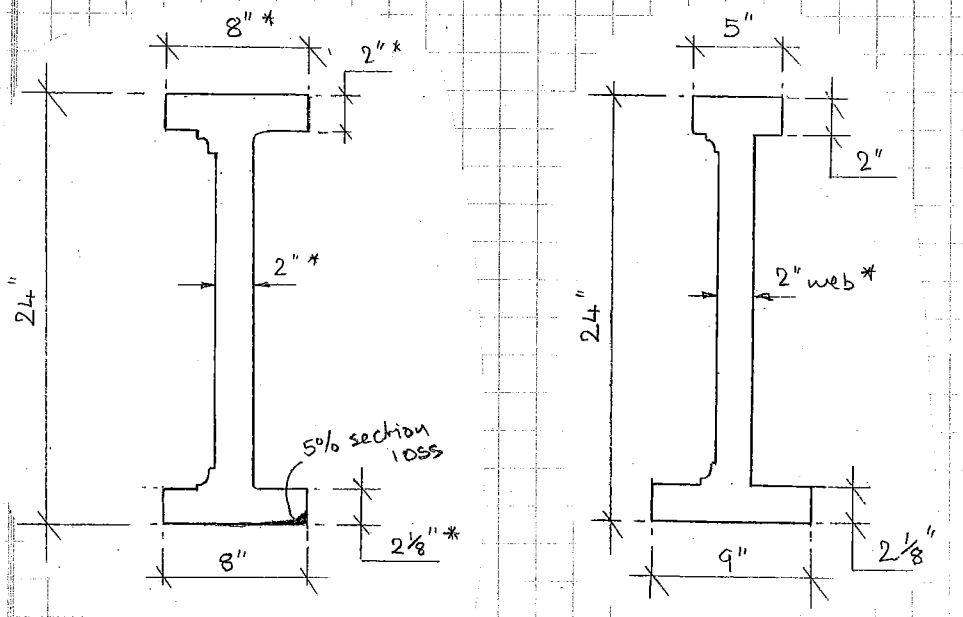
Arched girder:

CALCULATION SHEET

JACOBS

Project Title:		Sheet No: 3	
Subject: DMB15		Calc No: 157	
Job No:		File:	
Made By: JLR	Date: 4/08	Revised By:	Date:
Checked By: MC	Date: 3/09	Checked By:	Date:

Edge girders : section properties



* Assumed dimension

Horizontal leg

Arched girder

Element	Dimension b	Dimension d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	8	2	16.00	1	16.00	1923.38	5.33
Web	2	19.875	39.75	11.9375	474.52	0.03	1308.49
Bottom flange	8	2.02	16.16	22.885	369.82	1927.35	5.49
NET AREA			71.91		860.34		
GROSS AREA			71.91				
Depth to Neutral Axis y1		11.96					
					Sum	3850.75	1319.32
						Ixx=	5170.07
						Ztop	432.13
						Zbot	433.33

Horizontal leg :

Element	Dimension b	Dimension d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	5	2	10.00	1	10.00	1538.57	3.33
Web	2	19.875	39.75	11.9375	474.52	85.48	1308.49
Bottom flange	9	2.125	19.13	22.9375	438.68	1738.25	7.20
NET AREA			68.88		923.20		
GROSS AREA			68.88				
Depth to Neutral Axis y1		13.40					
					Sum	3362.31	1319.02
						Ixx=	4681.32
						Ztop	349.25
						Zbot	441.80

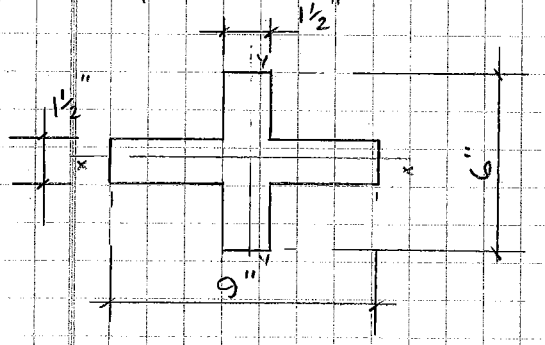
Arched girder :

CALCULATION SHEET

JACOBS

Project Title:				Sheet No:	4
Subject:	DMB15			Calc No:	157
Job No:	J24110NA			File:	
Made By:	JLR	Date:	4/08	Revised By:	Date:
Checked By:	ME	Date:	3/09	Checked By:	Date:

Spandrel columns:

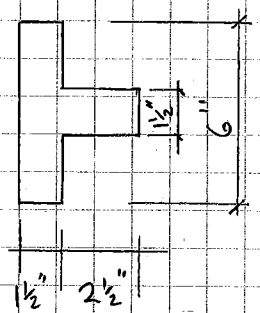


$A = 9 \times 1\frac{1}{2} + 4\frac{1}{2} \times 1\frac{1}{2} = 20.25\ in^2$.

$I_{xx} = \frac{1\frac{1}{2} \times 6^3}{12} + \frac{7\frac{1}{2} \times 1\frac{1}{2}^3}{12} = 29.11\ in^4$

$I_{yy} = \frac{1\frac{1}{2} \times 9^3}{12} + \frac{4\frac{1}{2} \times 1\frac{1}{2}^3}{12} = 92.39\ in^4$.

End spandrel:



$A = 6 \times 1\frac{1}{2} + 2\frac{1}{2} \times 1\frac{1}{2} = 12.75\ in^2$

$I_{xx} = \frac{1\frac{1}{2} \times 6^3}{12} + \frac{2\frac{1}{2} \times 1\frac{1}{2}^3}{12} = 27.7\ in^4$

I_{yy}:

Element	Dimension b	Dimension d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	6	1.5	9.00	0.75	6.75	3.11	1.69
Web	1.5	2.5	3.75	2.75	10.31	7.47	1.95
NET AREA			12.75		17.06		
Depth to Neutral Axis y1		1.34					
					Sum	10.59	3.64
					I_{yy} ~~I_{xx}~~=		14.23

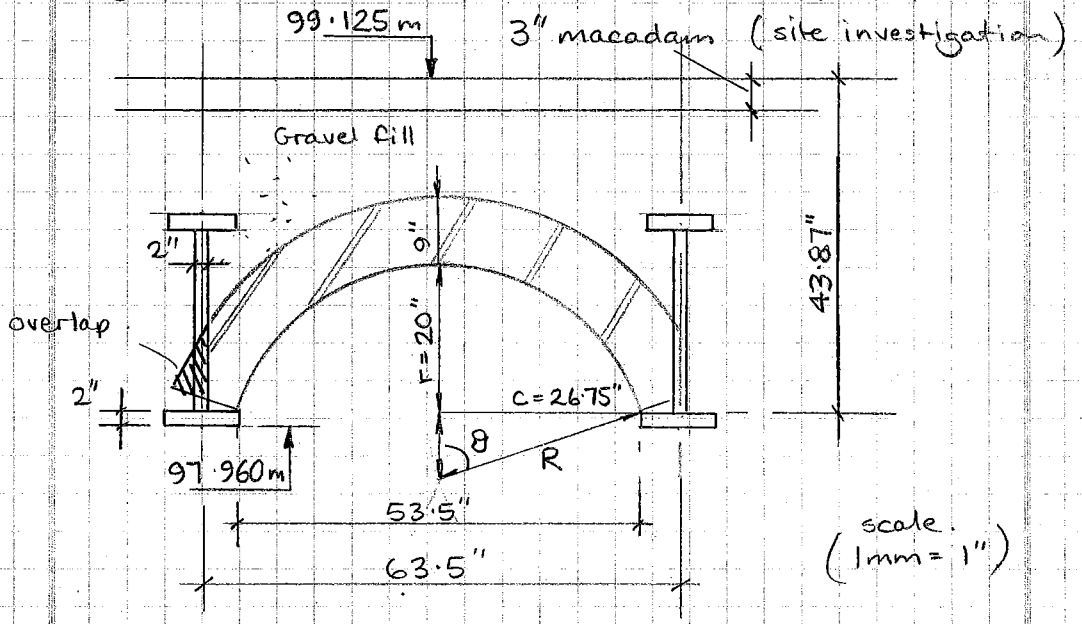
CALCULATION SHEET

JACOBS

Project Title:			Sheet No: 5
Subject: DMB|5			Calc No: 157
Job No:			File:
Made By:	Date:	Revised By:	Date:
Checked By: ME	Date: 3/09	Checked By:	Date:

DEAD LOAD ON MAIN GIRDERS :

Jack arch and road construction :



scale. (1mm = 1")

Jack arch span = 63·5" − 10" = 53·5" (site survey)

Rise = 20" (site survey)

$$R = \frac{r^2 + c^2}{2r} = 27.89''$$

$$\theta = \sin^{-1}\left(\frac{c}{R}\right) = 73.56^\circ$$

Area of sector $\nabla = \frac{2\theta}{360} \cdot \pi R^2 = 998.6 \text{ in}^2$

Area of triangle $\nabla = c(R-r) = 26.75 \times (7.89)$
$= 211 \text{ in}^2$

Area of segment $\frown = 998.6 - 211.0 = 787.6 \text{ in}^2$

Approx. area of arch barrel

$= \frac{2\theta}{360} \times \pi\left((R+r)^2 - R^2\right) = 748.5 \text{ in}^2$

Deduct overlap (scaled) $= 2 \times \frac{1}{2} \times 10 \times 5 = 50 \text{ in}^2$

Arch barrel area $= 698.5 \text{ in}^2$

CALCULATION SHEET

JACOBS

Project Title:		Sheet No: 6	
Subject: DMB|5		Calc No: 157	
Job No:		File:	
Made By: JLR	Date: 4|08	Revised By:	Date:
Checked By: ME	Date: 3|09	Checked By:	Date:

Area of fill

= 63·5 × 40·87 − (84 − 20) − 787·6 − 698·5 (Area girder above bottom flange)

= 1045·1 in²

Area of macadam surfacing

= 63·5 × 3 = 190·5 in²

Dead load imposed (excluding self-weight of girder)

Brick arch $\frac{698.5 \times 12}{12^3} \times 140 = 679.1$ lbs/ft

Gravel fill $\frac{1045.1 \times 12}{12^3} \times 135 = 979.8$ lbs/ft

macadam $\frac{190.5 \times 12}{12^3} \times 144 = 190.5$ lbs/ft

Total = 679·1 + 979·8 + 190·5 = 1849·4 lbs/ft

= 0·826 ton/ft

Adding in horizontal CI girder

$\frac{84 \times 12}{12^3} \times 450 = 262.5$ lbs/ft

Total with hor. CI girder = 0·943 ton/ft.

CALCULATION SHEET

JACOBS

Project Title:			Sheet No: 7
Subject: DMB/5			Calc No: 157
Job No:			File:
Made By: JLR	Date: 4/08	Revised By:	Date:
Checked By: ME	Date: 3/09	Checked By:	Date:

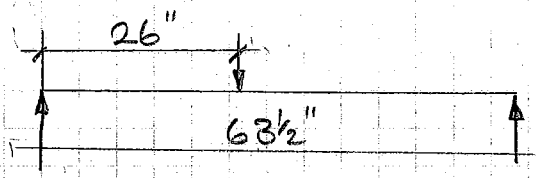
See Calc. Annex

LIVE LOAD DISTRIBUTION:

Previous work on a four girder jack arch bridge with almost identical beam spacing (63" against 63½") indicates by grillage analysis that proportion factors are 0.37 for the internal girder with one line of wheels placed directly on top, and 0.211* on the nearest edge girder under the same loading.

* In DMB/5 offset of wheel to outside girder is 26" as opposed to 16" in original model.

By simple statics the proportion factor would be:



$$\frac{26}{63\frac{1}{2}} \times \frac{1}{2} = 0.205$$

Increase 0.211 factor to 0.25 to allow for closer approach of wheels to edge girder.

BA 16/97 Fig. 2/2.

Bridge is at 37° skew. In accordance with BA16/97 increase proportion factors by 1.15 × as bridge is greater than 35° skew.

Internal girders $0.37 \times 1.15 = 0.425$

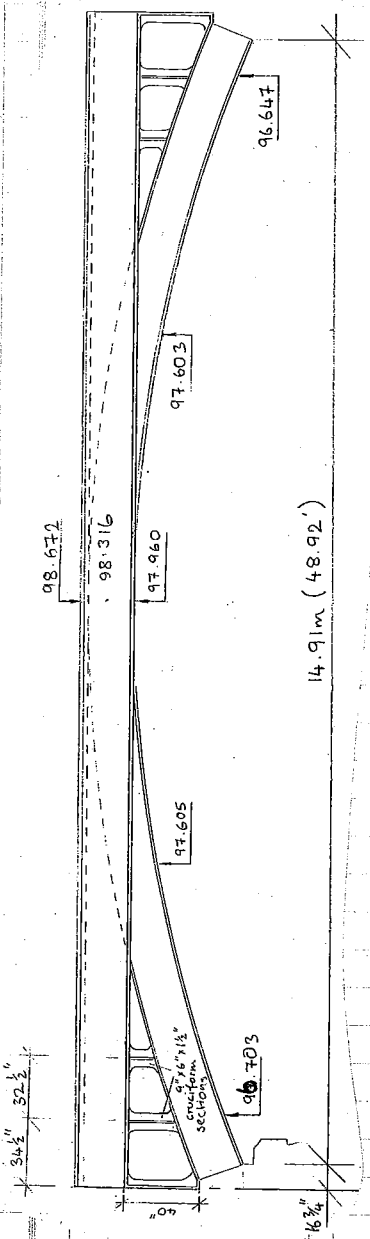
Edge girders $0.25 \times 1.15 = 0.287$

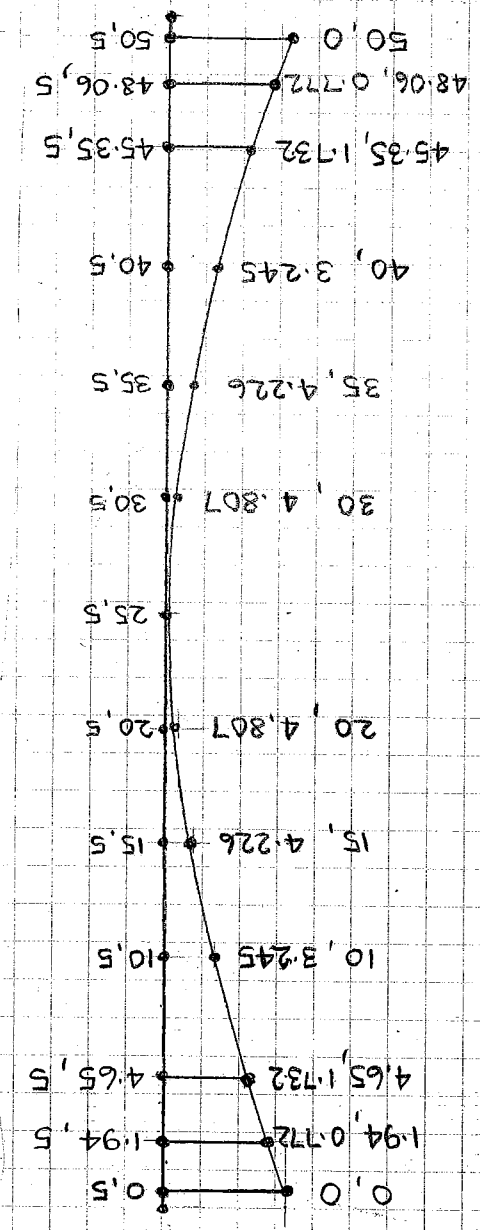
CALCULATION SHEET

JACOBS

Project Title:				Sheet No:	8
Subject:	DMB15			Calc No:	157
Job No:				File:	
Made By:	JLR	Date:	4/08	Revised By:	Date:
Checked By:	ME	Date:	3/09	Checked By:	Date:

2D structural model (STRAP)





Radius of arch based on 50ft span and 5ft rise to mid-span

$$R = \frac{F^2+C^2}{2F} = \frac{5^2+25^2}{2\times 5} = 65\,ft.$$

$x^2+y^2=r^2$ Level of offsets from centre

offset	level
0	5
5	4.807
10	4.226
15	3.245
20.35	1.732
23.06	0.772

STRAP

STRUCTURAL ANALYSIS PROGRAMS

GTS CADBUILD LIMITED
Woodbrook House
30 Bridge Street
Loughborough LE11 1NH
Tel:(0)1509 260559
Fax:(0)1509 269221

DMB5
Model data
Prepared by: JLR

Page: 1
Date: 22/04/08

SHEET No 9
CALC No 157
FILE
JOB No J24110NA
MADE BY JLR
CHECKED BY ME

NODAL COORDINATE TABLE (units - ft.)

NODE	X1	X2	X3
1	0.000	0.000	0.000
2	1.940	0.772	0.000
3	4.650	1.732	0.000
4	10.000	3.245	0.000
5	15.000	4.226	0.000
6	20.000	4.807	0.000
7	25.000	5.000	0.000
8	30.000	4.807	0.000
9	35.000	4.226	0.000
10	40.000	3.245	0.000
11	45.350	1.732	0.000
12	48.060	0.772	0.000
13	50.000	0.000	0.000
14	0.000	5.000	0.000
15	1.940	5.000	0.000
16	4.650	5.000	0.000
17	10.000	5.000	0.000
18	15.000	5.000	0.000
19	20.000	5.000	0.000
20	30.000	5.000	0.000
21	35.000	5.000	0.000
22	40.000	5.000	0.000
23	45.350	5.000	0.000
24	48.060	5.000	0.000
25	50.000	5.000	0.000

NODAL RESTRAINED DOF TABLE

NODE	X1	X2	X3	X4	X5	X6
1	1	1	1	1	1	0
13	1	1	1	1	1	0

MATERIAL TABLE (units - ton in.)

NO.	Name	Modulus of Elasticity	Poisson ratio	Density	Thermal coefficient	Shear modulus
1	CI	0.5826E+04	0.200	0.1163E-03	0.00000000	0.2427E+04

90000 N/mm² = 5825.6 ton/in² ✓

450 lbs/ft³ = 0.201 ton/ft³
= 0.000116 ton/in³ ✓

DMB5
Model data
Internal girder properties.
Prepared by: JLR

Page: 2
Date: 22/04/08

SECTION PROPERTY TABLE (units - in.)

PROPERTY NO. 1					
A=0.8400E+02 Material = 1 - Cl	I2=0.0000E+00	I3=0.8352E+04	J=0.0000E+00	SF2=0.850 SF3=0.850	See p.2
PROPERTY NO. 2					
A=0.7300E+02 Material = 1 - Cl	I2=0.0000E+00	I3=0.5183E+04	J=0.0000E+00	SF2=0.850 SF3=0.850	See p.2
PROPERTY NO. 3					
A=0.2025E+02 Material = 1 - Cl	I2=0.0000E+00	I3=0.9239E+02	J=0.0000E+00	SF2=0.850 SF3=0.850	See p 4
PROPERTY NO. 4					
A=0.1275E+02 Material = 1 - Cl	I2=0.0000E+00	I3=0.1423E+02	J=0.0000E+00	SF2=0.850 SF3=0.850	See p 4

SHEET No 10
CALC No 157
FILE
JOB No
MADE BY JLR
CHECKED BY ME

BEAM CONNECTIVITY TABLE

Beam No.	JA	JB	JC/ Beta	Release AJ	mv	mv	Length	prop no.	mat no.	Beam x2 direction cosines			offs. no.
1	1	2	0				2.088	2	1	-0.370	0.929	0.000	
2	2	3	0				2.875	2	1	-0.334	0.943	0.000	
3	3	4	0				5.560	2	1	-0.272	0.962	0.000	
4	4	5	0				5.095	2	1	-0.193	0.981	0.000	
5	5	6	0				5.034	2	1	-0.115	0.993	0.000	
6	6	7	0				5.004	2	1	-0.039	0.999	0.000	
7	7	8	0				5.004	2	1	0.039	0.999	0.000	
8	8	9	0				5.034	2	1	0.115	0.993	0.000	
9	9	10	0				5.095	2	1	0.193	0.981	0.000	
10	10	11	0				5.560	2	1	0.272	0.962	0.000	
11	11	12	0				2.875	2	1	0.334	0.943	0.000	
12	12	13	0				2.088	2	1	0.370	0.929	0.000	
13	14	15	0				1.940	1	1	0.000	1.000	0.000	
14	15	16	0				2.710	1	1	0.000	1.000	0.000	
15	16	17	0				5.350	1	1	0.000	1.000	0.000	
16	17	18	0				5.000	1	1	0.000	1.000	0.000	
17	18	19	0				5.000	1	1	0.000	1.000	0.000	
18	19	7	0				5.000	1	1	0.000	1.000	0.000	
19	7	20	0				5.000	1	1	0.000	1.000	0.000	
20	20	21	0				5.000	1	1	0.000	1.000	0.000	
21	21	22	0				5.000	1	1	0.000	1.000	0.000	
22	22	23	0				5.350	1	1	0.000	1.000	0.000	
23	23	24	0				2.710	1	1	0.000	1.000	0.000	
24	24	25	0				1.940	1	1	0.000	1.000	0.000	
25	1	14	0				5.000	4	1	-1.000	0.000	0.000	
26	2	15	0				4.228	3	1	-1.000	0.000	0.000	
27	3	16	0				3.268	3	1	-1.000	0.000	0.000	
28	11	23	0				3.268	3	1	-1.000	0.000	0.000	
29	12	24	0				4.228	3	1	-1.000	0.000	0.000	
30	13	25	0				5.000	4	1	-1.000	0.000	0.000	

TOTAL BEAMS WEIGHT OF PROPERTY NO.	1=	5.859
TOTAL BEAMS WEIGHT OF PROPERTY NO.	2=	5.226
TOTAL BEAMS WEIGHT OF PROPERTY NO.	3=	0.424
TOTAL BEAMS WEIGHT OF PROPERTY NO.	4=	0.178
TOTAL BEAMS WEIGHT =		11.686

DMB5

Moment envelope

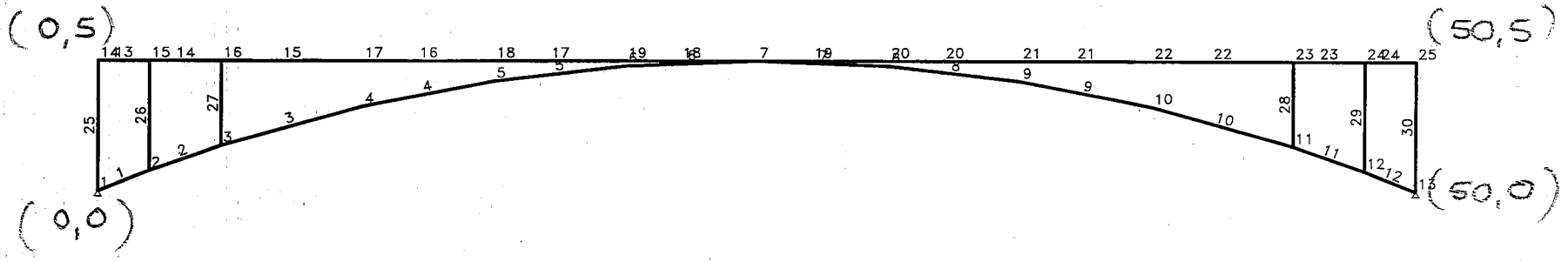
X2
X1

SCALE = 1:76.2 | UNITS: ton ft | DATE:21/04/08

SHEET No 11
CALC No
FILE
JOB No J2411ONA
MADE BY JLR
CHECKED BY

Structure model.

Node and member numbers.



GEOMETRY

DMB5

SCALE = 1:76.2

DATE:22/04/08

X2

X1

SHEET No 12

CALC No

FILE

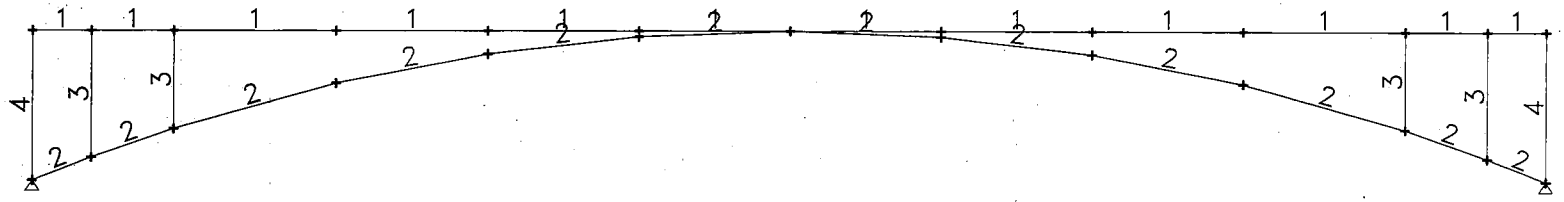
JOB No

MADE BY JLR

CHECKED BY MK

Structure model

Member properties.



DMB5

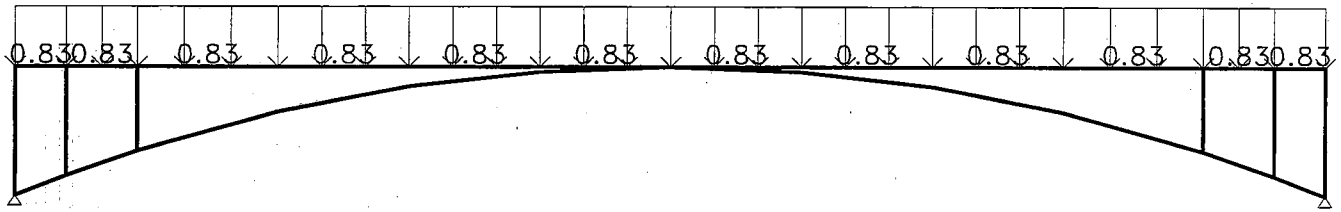
Load 1: Dead load jack arch deck

X2
X1

SCALE = 1:88	UNITS: ton ft	DATE:22/04/08

Dead load from deck construction excluding self-weight of girders :
0·826 ton/ft (see p.6)

SHEET No 13
CALC No
FILE
JOB No
MADE BY JLR
CHECKED BY



DMB5

Load 2: Self weight cast iron girders

X2
X1

SCALE = 1:88 | UNITS: ton ft | DATE:22/04/08

SHEET No 14
CALC No
FILE
JOB No
MADE BY JLR
CHECKED BY ME

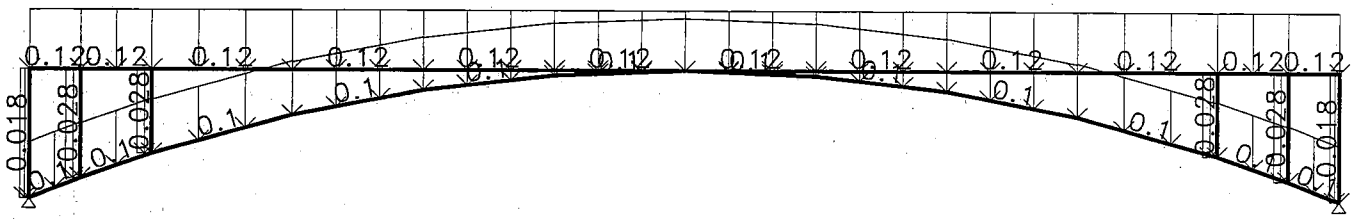
Self weight of cast iron girders

p.6 Horizontal : 262·5 lbs/ft = 0·117 ton/ft

p.2 Arched : $\frac{73 \times 12}{12^3} \times 450 = 228$ lbs/ft = 0·102 ton/ft

p.4 Internal spandrels = $\frac{20.25}{12^2} \times 450 = 63.3$ lbs/ft = 0·028 ton/ft

p4 End spandrels = $\frac{12.75}{12^2} \times 450 = 39.8$ lbs/ft = 0·0177 ton/ft



DMB5
Superimposed dead load
Prepared by: JLR

Page: 15
Date: 22/04/08

BEAM RESULTS for load no. 1 (Units: ton, ton*ft)
Dead load jack arch deck

Bm.	*Node*	*Axial*	*V2*	*M3*
1	1	50.152	2.987	0.425
	2	-50.152	-2.987	5.812
2	2	48.325	5.033	-2.497
	3	-48.325	-5.033	16.966
3	3	41.628	-3.548	-12.710
	4	-41.628	3.548	-7.014
4	4	41.779	-0.131	7.014
	5	-41.779	0.131	-7.684
5	5	41.662	3.127	7.684
	6	-41.662	-3.127	8.055
6	6	41.297	6.326	-8.055
	7	-41.297	-6.326	39.711
7	7	41.297	-6.326	-39.711
	8	-41.297	6.326	8.055
8	8	41.662	-3.127	-8.055
	9	-41.662	3.127	-7.684
9	9	41.779	0.131	7.684
	10	-41.779	-0.131	-7.014
10	10	41.628	3.548	7.014
	11	-41.628	-3.548	12.710
11	11	48.325	-5.033	-16.966
	12	-48.325	5.033	2.498
12	12	50.152	-2.987	-5.812
	13	-50.152	2.987	-0.425
13	14	0.175	-0.669	0.447
	15	-0.175	2.271	-3.299
14	15	1.797	-1.832	6.845
	16	-1.797	4.071	-14.844
15	16	4.645	8.894	19.895
	17	-4.645	-4.475	15.869
16	17	4.645	4.475	-15.869
	18	-4.645	-0.345	27.921
17	18	4.645	0.345	-27.921
	19	-4.645	3.785	19.323
18	19	4.645	-3.785	-19.323
	7	-4.645	7.915	-9.926
19	7	4.645	7.915	9.926
	20	-4.645	-3.785	19.323
20	20	4.645	3.785	-19.323
	21	-4.645	0.345	27.921
21	21	4.645	-0.345	-27.921
	22	-4.645	4.475	15.869
22	22	4.645	-4.475	-15.869
	23	-4.645	8.894	-19.895

BEAM RESULTS for load no. 1 (Units: ton, ton*ft)
Dead load jack arch deck

Bm.	*Node*	*Axial*	*V2*	*M3*
23	23	1.797	4.071	14.844
	24	-1.797	-1.832	-6.845
24	24	0.175	2.271	3.299
	25	-0.175	-0.669	-0.447
25	1	-0.669	-0.175	-0.425
	14	0.669	0.175	-0.447
26	2	0.439	-1.623	-3.314
	15	-0.439	1.623	-3.546
27	3	12.965	-2.848	-4.256
	16	-12.965	2.848	-5.051
28	11	12.965	2.848	4.256
	23	-12.965	-2.848	5.051
29	12	0.439	1.623	3.314
	24	-0.439	-1.623	3.546
30	13	-0.669	0.175	0.425
	25	0.669	-0.175	0.447
MAXIMUM		-50.152	8.894	39.711
Beam no.		12	22	6

Axial load and moments due to permanent load from deck.

SHEET No. 15
CALC No 157
FILE
JOB No
MADE BY JLR.
CHECKED BY ME

DMB5

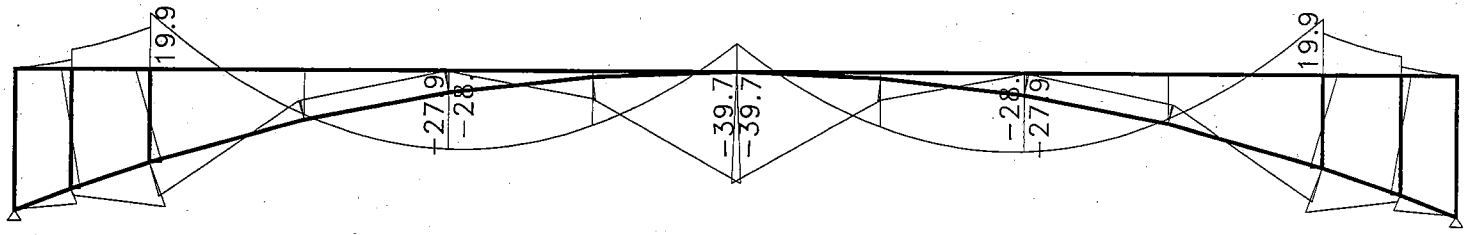
SCALE = 1:80 | UNITS: ton*ft | DATE:22/04/08

X2
X1

Permanent loads from deck construction

Graphical output of moments tabulated on p. 15.

SHEET No. 16
CALC No.
FILE
JOB No.
MADE BY JLR.
CHECKED BY ME



M3 MOMENT LOAD NO. 1 Dead load jack arch deck

DMB5

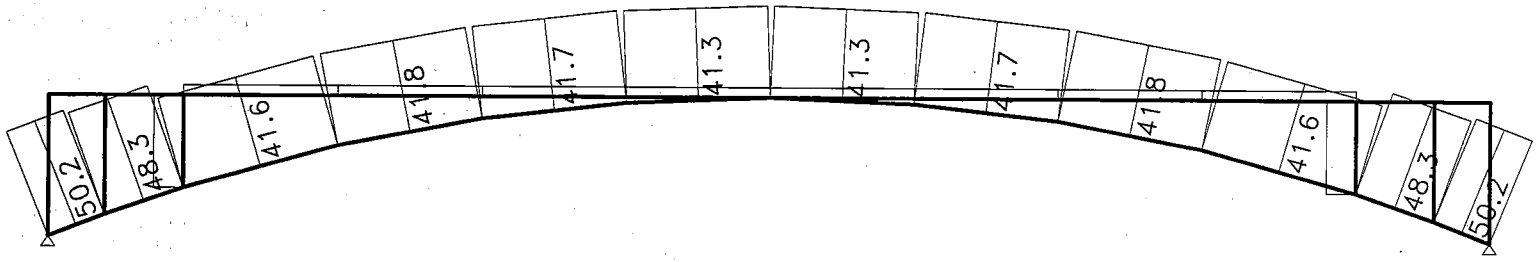
X2
X1

SCALE = 1:80	UNITS: ton	DATE:22/04/08

Permanent loads from deck construction

Graphical output of axial loads tabulated on p.15

SHEET No 17
CALC No
FILE
JOB No
MADE BY JLR
CHECKED BY



AXIAL FORCE LOAD NO. 1 Dead load jack arch deck

DMB5

Prepared by: JLR

BEAM RESULTS for load no. 2 (Units: ton, ton*ft)
Self weight cast iron girders

Bm.	Node	Axial	V2	M3
1	1	13.627	0.680	0.110
	2	-13.548	-0.482	1.103
2	2	13.040	0.887	-0.245
	3	-12.942	-0.611	2.397
3	3	11.680	-0.065	-1.245
	4	-11.526	0.610	-0.631
4	4	11.537	0.335	0.631
	5	-11.437	0.175	-0.224
5	5	11.416	0.718	0.224
	6	-11.357	-0.209	2.108
6	6	11.307	1.083	-2.108
	7	-11.287	-0.574	6.252
7	7	11.287	-0.574	-6.252
	8	-11.307	1.083	2.108
8	8	11.357	-0.209	-2.108
	9	-11.416	0.718	-0.224
9	9	11.437	0.175	0.224
	10	-11.537	0.335	-0.631
10	10	11.526	0.610	0.631
	11	-11.680	-0.065	1.245
11	11	12.942	-0.611	-2.397
	12	-13.040	0.887	0.245
12	12	13.548	-0.482	-1.103
	13	-13.627	0.680	-0.110
13	14	0.045	0.084	0.113
	15	-0.045	0.143	-0.170
14	15	0.459	0.005	1.064
	16	-0.459	0.313	-1.481
15	16	1.198	1.376	2.745
	17	-1.198	-0.749	2.941
16	17	1.198	0.749	-2.941
	18	-1.198	-0.163	5.223
17	18	1.198	0.163	-5.223
	19	-1.198	0.423	4.576
18	19	1.198	-0.423	-4.576
	7	-1.198	1.008	0.998
19	7	1.198	1.008	-0.998
	20	-1.198	-0.423	4.576
20	20	1.198	0.423	-4.576
	21	-1.198	0.163	5.223
21	21	1.198	-0.163	-5.223
	22	-1.198	0.749	2.941
22	22	1.198	-0.749	-2.941
	23	-1.198	1.376	-2.745

BEAM RESULTS for load no. 2 (Units: ton, ton*ft)
Self weight cast iron girders

Bm.	Node	Axial	V2	M3
23	23	0.459	0.313	1.481
	24	-0.459	0.005	-1.064
24	24	0.045	0.143	0.170
	25	-0.045	0.084	-0.113
25	1	0.173	-0.045	-0.110
	14	-0.084	0.045	-0.113
26	2	0.267	-0.414	-0.858
	15	-0.148	0.414	-0.894
27	3	1.781	-0.739	-1.152
	16	-1.689	0.739	-1.263
28	11	1.781	0.739	1.152
	23	-1.689	-0.739	1.263
29	12	0.267	0.414	0.858
	24	-0.148	-0.414	0.894
30	13	0.173	0.045	0.110
	25	-0.084	-0.045	0.113
MAXIMUM		-13.627	1.376	6.252
Beam no.		12	22	6

Axial load and moments due to self weight of cast iron girders.

SHEET No 18
CALC No 157
FILE
JOB No
MADE BY JLR
CHECKED BY ME

DMB5

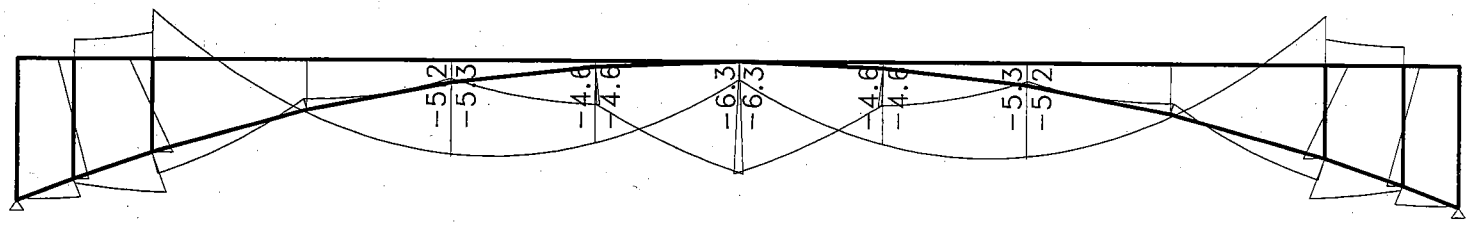
X2
X1

SCALE = 1:80 | UNITS: ton*ft | DATE:22/04/08

Self weight of girders

Graphical output of moments tabulated on p. 18.

SHEET No 19
CALC No
FILE
JOB No
MADE BY JLR
CHECKED BY MG



M3 MOMENT LOAD NO. 2 Self weight cast iron girders

DMB5

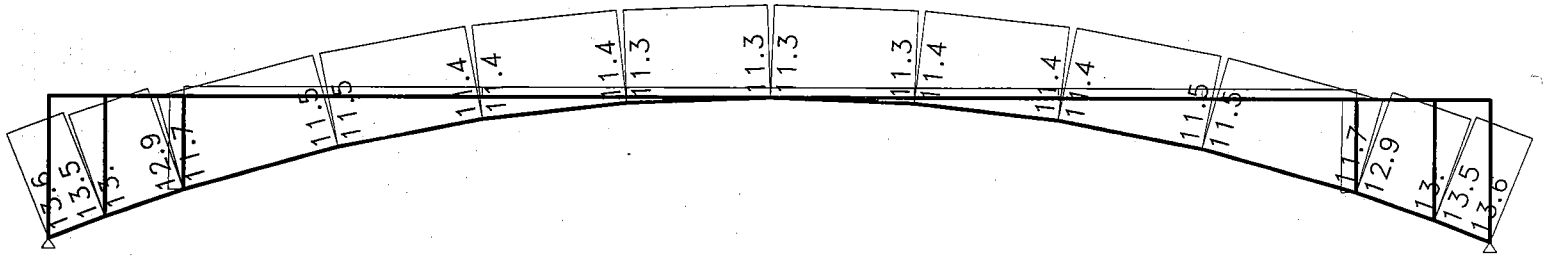
X2
X1

SCALE = 1:80	UNITS: ton	DATE:22/04/08

Self weight of girders

Graphical output of axial loads tabulated on p. 18.

SHEET No 20
CALC No
FILE
JOB No
MADE BY
CHECKED BY ML



AXIAL FORCE LOAD NO. 2 Self weight cast iron girders

CALCULATION SHEET

JACOBS

Project Title:		Sheet No: 21	
Subject: DMB 15		Calc No: 157	
Job No:		File:	
Made By: JLR	Date: 4/08	Revised By:	Date:
Checked By: ME	Date: 3/09	Checked By:	Date:

LIVE LOADING:

Live loading is examined using the BE4 24 ton 4 axle vehicle train. Two conditions are examined:

1) Full vehicle train tracking over the bridge examined at 2 foot intervals

2) Single 24 ton vehicle tracking over the bridge at 2 foot intervals

In both cases, as the model is symmetrical about mid-span, the critical axle is only applied over half the span :- 12 or 13 load cases at 2ft intervals from mid-span.

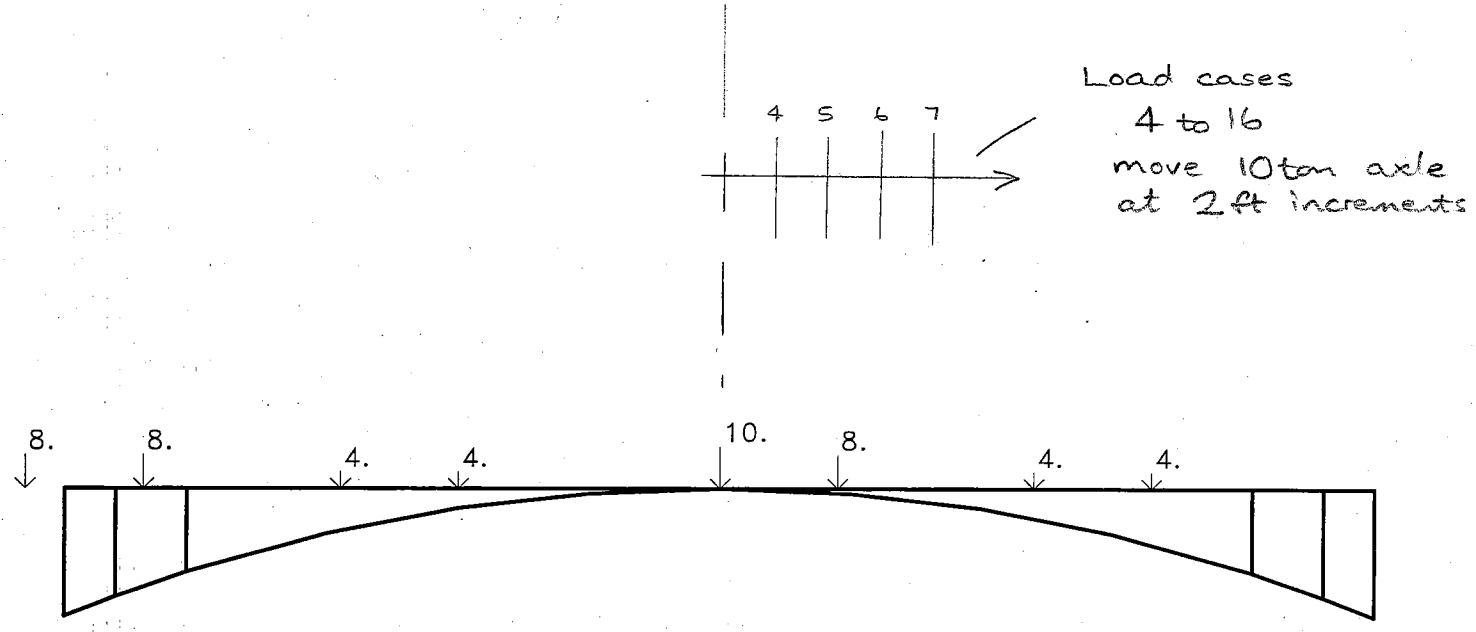
The full vehicle loading is applied to the model, so the proportion factor determined on page 7 needs to be applied to the load effects generated.

DMB5

Load 3: 24 ton vehicle train

X2
X1

SCALE = 1:88 | UNITS: ton ft | DATE:21/04/08



SHEET No 22
CALC No 157
FILE
JOB No
MADE BY JLR
CHECKED BY

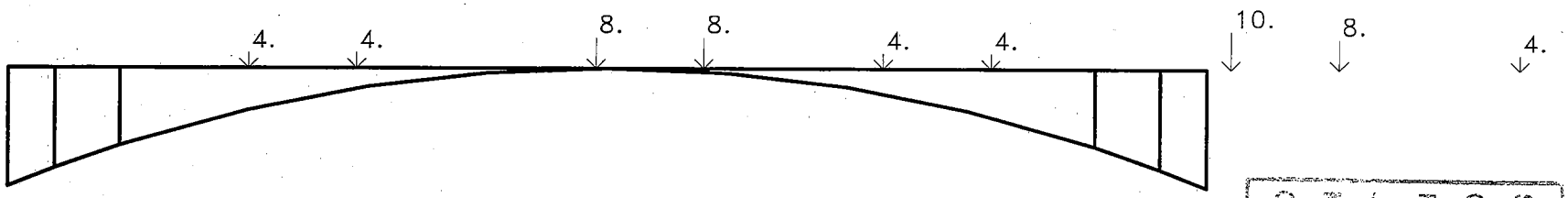
DMB5

Load 16: 24 ton vehicle train #14

X2
X1

SCALE = 1:88	UNITS: ton ft	DATE:21/04/08

Load case 16



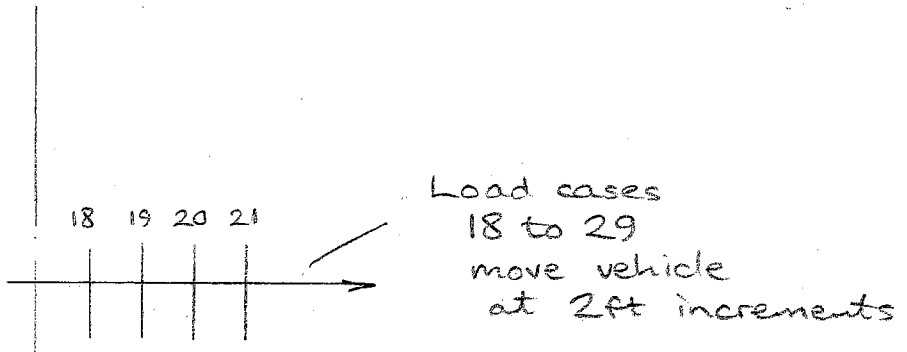
SHEET No 23
CALC No 157
FILE
JOB No
MADE BY JLR
CHECKED BY

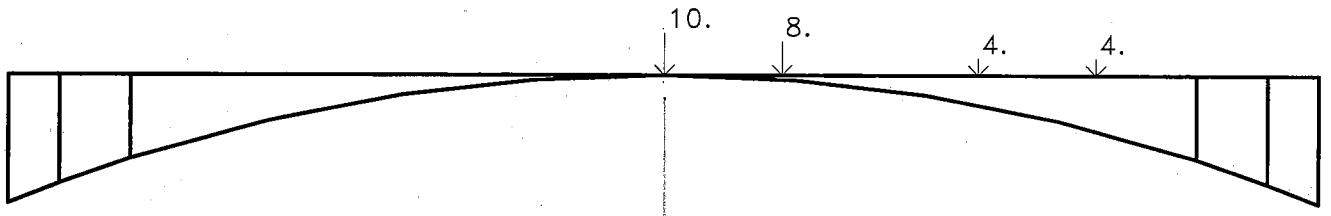
DMB5

Load 17: 24 ton single vehicle

X2
X1

SCALE = 1:88 | UNITS: ton ft | DATE:21/04/08





SHEET No 24
CALC No 157
FILE
JOB No
MADE BY JLR
CHECKED BY MG

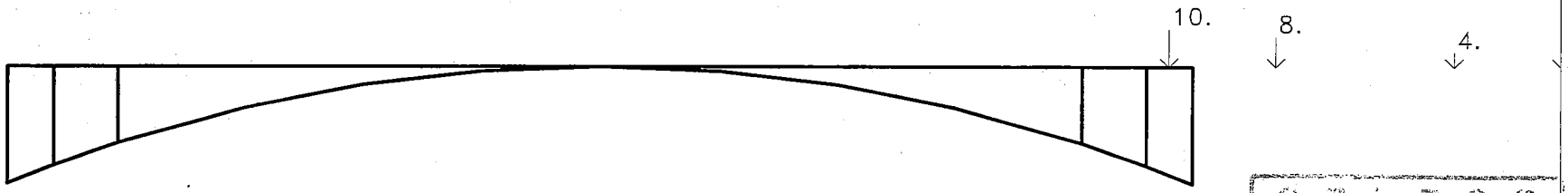
DMB5

Load 29: 24 ton single vehicle #13

X2
X1

SCALE = 1:88	UNITS: ton ft	DATE:21/04/08

Load case 29



SHEET No. 25
CALC No. 157
FILE
JOB No.
MADE BY JLR
CHECKED BY

DMB5
Model data
Prepared by: JLR

Live loads 3-29 only
Dead loads excluded.

Page: 26
Date: 23/04/08

MAXIMUM BEAM RESULTS (Units: ton, ton*ft)

Beam		*Axial*	*V2*	*M3*
1	M3 Max	36.142	-2.123	4.507
	Load			19
	M3 Min	61.730	7.659	-15.434
	Load			3
2	M3 Max	39.313	1.009	5.171
	Load			18
	M3 Min	60.113	6.939	-28.398
	Load			6
3	M3 Max	36.538	-2.717	18.484
	Load			18
	M3 Min	51.049	-5.065	-22.573
	Load			6
4	M3 Max	36.638	0.280	18.484
	Load			18
	M3 Min	1.395	-0.044	1.115
	Load			29
5	M3 Max	33.992	2.758	17.924
	Load			19
	M3 Min	46.002	3.819	-11.221
	Load			13
6	M3 Max	23.639	3.522	7.116
	Load			22
	M3 Min	47.011	7.480	-48.068
	Load			12
7	M3 Max	0.934	0.258	2.010
	Load			29
	M3 Min	49.741	-8.047	-53.546
	Load			4
8	M3 Max	50.709	-4.331	9.819
	Load			3
	M3 Min	32.698	-3.029	-18.885
	Load			18
9	M3 Max	50.892	-0.363	11.670
	Load			3
	M3 Min	12.011	0.982	-12.479
	Load			24
10	M3 Max	50.751	3.800	11.670
	Load			3
	M3 Min	11.890	1.961	-23.380
	Load			24
11	M3 Max	57.954	-5.154	0.865
	Load			3
	M3 Min	17.559	-5.290	-27.726
	Load			24
12	M3 Max	59.006	-6.873	0.574
	Load			11
	M3 Min	13.857	-8.807	-18.035
	Load			26
13	M3 Max	0.184	-3.749	7.743
	Load			11
	M3 Min	0.239	1.474	-2.260
	Load			5

MAXIMUM BEAM RESULTS (Units: ton, ton*ft)

Beam		*Axial*	*V2*	*M3*
14	M3 Max	2.204	-4.340	23.240
	Load			9
	M3 Min	-0.011	-0.280	0.347
	Load			29
15	M3 Max	5.753	10.586	29.549
	Load			9
	M3 Min	6.469	6.461	-29.978
	Load			7
16	M3 Max	0.704	0.946	15.739
	Load			20
	M3 Min	5.753	-5.414	-44.018
	Load			9
17	M3 Max	0.341	0.489	11.528
	Load			22
	M3 Min	5.753	-5.414	-44.018
	Load			9
18	M3 Max	5.753	-9.414	20.119
	Load			9
	M3 Min	4.935	-3.088	-30.261
	Load			12
19	M3 Max	6.021	11.350	26.273
	Load			6
	M3 Min	5.345	3.868	-42.491
	Load			19
20	M3 Max	0.409	-0.021	-0.036
	Load			29
	M3 Min	5.303	-1.979	-59.237
	Load			22
21	M3 Max	0.409	-0.021	0.071
	Load			29
	M3 Min	5.303	-1.979	-59.237
	Load			22
22	M3 Max	4.875	-8.732	28.727
	Load			3
	M3 Min	5.041	-3.766	-45.424
	Load			23
23	M3 Max	1.651	0.626	23.834
	Load			16
	M3 Min	0.912	-6.492	-15.760
	Load			27
24	M3 Max	0.154	9.670	19.112
	Load			16
	M3 Min	0.132	-2.893	-5.305
	Load			26
25	M3 Max	-0.099	-0.248	0.624
	Load			6
	M3 Min	2.822	-0.248	-0.614
	Load			6
26	M3 Max	0.774	-2.305	4.967
	Load			6
	M3 Min	3.063	-2.305	-4.777
	Load			6

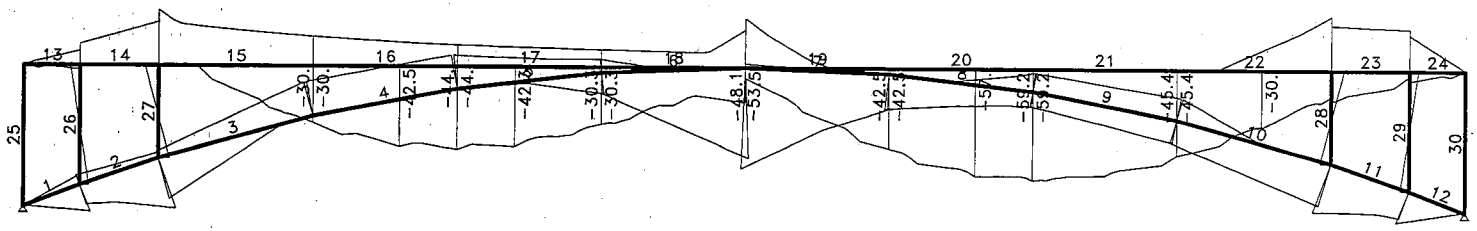
MAXIMUM BEAM RESULTS (Units: ton, ton*ft)

Beam		*Axial*	*V2*	*M3*
27	M3 Max	16.030	-3.929	6.933
	Load			7
	M3 Min	17.741	-3.929	-5.907
	Load			7
28	M3 Max	16.877	3.802	5.677
	Load			8
	M3 Min	16.701	3.802	-6.746
	Load			8
29	M3 Max	2.682	2.160	4.496
	Load			10
	M3 Min	1.294	2.163	-4.694
	Load			8
30	M3 Max	5.597	0.228	0.574
	Load			11
	M3 Min	-2.917	0.231	-0.585
	Load			8
	* Maximum	63.608	15.743	29.549
	Beam	1	19	15
	Load	6	18	9
	* Minimum	-9.670	-15.402	-59.237
	Beam	30	22	20
	Load	16	10	22

DMB5

SCALE = 1:80 | UNITS: ton*ft | DATE:23/04/08

X2
X1



Live load moment envelope.

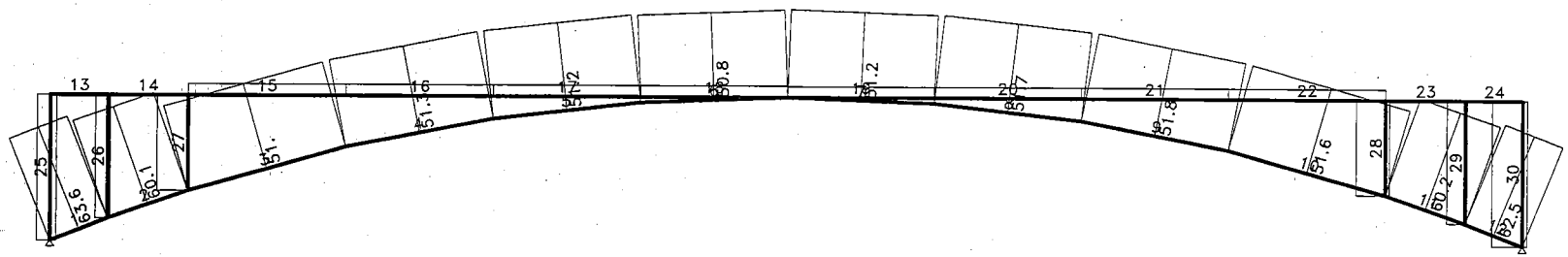
M3 MOMENT LOADS ENVELOPE

SHEET No 28
CALC No 157
FILE
JOB No
MADE BY JLR
CHECKED BY

DMB5

X2
X1

SCALE = 1:76 | UNITS: ton | DATE:23/04/08



Live axial load envelope

AXIAL FORCE LOADS ENVELOPE

SHEET No 29
CALC No 157
FILE
JOB No
MADE BY JLR
CHECKED BY

CALCULATION SHEET

JE JACOBS

Project Title:			Sheet No: 30
Subject: DMB|5			Calc No: 157
Job No:			File:
Made By: JLR	Date: 3|09	Revised By:	Date:
Checked By: ME	Date: 03-09	Checked By:	Date:

Horizontal Cast Iron girders:
(members 13 to 24)

p.26 Max. live load: 59.2 ton.ft (Mem. 20|21)

Apply proportion factor:

p.7. $59.2 \times 0.425 = 25.2$ ton.ft

Coexistent axial load $= 5.3 \times 0.425 = 2.25$ tons

Coexistent dead load effects:

p.15 Deck load, M = 27.9 ton.ft
A = 4.6 tons

p.18 Self weight M = 5.2 ton.ft
1.2 tons

TOTAL DEAD LOAD: M = 33.1 ton.ft
A = 5.8 ton.ft

Dead load bending stress (tension)

p.2 $f_D = M/Z = \frac{33.1 \times 12}{604.3} = 0.657$ ton/in^2

Live load bending stress (tension)

$f_L = \frac{25.2 \times 12}{604.3} = 0.500$ ton/in^2

Permissible tensile stress cast iron:

BE4 304 (c) $5f_L + 2.2f_D \not> 8$

$5 \times 0.500 + 2.2 \times 0.657 = 3.94$ ton/in^2 $\not>$ 8.0 ton/in^2

∴ Satisfactory.

CALCULATION SHEET

JE JACOBS

Project Title:		Sheet No: 31	
Subject: DMB|5		Calc No: 157	
Job No:		File:	
Made By: JLR	Date: 3|09	Revised By:	Date:
Checked By: MK	Date: 03-09	Checked By:	Date:

Arched Cast Iron girders (Members 1-12)

Maximum live load bending : 53·5 tan.ft (6\|7)

Apply proportion factor : 53·5 × 0·425 = 22·7 tan.ft

Coexistent axial compression = 49·7 × 0·425 = 21·2 tons

Coexistent dead load effects

p 15 Deck load M = 39·7 tan ft
A = 41·3 tons

Self weight M = 6·2 tan ft
A = 11·3 tons

TOTAL DEAD LOAD M = 45·9 tan ft
A = 52·6 tons (compression)

Dead load axial compressive stress

$= 52{\cdot}6 / 13{\cdot}34 = 3{\cdot}94$ tan/in².

Dead load bending tension :

$M/Z = \frac{45{\cdot}9 \times 12}{486{\cdot}3} = 1{\cdot}13$ tan/in²

Bottom flange compression = 3·94 − 1·13 = 2·81 tan/in².

Dead load bending compression

$= \frac{45{\cdot}9 \times 12}{388{\cdot}51} = 1{\cdot}42$ tan/in²

Top flange compression = 3·94 + 1·42 = 5·36 tan/in²

CALCULATION SHEET

JE JACOBS

Project Title:			Sheet No: 32
Subject: DMB/5			Calc No: 157
Job No:			File:
Made By: JLR	Date: 3/09	Revised By:	Date:
Checked By: ME	Date: 03.09	Checked By:	Date:

Live load axial compressive stress

$= 21.2 / 13.34 = 1.59$ ton/in²

Live load bending tension:

$= \frac{22.7 \times 12}{486.3} = 0.56$ ton/in².

Bottom flange compression $= 1.59 - 0.56 = 1.03$ ton/in²

Live load bending compression

$= \frac{21.2 \times 12}{388.5} = 0.65$ ton/in².

Top flange compression $= 1.59 + 0.65 = 2.24$ ton/in².

Permissible compressive stress:

Total applied stress $= 2.24 + 5.36 = 7.60$ ton/in²

BE4 304(c) Permissible stress: 10 ton/in². > 7.60.

Arch girder satisfactory.

CALCULATION SHEET

JE JACOBS

Project Title:			Sheet No: 33
Subject: DMB/5			Calc No: 157
Job No:			File:
Made By: JLR	Date: 3/09	Revised By:	Date:
Checked By: MG	Date: 03-09	Checked By:	Date:

Spandrel struts (28 - 30)

Max. axial compression 16·88 tons (live)
Apply prop factor = 16·88 × 0·425 = 7·17 tons
Dead load = 1·78 + 12·96 tons

Total compression = 21·9 tons (Member 28)

BE4 305 b(ii) 2 Safe load for cast iron columns is given by:

$$P = \frac{f_c \cdot A}{5\left(1 + F \cdot a \cdot \frac{L^2}{K^2}\right)}$$

For member 28:

BE4 f_c = 36 ton/in²

p4 A = 20·25 in²

F (fixity factor) = ¼ (both ends fixed)

BE4 a = material factor = 1/1600

p.8 $L = (3 \cdot 268 \times 12) - \frac{28}{2} - \frac{24}{2} = 13 \cdot 2''$

(Frame dimension − ½ depth of connecting girders)

K = least radius of gyration

$$= \sqrt{\frac{29 \cdot 11}{20 \cdot 25}} = 1 \cdot 20 \text{ in.}$$

$$P = \frac{36 \times 20 \cdot 25}{5\left(1 + \frac{1}{4 \times 1600} \cdot \frac{13 \cdot 2^2}{1 \cdot 2^2}\right)} = 143 \text{ tons}$$

CALCULATION SHEET

JACOBS

Project Title:			Sheet No: 34
Subject: DMB/5			Calc No: 157
Job No:			File:
Made By: JLR	Date: 3/09	Revised By:	Date:
Checked By: ME	Date: 03-09	Checked By:	Date:

Check capacity member 29

$$L = (4.228 \times 12) - {}^{28}/_{2} - {}^{24}/_{2} = 24.74 \text{ in.}$$

$$P = \frac{36 \times 20.25}{5\left(1 + \frac{1}{4 \times 1600} \cdot \frac{24.74^2}{1.2^2}\right)} = \underline{136 \text{ tons}}$$

Check end strut (member 30)

$$L = (5 \times 12) - {}^{28}/_{2} - {}^{24}/_{2} = 34 \text{ in.}$$

P. 4

$$k = \sqrt{\frac{14.23}{12.75}} = 1.06''$$

$$A = 12.75 \text{ in}^2$$

$$P = \frac{36 \times 12.75}{5\left(1 + \frac{1}{4 \times 1600} \cdot \frac{34^2}{1.06^2}\right)} = 79 \text{ tons.}$$

Capacity of all struts exceeds maximum imposed load. Therefore satisfactory.

CALCULATION SHEET

JACOBS

Project Title:			Sheet No: 35
Subject: DMB/5			Calc No: 157
Job No:			File:
Made By: JLR	Date: 3/09	Revised By:	Date:
Checked By: MB	Date: 03-09	Checked By:	Date:

Edge girders:

Load effects in the edge girders can be conservatively obtained without modelling by:

1) Using same self weight values

2) Using half dead load from deck construction (excluding self weight)

3) Using proportion factors for edge girders applied to live load. (0.287)

p.7

Horizontal members:

p.18 1) Self weight — M = 5.2 ton ft, A = 1.2 tons

p.15 2) Deck load /2 — M = 14.0 ton ft, A = 2.3 tons

TOTAL DEAD LOAD — M = 19.2 ton ft, A = 3.5 tons

p.26/p7. Max. live load = 59.2 × 0.287 = 17.0 ton ft
Coexistent axial load = 5.3 × 0.287 = 1.52 tons

Dead load bending stress (tension)

p.3 $f_D = M/Z = \frac{19.2 \times 12}{433.3} = 0.532$ ton/in²

Live load bending stress (tension)

$f_L = \frac{17.0 \times 12}{433.3} = 0.471$ ton/in²

$5f_L + 2.2f_D \leq 8$

$5 \times 0.471 + 2.2 \times 0.532 = 3.52$ ton/in² ≤ 8 ton/in²

∴ Satisfactory.

CALCULATION SHEET

JACOBS

Project Title:			Sheet No: 36
Subject: DMB/5			Calc No: 157
Job No:			File:
Made By: JLR	Date: 3/09	Revised By:	Date:
Checked By: ME	Date: 03-09	Checked By:	Date:

Arched cast iron girders :

Maximum live load bending : 53·5 ton ft

Apply proportion factor : 53·5 × 0·287 = 15·3 ton ft.

Coexistent axial compression : 49·7 × 0·287 = 14·3 tons.

Coexistent dead load effects :

Deck load /2 — M = 19·85 ton ft, A = 20·65 tons

Self weight — M = 6·2 ton ft, A = 11·3 tons

TOTAL DEAD LOAD — M = 26·05 ton ft, A = 31·95 tons (comp)

Dead load axial compressive stress

$$= \frac{31.95}{13.40} = 2.38 \text{ ton/in}^2$$ p 3

Dead load bending tension :

$$M/Z = \frac{26.05 \times 12}{441.8} = 0.71 \text{ ton/in}^2$$ p. 3

Bottom flange compression = 2·38 − 0·71 = 1·67 ton/in²

Dead load bending compression

$$= \frac{26.05 \times 12}{349.25} = 0.895 \text{ ton/in}^2$$ p. 3

Top flange compression = 2·38 + 0·89

= 3·27 ton/in²

CALCULATION SHEET

JACOBS

Project Title:		Sheet No: 37
Subject: DMB 5		Calc No: 157
Job No:		File:
Made By: JLR	Date: 3/09	Revised By: / Date:
Checked By:	Date: 03-09	Checked By: / Date:

Live load axial compressive stress

$= 14.3 / 13.40 = 1.067$ ton/in²

Live load bending tension

$= \frac{15.3 \times 12}{441.8} = 0.415$ ton/in²

Bottom flange compression = 1.067 − 0.415 = 0.384 ton/in²

Live load bending compression

$= \frac{15.3 \times 12}{349.25} = 0.52$ ton/in²

Top flange compression = 1.067 + 0.52 = 1.59 ton/in²

Permissible compressive stress:

Total applied stress = 1.59 + 3.27 = 4.86 ton/in²

Permissible stress: 10 ton/in² > 4.86

Arch girder is satisfactory.

PRO FORMA FOR EMPIRICAL ASSESSMENT OF BRICK, MASONRY AND CONCRETE JACK ARCHES AND ASSOCIATED TIES
(To be included with the Assessment Report Calculations)

BRIDGE NAME:	Bonnington Bridge, Lanark
RAILTRACK NO:	DMB/5

Assessment should include completion of all three Sections even where Section 1 has shown the bridge deck to be non-compliant.

SECTION 1 CHECKS FOR COMPLIANCE WITH 24 T CONFIGURATION REQUIREMENTS

		Compliant Yes/No
What is maximum clear span of the arch *Non-compliant if greater than 2.0m*	1.359m	Yes
Do jack arches spring from bottom flanges of beams? *If not, non compliant*		Yes
What is the beam spacing? What is the rise of the arch? Gross aspect ratio *Non-compliant if greater than 10*	b=1.613m r_c=0.558m b/r_c=2.9	Yes
What is the arch barrel thickness (including concrete fill above) and how is it derived ie from record drawings or site investigation? *Non-compliant if thickness less than 220*	d := 229 mm	Yes

SHEET No. 38
CALC No.
FILE
JOB No.
MADE BY JRR
CHECKED BY WF

PRO FORMA FOR EMPIRICAL ASSESSMENT OF BRICK, MASONRY AND CONCRETE JACK ARCHES AND ASSOCIATED TIES
(To be included with the Assessment Report Calculations)

BRIDGE NAME:	Bonnington Bridge, Lanark
RAILTRACK NO:	DMB/5

Assessment should include completion of all three Sections even where Section 1 has shown the bridge deck to be non-compliant.

SECTION 2 CHECKS FOR DEFICIENCY

Type No	Deficiency	Pass/ Fail
1	What is the backing material? Is it structural? Compacted earth fill, Yes	pass
	Does the structural backing extend to at least the crown level of the arch extrados? *If not, then fail (1) (4)*	Yes
	Height of structural fill above crown $d_f := 377\ mm$	
	What is effective shear depth of deck? (= arch rise + barrel thickness + depth of structural fill above crown of extrados) $D_s := r_c + d + d_f$ $D_s := 737\ mm$	pass
	Is $D_s \geq$ "minimum requirements of Fig 1 " Fail if < Fig 1	

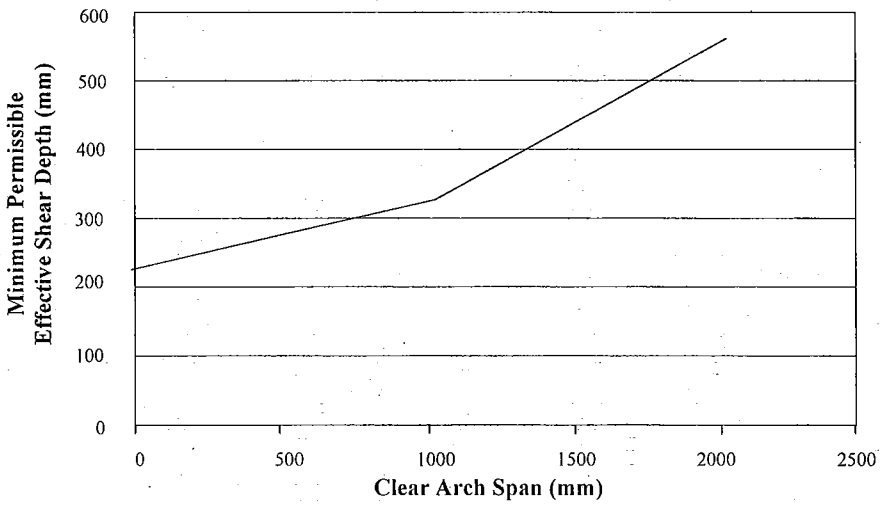


Figure 1

SHEET No. 39
CALC No
FILE
JOB No
MADE BY JRR
CHECKED BY

2	Do jack arches span longitudinally (eg in half through girder construction) or transversely between longitudinal girders? -Transversely- For longitudinal spanning jack arches, ignore following questions on ties/lateral restraint and state N/A. Are ties provided in edge bays of transversely spanning jack arches? yes *If yes, go to 3a/3b* *If not, fail unless edge bay is 'hard' (see 5)*	pass
3a CI	What is the cross sectional area of one tie? (allowing for corrosion losses) Diameter of tie $Dia := 38.1\ mm$ Therefore Area $A := \pi \frac{(38.1)^2}{4}$ $A := 1140\ mm^2$ What is number of ties per beam length? $n := 6$ What is the clear skew span? $L := 14.9\ m$ Specific area of tie $A_s := \frac{(n+1)\cdot A}{L}$ $A_s := 535\ \frac{mm^2}{m}$ *Non-compliant if less than 260mm²/m* What is maximum tie spacing? $S := 2.4\ m$ *Non-compliant if greater than 2.5m for cast iron*	pass
3b WI/ST	What is the cross sectional area of one tie? (allowing for corrosion losses) Diamensions of the tie $dt1 :=$ mm $dt2 :=$ mm Therefore Area $A := dt1 \cdot dt2$ $A = 1.14 \cdot 10^3\ mm^2$ What is number of ties per beam length? $n :=$ What is the clear skew span? $L :=$ m Specific area of tie $A_s := \frac{(n+1)\cdot A}{L}$ $A_s = 535.57\ \frac{mm^2}{m}$ *Non-compliant if less than 260mm²/m* What is maximum tie spacing? $S :=$ m *Non-compliant if greater than 3.0m for wrought iron/steel*	
4	Are ties located within crown of external arch? No *If so, then fail CI or possible fail for WI/steel*	pass
5	Does external bay construction provide alternative lateral restraint? (ie not soft edge)? *If so, pass.If not, are ties provided in first Jack Arch bay? if yes,treat as 3a (or 3b). otherwise fail.*	Pass

Notes: (1) Results also in loss of D/d (composite action) for cast iron beams
(4) A trial hole should be undertaken to confirm the existence of structural backing if there is any doubt.

SHEET No 10
CALC No
FILE
JOB No
MADE BY JLR
CHECKED BY ME

PRO FORMA FOR EMPIRICAL ASSESSMENT OF BRICK, MASONRY AND CONCRETE JACK ARCHES AND ASSOCIATED TIES
(To be included with the Assessment Report Calculations)

BRIDGE NAME:	Bonnington Bridge, Lanark
RAILTRACK NO:	DMB/5

Assessment should include completion of all three Sections even where Section 1 has shown the bridge deck to be non-compliant.

SECTION 3 CHECKS FOR DEFICIENCY

Type No	Defect	Empirical Assessment		Pass/ Fail
		CI Decks	WI/Steel Decks	
6	Rotation of supporting beam? No	Fail	NA	Pass
7	Horizontal displacement of supporting beam? No	Fail	NA	Pass
8	Inadequate support to springings eg corrosion of bottom flange of supporting beam over a significant length, missing bedding mortar? No	Possible Fail	NA	Pass
9	Transversely bowed bottom flange of supporting beam? No	Fail	NA	Pass
10	Cracking at crown of arch owing to spreading of springings (other than 12, 13)? No	Fail	NA	Pass
11	Distortion and any associated cracking of jack arch barrel? No	Fail	NA	Pass
12	Arch crack resulting in substructure crack? No	Fail	NA	Pass
13	Substructure crack or other distress resulting in crack to jack arch? No	Possible Fail	NA	Pass

Notes:

SHEET No 41
CALC No
FILE
JOB No
MADE BY JSR
CHECKED BY ME