JE JACOBS

BRB (Residuary) Ltd

02/03 BE4 ASSESSMENT PROGRAMME

ASSESSMENT AND INSPECTION REPORT

BE 4 1967 Assessment of Structure:

DVR1/46

March 2003

JACOBS

Document control sheet Form IP180/B

Client: BRB (Residuary) Ltd
Project: 02/03 BE4 Assessment Programme Job No: J20308A
Title: Structure DVR1/46 Assessment Report

	Prepared by	Reviewed by	Approved by
ORIGINAL	NAME Ioannis Karapasidis	NAME John Rigby	NAME
DATE 25 March 2003	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

This report, and information or advice, which it contains, is provided by JacobsGIBB Ltd solely for internal use and reliance by its Client in performance of JacobsGIBB Ltd's duties and liabilities under its contract with the Client. Any advice, opinions, or recommendations within this report should be read and relied upon only in the context of the report as a whole. The advice and opinions in this report are based upon the information made available to JacobsGIBB Ltd at the date of this report and on current UK standards, codes, technology and construction practices as at the date of this report. Following final delivery of this report to the Client, JacobsGIBB Ltd will have no further obligations or duty to advise the Client on any matters, including development affecting the information or advice provided in this report. This report has been prepared by JacobsGIBB Ltd in their professional capacity as Consulting Engineers. The contents of the report do not, in any way, purport to include any manner of legal advice or opinion. This report is prepared in accordance with the terms and conditions of JacobsGIBB Ltd's contract with the Client. Regard should be had to those terms and conditions when considering and/or placing any reliance on this report. Should the Client wish to release this report to a Third Party for that party's reliance, JacobsGIBB Ltd may, at its discretion, agree to such release provided that:

(a) JacobsGIBB Ltd's written agreement is obtained prior to such release, and
(b) By release of the report to the Third Party, that Third Party does not acquire any rights, contractual or otherwise, whatsoever against JacobsGIBB Ltd, and JacobsGIBB Ltd accordingly assume no duties, liabilities or obligations to that Third Party, and
(c) JacobsGIBB Ltd accepts no responsibility for any loss or damage incurred by the Client or for any conflict of JacobsGIBB Ltd's interests arising out of the Client's release of this report to the Third Party.

Contents

1	**General Description and Structural Details**	**1-1**
1.1	Location	1-1
1.2	Construction type	1-1
2	**Existing Information Search**	**2-1**
2.1	Information Used to Form Assessment	2-1
2.2	Ground Investigation/ SI Results	2-1
2.3	Existing Drawings	2-1
3	**Structure Condition**	**3-1**
3.1	General	3-1
3.2	External Girders	3-1
3.3	Internal Girder	3-2
3.4	Tees	3-2
3.5	Troughs	3-2
3.6	Abutments	3-2
3.7	Bedstones	3-2
3.8	Wingwalls and Buttresses	3-3
3.9	Parapets and pilasters	3-3
3.10	Road	3-3
3.11	Formation	3-3
4	**Conclusions and Recommendations**	**4-1**

Appendix A - Photographs
Appendix B - Form AA
Appendix C - Summary of BE4 Results and Recommendations
Appendix D - Metal Test Results
Appendix E - Form BA
Appendix F - Inspection Records
Appendix G - Calculations

1 General Description and Structural Details

1.1 Location

Structure DVR1/46 carries an unclassified public road (Green Lane) over the disused Dearne Valley railway line. The structure is located between Barnsley and Doncaster at OS ref. SE 474 036. (See photo 1, 2 and 3)

1.2 Construction type

The single span structure comprises 3 mild steel main girders with transverse Hobsons troughing, which are not continuous over the central girder. The abutments and wingwalls are constructed from brickwork and the girders are supported on stone bedstones.

The bridge was constructed in 1904.

2 Existing Information Search

2.1 Information Used to Form Assessment

The following documents were provided by BRB (Residuary) Ltd:

Historical overbridge assessment report dated 8/11/82.

2.2 Ground Investigation/ SI Results

An inspection pit was excavated on the bridge deck to determine the depth and composition of the fill and the condition of troughing.

A metal sample was also extracted from the structure to determine the characteristics of the metal girders and the troughing.

The test results are indicated in Appendix D.

2.3 Existing Drawings

Sketches are provided in the overbridge assessment report dated 08/11/82.

3 Structure Condition

3.1 General

The structure is located about 300m away from the T-junction (Green Lane - Barnburgh Road), on a straight part of the road. It is a rural area on a de-restricted road and consequently, there are fast moving vehicles passing over the bridge.

At the day of the site visit the weather was rainy and the temperature was around 6° Celsius.

3.2 External Girders

(a) East parapet girder

There is a laminated area of the east parapet girder at the south-east corner support. The laminated area of the flange is towards the inside of the bridge. Half the thickness of the flange is lost, but only for approximately one third of the total width of the bottom flange (Ref Appendix F), (See also photo No 4). The other two-thirds of the bottom flange is intact. The lamination area extends 1m from the supported side of the girder. The connection between the troughing and the east girder is generally good. Even at the S-E corner, where the connection is corroded, it is in fair condition (See photo No 5). The remaining bottom flange is in good condition.

Viewed from beneath, the top flange is in good condition. Looking from above, there is a complete loss of the paint system, but no section loss.

All rivet-heads have minor corrosion problems.

The external face of the web has localised pitting of the paint system. The local loss of paint is towards the bottom quarter of the depth of the web. There is no loss of section. The inside face of the east parapet girder has approximately 20% loss of paint.

The web stiffeners have full section, but three of them indicate about 15% loss of paint.

The top flange appears in good condition from beneath. Viewing from above, there is a 60% loss of paint, though no loss of section. The rivet-heads are 40% corroded in area and about 20% in number.

(b) West parapet girder

The west parapet girder has, similar to the east parapet girder, lamination at the bottom flange, however not as widespread. The corrosion extends to 1/4 of the bottom flange width and the loss is about 50%. The corrosion extends 1m in length from the adjacent north-west support (Ref Appendix F). The remainder of the bottom flange is in good condition.

The external face of the web has localised pitting of the paint system. The local loss of paint is towards the bottom quarter of the depth of the web. However, there is no loss of section. The inside face of the east parapet girder has 20% loss of paint.

All the web stiffeners have full section, but 3 No of them have 15% loss of paint.

Looking from beneath, the top flange is in good condition. From above there is a 60% loss of paint, though no loss of section. The rivet-heads are 40% corroded in area and about 20% in number.

3.3 Internal Girder

The bottom flange of the main (centre) girder is in good condition. The paint system is still intact, but there are very small areas of localised corrosion of paint. The top flange, web and stiffeners are in good condition (See photo No 6).

3.4 Tees

The Tee members have full section and there are generally in good condition. There is some corrosion towards each abutment. That corrosion is more extensive towards the south-east corner, but there is no significant loss of section. (See photo No 6 and 7)

3.5 Troughs

The paint system is corroded on the blast lines, but there is no visible loss of section. The troughing connections to inner and parapet girders are in satisfactory condition. The troughing is not continuous over the centre girder. (See photo No 7, 5 and 6)

3.6 Abutments

(a) North abutment

There is some minor spalling in localised areas and 20mm deep localised open joints. There is a full height crack towards the middle of the abutment, starting from hairline up to 10mm deep. This crack is a long-standing one. The bedstones are in good condition.

(b) South abutment

There are a few isolated spalled bricks at several areas. The maximum spalled depth is 20mm.

Overall the abutments are in good condition.

3.7 Bedstones

The bedstones at both North and South abutments are in good condition.

3.8 Wingwalls and Buttresses

(i) North - East

There are very minor open joints and spalling on the wingwall. Overall, the wingwall and buttress are in good condition and there is no vegetation on them.

(ii) South – East

There is a diagonal crack starting at ground level adjacent to the buttress going diagonally up to 3 metres away from the pilaster. The crack varies from hairline up to 15mm width. The adjacent bricks to the fracture are also displaced slightly. For cracked brickwork see photo No 8. The remaining of the wingwall is in good condition and there is no vegetation on it or the buttress.

(iii) North – West

There is a vertical crack adjacent to the buttress approximately 4m long starting from a hairline up to 10mm width. The remaining of the wingwall is in good condition and there is some minor vegetation growth on the wingwall and the buttress.

(iv) South – West

Despite of some open joints and spalling, the wingwall and the buttress are in good overall condition without any vegetation growth.

3.9 Parapets and pilasters

The metal parapets have full section but 40% loss of paint. The up-stands (stiffeners) are in good condition.

The parapets above the wingwalls are of brickwork construction and these are generally in good condition. The diagonal crack in the south-east wingwall does extend into its parapet.

From above the pilasters appear in good condition and the copingstones are in place.

3.10 Road

The condition of the road surfacing is good. There is a footpath to the west and a verge to the east side of the bridge. The footpath is in very good condition and the verge has grass with very light vegetation. (See photos No 2 and 3)

3.11 Formation

Disused railway formation. A public walkway exists beneath the bridge. The area is lightly vegetated. Minor debris is collected underneath the bridge and adjacent to the wingwalls. It is a steep cutting formation at both sides of the bridge. (See photo No 1)

4 Conclusions and Recommendations

1. There is some loss of section to the bottom flanges of the edge girder. The estimated reduced section should be used in the assessment.

2. The connections between the main girders and the troughing tees are generally in good condition, therefore it is reasonable to assume that some U-Frame action will be possible.

3. There is extensive paint loss. Maintenance painting is recommended as a priority.

4. Cracks in the wingwalls and minor defects in the abutment brickwork should be repaired.

Appendix A - Photographs



Photo No 1 - West elevation



Photo No 2 looking south from the main road. There is a footpath at the east parapet and a verge at the west side of the bridge.



Photo No 3 looking north. The T- junction is at the far end of the main road.



Photo No 4 showing the lamination at the S-E corner of the east parapet girder. Notice the loss of section and the corrosion of the rivets.



Photo No 5 showing the lamination at the of the east parapet girder. The connection points between the troughing and the girder are in good condition.

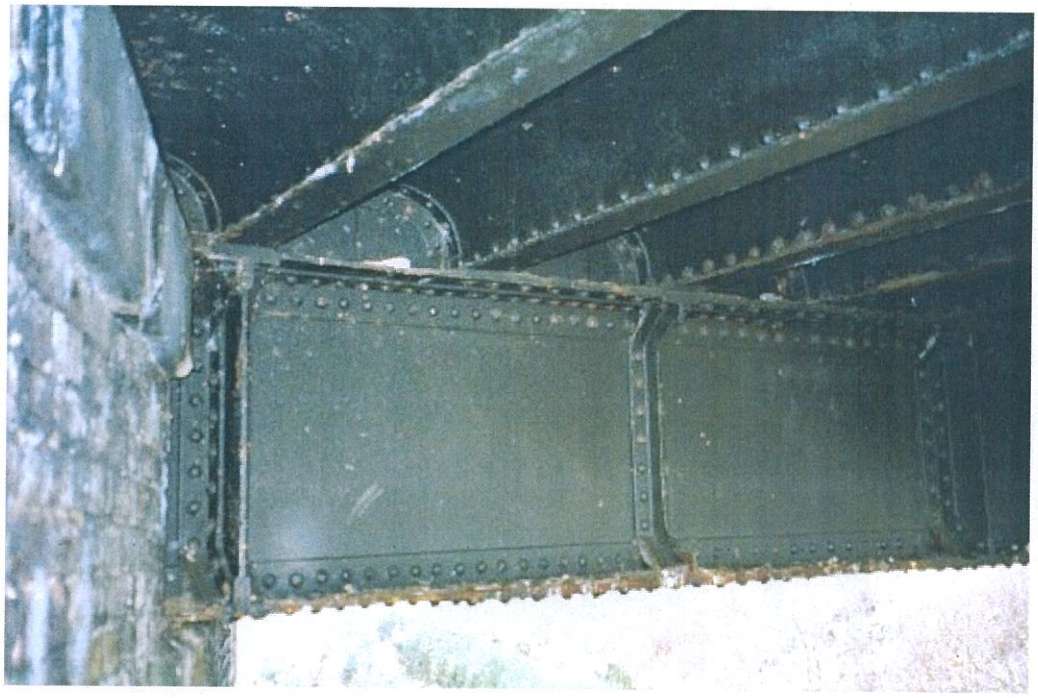


Photo No 6 showing the lamination at the of the east parapet girder. The connection points between the troughing and the girder are in good condition.



Photo No 7 showing the Tee sections, the troughing and the connections to the parapet girder.



Photo No 8 showing the crack and the displacement of the brickwork at the south-east wingwall.

Appendix B - Form AA

FORM 'AA' (BRIDGES) **GC/TP0356**

Appendix: 4

ELR/ Bridge No DVR1/46 Issue: 1

Revision: B (Nov 2000)

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Bridge/Line Name: Westfield Lane Bridge / Dearne Valley Railway

ELR/Bridge No. DVR1/46

Brief Description of Existing Bridge:

(a) Span Arrangement

Single span bridge with a clear span between abutments of 28 feet 0 inches (8.53m) at a skew of 20°. The distance between the centrelines of the edge girders is 26 feet 6¾ inches (8.10m).

(b) Superstructure Type

Longitudinally spanning girder bridge with transverse Hobson's No.7 troughing units. There are three spanning girders, all are riveted steel plate girders of similar overall size, but the centre girder has larger plate sizes. The parapet edge girders support the Hobson's troughing on their bottom flanges, but the centre spanning girder supports the troughing on its top flange. There is approximately 2 ft 9 ins (0.838 m) of fill and road construction over the troughing.

(c) Substructure Type

Brick, gravity type abutments and wingwalls. There are stone bedstones to the main girders.

(d) Details of any Special Features

None

Assessment Criteria

(a) Loadings and Speed

Section sizes used to calculate dead loads obtained from archive drawings and historical assessment calculations produced by British Rail. 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).

BS 153 : Parts 3B & 4 : 1958 "Steel Girder Bridges" British Standards Institution (with amendments to 12 Sept. 1968).

APPROVAL IN PRINCIPLE FOR ASSESSMENT

(c) Proposed Method of Structural Analysis

Loadings applied to all girders by simple statics. The troughing is not continuous over the central girder. The BE4 quick assessment methods are not applicable.

The transverse troughing will provide partial lateral restraint to the compression flanges of the parapet girders by u-frame action. Its condition is unknown. Checks will therefore be carried out with and without u-frame action.

Capacities of the plate girders will be calculated using measurements of the reduced section sizes where corrosion is present. Consequently, a general condition factor is not applied.

The capacity of the Hobson's troughing will be assessed by simple bending principles using the section modulus obtained from historical documentation on pressed flooring. Dispersal of the loading will not be extended in accordance with BE4 Part 1 303 e as the units are not considered to be adequately connected. A condition factor as determined by inspection will be applied. *

An inspection pit is to be excavated over the bridge deck. The excavation is to determine the depth and composition of the fill above the troughing and to establish the condition.

A metallic sample is to be extracted from the structure to determine the composition.

(d) Details of any Special Requirements

None

Senior Civil Engineer's Comments

* Unsure as to the reason for this... are the connections between the troughing units in the longitudinal axis of the bridge considered to be inadequately connected or are the units not connected (i.e. discontinuous) over the centre girder in the transverse direction?

FORM 'AA' (BRIDGES)

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

ELR/ Bridge No DVR1/46

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Proposed Category for Independent Check .....

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 ..... S.MEDI .....
Title ..... Civil Engineer .....
Date ..... 5/3/03 .....

Category 2 and 3

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

Signed .....
Title .....
Date .....

Signed .....
Title .....
Date .....

Appendix C - Summary of BE4 Results and Recommendations

Summary of calculations

Element: central longitudinal girder

Action	Location	Dead load effect	Full C&U load effect	Total load effect	Assessed resistance	Live load capacity
Bending	mid-span	1108kN.m	543kN.m	1651kN.m	2365kN.m	Full C&U 24 tons
Shear	support	468 kN.	285 kN	753 kN.m	898 kN	Full C&U 24 tons
Rivet shear	Angle/ flange			27.8 kN/ rivet	41 kN	Full C&U 24 tons
Rivet shear	Angle/ web			40 kN/ rivet	41 kN	Full C&U 24 tons

Element: longitudinal edge girders (no U-frame action assumed):

Action	Location	Dead load effect	Full C&U load effect	Total load effect	Assessed resistance	Live load capacity
Bending	mid-span	562kN.m	282kN.m	844kN.m	1478kN.m	Full C&U 24 tons
Shear	support	241 kN	147 kN	388kN.m	924 kN	Full C&U 24 tons
Rivet shear	Angle/ web			20 kN/ rivet	41 kN	Full C&U 24 tons
Bearing stiffeners	support stress			33 N/mm^2	139N/mm^2	Full C&U 24 ton

Element: longitudinal edge girders (U frame action with troughing tees assumed)

Action	Location	Dead load effect	Full C&U load effect	Total load effect	Assessed resistance	Live load capacity
Bending	mid-span	562kN.m	282kN.m	844kN.m	1576kN.m	Full C&U 24 tons

Element: Transverse Hobson's troughing

Action	Location	Dead load effect	Full C&U load effect	Total load effect	Assessed resistance	Live load capacity
Bending	mid-span	36.7kN.m	36.7kN.m	73.4kN.m	206kN.m	Full C&U axle load

Note: Loading has not been distributed in the troughing as outlined in BE4 303 (e) because this clause refers principally to trapezoidal troughing which has considerable transverse rigidity. The Hobsons troughing arches are not able to distribute loads in the same way. The troughing adequately supports full C&U axle loads without the needing to consider distribution.

Recommendations

1. The bridge is adequate for Construction & Use loadings as defined by BE4 whether considering U-frame action or not.

Appendix D - Metal Test Results

STRUCTURAL SOILS

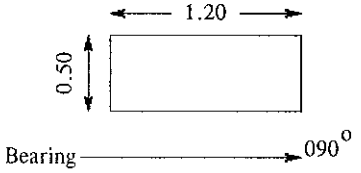
TRIAL PIT LOG

Contract	Client	Trial Pit
BE4 Bridges - DVR/46	**Jacobs**	No **TP 01**

Job No	Date	Ground Level (m AOD)	Co-Ordinates	Sheet
36206	**04.03.03**			**1** of **1**

Samples and In-situ Tests				Water	Description of Strata	Depth (Thick-ness)	Legend
Depth	No	Type	Result				
					Grass over TOPSOIL (verge).	0.10	
					MADE GROUND: Dark grey sandy angular to subangular fine to coarse GRAVEL of sandstone, clinker, tarmac and bituminous material. Occasional cobbles and boulders of tarmac and sandstone.	(1.05)	
					Trial pit completed at 1.15m. Metal deck of bridge at 1.15m.	1.15	

Plan (Not to Scale)



General Remarks
EASE OF EXCAVATION: Easy.
SIMILARITY OF FACES: Metal parapet in Face A.
STABILITY OF FACES: Spalling during excavation.
WATER: Slight seepage at 1.10m.

All dimensions in metres	Method	Logged By	Checked By
Scale **1:25**	**Hand Excavated**	**MRD**	

COM2

STRUCTURAL
SOILS LTD

BRIDGE INVESTIGATION

BE4 ASSESSMENT PROGRAMME

CONTRACT NO. 36206

BRIDGE DVR1/46

Site Description

The investigation on Bridge DVR1/46 was carried out for and on the instructions of Jacobs. The bridge is located on Green Lane, 1km east of the village of Dearne, South Yorkshire at National Grid Reference SE474036.

The bridge carries Green Lane over the disused Dearne Valley Railway and comprises of single spanning steel longitudinal girders with transverse troughing units. The investigation was carried out to provide information for the structural assessment of the bridge.

Sitework was undertaken on 4th March 2003.

Fieldwork

1 no. metal sample, <25mm x 25mm in size, was taken from a girder spanning between abutments at a position specified by Jacobs. The sample was labelled and sent to a UKAS accredited laboratory for testing.

Laboratory Testing

The chemical composition and grading of the sample was determined using combustion and ICP AES techniques. The results are presented overleaf.

SHEFFIELD
TESTING LABORATORIES
50 - 56 Nursery Street, Sheffield, S3 8GP. U.K.
Telephone: 0114 272 6581 Fax: 0114 272 3248 e-mail: hq@sheffieldtesting.com

TEST CERTIFICATE

UKAS TESTING
0136

Date. 13 March 2003

Serial No. 3030286

ORDER NO. 60/MD/2004 **OUR REF AB/AJH**

CLIENT: STRUCTURAL SOILS LTD
CHEVET HOUSE
A1 GREAT NORTH ROAD
KNOTTINGLEY, WEST YORKS, WF11 0BS

Results of Chemical Analysis of Sample,

STL Test No.	C420
Sample Description	Metal Sample Identified :- Bridge DVR/46
	Mass %
Carbon	0.19
Silicon	0.03
Manganese	0.41
Phosphorus	0.019
Sulphur	0.061
Chromium	<0.02
Molybdenum	<0.02
Nickel	0.04

Determined by Combustion & ICP AES Techniques.

Sample C420 is mild steel similar to Grade 040A12 of BS970:Part 1:1983 but with carbon above the specified 0.10/0.15% range and sulphur above the specified 0.050% maximum.

It is also similar to En 2C of BS970:1955 but with sulphur above the specified 0.050% maximum.

Certified A Beadsley

Authorised Signatory
A. BEADSLEY

Form TCUP-01

This certificate is issued on the understanding that it may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

Appendix E - Form BA

FORM 'BA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Feb 1993)

ELR/ Bridge No DVR1/46

CERTIFICATION FOR ASSESSMENT CHECK

Assessment Group JacobsGIBB Ltd.
(or name of Consulting Engineer)

Bridge/Line Name: Westfield Lane Bridge /Dearne Valley Railway

Category Of Check: 1

ELR/ Bridge No: DVR1/46

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 (where appropriate) as recorded on Form AA approved on 5 March 2003.

(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).

BS 153 : Parts 3B & 4 : 1958 "Steel Girder Bridges" British Standards Institution (with amendments to 12 Sept. 1968).

List any departures from the above, and additional methods or criteria adopted, with reference and justification for their acceptance (commenting on the results if appropriate).

None

Category 1

Name	Signature	Date	
J.L. RIGBY	J L Rigby	25/3/03	Assessor
C J BURROWS	C J Burrows	25.03.03.	Assessment Checker
N KELLY	N K	29.4.03	Authorised signatory of the Firm of Consulting Engineers to whom Assessor/Checker is responsible.

FORM 'BA' (BRIDGES) **GC/TP0356**

Appendix: 4

ELR/ Bridge No DVR1/46 Issue: 1

Revision: A (Feb 1993)

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 by..... (S. MEDD) .....

24/6/05

FORM 'BAA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Feb 1993)

ELR/ Bridge No DVR1/46

CERTIFICATION FOR ASSESSMENT CHECK

Notification of Assessment Check

Assessment Group (or name of Consulting Engineer)	JacobsGIBB Ltd.
Bridge Name/Road No.	Westfield Lane Bridge / unclassified
Line Name	Dearne Valley Railway
ELR Code/Structure No.	DVR1/46

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

Centre Longitudinal Girder

Full C&U vehicle loading to BE4 - 4 axle 24 ton vehicle train

Edge Longitudinal Girders

Full C&U vehicle loading to BE4 - 4 axle 24 ton vehicle train

Transverse Hobson's Troughing

Full C&U vehicle loading to BE4 - 11 ton axle loads

Recommended Loading Restrictions

None. Adequate for 24 ton vehicle train.

Description of Structural Deficiencies and Recommended Strengthening

Maintenance painting is recommended.

Cracks in the wingwalls and minor defects in the abutment brickwork should be repaired.

FORM 'BAA' (BRIDGES)

GC/TP0356
Appendix: 4
Issue: 1
Revision: A (Feb 1993)

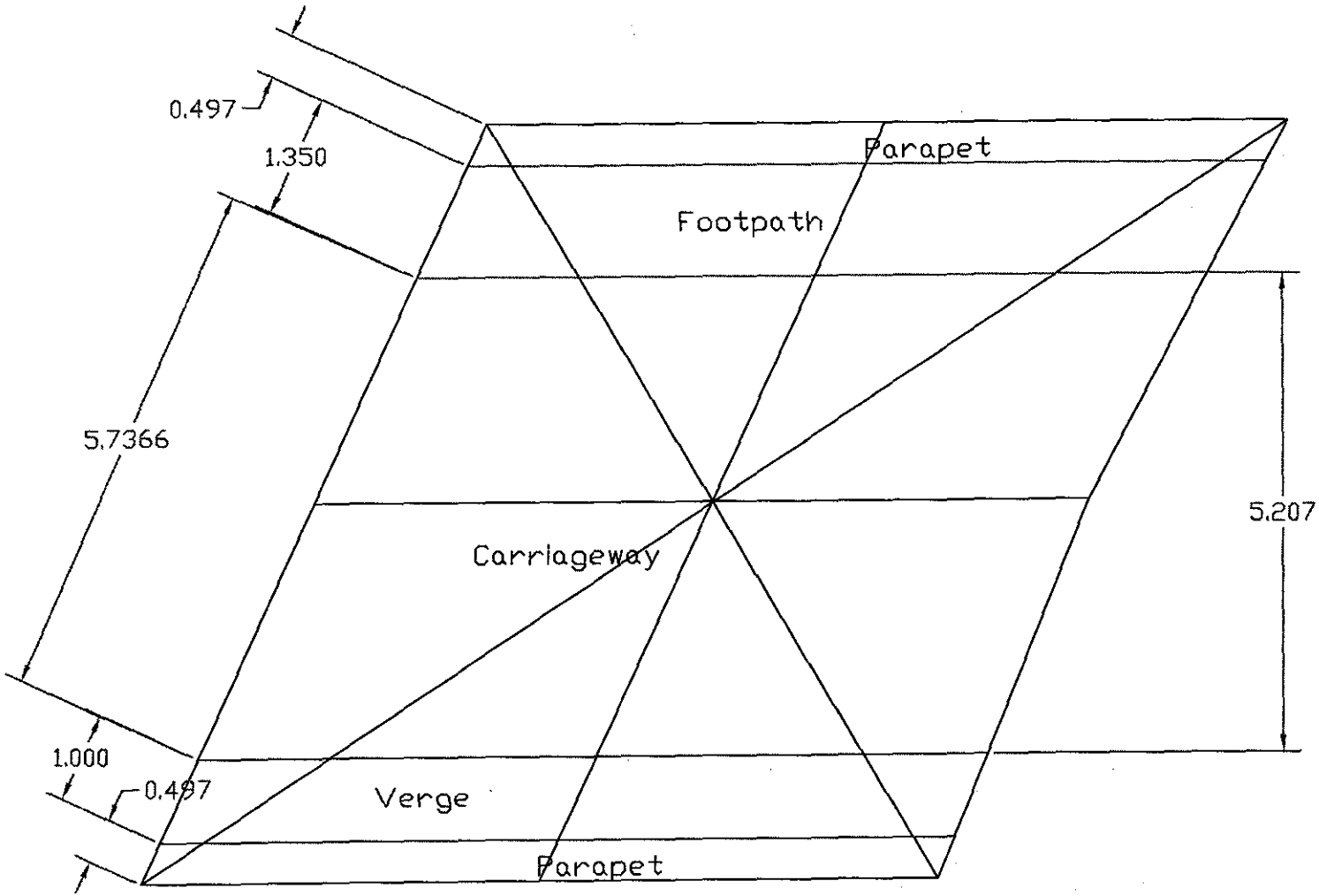
ELR/ Bridge No DVR1/46

CERTIFICATION FOR ASSESSMENT CHECK

Name	Signature	Date	
J.L.RIGBY	J L Rigby	25/3/03	Assessor
C J BURROWS	C J Burrows	25.03.03	Assessment Checker
N KERRY	N Kerry	29.4.03	Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible.

This Certificate is accepted by..... (S.MADA) 24/6/05

Appendix F - Inspection Records

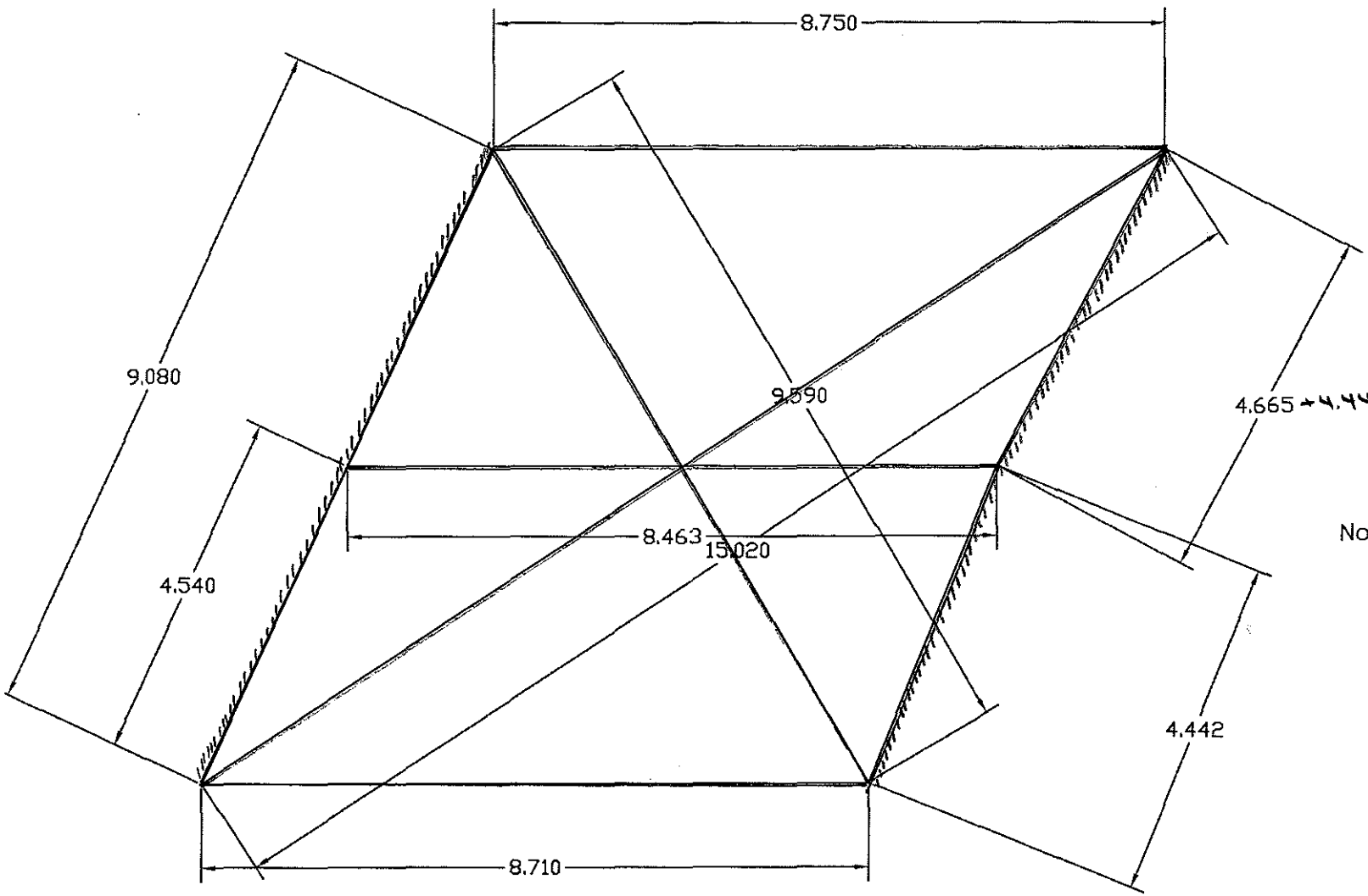


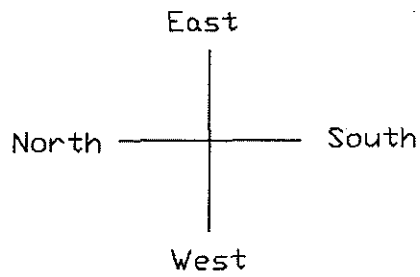
East
North
South
West

SHEET No. 1
CALC No.
FILE
JOB No. J203084
MADE BY FT
CHECKED BY

Appendix F

VR , 16





Appendix F

JOB NO J2930 8A

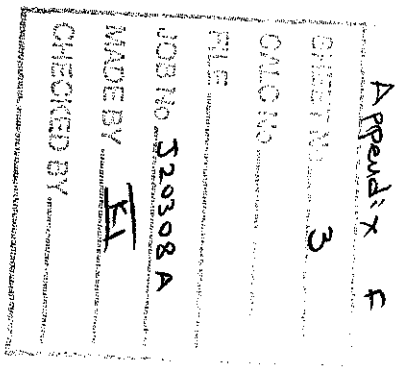
MADE BY KT

CHECKED BY

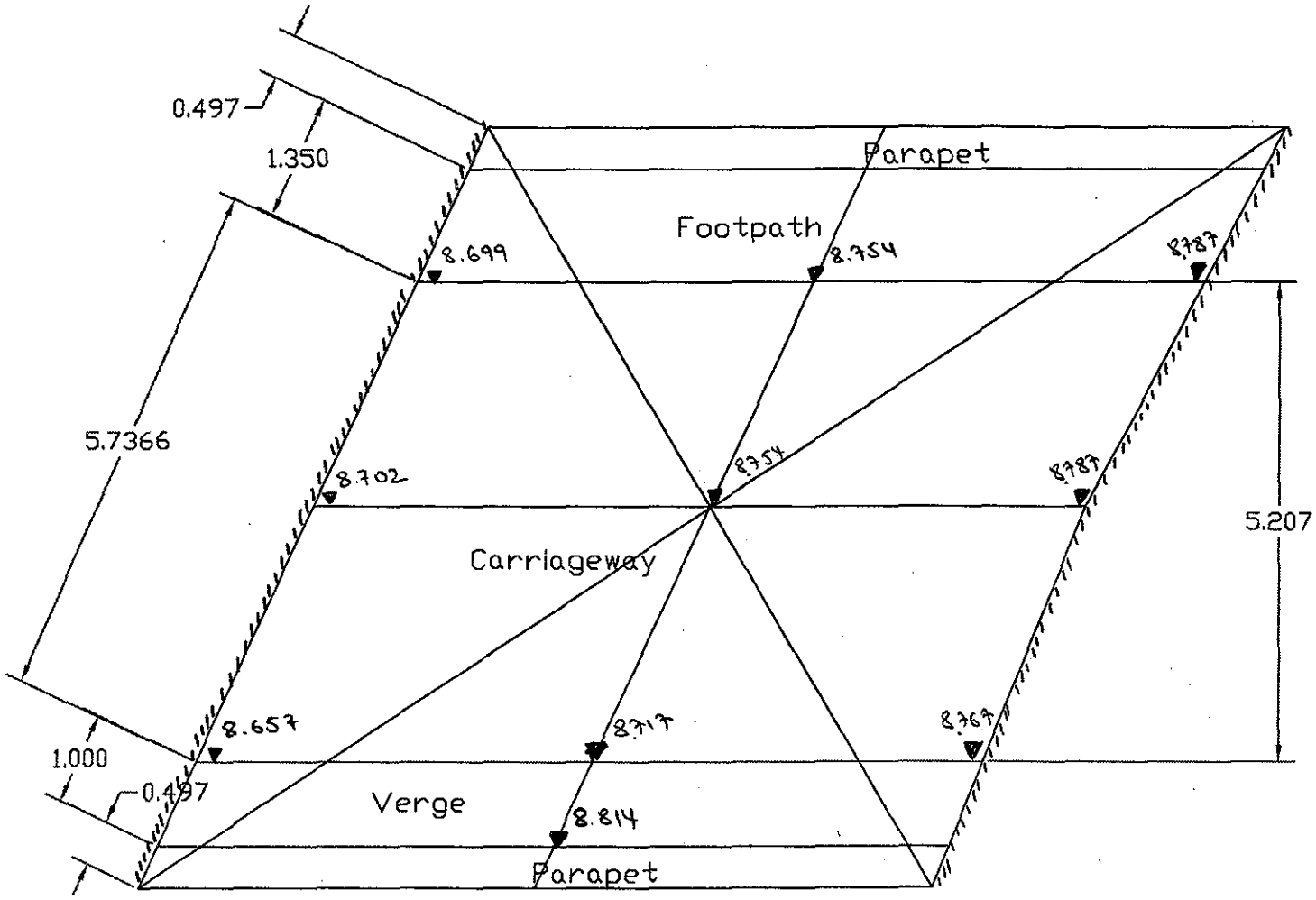
DVR1/46

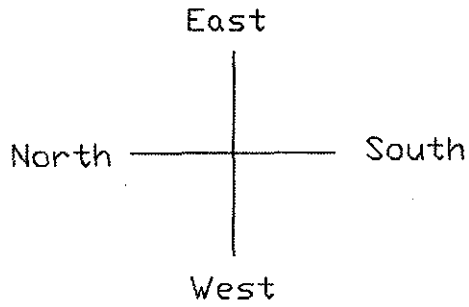
Extra notes
road surfacing = 85mm

back sight	intermediate	fore sight	hpc	reduced level	distance	remarks	
0.182			10.182	10.000		**TBM** - North East corner of North West coping stone	
	2.501			7.681		**(TP1)** - Bottom of **Trial Pit 1** (top of troughing)	
	1.525			8.657		**Road 1** - North West	
	1.480			8.702		**Road 2** - North Centre	
	1.483			8.699		**Road 3** - North East	
	1.428			8.754		**Road 4** - Centre East	
	1.428			8.754		**Road 5** - Centre Centre	
	1.465			8.717		**Road 6** - Centre West	
	1.415			8.767		**Road 7** - South West	
	1.395			8.787		**Road 8** - South Centre	
	1.395			8.787		**Road 9** - South East	
	1.368			8.814		**Verge** adjacent to TP1 adjacent to parapet	
	1.891			8.291		Top of **West** flange - mid span	
	1.754			8.428		Top of **East** flange - mid span	
	1.926			8.256		Top of **West** flange - North suppor	
	1.878			8.304		Top of **West** flange - South suppor	
	1.737			8.445		Top of **East** flange - South suppor	
	1.789			8.393		Top of **East** flange - North suppor	
-4.395		0.190	5.597	9.992		Change Point	
	-2.079			7.676		Crown of trough (under trial pit 1)	
	-2.071			7.668		Quarter point **South** side of trough	
	-2.015			7.612		**South** springer of trough	
	-1.790			7.387		Tee underside	
	4.475			1.122		Formation	
	-1.755			7.352		**West** edge girder bottom flange	
	-0.890			6.487		**Central** girder bottom flange	
	-1.900			7.497		**East** girder bottom flange	
0.085		-4.395	10.077	9.992		Change Point	
		0.078		9.999		TBM 1mm misclosure	



Appendix F





Appendix F

SHEET NO. 4

CALC NO.

FILE

JOB No. J20308A

MADE BY FT

CHECKED BY

JACOBS

CALCULATION SHEET

Project Title: BE4 – Assessment DVR 1/46			Sheet No: 5
Subject: Appendix F			Calc. No:
Job No: 5203084			File:
Made by: EI	Date: 03/03	Revised:	Date:
Checked by:	Date:	Checked by:	Date:

Interpretation of leveling data

Top of troughing = 7.681 m

Level of verge adjacent to Trial pit = 8.814 m

Level of road adjacent to Trial Pit = 8.717 m

Depth of verge = 8.814 - 8.717 = 0.097 m (97 mm)

Depth of Fill + surfacing = 8.717 - 7.681 = 1.036 m

Depth of surfacing = 85 mm

Depth of Fill = 1036 - 85 = 951 mm on top of T.P.

Tee section properties from historic drawings were verified ✓

Hobson troughing dimensions were verified ✓

Parapet dimensions (height, angle) verified ✓

The metal testing report shown that the troughing and the girders are mild steel

JACOBS

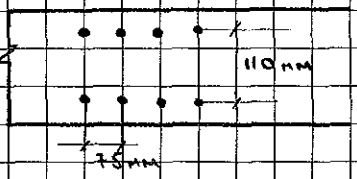
CALCULATION SHEET

Project Title: BE4 - Assessment DVR 1/46			Sheet No: 6
Subject: Appendix F			Calc. No:
Job No: J20308A			File:
Made by: EI	Date: 03/03	Revised:	Date:
Checked by:	Date:	Checked by:	Date:

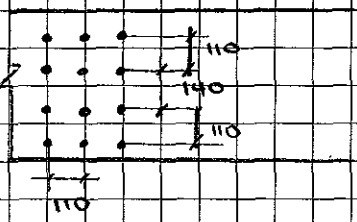
Rivet spacing

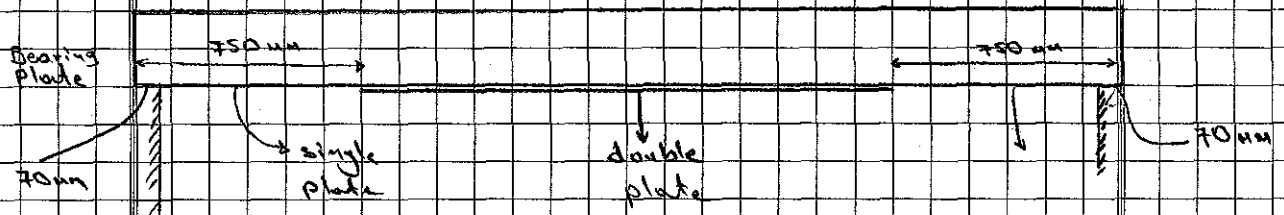
Rivet head = 40 mm

Single plate



Double plate





For main girder

Span c/l of bearing to c/l of bearing

= 8395 + 70 + 70 = 8535 mm

Distance between stiffeners C-C = 1525 mm

Thickness of stiffeners = 14 mm

Inside depth of parapet (till verge) = 870 mm = 34.25 in

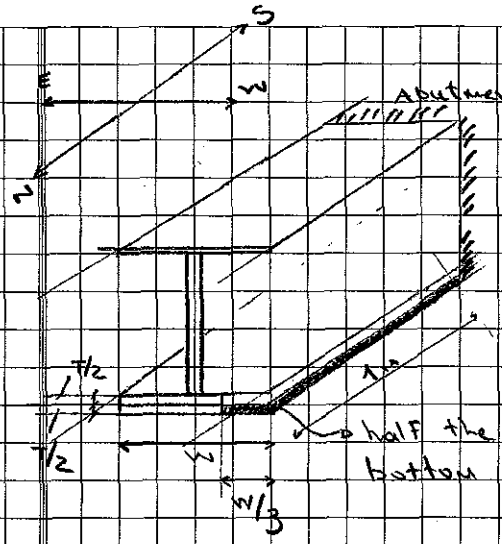
Outside depth of parapet till top flange of girder = 1370 mm = 4'-6"

JACOBS

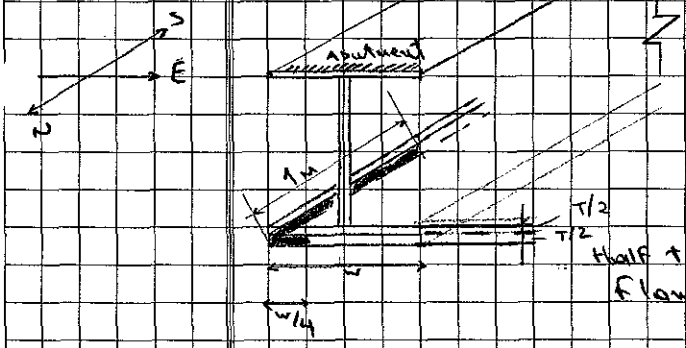
CALCULATION SHEET

Project Title: BE4 - Assessment DVR1/46			Sheet No: 7
Subject: Appendix F			Calc. No:
Job No: 320308 A			File:
Made by: EI	Date: 03/03	Revised:	Date:
Checked by:	Date:	Checked by:	Date:

East parapet girder
S-E corner



West parapet girder
N-W corner



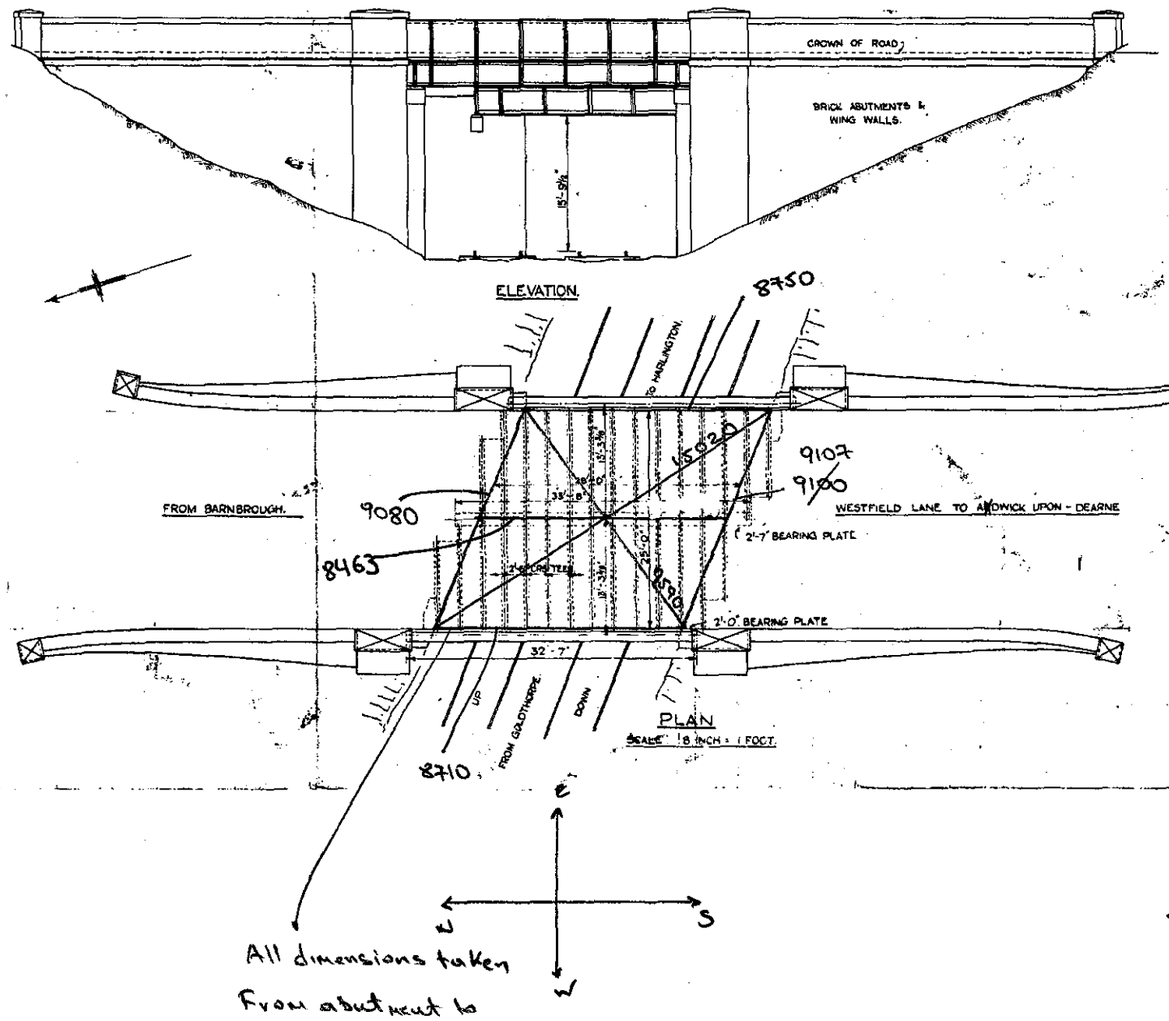
Appendix f

CHEET No. 8
CALC No.
FILE
JOB No. J20308 A
MADE BY KJ
CHECKED BY

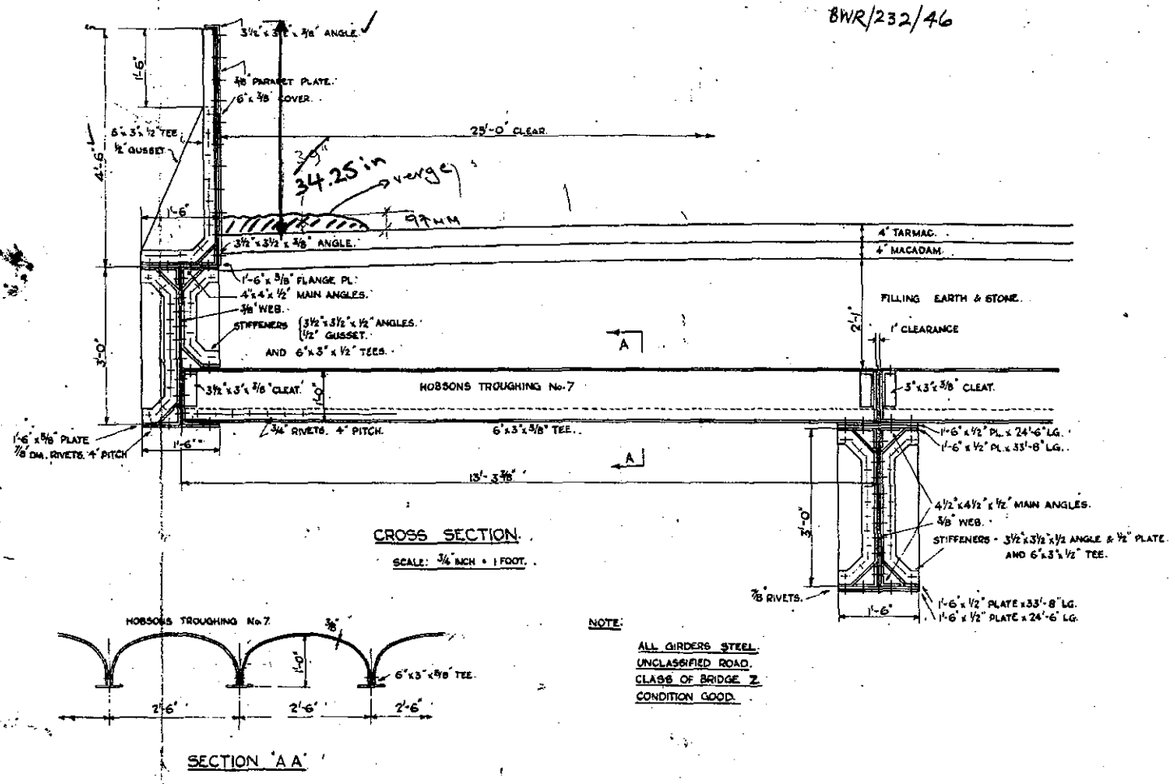
L.M.S.R. DEARNE VALLEY RAILWAY. OVERBRIDGE No. 46.

704/46.

BWR/232/46



All dimensions taken From abutment to abutment.



West verge = 1m

East Footpath = 1350 mm — depth of Kerb = 100 mm

Traveling, Tee section, Parapet and girders dimensions were verified.

Appendix G - Calculations

CALCULATION COVER SHEET

JacobsGIBB Ltd.
Reading

Project Title:	BE4 Assessments - 2002/2003		Calc. No.: 14.1
Job No: J20308A			File: R2
Project Manager	C McNichol	Subject: Westfield Lane	DVR1/46
Designer	J Rigby	Introduction	
Project Group	J110		

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	2	JLR	2/03	CJB	2/03				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

CALCULATION SHEET

JACOBS GIBB

Project Title: BE4 ASSESSMENTS			Sheet No. 1
Subject DVR1/46 - WESTFIELD LANE BR.			Calc. No. 14·1
Job No: J20308A			File: R2
Made by: JLR	Date: 11/2/03	Revised:	Date:
Checked by: CAB	Date: 2/03.	Checked by:	Date:

Purpose:

To carry out an assessment to the requirements of BE4.

Components to be checked:

1. Central girder - bending at mid-span
2. Central girder - shear at support
3. central girder - rivet shear

} Calc. 14.2

4. Edge girder - bending at mid-span
5. Edge girder - shear at support
6. Edge girder - rivet shear
7. Edge girder - bearing stiffners

} calc 14.3

8. Hobsons troughing - bending 14.4

Assumptions:

Material is steel : consistent with 1904 construction (as described on drg) and use of troughing.

Effective span:

Edge girders : $32'7'' - (2 \times 2'0''/2) = 30'7''$ ✓

LMSR Drg 704/46 centre girder : $33'8'' - (2 \times 2'7''/2) = 31'1''$ ✓

" * Fill + surfacing : $2'1'' + 8'' = 2'9''$ ✓

" *Carriageway width : $25'0''$ ✓

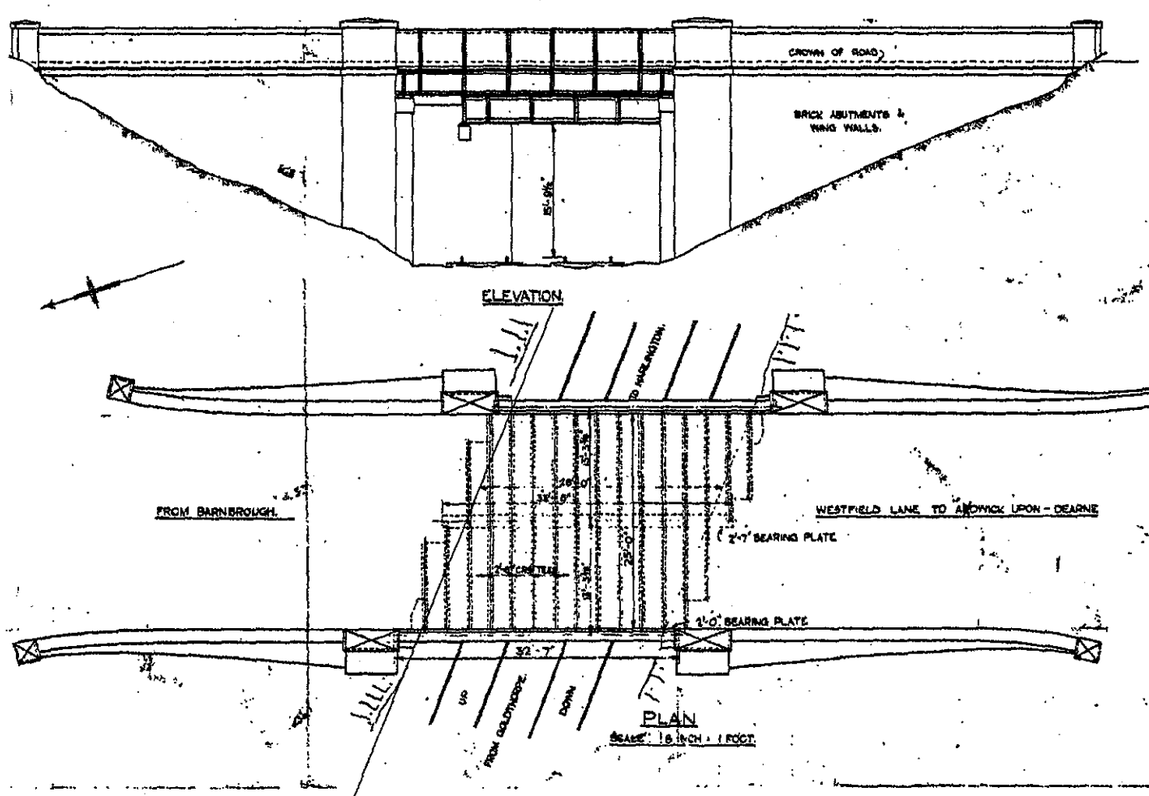
* To be confirmed on site.

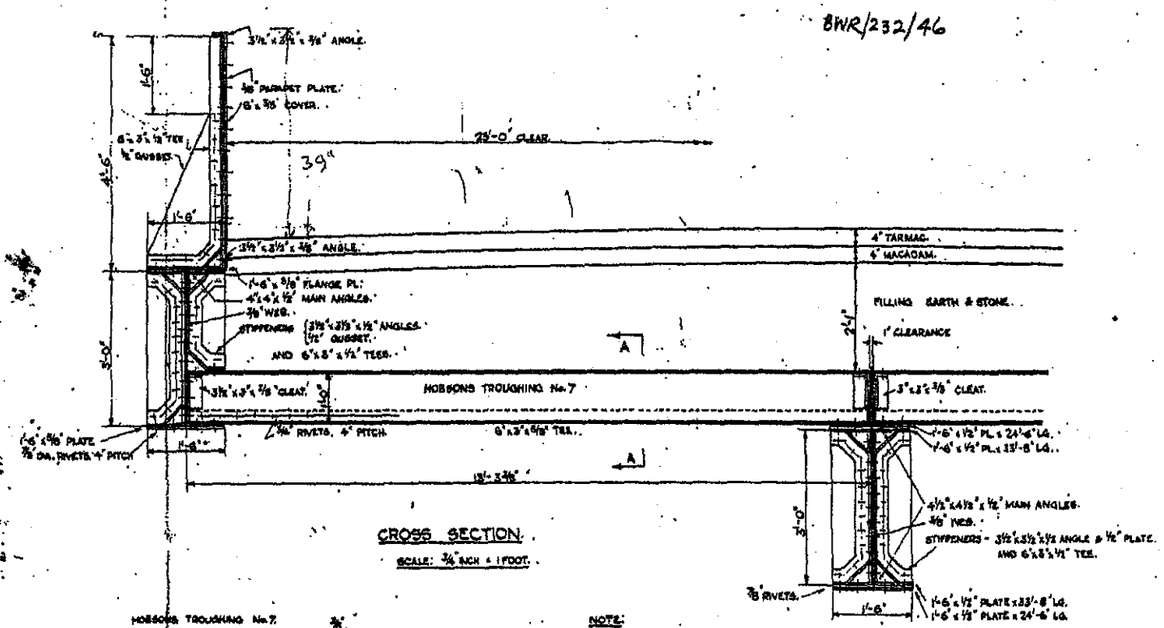
SHEET No	2
CALC No	14.1
FILE	R2
JOB No	J20308A
MADE BY	JLR
CHECKED BY	CBB.

L.M.S.R. DEARNE VALLEY RAILWAY. OVERBRIDGE No. 46.

704/46.

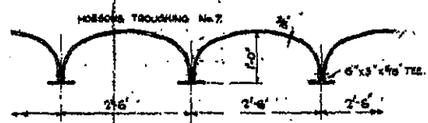
BWR/232/46





CROSS SECTION.

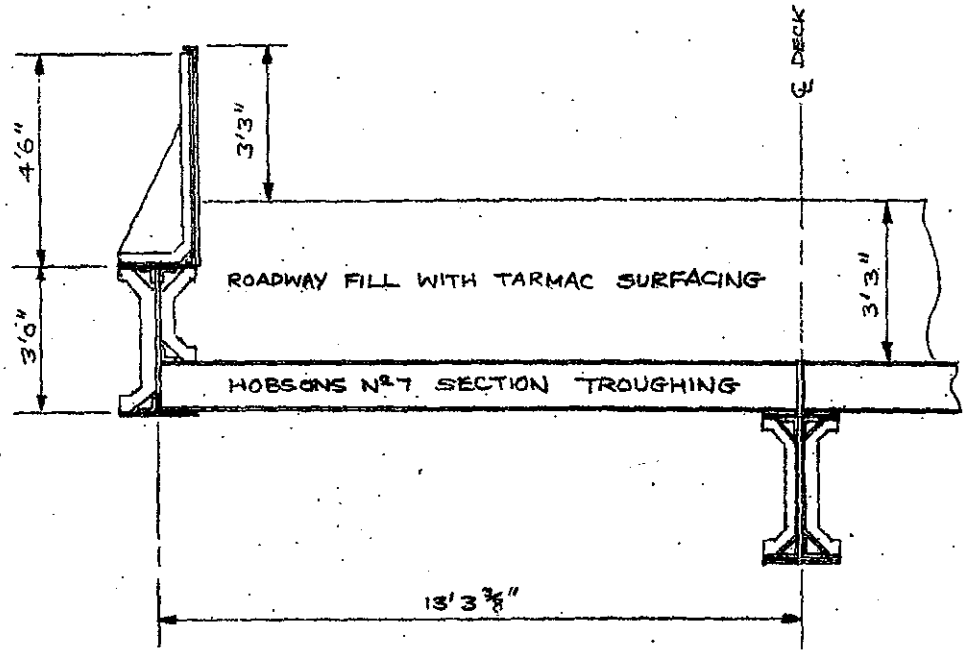
SCALE: ¾ INCH = 1 FOOT.



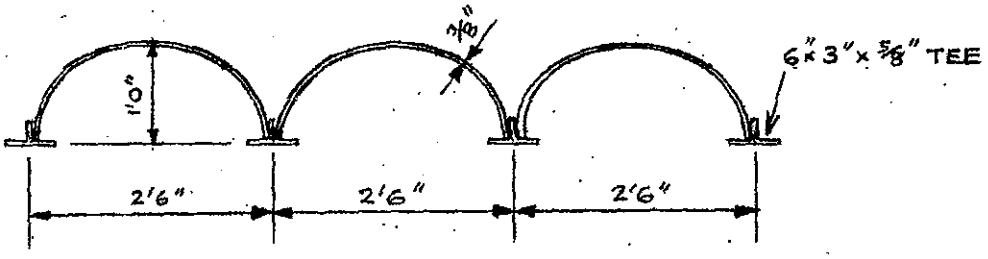
SECTION 'AA'

NOTE:

ALL GIRDERS STEEL.
UNCLASSIFIED ROAD.
CLASS OF BRIDGE 2.
CONDITION GOOD.



SECTION (¼ INCH = 1 FOOT)



SECTION THROUGH TROUGHING

T. C. E. DRAWINGS	D.E. DRAWINGS	DETAILS OF NOTICE PLATES	
BRIEF DESCRIPTION AND CONSTRUCTION DATES ETC.			SURVEYED AND EXAMINED BY
SUPERSTRUCTURE		SUBSTRUCTURE	G.R.
BRIEF NOTES ON CONDITION (SEE ALSO REPORT)			DATE
SUPERSTRUCTURE		SUBSTRUCTURE	11/82
			SHEET 4 OF 9

CALCULATION COVER SHEET

JacobsGIBB Ltd.
Reading

Project Title:	BE4 Assessments - 2002/2003		Calc. No.: 14.2
Job No: J20308A			File: R2
Project Manager	C McNichol	Subject: Westfield Lane	DVR1/46
Designer	J Rigby	Centre Girder	
Project Group	J110		

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	8	JLR	2/03	CJB	2/03				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

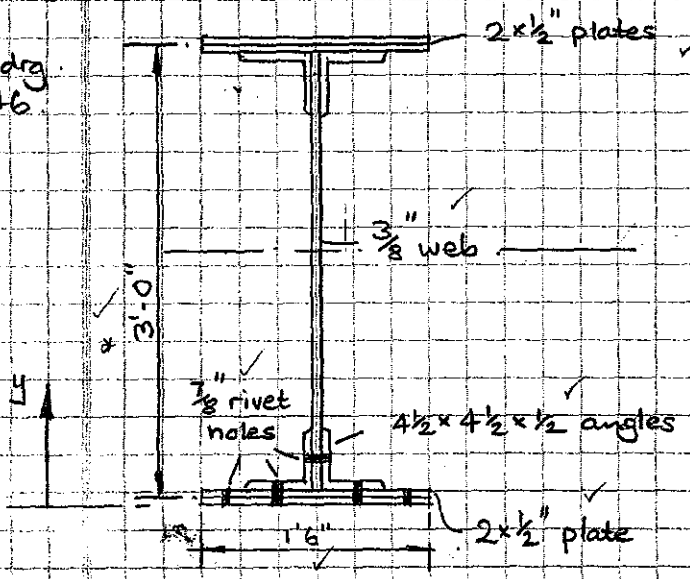
CALCULATION SHEET

JACOBS GIBB

Project Title: BE4 ASSESSMENTS			Sheet No. 1
Subject DVR1/46 - WESTFIELD LANE BR. CENTRE GIRDER.			Calc. No. 14·2
Job No: J20308A			File: R2
Made by: JLR.	Date: 11/2/03	Revised:	Date:
Checked by: CHB	Date: 2/03	Checked by:	Date:

Centre girder properties at mid-span

LMSR drg. 704/46



* Conservative - drg 46 appears to show web height as 3'0", ie to inside face of flanges. CHB

		A in²	y in.	Ay
Top plates	18" × 2 × ½"	18	36·5	657
Top angles	4½ × 2 × ½	4·5	35·75	161
	½ × 4 × 2	4·0	34·5	138
Web	35" × 3/8"	13·125	18·5	243
Bottom angles	½ × 4 × 2	4·0	3·5	14
	4½ × 2 × ½	4·5	1·25	6
Bottom plates	18" × 2 × ½	18	0·5	9
GROSS AREA		66·125		
Bottom plate rivets	4 × 7/8 × 1	− 3·5	0·5	− 2
∠ rivets	2 × 7/8 × ½	− 0·875	1·25	− 1
web rivets	1⅜ × 7/8	− 1·203	3·5	+ 3
NET AREA		60·42		1220
		(60·55)		(1218)

y = 33.5; Ay = 1

Ay = −4

Ht. to neutral axis = $\bar{y} = \frac{Ay}{y} =$ 20·2" (20·1)

(Checker's figures in brackets)

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 2
Subject			Calc. No. 14·2
Job No: J20308A			File: R2
Made by: JLR	Date: 11/2/03	Revised:	Date:
Checked by: CdB	Date: 2/03	Checked by:	Date:

Second moment of area

	I in^4	A	$\bar{y}-y$	y^2	Ay^2	
Top plates	1·5 ✓	18 ✓	16·3 ✓	265·7 ✓	4783 ✓	
Top angles	✓ 0·094	4·5 ✓	15·6 ✓	243·4 ✓	1095 ✓	
	5·33 ✓	4·0 ✓	14·3 ✓	204·5 ✓	818 ✓	
Web	1339·8 ✓	13·125 ✓	1·7 ✓	2·9 ✓	38 ✓	
Bottom angles	5·33 ✓	4·0 ✓	17·7 ✓	313·3 ✓	1253 ✓	$\bar{y}-y = 16·7$, $Ay = 1115$
	0·094 ✓	4·5 ✓	19·0 ✓	361·0 ✓	1624 ✓	
Bottom plates	1·5 ✓	18 ✓	19·7 ✓	388·1 ✓	6985 ✓	
Plate rivets	− 0·29 ✓	− 3·5 ✓	19·7 ✓	388·1 ✓	− 1358 ✓	
Angle rivets	− 0·02 ✓	− 0·9 ✓	19·0 ✓	361·0 ✓	− 325 ✓	
Web rivets	− 0·08 ✓	− 1·2 ✓	17·7 ✓	313·3 ✓	− 376 ✓	$\bar{y}-y = 16·7$, $Ay^2 = 335$
	1353 ✓				14537	(14440)

$\Sigma I + \Sigma Ay^2 = 15890$ in^4 (15793)

Section moduli

$$Z_t = \frac{15890}{(37-20·2)} = 945 \text{ in}^3 \checkmark \quad (940 \text{ in}^3)$$

$$Z_b = \frac{15890}{20·2} = 787 \text{ in}^3 \checkmark \quad (781 \text{ in}^3)$$

CALCULATION SHEET

JACOBS GIBB

Project Title:		Sheet No. 3	
Subject		Calc. No. 14·2	
Job No: J20308A		File: R2	
Made by: JLR	Date: 11/2/03	Revised:	Date:
Checked by: CHB	Date: 2/03	Checked by:	Date:

DEAD LOAD ON CENTRE GIRDER.

Self-weight of girder :-

P.L. X-Sec. area = 66·1 in^2. ✓

BEA Density steel = 490 lb/ft^3. ✓

Wt. per ft. = $\frac{66·1 \times 12}{12^3} \times 490 =$ 225 lbs/ft. ✓

Allow 10% for rivet heads, stiffeners etc.

225 + 10% = 248 lbs/ft. (0·111 ton/ft). ✓ ✓

Tees Side Bridge Pressed Steel Flooring — Hobsons troughing :-

3/8" plate = 29·23 lbs/ft^2. ✓

LMSR Drg 704/46 — Span of troughing between girders 13' 3 3/8" ✓

2 × ½ spans 13·28 × 29·23 = 388·2 lbs/ft on girder ✓

Fill over troughing :-

LMSR Drg 704/46. 2'1" described as 'earth + stone' (Original depth as indicated on 1936 drawing)

BEA Density 135 lb/ft^3. ✓

= 13·28 × 2·08' × 135 = 3729 lbs/ft ✓

Add 5% for filling between troughs

3729 × 1·05 = 3915 lbs/ft on girder ✓

Surfacing :-

LMSR 704/46 BEA 1982 survey dwg — 8" Macadam Density 144 lbs/ft^3. ✓

+6" overlay (1982 drawing).

Project Title:			Sheet No. 4
Subject			Calc. No. 14·2
Job No: J20308A			File: R2
Made by: JLR	Date: 11/2/03	Revised:	Date:
Checked by: CJB	Date: 2/03.	Checked by:	Date:

$\equiv 13{\cdot}28 \times 1{\cdot}167' \times 144 = 2231$ lbs/ft on girder ✓

TOTAL DEAD LOAD ON CENTRE GIRDER:-

$= 248 + 388 + 3915 + 2231 = 6782$ lbs/ft.

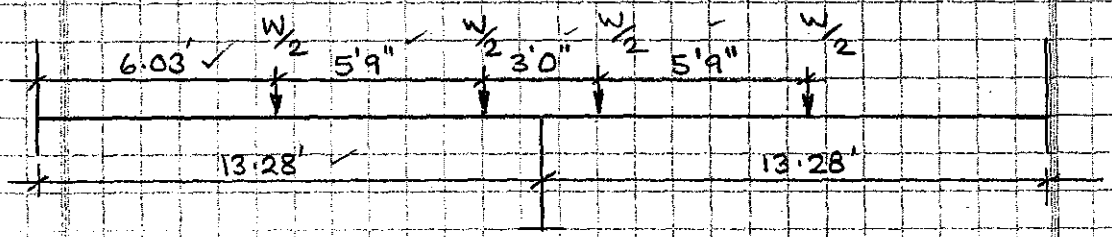
$\equiv 3{\cdot}02$ ton/ft. ✓

LIVE LOAD ON CENTRE GIRDER:

Carriageway width = 25'0" ✓

Therefore 2 lanes loading ✓

BE4 302a.



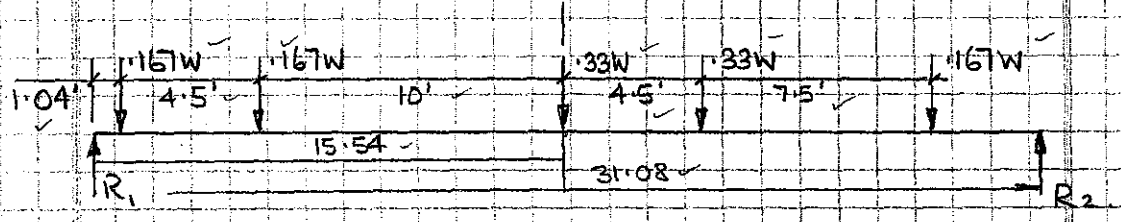
Critical disposition is with vehicle trains centred

$13{\cdot}28\, R_c = 6{\cdot}03\, W/2 + 11{\cdot}78\, W/2$ ✓

$R_c = 0{\cdot}67W \times 2 = 1{\cdot}34W.$ ✓

BS 5400 Pt 2 cl 14.1 Effective span = 31'1" ✓.

BE4 202a



$31{\cdot}08\, R_2 = 0{\cdot}167W(1{\cdot}04 + 5{\cdot}54 + 27{\cdot}54) + 0{\cdot}33W(15{\cdot}54 + 20{\cdot}04)$

$R_2 = \frac{17{\cdot}439}{31{\cdot}08} = 0{\cdot}561\, W.$ ✓

Project Title:			Sheet No. 5
Subject			Calc. No. 14.2
Job No: J20308A			File: R2
Made by: JLR	Date: 11/2/03	Revised:	Date:
Checked by: CHb	Date: 2/03	Checked by:	Date:

$M_{mid} = 0.561W \times 15.54 - 0.33W \times 4.5 - 0.167W \times 12.0$

$= 5.229W$ ✓ for one vehicle train

p4. 1.34 vehicle trains apply: $1.34 \times 5.229W = 7.01W$ ✓

Impact on one axle at mid-span × 0.67* (* contribution on centre girder)

$\frac{WL}{4} = \frac{(0.25 \times 0.33W) \times 31.08}{4} \times 0.67 = 0.43W$ ✓

Total = 7.44 W ✓

for 24 tons M = 178.6 ton.ft. (542.6 kN.m) ✓

CHECK CENTRE GIRDER BENDING CAPACITY:

Dead load moment

p4. $= \frac{3.02 \times 31.08^2}{8} = 364.6$ ton.ft (1108 kN.m)

Total imposed moment = 178.6 + 364.6 = 543.2 ton ft.

Girder top flange is fully restrained by toughing ∴ $l_e = 0$ ∴ Bottom flange in tension is critical.

BS 153 : 3B Table 3

Basic permissible stress for mild steel:

$\frac{d_1}{t} = \frac{\text{clear dist. between flange angles}}{\text{web thickness}} = \frac{26}{(\frac{3}{8})} = 69$.

$\frac{d_1}{t} \not> 85$ ✓ ∴ $p_{bt} = 9.5$ ton/in² (lower yield stress value)

BE4 : 304(a) BS 153 : 3B Table 1. Case II

Apply 25% enhancement $p = 11.87$ ton/in² ✓

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 6
Subject			Calc. No.
Job No: J20308A			File:
Made by: JLR	Date: 11/2/03	Revised:	Date:
Checked by: CHB	Date: 2/03	Checked by:	Date:

Moment capacity

$M = p \cdot Z_b$

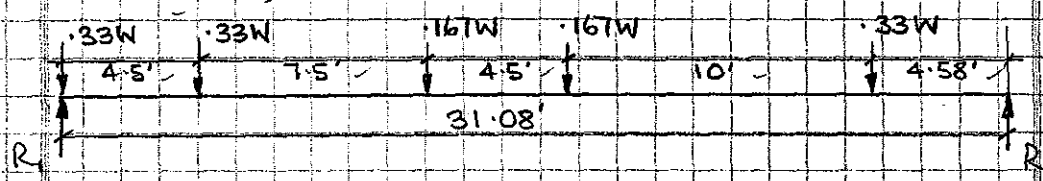
Sht. 2 $= \frac{11.87 \times 787}{12} = 778$ ton.ft. (2365 kN.m)

p.5. $778 > 543$ ∴ OK for 24 ton vehicle train.

SHEAR LOADS:

p4. Dead load shear $= \frac{3.02 \times 31.08}{2} = 46.9$ tons (467.8 kN)

Live load shear:



$31.08 R_1 = .33W(4.58 + 26.58 + 31.08) + .167W(14.58 + 19.08)$

$R_1 = 0.842W$

p4. 1·34 trains apply: $1.34 \times 0.842W = 1.13W$

Add impact on 1 axle $.33W \times 0.25 \times 0.67 = 0.06W$

Total $= 1.19W$

For 24 ton vehicles

$V = 1.19 \times 24 = 28.6$ tons (285.1 kN)

Total shear $= 46.9 + 28.6 = 75.5$ tons

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 7
Subject			Calc. No.
Job No: J20308A			File:
Made by: JLR	Date: 12/2/03	Revised:	Date:
Checked by: CJB	Date: 2/03	Checked by:	Date:

CENTRE GIRDER: SHEAR CAPACITY:

Assume web thickness near end of girder is same as at mid-span ie. 3/8". This cannot be confirmed on the available drawing. Thicker web plates are often used near the ends of girders.

Web area = 35" × 3/8" = 13.125 in² (Conservative - possibly 36" CJB)

pG Average shear stress $f_q = \frac{V}{A} = \frac{75.5}{13.125}$ ✓

= 5.75 ton/in² ✓

BS153:3B Table 3. Permissible average shear stress 5.5 ton/in² ✓

Table 1 Apply enhancement 5.5 × 1.25 = 6.87 ton/in² ✓

Girder shear capacity = 6.87 × 13.125

= 90.1 tons (898 kN)

OK. for 24 ton vehicle trains. ✓

CENTRE GIRDER: RIVET SHEAR

Angle/flange rivets

Sht. 1 Area attaching = 18 in² ✓

Sht. 2 $\bar{y}$ (attaching area) = 16.3 in ✓

Sht 2 I = 15890 in⁴ (15793).

dg 46. Rivet pitch = 4" ✓ No. of rivets = 2 ✓

Shear planes/rivet = 1 ✓

Long. shear = $\frac{V.a.\bar{y}}{I} = \frac{75.5 \times 18 \times 16.3}{15890}$ ✓

= 1.394 tons/in ✓

CALCULATION SHEET

JACOBS GIBB

Project Title:		Sheet No. 8
Subject		Calc. No.
Job No: J20308A		File:
Made by: JLR	Date: 12/2/03	Revised: Date:
Checked by: CSB	Date: 2/03	Checked by: Date:

Shear load per rivet

$= 1.394 \times 4''/2 = 2.79$ tons/rivet. ✓

Rivet capacity:

BS153 TABLE 3

Permissible shear (hand driven rivets) ✓

5.5 tons/in^2 $\times$ $1.25 = 6.88$ tons/in^2.

$A = \frac{\pi}{4} \times \left(\frac{7}{8}\right)^2 = 0.60$ in^2 ✓

Capacity $= 0.6 \times 6.88 = 4.1$ tons ✓

ok for 24 ton vehicle trains ✓

Web/angle rivets

Attaching area $= 26.5$ in^2 ✓ (flange + 2x angles).

Sht. 2

$\bar{y} = \frac{18 \times 16.3 + 4.5 \times 15.6 + 4.0 \times 14.3}{26.5} = 15.9$ in ✓

$I = 15890$ in^4 ✓ (15793)

Long. shear $= \frac{V.a.\bar{y}}{I} = \frac{75.5 \times 26.5 \times 15.9}{15890}$ ✓ ✓ ✓

$= 2.00$ tons/in ✓

Rivet pitch = 4" No. of rivets = 1

No. of shear planes/rivet = 2 ✓

$2.00 \times 4/2 = 4.00$ tons/rivet ✓

Rivet capacity (as above) = 4.1 tons ✓

ok for 24 ton vehicle trains ✓

CALCULATION COVER SHEET

JacobsGIBB Ltd.
Reading

Project Title:	BE4 Assessments - 2002/2003		Calc. No.: 14.3
Job No: J20308A			File: R2
Project Manager	C McNichol	Subject: Westfield Lane	DVR1/46
Designer	J Rigby	Edge Girders	
Project Group	J110		

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	11	JLR	2/03	CJB	2/03				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

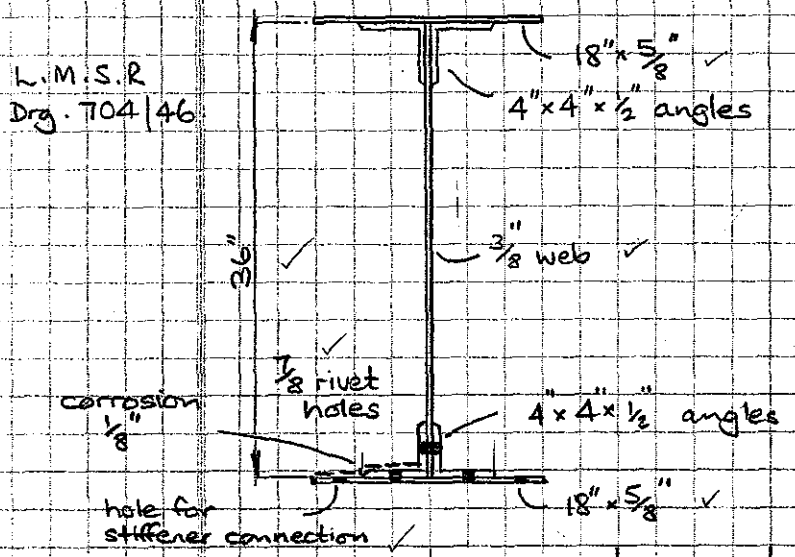
For design criteria, refer to Approval in Principle (Form AA) document

CALCULATION SHEET

JACOBS GIBB

Project Title: BE4 ASSESSMENTS			Sheet No. 1
Subject DVR1/46 - WESTFIELD LANE BR. EDGE GIRDERS.			Calc. No. 14.3
Job No: J20308A			File: R2
Made by: JLR	Date: 12/2/03	Revised:	Date:
Checked by: CJB	Date: 2/03.	Checked by:	Date:

Edge girders : properties at mid-span



		A in²	y in	Ay	
Top plate	18 × 5/8"	✓11.25	36.9✓	415	✓
Top angles	4 × 2 × 1/2	✓4.0	36.4✓	146	✓
	1/2 × 3 1/2 × 2	✓3.5	34.4✓	120	✓
Web	36 × 3/8"	✓13.5	18.6✓	251	✓
Bottom angles	1/2 × 3 1/2 × 2	✓3.5	2.9✓	10	✓
	4 × 2 × 1/2	✓4.0	0.9	4	✓
Bottom plate	18 × 5/8"	✓11.25	0.3	3	✓
GROSS AREA		51.00✓			
Bottom plate rivets	4 × 7/8 × 5/8	-2.2✓	0.3	- 1	
Angle rivets	2 × 7/8 × 1/2	-0.9✓	0.9	- 1	
Web rivets	1 3/8 × 7/8 ✓	-1.2	2.9✓	- 3	
CORROSION	8 1/2 × 1/8 ✓	-1.1	0.5	- 1	
NET AREA		45.6 ✓		943✓	

Ht. to neutral axis = $\bar{y} = Ay/y = 20.7"$ ✓.

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 2
Subject			Calc. No. 14.3
Job No: J20308A			File: R2
Made by: JLR	Date: 12/2/03	Revised:	Date:
Checked by: CSB	Date: 2/03.	Checked by:	Date:

Second moment of area:

	I in⁴	A	$\bar{y}$-y	y²	Ay².	
Top plate	0.4 ✓	11.25 ✓	16.2 ✓	262.4 ✓	2952	✓
Top angles	0.1	4.0 ✓	15.7 ✓	246.5 ✓	986	✓
	1.8 ✓	3.5 ✓	13.7 ✓	187.7 ✓	657	✓
Web	1458 ✓	13.5 ✓	2.1 ✓	4.4 ✓	59	✓
Bottom angles	1.8 ✓	3.5 ✓	17.8 ✓	316.8 ✓	1108	✓
	0.1	4.0 ✓	19.8 ✓	392.0 ✓	1568	✓
Bottom plate	0.4	11.25 ✓	20.4 ✓	416.2 ✓	4682	✓
Plate rivets	- 0.1	-2.2 ✓	20.4 ✓	416.2 ✓	- 915	✓
Angle rivets	-	- 0.9 ✓	19.8 ✓	392.0 ✓	- 353	✓
Web rivets	- 0.1	- 1.2 ✓	17.8 ✓	316.8 ✓	- 380	✓
Corrosion	-	- 1.1 ✓	20.2 ✓	408.0 ✓	- 449	✓
	1462	✓			9915	✓

$\Sigma I + \Sigma Ay^2 = 1462 + 9915 = 11377 \text{ in}^4$ ✓

Section moduli

$Z_t = \frac{11377}{(37.25 - 20.7)} = 687 \text{ in}^3$ ✓

$Z_b = \frac{11377}{20.7} = 550 \text{ in}^3$ ✓

$I_{yy} = \frac{2 \times \frac{5}{8} \times 18^3}{12} + \frac{2 \times \frac{1}{2} \times 8^3}{12}$

$= 650 \text{ in}^4$ ✓

$r_y = \sqrt{\frac{I_{yy}}{A}} = \sqrt{\frac{650}{45.6}} = 3.77 \text{ in}$ ✓

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 3
Subject			Calc. No. 14.3
Job No: J20308A			File: R2
Made by: JLR	Date: 12/2/03	Revised:	Date:
Checked by: CJB	Date: 2/03	Checked by:	Date:

DEAD LOAD ON EDGE GIRDER

Self weight of girder:

Area = 51.0 in^2 ✓

BEA Density steel = 490 lb/ft^3 ✓

Wt. per ft. $\frac{51.0 \times 12}{12^3} \times 490 = 173$ lbs/ft ✓

Allow 10% for stiffeners, rivet heads etc.

173 + 10% = 190 lbs/ft. ✓

Parapet plate:

54" × 3/8" = 20.2 in^2

Wt. per ft $\frac{20.2 \times 12}{12^3} \times 490 = 68$ lbs/ft.

Add 20% for stiffeners, gussets, cover plates etc.

68 + 20% = 83 lbs/ft.

Hobsons troughing

½ value on centre girder

14.2 Sht. 3 388.2 × ½ = 194 lbs/ft ✓

Fill:

" 3915 × ½ = 1958 lbs/ft.

Surfacing

" 4 2231 × ½ = 1115 lbs/ft. ✓

Total dead load on edge girder

= 190 + 83 + 194 + 1958 + 1115 = 3540 lbs/ft

= 1.58 ton/ft ✓

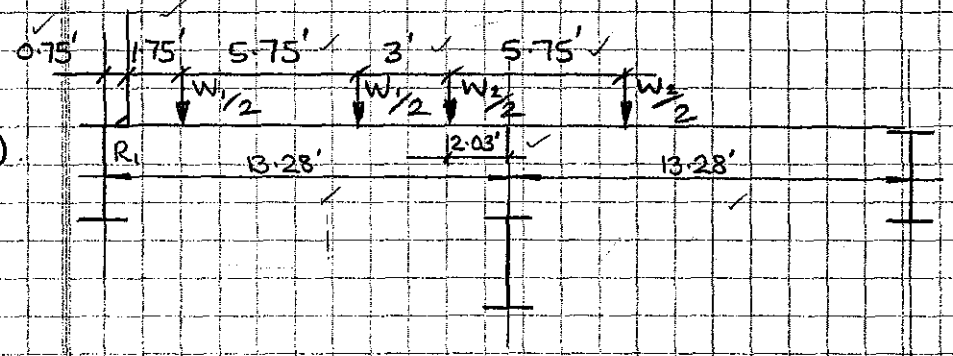
CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 4
Subject			Calc. No. 14·3
Job No: J20308A			File: R2
Made by: JLR	Date: 12/2/03	Revised:	Date:
Checked by: CdB	Date: 2/03.	Checked by:	Date:

LIVE LOADING ON EDGE GIRDER

BE4 302 (a).



Critical disposition of vehicle trains for maximum loading on edge girder as indicated above.

$13{\cdot}28\,R_1 = W/2\,(2{\cdot}03 + 5{\cdot}03 + 10{\cdot}78)$

$R_1 = 0{\cdot}67W$ ✓ ($0{\cdot}59W$ without $W_2/2$)

67% of single train loading on edge girder
59% of impact load.

pl; calc 14·1 Effective span = 30'7"

For max. bending at mid-span, use same effect as for centre girder: (approx only, as spans not identical. CdB)

14·2 Sh.5 5·229W for one vehicle train

0·67 of one train applies : $0{\cdot}67 \times 5{\cdot}229W = 3{\cdot}50W$ ✓

Impact on one axle at mid-span × 0·59

$\frac{WL}{4} = \frac{(0{\cdot}25 \times 0{\cdot}33W) \times 30{\cdot}6}{4} \times 0{\cdot}59 = 0{\cdot}37W$ ✓

Total = $3{\cdot}87W$ ✓

for 24 tons $M = 3{\cdot}87 \times 24 = 92{\cdot}9$ ton.ft (282·2 kN.m) ✓

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 5
Subject			Calc. No. 14·3
Job No: J20308A			File: R2
Made by: JLR	Date: 12/2/03	Revised:	Date:
Checked by: CTB	Date: 2/03.	Checked by:	Date:

EDGE GIRDER BENDING CAPACITY

Dead load moment

p3 $= \frac{1.58 \times 30.6^2}{8} = 185.0$ ton.ft. (561.9 kN.m)

p4. Total imposed moment = 92.9 + 185.0 = 277.9 ton.ft.

Consider girder top flange :
a) unrestrained
b) restrained by U-frame action from troughing.

a) Unrestrained condition.

BS 153 Pt 4 21a. For member unrestrained in lateral bending, effective length of compression flange
L_1 = span = 30.6' (load is not applied to compression flange)

Sht. 2. r_y = 3.77 in (radius of gyration about y-y axis)

T = 5/8 in (thickness of compression flange)
D = 37.25 in (overall depth)
t = 3/8 in (thickness of web)

d_1 = 28 in (clear distance between flange angles)

BS153 : Pt 3B 28b.i. $d/t = 74.6 > 85$ and $T/t = 1.67 > 2$
∴ C_s can be increased by 20%

$$C_s = \frac{170000}{\left(\frac{L}{r_y}\right)^2}\sqrt{\left[1 + \frac{1}{20}\left(\frac{L.T}{r_y.D}\right)^2\right]} \text{ ton/in}^2$$

$$C_s = \frac{170000}{\left(\frac{30.6 \times 12}{3.77}\right)^2}\sqrt{\left[1 + \frac{1}{20}\left(\frac{30.6 \times 12 \times 5/8}{3.77 \times 37.25}\right)^2\right]} \times 1.2$$

C_s = 22.9 ton/in^2.

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 6
Subject			Calc. No. 14·3
Job No:			File: R2
Made by: JLR	Date: 12/2/03	Revised:	Date:
Checked by: CJB	Date: 2/03	Checked by:	Date:

BS 153 : 3B Table 8 — for $C_s = 22.9$ ton/in²

$P_{bc} = 6.8$ ton/in² ✓

BE4 304 a
BS 153:3B:Table 1 — $P_{bc} = 6.8 \times 1.25 = 8.5$ ton/in². ✓

$M = P_{bc} Z_t$ ✓

p2. $M = \frac{8.5 \times 687}{12} = 486.6$ ton.ft. ✓ (1478.3 kN.m) (> 278 applied p5 Lt6)

b. Restrained condition.

Consider U-frame action. Connection details between troughing and girder are not certain. Conservatively consider web stiffeners at 5' centres and Tee sections of troughing at 2'6" centres as being the only effective members. Ignore troughing plates.

BS 153 : 4 21b. $L = 2.5 \sqrt[4]{(EI a \delta)}$ ✓

but not less than a

$a = 5' = 60$ in ✓

$E = 13270$ ton/in² ✓ (205 000 N/mm²) - BD21.

$I = 304$ in². ✓ (2nd mom. comp. flange about y-y) $(\frac{5}{8} \times \frac{18^3}{12})$

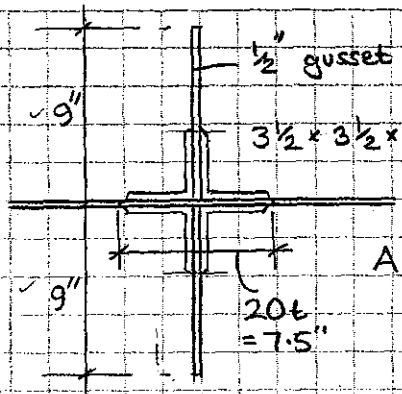
$\delta = \frac{(d')^3}{3EI_1} + \frac{(d'')^2 b}{EI_2}$

$d' = 33.3$ in.

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 7
Subject			Calc. No. 14.3
Job No: J20308A			File: R2
Made by: JLR	Date: 13/2/03	Revised:	Date:
Checked by: CJB	Date: 2/03.	Checked by:	Date:

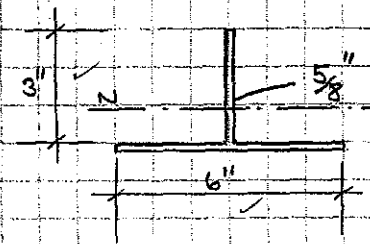


$A = 2\times9\times\tfrac{1}{2} + 4\times3\tfrac{1}{2}\times\tfrac{1}{2} + 4\times3\times\tfrac{1}{2} + 7.5\times\tfrac{3}{8}$

$= 24.8\ in^2$ ✓

$I_1 = \frac{\frac{1}{2}\times18^3}{12} + \frac{\frac{1}{2}\times2\times7^3}{12} = 271\ in^4$ ✓

Cross member:



$A = 5.62\ in^2$ ✓

$\Sigma Ay = \left(6\times\tfrac{5}{8}\times\tfrac{5}{16}\right) + \left(3\times\tfrac{5}{8}\times2\tfrac{1}{8}\right)$

$= 1.172 + 3.984 = 5.156$ ✓

$\bar{y} = 5.156/5.62 = 0.917\ in.$ ✓

$I \quad \left(6\times\tfrac{5}{8}\right)\times(0.604)^2 + \left(\tfrac{5}{8}\times\tfrac{3^3}{12}\right) + \left(\tfrac{5}{8}\times3\right)\times(1.208)^2$

$1.368 + 1.406 + 2.736 = 5.5\ in^4$ ✓

$I_2 = 2\times5.5 = 11.0\ in^4$ (2No. members in 5')

$d'' = 36.00\ in.$ ✓ (36.3)

$b = 13.28' = 159.36\ in.$ ✓

$\delta = \frac{(33.3)^3}{3\times13270\times271} + \frac{(36)^2\times159.4}{13270\times11} = 1.42\ in.$ ✓

$l = 2.5\sqrt[4]{(13270\times304\times60\times1.42)}$ ✓

$= 340\ in.$ ✓

$C_s = \frac{170000}{\left(\frac{340}{3.77}\right)^2}\sqrt{\left[1+\frac{1}{20}\left(\frac{340\times\frac{5}{8}}{3.77\times37.35}\right)^2\right]}\times1.2$

$C_s = 26.5\ ton/in^2$ ✓

CALCULATION SHEET

JACOBS GIBB

Project Title:		Sheet No.	8
Subject		Calc. No.	14·3
Job No:		File:	R2
Made by: JLR	Date: 13/2/03	Revised:	Date:
Checked by: CHB	Date: 2/03.	Checked by:	Date:

BS 153 : 3B Table 8

for $C_s = 26.5$ ton/in².

$P_{bc} = 7.25$ ton/in² ✓

$P_{bc} = 7.25 \times 1.25 = 9.06$ ton/in² ✓

$M = \frac{9.06 \times 687}{12} = 518.7$ ton.ft ✓

SHEAR LOADS

p.3. Dead load shear $= \frac{1.158 \times 30.6}{2} = 24.2$ tons ✓ (241.2 kN) ✓

Live load shear:

Configuration as for centre girder

14.2 Sht. 6 Effect from one vehicle train = 0.842W ✓ (slight diff in span)

0.67 trains apply = $0.67 \times 0.842W = 0.564W$ ✓

Impact on 1 axle = $.33W \times 0.25 \times 0.59$

$= 0.049W$ ✓

Total = $0.613W$ ✓

For 24 ton vehicles

$V = 0.613 \times 24 = 14.7$ tons ✓ (146.6 kN) ✓

Total shear = $24.2 + 14.7 = 38.9$ tons ✓

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 9
Subject			Calc. No. 14.3
Job No:			File: R2
Made by: JLR	Date: 13/2/03	Revised:	Date:
Checked by: CJB	Date: 18/2/03.	Checked by:	Date:

EDGE GIRDER : SHEAR CAPACITY

Web area = $36'' \times \frac{3}{8}'' = 13.5\ in^2$ ✓

p8. Average shear stress = $\frac{38.9}{13.5} = 2.88\ ton/in^2$ ✓

BS 153:3B Table 3 Permissible average shear stress = $5.5\ ton/in^2$ ✓

Table 1 Apply enhancement $5.5 \times 1.25 = 6.87\ ton/in^2$ ✓

Girder capacity = $6.87 \times 13.5 = 92.7$ tons ✓ (923.9 kN) (> 38K)

— Satisfactory for 24 ton vehicles ✓

EDGE GIRDER : RIVET SHEAR

Web / angle rivets

Attaching area (flange + 2 angles) = $18.75\ in^2$ ✓

Sht. 2 $\bar{y} = \frac{11.25 \times 16.2 + 4.0 \times 15.7 + 3.5 \times 13.7}{18.75} = 15.63$ in ✓

$I = 11377\ in^4$ ✓

Long. shear = $\frac{V.a.y}{I} = \frac{38.9 \times 18.75 \times 15.63}{11377}$ ✓

$= 1.00\ tons/in$ ✓

Rivet pitch = 4" No. of rivets = 1

No. of shear planes / rivet = 2

$1.00 \times 4''/2 = 2.0$ tons / rivet ✓

14.2 Sht. 8 Rivet capacity = 4.1 tons ✓

Satisfactory for 24 tons ✓

By inspection : angle / flange rivets will also be satisfactory ✓

CALCULATION SHEET

JE JACOBS GIBB

Project Title:		Sheet No.	10
Subject		Calc. No.	14.3
Job No:		File:	R2
Made by: JLR	Date: 17/2/03	Revised:	Date:
Checked by: CJB	Date: 2/03	Checked by:	Date:

EDGE GIRDER: BEARING STIFFENERS.

It is assumed that the bearing stiffeners have the same section as the intermediate stiffeners as shown on the drawings.

BS153 Pt.4 27a. Theoretical I value

$$= \frac{D^3 . T}{250} \cdot \frac{R}{W}$$

D = overall depth = 37¼" ✓

T = thickness comp. flange = ⅝" ✓

$\frac{R}{W} = \frac{\text{reaction on bearing}}{\text{total load on girder}} = 0.5$

$$I = \frac{(37.25)^3 \times \frac{5}{8}}{250} \cdot 0.5 = 64.6 \text{ in}^4 \quad \checkmark$$

p7 Actual value = 271 in⁴ ok. ✓

BS 153 Pt4 21a. Restraint against torsion is provided solely by the bearing stiffener

Horizontal force F at flange height

$$= \frac{1.4 \times 10^{-3} \ell}{\delta \left(\frac{C_s}{f_{bc}} - 1.7 \right)} \quad \checkmark$$

ℓ = 367 in. (30'7")

BS 153 Pt4 21a (See Amdt No.2) Girder is on rigid bearing ∴ treat as cantilever

$\delta = \ell^3/3EI = (33.3)^3/(3 \times 13270 \times 271) = 0.003"$ ✓

but not less than $\ell^3/40EI = \frac{367^3}{40 \times 13270 \times 304} = 0.306"$ ∴ Use 0.306 in ✓

Sht 5 C_s = 22.9 ton/in² ✓ ✓

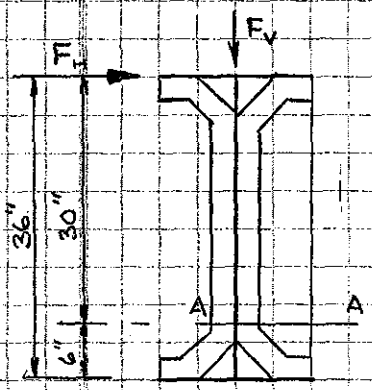
Sht.5 Sht.2. $f_{bc} = \frac{M}{Z_t} = \frac{277.9 \times 12}{687} = 4.85$ ton/in² ✓ ✓

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 11
Subject			Calc. No. 14·3
Job No:			File: R2
Made by: JLR	Date: 17/2/03	Revised:	Date:
Checked by: CSB	Date: 2/03.	Checked by:	Date:

$$F_H = \frac{1.4 \times 10^{-3} \times 367}{0.306\left(\frac{22.9}{4.85} - 1.7\right)} = 0.556 \text{ ton.}$$



Moment at A

$M_A = 0.556 \times 30 = 16.68$ ton.in

Stress due to moment

$= M/Z$ p7.

Sht.7 $Z = 271/9 = 30.11 \text{ in}^3$.

$f_m = 16.68/30.11 = 0.55 \text{ ton/in}^2$

Sht.8. $F_V = 38.9$ tons

p7. $A = 24.8 \text{ in}^2$.

Vertical stress $= F_V/A = \frac{38.9}{24.8} = 1.57 \text{ ton/in}^2$

Total stress $= 0.55 + 1.57 = 2.12 \text{ ton/in}^2$

BS 153:3B 25:Table 3 Permissible stress $= 9.0 \text{ ton/in}^2$ — UNITS chel.

(BS15 : Yield 15 t/in² : Part in axial compression)

∴ Adequate for 24 ton C&U loading.

CALCULATION COVER SHEET

JacobsGIBB Ltd.
Reading

Project Title:	BRB (Residuary) Ltd - VAR 9/775 BE4 Assessments	Calc. No.:	14.3
Job No: J20308A		File:	R2
Project Manager	C. Chantler	Subject:	DVR1/46
Designer	J Rigby		Bearing stiffener - unity check
Project Group	31400		Addendum to calculation 14.3

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	2	JLR	Jun-05	IK	Jun-05				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

JACOBS **CALCULATION SHEET**

Project Title: VAR9/775 - BE4 ASSESSMENTS			Sheet No: A1
Subject: DVR 1/46 - WESTFIELD LANE BR. - Bearing stiffeners			Calc. No: 14·3
Job No: J20308A			File: R2
Made by: JLR	Date: 21/6/05	Revised:	Date:
Checked by: RI	Date: June 05	Checked by:	Date:

Check combined bending and axial load in accordance with unity check BS 153: 3B clause 23a.

14·3 Sheet 11

Vertical load in stiffener = 38·9 tons ✓

Moment due to lateral force F = 16·68 ton.in ✓

Axial compressive stress, f_{ac}

$A = 24.8\ in^2$ ✓

$f_{ac} = \frac{38.9}{24.8} = \underline{1.57\ ton/in^2}$ ✓

Bending stress, f_{bc}

$Z = 30.11\ in^3$

$f_{bc} = M/Z = \frac{16.68}{30.11} = \underline{0.55\ ton/in^2}$ ✓

Permissible axial stress : p_{ac}

Sheet 10

$r = \sqrt{I/A} = \sqrt{\frac{271}{24.8}} = 3.30\ in.$ ✓

Take l = depth of girder = 36"

$l/r = \frac{36}{3.3} = 10.9$ ✓

BS 153 : 3B Table 4

$p_{ac} = 8.7\ ton/in^2$ ✓

Apply Case II increase = $8.7 \times 1.25 = \underline{10.87\ ton/in^2}$ ✓

Permissible bending stress, p_{bc}

Treat gusset as a plate in bending in a plane parallel to its surface

BS 153: 3B Appendix. d

$C_s = 26000\ t^2/lD\ \ ton/in^2.$

JACOBS

CALCULATION SHEET

Project Title:			Sheet No: A2
Subject:			Calc. No: 14·3
Job No: J20308A			File: R2
Made by: JLR	Date: 21/6/05	Revised:	Date:
Checked by: RJ	Date: June 05	Checked by:	Date:

$t = \frac{1}{2}"$ ✓

sheet 7 $D = 18"$ ✓

$l = 36"$ ✓

$C_s = 10.03$ ton/in². ✓

Table 8 $p_{bc} = 4.2$ ton/in² ✓

Apply case II enhancement

$p_{bc} = 1.25 \times 4.2 = 5.25$ ton/in². ✓

Unity check:

BS153:3B Cl. 23a.

$$\frac{f_{ac}}{p_{ac}} + \frac{f_{bc}}{p_{bc}} \not> 1$$

$$\frac{1.57}{10.87} + \frac{0.55}{5.25} = 0.249$$ ✓

∴ OK. ✓

CALCULATION COVER SHEET

JacobsGIBB Ltd.
Reading

Project Title:	BE4 Assessments - 2002/2003		Calc. No.: 14.4
Job No: J20308A			File: R2
Project Manager	C McNichol	Subject: Westfield Lane	DVR1/46
Designer	J Rigby	Transverse troughing	
Project Group	J110		

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	3	JLR	2/03	RL	2/03				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

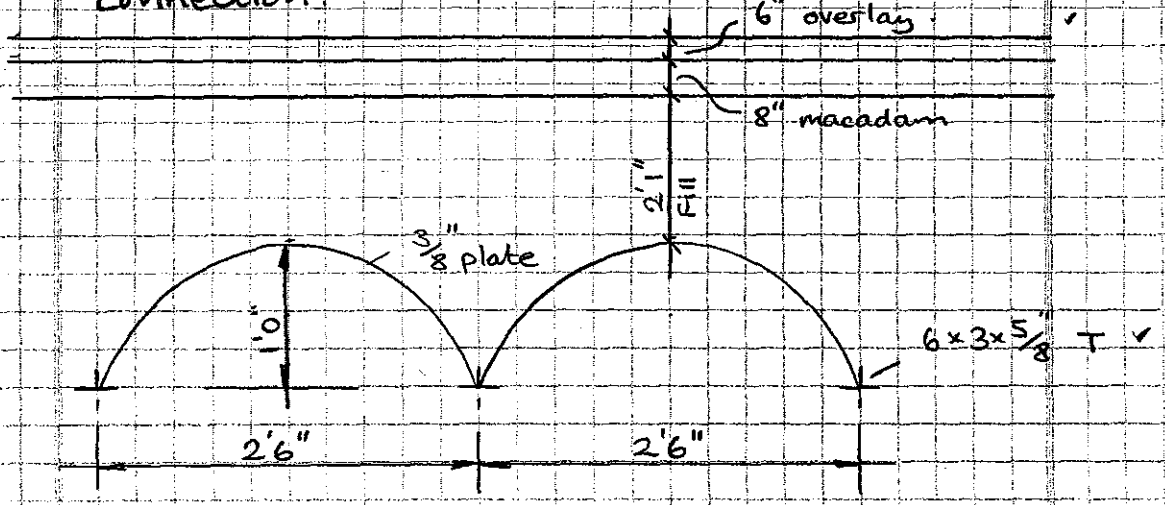
CALCULATION SHEET

JACOBS GIBB

Project Title: BE4 ASSESSMENTS			Sheet No. 1
Subject DVR 1/46 - WESTFIELD LANE BRIDGE			Calc. No. 14.4
Job No: J20308A	HOBSON'S TROUGHING.		File: R2.
Made by: JLR	Date: 26/2/03	Revised:	Date:
Checked by: RI	Date: 26/2/03	Checked by:	Date:

Check transverse troughing under dead load and axle loading.

Assume troughing is simply supported at edge and centre girder. Connections appear not to constitute a full moment connection.



Tees-side Bridge Pressed steel flooring No 15

Section modulus of troughing = 65.079 in³ ✓

Dead load (inc. rivets/covers etc) = 29.23 lbs/ft² ✓

Dead load on one troughing section (2'6" width)

Troughing : 29.23 × 2.5 = 73.1 lbs/ft ✓

Fill : Density = 135 lb/ft³ ✓

≡ 2.5' × 2.08' × 135 = 702 ✓

3.0²

6x8²

12³⁰

Add 5% for fill between units = 737 lbs/ft

Macadam + overlay : Density = 144 lbs/ft³

≡ 2.5' × 1.167' × 144 = 420 lbs/ft

TOTAL DEAD LOAD = 73 + 737 + 420 = 1230 lbs/ft ✓

= 0.549 ton/ft

CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 2
Subject			Calc. No. 14·4
Job No: J20308A			File: R2.
Made by: JLR	Date: 26/2/03	Revised:	Date:
Checked by: KI	Date: 26/2/03	Checked by:	Date:

BE4 303 b

Live load dispersion through surfacing and fill

Take 45° through to top of troughing.

Depth = 2'1" + 6" + 8" = 3'3"

FOR SINGLE 11 ton axles, dispersal width = 6'6" ✓

Proportion of live load on one troughing section:

$$\frac{2.5}{6.5} = 0.385$$ ✓

FOR DOUBLE 9 ton bogie, dispersal width

4'6" + 6'6"
(axle spacing)

= 11'0"

Proportion of live load on one troughing section:

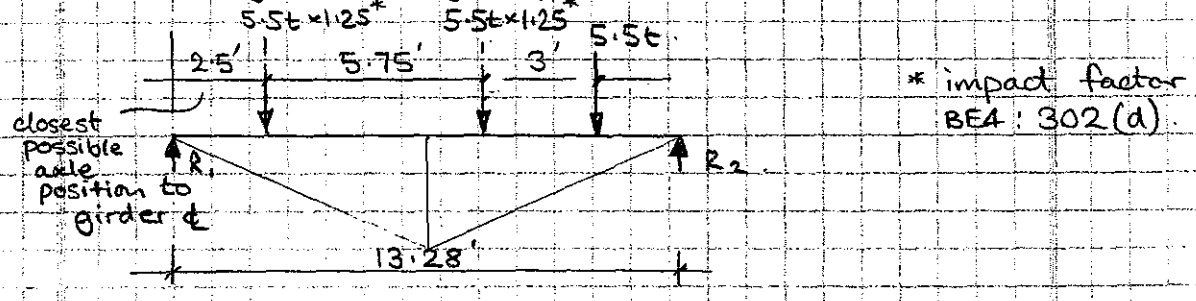
$$\frac{2.5}{11.0} = 0.227$$

11t × 1.25 impact × 0.385 = 5.29t.

(9t + 9 × 1.25) × 0.227 = 4.60t

Single 11 ton axle is critical load case. ✓

Disposition of axle loading for maximum bending in troughing.



CALCULATION SHEET

JACOBS GIBB

Project Title:			Sheet No. 3
Subject			Calc. No. 14.4
Job No: J20308A			File: R2
Made by: JLR	Date: 26/2/03	Revised:	Date:
Checked by: KL	Date: 26/2/03	Checked by:	Date:

Calculate maximum moment at mid-span

$13.28R_2 = 5.5 \times 1.25(2.5 + 8.25) + 5.5 \times 11.25$

$R_2 = 10.22$ ✓

$M_{mid} = 13.28/2 \times 10.22 - 1.61 \times 5.5 \times 1.25 - 4.61 \times 5.5$

$= 31.4$ ton.ft. ✓

Live moment applied to one troughing section

$= 31.4 \times 0.385 = 12.1$ ton.ft. (36.7 KN.m)

Dead load moment

$= \frac{0.549 \times 13.28^2}{8} = 12.1$ ton.ft (36.7 kN.m) ✓

Total moment = 24.2 ton.ft. ✓

Max. steel stress = $\frac{24.2 \times 12}{65.079} = 4.46$ ton/in² ✓

Permissible steel stress in troughing

BS 153:3B Table 3 — Take as "parts in bending" 1) - plates flats, tubes etc.

= 10 ton/in². ✓

BE4 304(a) — Apply 25% uplift = 12.5 ton/in² > 4.46 ✓

∴ satisfactory for BE4 C&U loading (24 tons)

Actual moment capacity

$= \frac{12.5 \times 65.079}{12} = 67.8$ ton.ft (205.9 kN.m)