ESSEX COUNTY COUNCIL
ASSESSMENT CONTRACT 3

APPROVAL IN PRINCIPLE FOR THE ASSESSMENT OF PAINTERS BRIDGE

ECC BRIDGE NO. 1018
RAIL PROPERTY Ltd BRIDGE NO. AEB/2122

TOPS

Essex County Council
Transportation &
Operational Services

ESSEX COUNTY COUNCIL
ASSESSMENT CONTRACT 3

APPROVAL IN PRINCIPLE FOR THE ASSESSMENT OF PAINTERS BRIDGE

ECC BRIDGE NO. 1018
RAIL PROPERTY Ltd BRIDGE NO. AEB/2122

22/12/99

22/12/99

03/02/00

CEng. MICE

Essex County Council
Transportation and Operational Services Division
County Hall
Chelmsford
Essex
CM1 1QH

WS Atkins Consultants - Essex
Threadneedle House
9 - 10 Market Road
Chelmsford
Essex
CM1 1JQ

Rail Property Ltd
Room C5
Hudson House
York
YO1 6HP

Copy No. 1
Version No. 1.0

APPROVAL IN PRINCIPLE FOR THE ASSESSMENT OF PAINTERS BRIDGE

ECC Bridge Number 1018

Rail Property Number AEB/2122

APPROVAL IN PRINCIPLE CONTENTS

- British Railways Board FORM 'AA' (BRIDGES)
- British Railways Board FORM 'AA/1' (BRIDGES)
- Location Plan
- General Arrangement, Cross Section and Idealisation Drawings
- Technical Approval Schedule "TAS" (June 1989)
- Appendix to TAS Schedule dated (June 1989) WS Atkins amended March 1999
- Appendix: Inspection for Assessment

FORM 'AA' (BRIDGES)

APPROVAL IN PRINCIPLE FOR ASSESSMENT

STRUCTURE / LINE NAME PAINTERS BRIDGE

ELR / STRUCTURE NO. AEB 2122

BRIEF DESCRIPTION OF EXISTING BRIDGE:

(a) Span Arrangement

The clear skew spans of the 3 no. spans are 7.950m, 8.110m and 7.486m for the north, central and south arches respectively. The angle of skew is 23°.

(b) Superstructure Type

3 span brick arch.

(c) Substructure Type

Brick abutments and piers.

(d) Details of any Special Features

None

ASSESSMENT CRITERIA

(a) Loadings and Speed

Loadings to be in accordance with BD 21/97. The current permitted traffic speed across the structure is 60mph.

(b) Codes to be used

See attached TAS schedule and March 1999 addendum.

(c) Proposed Method of Structural Analysis

The structure will be analysed as a multi span arch using the MULTI mechanism method computer program. The individual arches will be analysed using the modified MEXE method, detailed in BD 21/97 and BA 16/97, and the ARCHIE computer program. The MEXE results will be adopted where the fill depth is less than or equal to the barrel thickness, otherwise the ARCHIE result will be used. The values obtained from MEXE for individual arches will be considered as upper bound solutions. The results of MULTI mechanism will be used for the overall capacity of the whole structure. For the analysis the following parameters will be adopted.

ARCHIE / MULTI

Backing level	None
Masonry self weight	21 kN/m3
Fill self weight	19 kN/m3
Surfacing self weight	23 kN/m3
Ø' for fill	30°
ARCHIE pressure coefficient	0.3
Masonry Strength	2.3 N/mm2

Passive pressures generated behind the arch will be limited to 30% of the full passive pressures.

MEXE

From the visual inspection report the following factors will be adopted for the MEXE assessment.

		South Arch	Centre Arch	North Arch
Condition Factor	F_{cM}	0.9	0.95	0.85
Barrel Factor	F_b	1.0	1.0	1.0
Fill Factor	F_f	0.7	0.7	0.7
Width Factor	F_w	0.9	0.9	0.9
Mortar Factor	F_{mo}	0.9	0.9	0.9
Depth Factor	F_d	0.9	0.8	0.9

For the north arch barrel the ring separation will be accounted for by reducing the allowable axle load in accordance with annex G of BA 16/97 assuming one ring has become separated.

Section sizes and dimensions will be based on drawings AI1877/1018/FIG 01,02,06,07

(d) Details of any Special Requirements

None

STRUCTURAL ASSESSMENT ENGINEER'S COMMENTS

FORM 'AA' (BRIDGES)

APPROVAL IN PRINCIPLE FOR ASSESSMENT

CIVIL ENGINEER'S COMMENTS

BRB WORKS GROUP COMMENTS - IF APPLICABLE

PROPOSED CATEGORY FOR INDEPENDENT CHECK

SUPERSTRUCTURE 2

SUBSTRUCTURE N/A

NAME OF CHECKER SUGGESTED IF CAT 2 OR 3 Different team within office

THE ABOVE IS SUBMITTED FOR APPROVAL IN PRINCIPLE

SIGNED [redacted]

TITLE ASSESSMENT TEAM LEADER

DATE 22/12/99

FOR AND ON BEHALF OF WS ATKINS CONSULTANTS LTD

APPROVAL IN PRINCIPLE FOR ASSESSMENT

CATEGORY 1

THE ABOVE ASSESSMENT, WITH AMENDMENTS SHOWN, IS APPROVED IN PRINCIPLE:

SIGNED N/A

TITLE .....

DATE .....

CATEGORY 2 AND 3

THE ABOVE ASSESSMENT, WITH AMENDMENTS SHOWN, IS APPROVED IN PRINCIPLE:

SIGNED [redacted]

TITLE Senior Civil Engineer

DATE 21/2/00

ADDITIONAL INFORMATION REQUIRED FOR BRB PUBLIC ROAD OVERBRIDGES ASSESSED AS PART OF BRIDGEGUARD III

STRUCTURE / LINE NAME PAINTERS BRIDGE

ELR / STRUCTURE NO. AEB 2122

SCOPE OF ASSESSMENT

An inspection of the structure has been carried out prior to the assessment in order to confirm section sizes and overall dimensions as shown on the drawings. The substructure shows no signs of distress and is deemed satisfactory, therefore no analysis will be carried out.
The deck will be assessed to determine its load carrying capacity at ULS. HB loading and SLS checks are not applicable to arches. The parapets will not be assessed since they do not meet current standards.

ASSESSMENT CRITERIA

a) Standards and Codes of Practice to be used in assessment

See attached TAS schedule and March 1999 addendum.

b) Proposed method of structural analysis

The structure will be analysed as a multi span arch using the MULTI mechanism method computer program. The individual arches will be analysed using the modified MEXE method, detailed in BD 21/97 and BA 16/97, and the ARCHIE computer program. The MEXE results will be adopted where the fill depth is less than or equal to the barrel thickness, otherwise the ARCHIE result will be used. The values obtained from MEXE for individual arches will be considered as upper bound solutions. The results of MULTI mechanism will be used for the overall capacity of the whole structure. For the analysis the following parameters will be adopted.

ARCHIE / MULTI

Backing level	None
Masonry self weight	21kN/m3
Fill self weight	19 kN/m3
Surfacing self weight	23 kN/m3
Ø' for fill	30°
ARCHIE pressure coefficient	0.3
Masonry Strength	2.3 N/mm2

Passive pressures generated behind the arch will be limited to 30% of the full passive pressures.

MEXE

From the visual inspection report the following factors will be adopted for the MEXE assessment.

		South Arch	Centre Arch	North Arch
Condition Factor	F_{cM}	0.9	0.95	0.85
Barrel Factor	F_b	1.0	1.0	1.0
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Width Factor	F_w	0.9	0.9	0.9
Mortar Factor	F_{mo}	0.9	0.9	0.9
Depth Factor	F_d	0.9	0.8	0.9

For the north arch barrel the ring separation will be accounted for by reducing the allowable axle load in accordance with annex G of BA 16/97 assuming one ring has become separated.

Section sizes and dimensions will be based on drawings AI1877/1018/FIG 01,02,06,07

c) Planned Highway works / modifications at this site

Intrusive investigations have been carried out within the carriageway. There are no other known works planned.

d) Road designation / class and whether classed as a heavy load route

Unclassified road. The road is not a heavy load route.

e) Any other requirement

None.

The above is agreed subject to the amendments and c

SIGNED [redacted]

TITLE County Bridges Manager

DATE 7 February 2000

FOR AND ON BEHALF ESSEX COUNTY COUNCIL TRANSPORTATION AND OPERATIONAL SERVICES DIVISION.

Essex County Council
Transportation &
Operational Services

[redacted]

Atkins

PAINTERS BRIDGE

Map Ref: TL 556403 239955

A4	DRWG.NO. B1204/1018/LP001–
	CAD NO. PAI–LP01
	SCALES 1:5000
	DATE AUG 99 — DRAWN/TRACED TNP
	DATE AUG 99 — CHECKED AJS
	DATE — AUTHORISED

HEME TITLE

PAINTERS BRIDGE
SAFFRON WALDEN
LOCATION PLAN

DO NOT SCALE

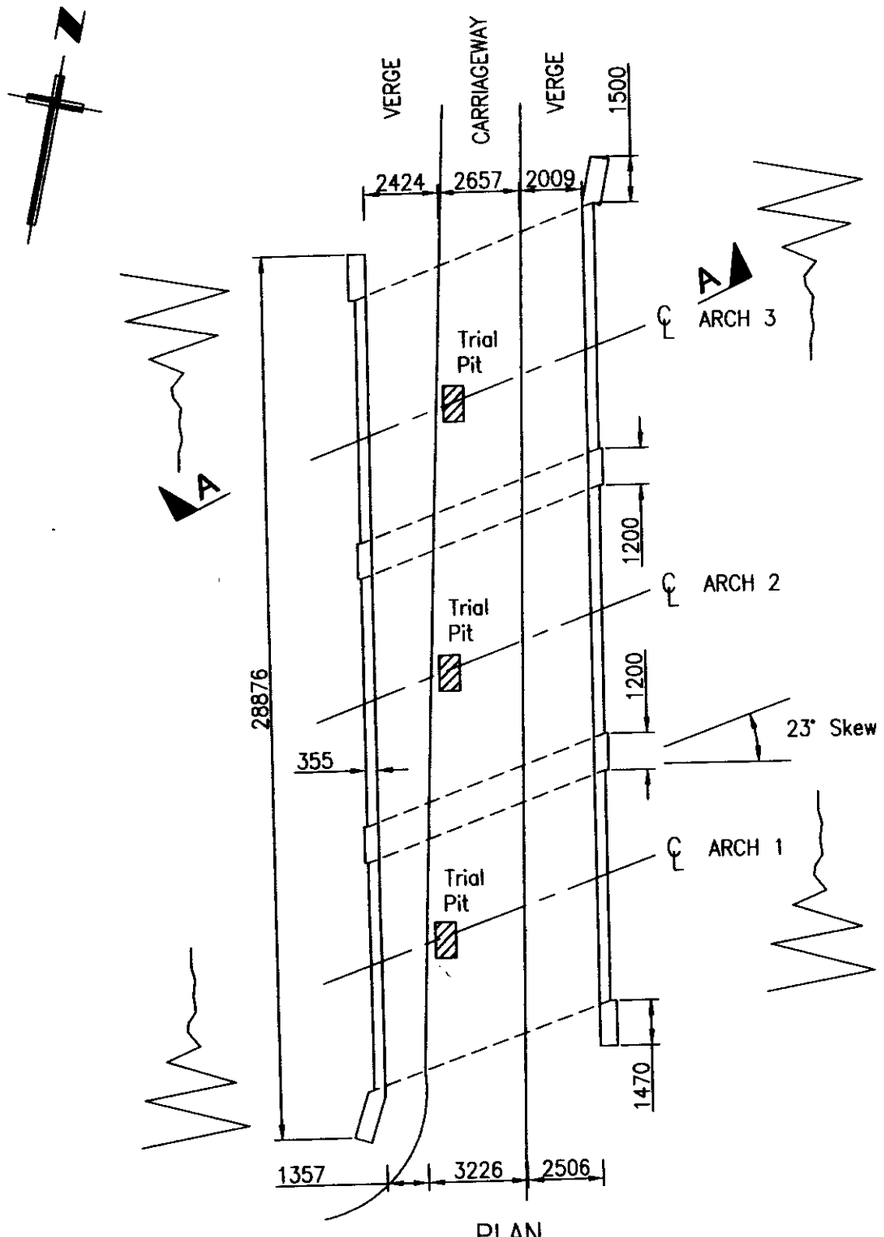
ECC Bridge No. 1018
Rail Property Baord No. AEB/2122

Notes:

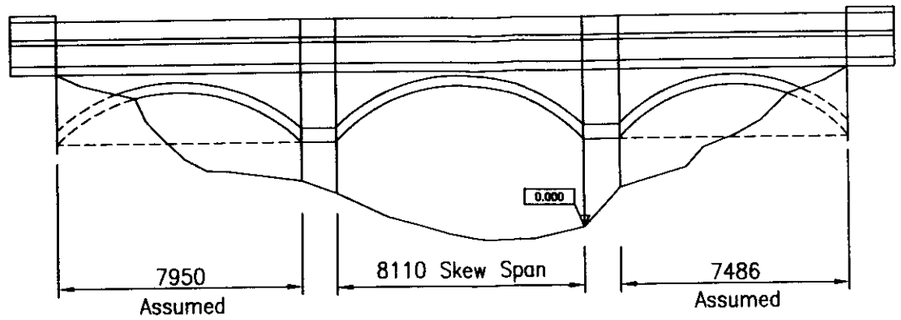
All dimensions in mm

All levels in m above local datum

For section A–A see Fig 02



PLAN
Scale 1:200



EAST ELEVATION
Scale 1:200

	Arch 1 (South)	Arch 2 (Central)	Arch 3 (North)
South Springer	2.778	2.802	*
South Quarter Point	4.098	4.189	*
Crown	4.437	4.600	4.510
North Quarter Point	*	4.218	4.183
North Springer	*	2.827	2.843
Average Ground Level at base of south abutment/pier	1.538	0.895	*
Average Ground Level at base of north abutment/pier	*	0.000	1.128

ARCH LEVELS

* Buried; levels could not be taken

Essex County Council
Transportation & Operational Services

[redacted]

Atkins

SCALES		SURVEYED	LEVELLED	DESIGNED	DRAWN/TRACED	CHECKED	AUTHORISED
1:200	INITIALS	JF	JF		SD		
	DATE	OCT 99	OCT99		NOV 99		
CAD FILE N:AI1877–62–01	REVISION NOTES			REVISION		CHECKED	

DESCRIPTION OF DRAWING
PAINTERS BRIDGE
GENERAL ARRANGEMENT AND
ARCH LEVELS

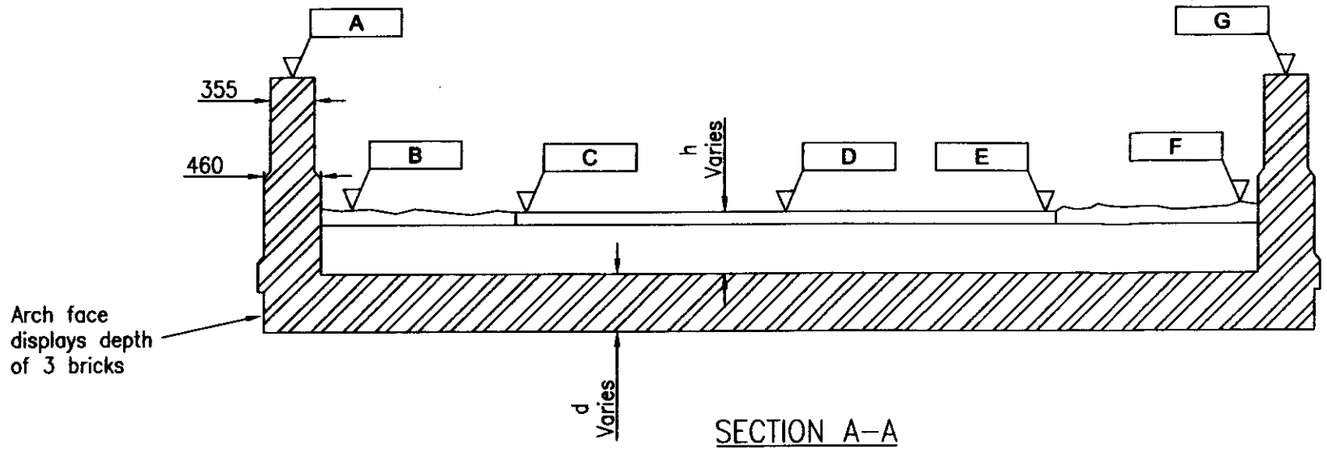
Sheet 1 of 1

SCHEME TITLE
ECC ASSESSMENT PACKAGE 3
RAIL PROPERTY Ltd BRIDGES

DRAWING NO. AI1877/1018/FIG 01

DO NOT SCALE

ECC Bridge No. 1018
Rail Property Baord No. AEB/2122



SECTION A–A
N.T.S

Notes:

All levels in m above local datum

For section A–A Location, See Fig 01

	A	B	C	D	E	F	G
+ 5m South			4.834	4.844	4.777		
South Parapet End	6.761	5.058	5.056	5.051	4.997	5.076	
South Arch South Abutment	6.755	5.173	5.137	5.166	5.100	5.216	6.711
South Arch South 1/4	6.776	5.267	5.243	5.262	5.181	5.314	6.756
South Arch Crown	6.792	5.343	5.327	5.361	5.349	5.437	6.760
South Arch North 1/4	6.801	5.407	5.371	5.422	5.394	5.530	6.774
South Arch North Abutment	6.813	5.481	5.401	5.463	5.448	5.540	6.788
Central Arch South Abutment	6.815	5.463	5.427	5.483	5.468	5.551	6.791
Central Arch South 1/4	6.817	5.529	5.484	5.552	5.531	5.585	6.789
Central Arch Crown	6.814	5.567	5.482	5.582	5.564	5.617	6.786
Central Arch North 1/4	6.820	5.634	5.543	5.600	5.575	5.586	6.787
Central Arch North Abutment	6.832	5.639	5.569	5.630	5.612	5.574	6.792
North Arch South Abutment	6.834	5.639	5.562	5.634	5.624	5.569	6.799
North Arch South 1/4	6.824	5.646	5.585	5.642	5.635	5.573	6.787
North Arch Crown	6.815	5.683	5.584	5.643	5.628	5.574	6.781
North Arch North 1/4	6.796	5.663	5.606	5.636	5.618	5.577	6.765
North Arch North Abutment	6.779	5.664	5.611	5.645	5.622	5.537	6.747
North Parapet End	6.798	5.597	5.602	5.651	5.623	5.460	6.747
+ 5m North			5.645	5.698	5.678		

CARRIAGEWAY LEVELS

	South Arch	Central Arch	North Arch
d	470	470	480
h	430	475	645
Surfacing	100	110	100

ARCH BARREL AND FILL DEPTH
(Dimensions in mm)

Essex County Council
Transportation & Operational Services

WS Atkins

SCALES: NTS
CAD FILE: N:AI1877-62-01

	SURVEYED	LEVELLED	DESIGNED	DRAWN/TRACED	CHECKED	AUTHORISED
INITIALS	JF	JF		SD		
DATE	OCT 99	OCT99		NOV 99		

REVISION NOTES | REVISION | CHECKED

DESCRIPTION OF DRAWING: PAINTERS BRIDGE
CROSS SECTION AND LEVELS

Sheet 1 of 1

SCHEME TITLE: ECC ASSESSMENT PACKAGE 3
RAIL PROPERTY Ltd BRIDGES

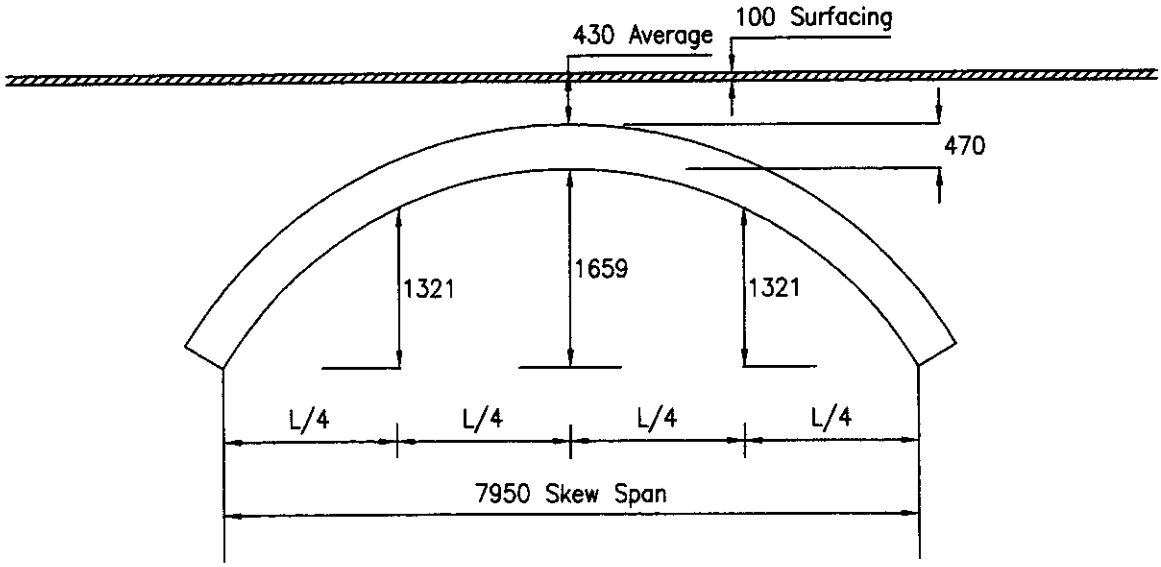
DRAWING NO. A11877/DWGS/1018/FIG 02

Essex County Council
Transportation &
Operational Services

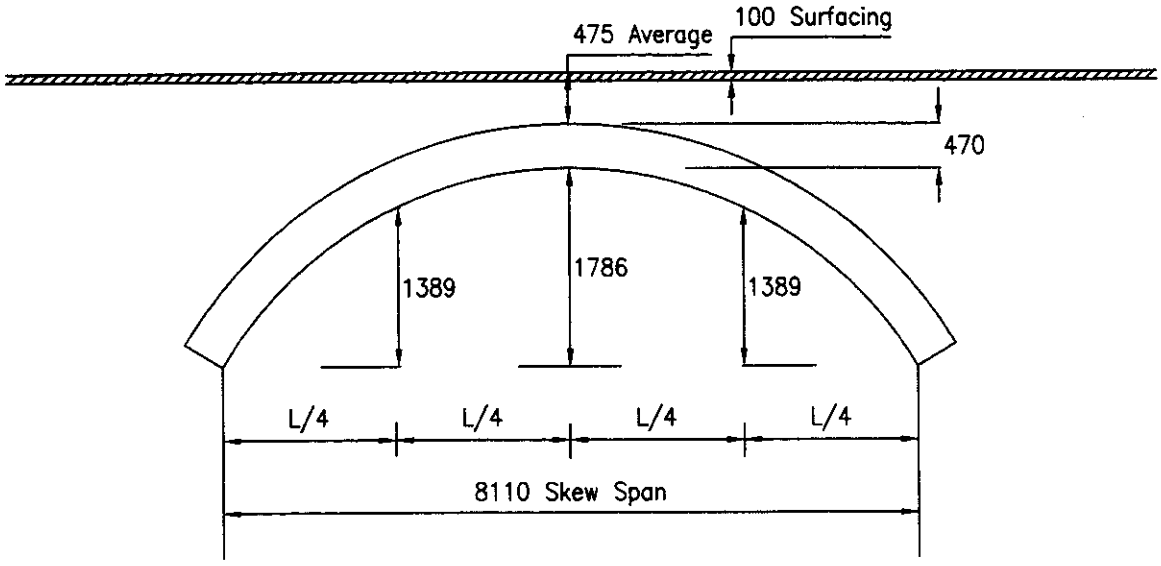
[redacted]

WS Atkins

ECC Bridge No. 1018
Rail Property Board No. AEB/2122



SOUTH ARCH
N.T.S



CENTRAL ARCH
N.T.S

SCHEME TITLE ECC ASSESSMENT CONTRACT 3
PAINTERS BRIDGE
IDEALISATION DIAGRAM

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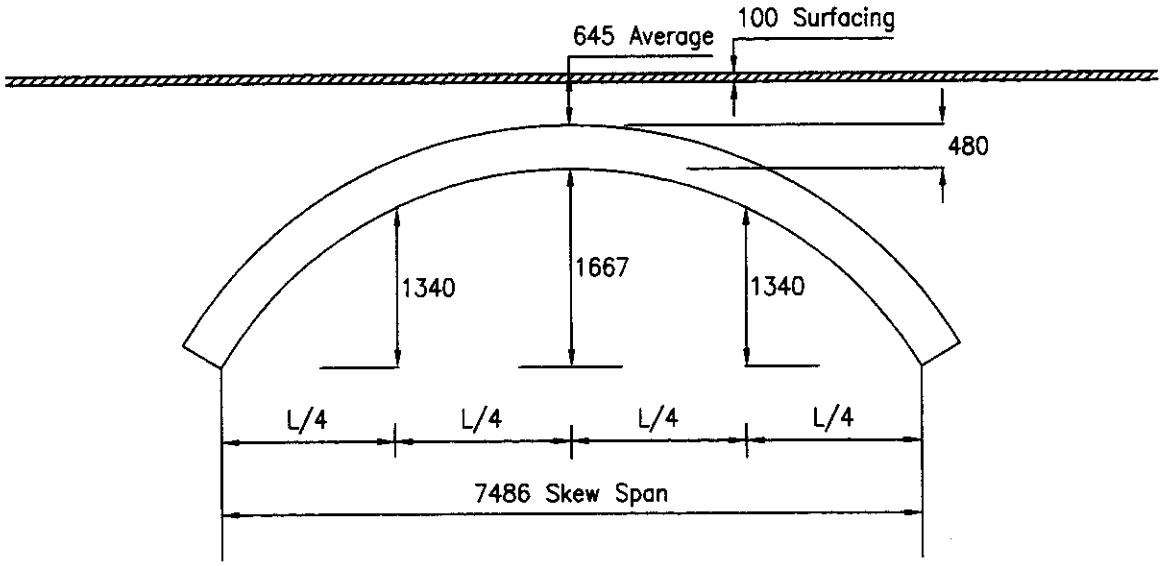
CAD NO. N:AI1877-66-01	
SCALES N.T.S	
DATE NOV 99	DRAWN/TRACED SD
DATE NOV 99	CHECKED
DATE	AUTHORISED

Essex County Council
Transportation & Operational Services

[redacted]

WS Atkins

ECC Bridge No. 1018
Rail Property Board No. AEB/2122



NORTH ARCH
N.T.S

DRWG.NO.	AI1877/DWGS/1018/07
CAD NO.	N:AI1877-66-01
SCALES	N.T.S
DATE NOV 99	DRAWN/TRACED SD
DATE NOV 99	CHECKED
DATE	AUTHORISED

SCHEME TITLE ECC ASSESSMENT CONTRACT 3
PAINTERS BRIDGE
IDEALISATION DIAGRAM

TECHNICAL APPROVAL SCHEDULE

TECHNICAL APPROVAL SCHEDULE "TAS" (JUNE 1989)

SCHEDULE OF DESIGN DOCUMENTS RELATING TO HIGHWAY BRIDGES & STRUCTURES (All documents are taken to include revisions current at date of this TAS).

1. BRITISH STANDARDS

~~BS 153: Part 3A, Specification for Steel Girder Bridges (see BE 1/77).~~

~~BS 5268: Part 2, Structural Use of Timber~~

~~BS 5400 - Steel concrete and composite bridges~~

~~Part 1: 1978 - General Statement (SEE BD 15/82)~~

~~Part 2: 1978 - Specification for loads (see BD 14/82)~~

~~Part 3: 1982 - CP for design of steel bridges (see BD 13/82)~~

~~Part 4: 1984 - CP for design of concrete bridges (see BD 24/84)~~

~~Part 5: 1979 - CP for design of composite bridges (see BD 16/82)~~

~~Part 9: 1983 - Bridge bearings (see BD 20/83)~~

~~Part 10: - 1980 - CP for fatigue (see BD 9/81)~~

~~BS 5628: Part 1: 1978 - Unreinforced Masonry~~

~~BS 5930: 1981 - Site investigations~~

~~BS 6031: 1981 - Earthworks~~

2. BRITISH STANDARD CODES OF PRACTICE

~~CP 114: Part 2 Reinforced concrete in buildings (see Tech Memo BE 1/73)~~

~~CP 116: Part 2 The structural use of precast concrete (see Tech Memo BE 1/73~~)

~~CP 118 The structural use of aluminium~~

~~CP 2 Earth retaining structures~~

~~CP 2004 Foundations~~

3. PUBLICATIONS (HMSO)

~~Railway construction and Operation Requirements, Structural and Electrical clearances (1977).~~

~~Railway construction and operation. Requirements for passenger lines and recommendations for goods lines 1950 (reprinted 1970).~~

~~Roads in urban areas and Metric Supplement (as amended by TA 32/82)~~

~~Layout of roads in rural areas and Metric Supplement (as amended by TA 28/82).~~

~~Specification for Highway Works and Notes for Guidance (1986 Edition).~~

~~Highway Construction Details (1987 Edition).~~

~~Simplified Tables of External loads on Buried Pipelines (1970).~~

4. MISCELLANEOUS

~~Circular Roads No 61/72 – Routes for heavy and high abnormal loads.~~

5. TECHNICAL MEMORANDA (BRIDGES)

~~BE 5 ——— The design of Highway bridge parapets (4th revision)~~

~~BE 27 ——— Waterproofing and surfacing of bridge decks.~~

~~BE 3/72 ——— Expansion joints for use La highway bridge decks.~~

~~BE 1/73 ——— Reinforced concrete for highway structures (Relevant ports for the design of buried precast concrete pipes and sign/signal gantries only).~~

~~BE 1/74 ——— The independent checking of erection proposals and temporary works details for major highway structure an trunk roads and motorways.~~

~~BE 8/75 ——— Painting of concrete highway structures~~

~~BE 1/77 ——— Standard highway loadings (Relevant parts for the design of buried precast concrete pipes and sign/signal gantries only)~~

~~BE 7/77 ——— Department standard (interim) motorway sign/signal gantries~~

~~BE 1/78 ——— Design criteria for footbridges and sign/signal gantries (Relevant for the design of sign/signal gantries only)~~

~~BE 3/78 ——— Reinforced earth, and anchored earth retaining walls and bridges abutments for embankments~~

6. HIGHWAYS TECHNICAL MEMORANDA

~~H 14/76 ——— Noise barriers – Standard and Materials~~

7. MEMORANDA (BRIDGES)

~~IM 5 ——— Formation of continuity joints in bridge decks~~

8. DEPARTMENTAL STANDARDS

8.1 TRAFFIC ENGINEERING AND CONTROL

~~TD 2/78 Pedestrian Subways - layout and dimensions~~

~~TD 3/79 Combined pedestrian and cycle subways - layout and dimensions~~

~~TD 9/81 Road layout and geometry. Highway link design~~

~~TD 19/83 Safety fences and barriers~~

~~TD) 27/86 Cross Sections and headroom~~

8.2 BRIDGES AND STRUCTURES

BD 2/89 Technical approval of DTp highway structures on motorways and other trunk roads

~~BD 6/81 Approval in principle and calibrating of computer programs for use in DTp highway structures on trunk roads and motorways~~

~~BD 7/81 Weathering steel for highway structures~~

~~BD 9/81 Implementation of BS 5400 Pt 10, CP for fatigue~~

~~BD 10/82 Design of highway structures in areas of mining subsidence~~

~~BD 12/82 Corrugated steel buried structures~~

~~BD 13/82 Design of steel bridges - 'Use of BS 5400 Pt 3: 1982~~

~~BD 14/82 Loads for highway bridges - Use of BS 5400 Pt 2: 1978~~

~~BD 15/82 General principles - Use of BS 5400 Pt 1 : 1978~~

~~BD 16/82 Design of composite bridges - 'Use of B3 5400 Pt 5-. 1979~~

~~BD 19/83 Standard Bridges~~

~~BD 20/83 Bridge Bearings - 'Use of BS S400 Part 9: 1983~~

~~BD 21/84 The assessment of highway bridges and structures~~

~~BD 24/84 Design of concrete bridges - Use of BS 5400 Pt 4: 1984~~

~~BD 26/86 Design of lighting columns~~

~~BD 27/86 Materials for the repair of concrete highway structures~~

~~BD 28/87 Early thermal cracking of concrete~~

~~BD 29/87 Design criteria for footbridges~~

~~BD 30/87 Backfilled retaining walls and bridge abutments~~

~~BD 31/87 Buried concrete box type structures~~

~~BD 32/88 Piled foundations~~

~~BD 34/88 Assessment and Strengthening of Highway Structures on Motorways and other Trunk Roads~~

~~BD 35/88 Quality Assurance Scheme for paints and similar protective coatings~~

~~BD 36/88 The Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures~~

~~BD 37/88 Loads for Highway Bridges~~

APPENDIX TO TAS SCHEDULE DATED JUNE 1989
(WS Atkins amended March 1999, incorporating relevant technical standards published since June 1989)

1. BRITISH STANDARDS

BS 4360: 1990 - Specification for Weldable Structural Steel.

BS 4466: 1989 - Scheduling, Dimensioning, Bending and Cutting of Steel Reinforcement for Concrete

BS 5400 - Steel, Concrete and Composite Bridges.
Part 1: 1988 - General Statement (see BD 15/92).
Part 4: 1990 - CP for Design of Concrete Bridges (see BD 24/92).

BS 5628 - Use of Masonry.
Part 1: 1992 - Unreinforced Masonry.
Part 2: 1985 - Reinforced and Prestressed Masonry.

BS 5975: 1996 - CP for Falsework

BS 6651: 1992 - CP for Protection of Structures Against Lightning.

BS 6779 - Highway Parapets for Bridges and Other Structures
Part 1: 1998 - Specification for Vehicle Containment Parapets of Metal Construction.
Part 2: 1991 - Specification for Vehicle Containment Parapets of Concrete Construction.
Part 3: 1994 - Specification for Vehicle Containment Parapets of Combined Metal and Concrete Construction.

BS 7295: 1990: Parts 1 & 2 - Fusion Bonded Epoxy Coated Carbon Steel Bars for the Reinforcement of Concrete

BS 7668: 1984 - Weldable Structural Steels. Hot Finished Structural Hollow Sections in Weather Resistant Steels

BS 8002: 1994 - CP for Earth Retaining Structures.

BS 8004: 1986 - CP for Foundations.

BS 8118 - Structural Use of Aluminium.

BS EN 10025: 1993 - Specification for Hot Rolled Products of Non-alloy Structural Steels - Technical Delivery Conditions.

BS EN 10113: Parts 1-3 - Hot Rolled Products in Weldable Fine Grain Structural Steel.

BS EN 10155: 1993 - Structural Steel with Improved Atmospheric Corrosion Resistance. Technical Delivery Conditions.

3. DoT PUBLICATIONS (HMSO)

Manual of Contract Documents for Highways Works:
Volume 1: Specification for Highway Works.
Volume 2: Notes for Guidance on the Specification for Highways Works.
Volume 3: Highway Construction Details.
Volume 4: Bills of Quantities for Highways Works.

8. DEPARTMENTAL STANDARDS

8.1 TRAFFIC ENGINEERING AND CONTROL

TD 9/93 - Road Layout and Geometry. Highway Link Design.

TD 27/96 - Road Geometry Links - Cross Sections and Headrooms.

TD 32/93 - Wire Rope Safety Fences.

TD 36/93 - Subways for Pedestrians and Pedal Cyclists - Layout and Dimensions.

8.2 BRIDGES AND STRUCTURES

BD 10/97 - Design of Highway Structures in Areas of Mining Subsidence.

BD 12/95 - Design of Corrugated Steel Buried Structures with Spans not Exceeding 8m, Including Circular Arches.

BD 13/90 - Design of Steel Bridges. Use of BS 5400 Pt 3: 1982.

BD 15/92 - General Principles for the Design and Construction of Bridges - Use of BS 5400 Pt 1: 1988.

BD 20/92 - Bridge Bearings. Use of BS 5400 Pt 9: 1983.

BD 21/97 - The Assessment of Highway Bridges and Structures.

BD 24/92 - Design of Concrete Bridges - Use of BS 5400 Pt 4: 1990.

BD 26/94 - Design of Lighting Columns.

BD 33/94 - Expansion Joints for Use in Highway Bridge Decks.

BD 34/90 - Technical Requirements for the Assessment and Strengthening Programme for Highway Structures on Motorways and Other Trunk Roads.
Stage 1 - Older Short Span Bridges and Retaining Structures.

~~BD 35/93 - Quality Assurance Schemes for Paints and Similar Protective Coatings.~~

~~BD 36/92 - Evaluation of Maintenance Costs in Comparing Alternative Designs for Highway Structures.~~

~~BD 41/97 - Reinforced Clay Brickwork Retaining Walls of Pocket Type and Grouted Cavity Type Construction.~~

~~BD 42/94 - Design of Embedded Retaining Walls and Bridge Abutments (Unpropped or Propped at the Top).~~

~~BD 43/90 - Criteria and Materials for the Impregnation of Concrete Structures.~~

~~BD 44/95 - The Assessment of Concrete Highway Bridges and Structures.~~

~~BD 45/93 - Identification Marking of Highway Structures.~~

~~BD 46/92 - Technical Requirements for the Assessment and Strengthening Programme for Highway Structures.~~
~~Stage 2 - Modern Short Span Bridges.~~

~~BD 47/94 - Waterproofing and Surfacing of Concrete Bridge Decks.~~

~~BD 48/93 - The Assessment and Strengthening of Highway Bridge Supports.~~

~~BD 49/93 - Design Rules for Aerodynamic Effects on Bridges.~~

~~BD 50/92 - Technical Requirements for the Assessment and Strengthening Programme for Highways Structures.~~
~~Stage 3 - Long Span Bridges.~~

~~BD 51/98 - Design Criteria for Portal and Cantilever Sign/Signal Gantries.~~

BD 52/93 - The Design of Highway Bridge Parapets.

~~BD 53/95 - Inspections and Records for Road Tunnels.~~

~~BD 54/93 - Post Tensioned Concrete Bridges. Prioritisation of Special Inspections.~~

~~BD 56/96 - The Assessment of Steel Highway Bridges and Structures.~~

~~BD 57/95 — Design for Durability.~~

~~BD 58/94 — The Design of Concrete Highway Bridges and Structures with External and Unbonded Prestressing.~~

~~BD 60/94 — The Design of Highway Bridges for Vehicle Collision Loads.~~

~~BD 61/96 — The Assessment of Composite Highway Bridges.~~

~~BD 62/94 — As Built, Operational and Maintenance Records for Highway Structures.~~

~~BD 63/94 — Inspection of Highway Structures.~~

~~BD 65/97 — Design Criteria for Collision Protector Beams.~~

~~BD 67/96 — Enclosures of Bridges.~~

~~BD 68/97 — Crib Retaining Walls.~~

~~BD 70/97 — Strengthened / Reinforced Soils and Other Fills for Retaining Walls and Bridge Abutments (Use of BS 8006: 1995).~~

~~SD 4/92 — Procedure for Adoption of Proprietary Manufactured Structures.~~

Appendix

Inspection for Assessment

BRIDGE INSPECTION DETAILS AND CONDITION RATING

ECC Bridge No.: 1018

Rail Property Ltd Bridge No.: AEB/2122

Bridge Name : Painters Bridge

Location : Painters Bridge, Saffron Walden,
Essex
Grid reference TL 56403 39955

Date of Inspection : 19 October 1999
Weather : Sunny & cold

Description : Three span brick arch with brick piers, abutments and parapets.

Inspection Method : Hands on

CONSULTING ENGINEERS CONDITION RATING		
	****	Satisfactory Condition
	***	Repairs Required
✓	**	Urgent Repairs Required
	*	Bridge In Dangerous Condition

To be filled in by Essex County Council

	[redacted]	Date
Inspected by		19 Oct 1999
Prepared by		Nov 1999
Checked by		Dec 1999

BRIDGE CLIENT		BRIDGE NO 1018	
File	Initial	Date	Suggested Condition Rating
Read by			
Read by			
Comments			

Index

1.0 INTRODUCTION

1.1 Essex County Council (ECC) entered into An agreement with Rail Property Ltd to assess Rail Property Ltd owned bridges carrying publicly maintainable highways. WS Atkins Consultants Ltd – Essex (WSAE) have been appointed by ECC to carry out the visual inspections and assessments of the bridges.

1.2 Painters Bridge carries an unclassified road over a dismantled railway line in Saffron Walden, Essex OS Ref. TL 56403 39955.

1.3 An inspection of the structure was carried out on 19 October 1999. The inspection included a visual inspection, dimension survey and intrusive investigation works to confirm structural details. The weather was sunny and cold during the inspection.

1.4 The results of the inspection are presented within the text of this report.

1.5 The structure is a three span brick arch with brick piers, abutments and parapets. The south, central and north arches have skew spans of 7.486m, 8.110m and 7.950m respectively, and all three arches are skewed at 23°.

1.6 The carriageway has an average width of 7.07m. The east and west grass verges have an average width of 1.98m and 1.92m respectively. The vertical alignment over the bridge is level and the horizontal alignment straight.

1.7 There is no weight restriction on the structure.

2.0 REFERENCE DRAWINGS

2.1 Following the inspection, survey drawings are produced as below and enclosed in the Approval in Principle for Assessment.

AI1877/DWGS/1018/FIG 01	General arrangement & arch levels
AI1877/DWGS/1018/FIG 02	Cross section and levels

2.2 Following the inspection, defect diagrams are produced as below and enclosed in appendix B.

AI1877/DWGS/1018/FIG 03	Arch and abutment defect diagrams
AI1877/DWGS/1018/FIG 04	Elevation defect diagrams
AI1877/DWGS/1018/FIG 05	Parapet defect diagrams

3.0 INSPECTION PROCEDURE

3.1 The inspection was undertaken on 19 October 1999. Reference was made to the Bridge Inspection Guide (HMSO 1983) and the Department of Transport standard BD21/97 and advice note BA16/97.

3.2 The visual inspection of the structure was carried out to determine the condition of the bridge. The inspection was carried out within touching distance with the exception of the crown region of the central arch barrel soffit. Inspection of this area from within a few metres did not highlight any defects requiring the construction of an access tower. Where required, access to the higher level elements of the structure was gained using a ladder.

3.3 A full level and dimensional survey was undertaken as well as intrusive testing works. Details of the levels and dimensions taken during the inspection and intrusive works are indicated on Drawings No. AI1877/DWGS/1018/FIG 01 and FIG 02 which are included in the Approval in Principle.

3.4 The extent and severity of all defects were recorded. The photographs in Appendix A and the defect diagrams (Drawing No. AI1877/DWGS/1018/FIG 03, FIG 04 and FIG 05) in Appendix B illustrate the defects.

3.5 The intrusive investigation works comprised a trial pit over the crown on each arch. The arch barrel was also drilled through at the same three locations. Three further drill holes where located at springing level close to the piers. The results of this investigation are given in section 5.0 of this report.

4.0 CONDITION REPORT

4.1 Foundations

The foundations were not accessible during the inspection. No evidence of any movement or distress was detected.

4.2 Abutments

4.2.1 The abutments were buried, and therefore inaccessible. No arch cracks, consistent with rotation of the abutments were noted (Photo 13).

4.3 Intermediate Piers

4.3.1 The substructure of the bridge consists of brickwork piers. There have been areas of repointing carried out in the past to both piers.

4.3.2 The piers appear to be in fair condition with the following defects identified:

- The brickwork string course at the springing level and large areas of the pier faces are damp, with mould and displaying large amounts of leach staining and algae growth. Calcareous deposits cover dry areas on both piers (Photos 4 and 9).
- Erosion of brickwork and, more seriously, the mortar from the joints has occurred where water flows down the pier faces. Further isolated areas of spalling brickwork and mortar loss were found throughout both piers. Remaining mortar is loose and slightly friable in places.
- Loss of brickwork has occurred from the east end of the string course at the springer level on both piers (Photo 4).
- A vertical crack 1mm wide runs the full height of the east end of the south face of the north pier. It is possible that this is due to minor movement of east spandrel wall since the crack continues into the arch barrel.

4.4 Arch barrels

4.4.1 The arch barrels are constructed from London Stocks and lime mortar. Three brick rings are visible in elevation.

4.4.2 The north and south brickwork arch barrels are partially buried and therefore could not be fully inspected. Drainage pipes are

present in both the north and south arch barrels above the springing level and adjacent to the intermediate piers.

4.4.3 As well as element specific defects the inspection identified isolated bricks spalled to depths of up to 70mm throughout the soffits of all the arch barrels. There are several areas of mortar loss to depth up to 45mm with the remaining mortar loose and slightly friable in places.

4.4.4 The central arch barrel is in fair condition with the brickwork above both springing levels damp and covered by leach staining.

4.4.5 The south arch barrel is in fair condition with several missing fascia bricks from the west side of the barrel. The soffit is damp above the springer level with leach staining present. A short 1mm wide longitudinal crack has occurred in one of the damp areas on the east side of the soffit just above the springer level. It is possible the crack is a result of slight spandrel wall movement or due to frost action on the damp brickwork.

4.4.6 The north arch barrel is in poor condition with the following defects:

- A number of bricks have dropped downwards by up to 55mm along the line where the embankment stops covering the arch barrel. The bricks were loose and the area rang hollow when tapped with a hammer (Photo 10).
- It appeared that there had been some mortar repair work around the dropped bricks in the past. The bricks have detached from the repairs and are still loose.
- The full extent of loose brickwork and whether the damage was just to the lower arch ring or to further rings could not be safely determined. There was no obvious vertical deflection in the carriageway surfacing above the area.
- The 1mm crack discussed in section 4.3.2 continues for a short distance into the arch barrel. It is possible that this is due to slight movement of the east spandrel wall.
- There is an area of missing brickwork from the east side of the barrel above the springing level as well as missing fascia bricks from the east side.
- The soffit is damp with leach staining above the springing level.

4.5 Spandrels and Arch Face

4.5.1 The upper few courses of both spandrel walls have been recently reconstructed along with the parapets. The arch face displays an arch barrel three bricks deep where as intrusive testing confirmed that the internal barrel depth was four bricks deep.

4.5.2 The remaining older brickwork of the spandrel walls and arch faces has been repointed in places but is generally in poor condition with the following defects:

- The spandrel wall has separated from all of the arch rings with the exception of the west side of the south arch. Where separation has occurred the spandrel walls are laterally displaced by up to 10mm (Photo 3).
- The majority of both spandrel walls and throughout all the arch faces several areas of severe spalling and mortar loss as well as loose and missing brickwork have occurred (Photo 6).
- A line of fascia bricks from the outer ring on the east side of the central arch face is laterally displaced by 10mm (Photo 7). The brickwork is very loose in the surrounding area. It could not be determined whether just the fascia brickwork was loose, however several large areas of the arch face rang hollow when a tapping survey was conducted. This indicated that the fascia bricks had separated from the arch barrel.
- Several small areas of leach staining were found throughout both elevations (Photo 3).
- Several diagonal and vertical cracks up to 10mm wide run down both spandrel walls. The cracks continue down from the parapets. As the parapet is long and has not been provided with any vertical joints it is thought that the cracks are due to thermal expansion and contraction of the brickwork, with additional cracking caused by settlement of the south west pilaster (Photo 5). This movement has resulted in fresh cracking in the older spandrel wall brickwork below.
- One crack (a vertical 2mm wide crack on the west spandrel wall) is covered by dense vegetation so its possible origin from parapet movement is unclear.

4.6 Embankments

4.6.1 The embankments adjacent to the bridge are heavily overgrown and show no signs of any significant erosion or slippage.

4.7 Parapets

4.7.1 The brick parapets comprise 460mm thick brickwork (at the base) and have been reconstructed down to the lower parapet plinth course. No vertical movement joints were found along the parapets.

4.7.2 Despite being of recent construction the parapets are in poor condition with the following defects:

- Numerous diagonal, vertical and horizontal cracks up to 10mm wide are found throughout both parapets; several are through the full breadth of the parapet (Photo 11). As the parapet is long and no vertical joints have been included it appears that the cracking is due to thermal movement of the brickwork.
- There is also a tapering diagonal crack up to 40mm wide (at the top) at the south end of the west parapet (Photo 8). It appears that this cracking is due to some differential settlement of the south pilaster. Vertical displacement is apparent.
- There is slight lateral displacement of some of the sections of parapets adjacent to the cracking discussed above.
- Dense ivy growth and vegetation growth covers areas of both parapets.
- There are isolated areas of spalling and mortar loss on both parapets.
- Small areas of leach staining cover both parapets.

4.8 Road Surface

4.8.1 The road surface over the bridge deck is in fair condition with minor depressions, slight rutting and some loss of skid resistant surfacing in the wheel tracks.

4.9 Waterproofing

4.9.1 The damp pier faces and arch barrel soffit along with the large amount of leach staining indicate the lack of an effective waterproofing system. When a hole was drilled through the arch barrel (just above the springing level) in the north arch water streamed through the hole from the fill behind (Photo 12). This both indicates a large storage of water above the pier and that the existing drainage pipe is either blocked or too high up the arch barrel to be effective.

4.9.2 The absence of a waterproofing system was confirmed by the excavation of trial holes.

5.0 INTRUSIVE INVESTIGATION REPORT

5.1 The following information was obtained from the intrusive investigation:

South Arch

Barrel thickness (d)	=470mm
Fill depth including servicing (h)	=430mm (avg)
Depth of surfacing	=100mm

Central Arch

Barrel thickness (d)	=470mm
Fill depth including servicing (h)	=475mm (avg)
Depth of surfacing	=100mm

North Arch

Barrel thickness (d)	=480mm
Fill depth including servicing (h)	=645mm (avg)
Depth of surfacing	=100mm

5.2 All fill material was found to be crushed limestone with some gravel, sand and clay.

5.3 The investigation indicated that there is no backing to the arch barrel.

5.4 No waterproofing materials were evident in the trial holes.

6.0 CONCLUSIONS

6.1 The structure is in poor condition overall. As well as element specific remedial works there are several areas of spalled, loose and missing brickwork (some severe) and mortar loss throughout the structure that require repair. Loose and friable mortar throughout requires raking out and the brickwork repointing.

6.2 The intermediate piers are in fair condition. A full height vertical crack was present to the south face of the north pier. It is felt that this crack has occurred due minor movement of the east spandrel wall and will require monitoring for further lateral movement before being repaired. This crack extends onto the north arch barrel.

6.3 The south arch barrel is in fair condition. A longitudinal crack was also present above the springing level. This may have resulted from slight spandrel wall movement or frost damage. This crack should be repaired and will require monitoring for further deterioration.

6.4 The central arch barrel is in fair condition with no element specific comments.

6.5 The north arch barrel is in poor condition. A number of bricks have dropped downwards and are loose along the line where the embankment meets the arch barrel. A special inspection into the extent and possible cause of the damage is required before the arch barrel is repaired

6.6 The spandrel walls are in poor condition. The walls have separated from the arch rings and lateral displacement is evident. Monitoring of the walls is required and, should further movement occur, consideration into tying the walls will be required. Several diagonal and horizontal cracks also extend from the parapets onto the spandrel walls. It is believed that these cracks have resulted from the thermal expansion and contraction of the parapets. The cracking will require monitoring for further deterioration before repairs to the cracks are carried out.

6.7 The arch faces are in poor condition. Spalled brickwork and mortar loss have occurred throughout and should be repaired. A line of fascia bricks from the outer ring on the east side of the central arch show some lateral displacement and a hammer survey indicated that these bricks have separated from the arch barrel. A large number of the fascia bricks are missing or badly spalled. Consideration should be given to removing the fascia brickwork and refacing the arch barrel ends.

6.8 The parapets are in poor condition. Numerous cracks are present to both parapets due to its thermal movement. These cracks should be repaired and expansion joints added to the parapet. Some settlement of the south west pilaster has also resulted in tapering diagonal cracks. These cracks and settlement will require monitoring for any further movement (as the parapets are fairly new, movement is likely) before being repaired.

6.9 The absence of a deck waterproofing system has resulted in serious water percolation through the arch barrels as well as water collecting above the intermediate piers. The water leakage is contributed to spalling brickwork, mortar loss and possibly cracking of brickwork as well as heavy leach staining throughout. An effective waterproofing membrane will be required to prevent further deterioration of the brickwork. In the short term a special inspection into the effectiveness of the existing drains should be undertaken.

6.10 Based on the level and dimensional survey the structure has the following geometric features:-

	SOUTH	ARCH CENTRAL	NORTH
Skew span (L)	7.950m	8.110m	7.486m
Skew angle (α)	23°	23°	23°
Rise of the arch barrel(r_c)	1.659m	1.786m	1.667m
Rise at quarter points (r_q)	1.321m	1.389m	1.340m

Dimensions were obtained from levels, site measurements and photographs. See drawings in the Approval in Principle.

6.11 Based on this inspection and the recommendations of BA16/97 Annex D, it is suggested that the following factors are used for Modified MEXE analysis :-

		SOUTH	ARCH CENTRAL	NORTH
Condition Factor	F_c	0.9	0.95	0.85
Barrel Factor	F_b	1.0	1.0	1.0
Fill Factor	F_f	0.7	0.7	0.7
Width Factor	F_w	0.9	0.9	0.9
Mortar Factor	F_{mo}	0.9	0.9	0.9
Depth Factor	F_d	0.9	0.8	0.9

For alternative analysis by the ARCHIE and MULTI computer programs, the overall condition factor F_c, based on the above factors and the recommendations of BD 21/97 6.21, would be appropriate.

6.12 Based on the inspection and intrusive investigation the arch barrel has the following properties:

Barrel thickness (south & central spans)	=470mm
Barrel thickness(north span)	=480mm
Masonry strength	=2.3N/mm^2
(BD 21/97 fig 4.2, London Stocks & lime mortar)	
No structurally significant longitudinal cracking.	
Arch separation evident to the north arch.	

6.13 There is no Statutory Undertaker's plant present on the structure.

7.0 RECOMMENDATIONS FOR ASSESSMENT

7.1 The information collected from the site inspection, with respect to defects affecting the structural integrity of the bridge, should be incorporated into the Approval in Principle. Defects affecting the assessment are described in section 6.0. It is recommended that, for the Modified MEXE, ARCHIE and MULTI analyses, the factors in section 6.11 should be adopted. A reduction in the Allowable Axle Load in accordance with Annex G of BA 16/97 should be adopted for the assessment of the north arch, assuming that one arch ring has separated. However, it should be confirmed by further investigations. No other allowance need be made for the structural deterioration in the assessment calculations.

7.2 For the assessment, the geometric properties and material strengths in sections 6.10 and 6.12 should be adopted.

7.3 For the assessment axle lift-off need not be considered.

7.4 Abutments, wing walls and foundations should be assessed qualitatively in accordance with BD 21/97 Chapter 8.

Note that the following are maintenance recommendations and will not affect the proposed assessment.

7.5 The weathered, eroded and missing areas of brickwork should be replaced or repaired. All cracking to the structure should be monitored and repaired as necessary.

7.6 The north arch should be given special consideration in terms of maintenance. Several bricks are dropping dangerously from this arch. A detailed inspection of this defect should be initiated and repairs carried out where necessary.

7.7 The spandrel walls should be monitored for further lateral movement.

APPENDIX A

Photographs

Photograph 1 – West elevation of Painters Bridge

Photograph 2 – View over Painters Bridge looking north

Photograph 3 – View of south west spandrel wall showing lateral displacement

Photograph 4 – Missing brickwork, algae growth and leaching on north arch barrel and east end of north pier

Photograph 5 – Diagonal crack in west spandrel wall above south pier

Photograph 6 – East spandrel wall above the north pier showing severe spalling and loss of brickwork

Photograph 7 – Loose brick work from east arch face of central arch

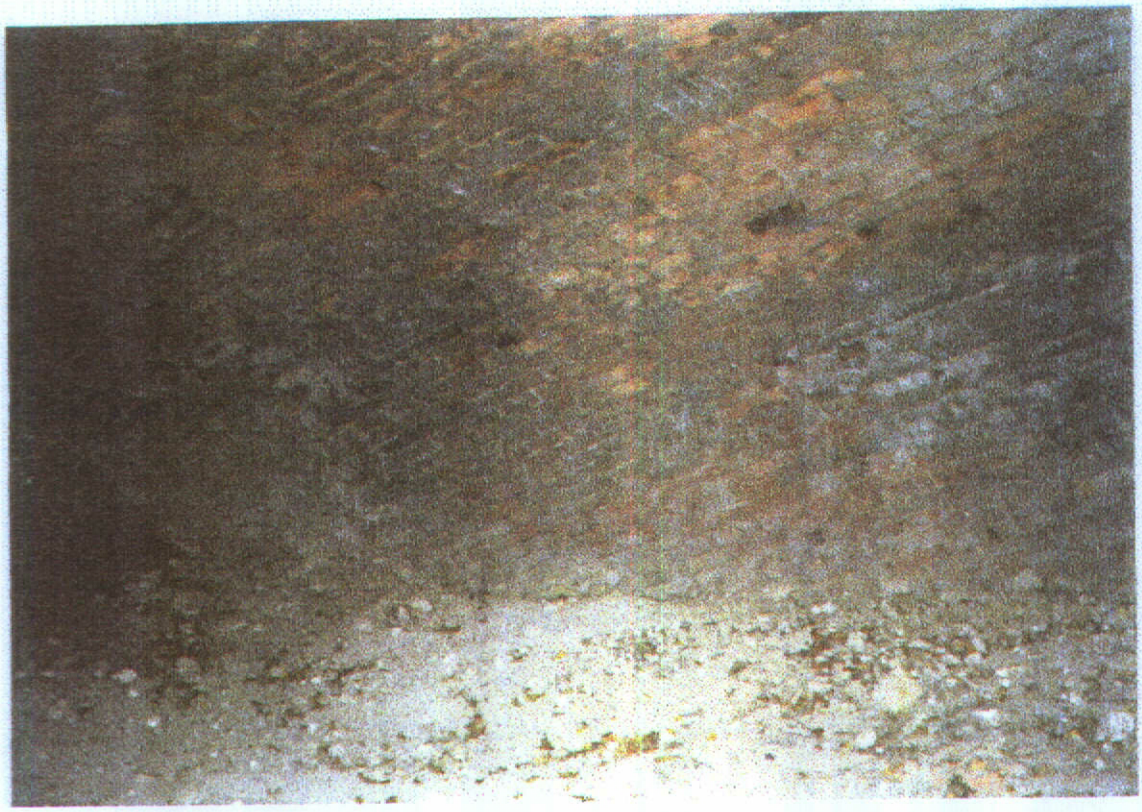
Photograph 8 – Diagonal crack and settlement of south end of west parapet

Photograph 9 – Typical leach staining and damp brickwork on pier face and barrel

Photograph 10 – Dropped bricks from north arch barrel

Photograph 11 – Vertical crack in west parapet above south pier

Photograph 12 – Water streaming from hole drilled in north arch barrel just above springing



Photograph 13 – View of south arch barrel showing fill burying abutment

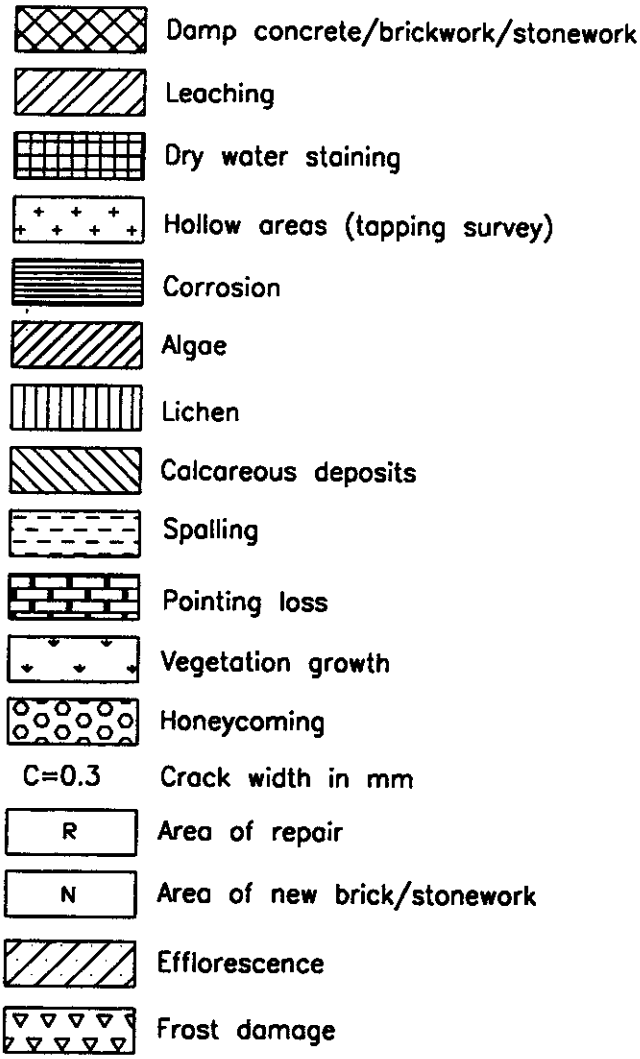
APPENDIX B

Defect Diagrams

ECC ASSESMENT CONTRACT 3 – RAIL PROPERTY Ltd BRIDGES

DETAIL OF STANDARD KEY

KEY



DO NOT SCALE

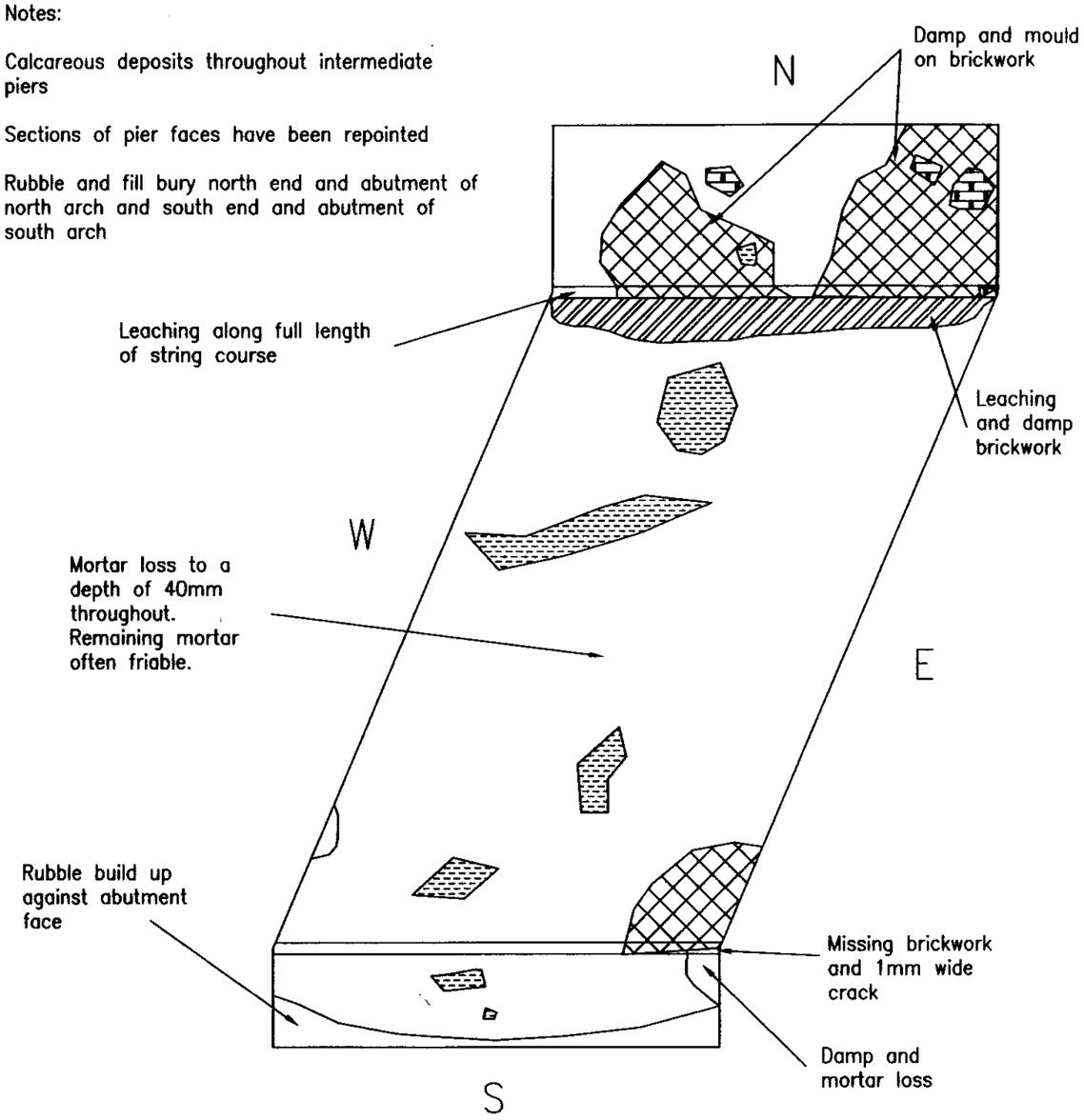
ECC Bridge No. 1018
Rail Property Baord No. AEB/2122

Notes:

Calcareous deposits throughout intermediate piers

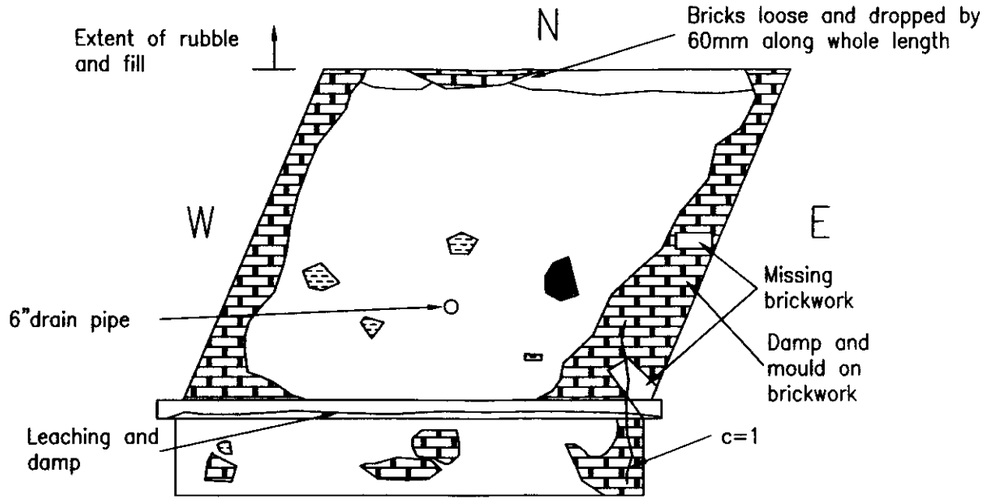
Sections of pier faces have been repointed

Rubble and fill bury north end and abutment of north arch and south end and abutment of south arch



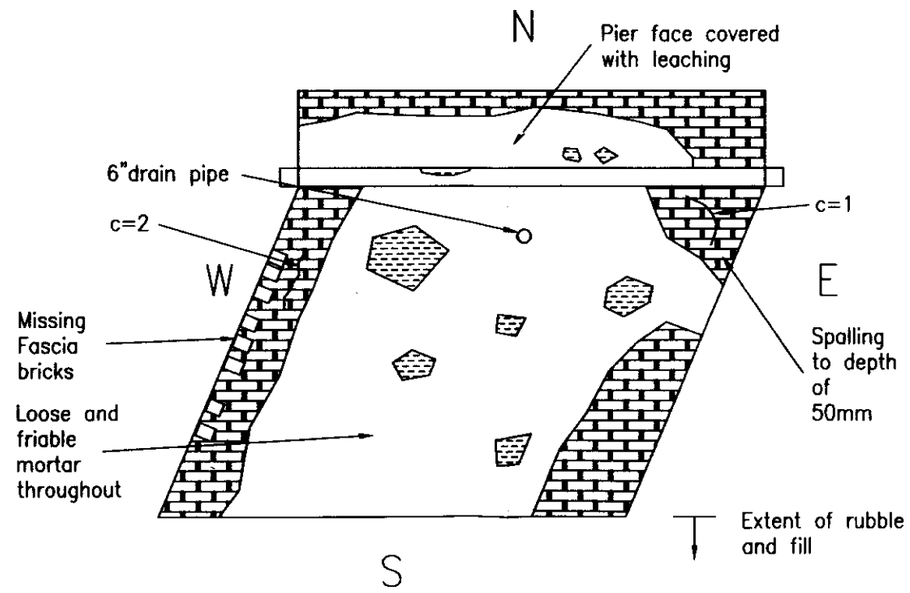
DEVELOPED PLAN OF CENTRAL ARCH

Scale 1:100



DEVELOPED PLAN OF NORTH ARCH

Scale 1:100



DEVELOPED PLAN OF SOUTH ARCH

Scale 1:100

Essex County Council
Transportation & Operational Services

[redacted]

WS Atkins

SCALES		SURVEYED	LEVELLED	DESIGNED	DRAWN/TRACED	CHECKED	AUTHORISED
1:100	INITIALS	JF	JF		SD		
CAD FILE N:AI1877-62-01	DATE	OCT 99	OCT99		NOV 99		

REVISION NOTES	REVISION	CHECKED

DESCRIPTION OF DRAWING

PAINTERS BRIDGE
ARCH AND ABUTMENT DEFECT DIAGRAMS

Sheet 1 of 1

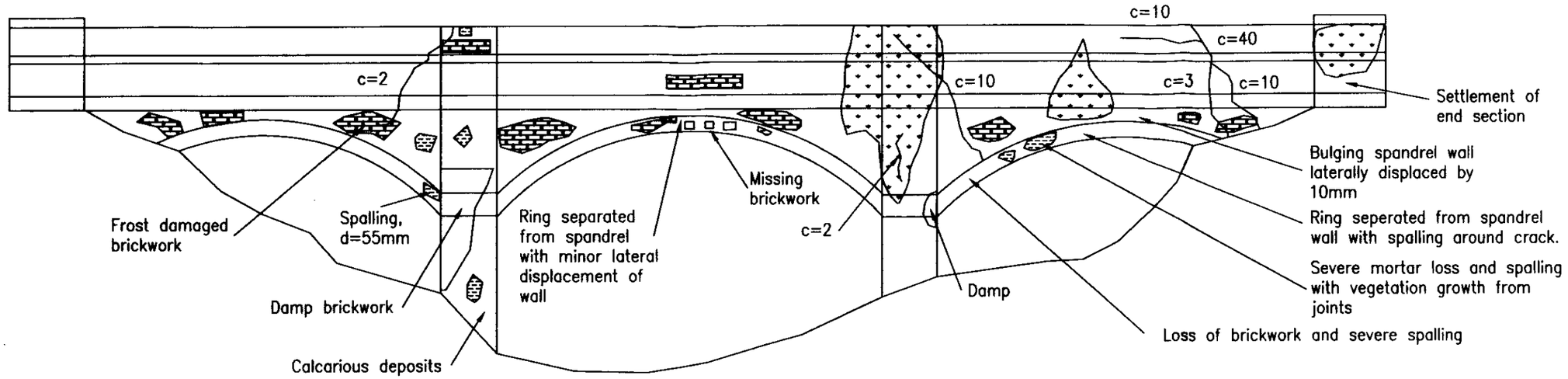
SCHEME TITLE

ECC ASSESSMENT PACKAGE 3
RAIL PROPERTY Ltd BRIDGES

DRAWING NO. A11877/DWGS/1018/FIG 03

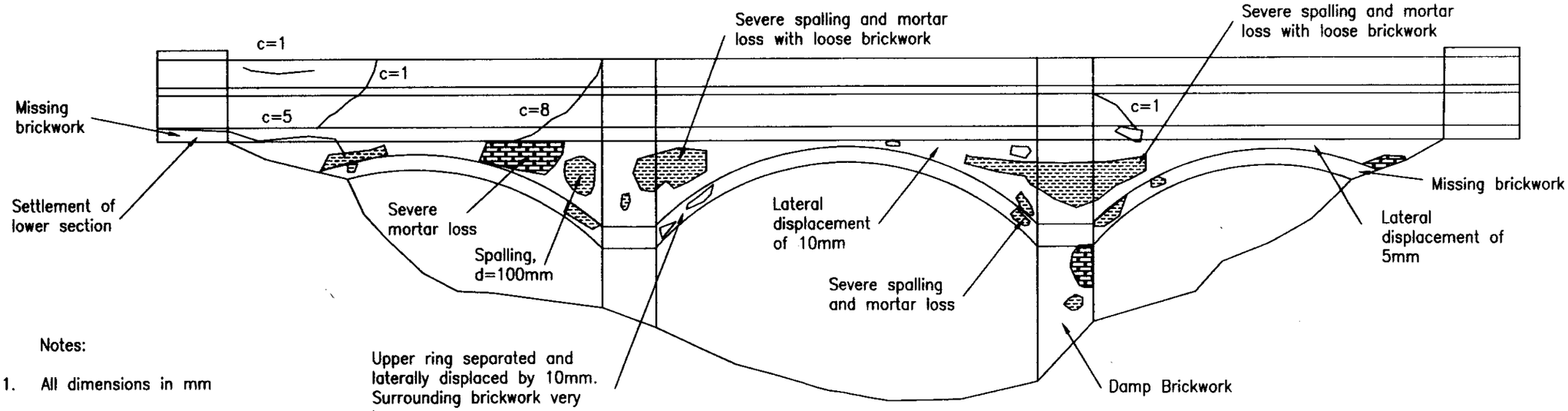
DO NOT SCALE

ECC Bridge No. 1018
Rail Property Baord No. AEB/2122



WEST ELEVATION

Scale 1:100



Notes:

1. All dimensions in mm
2. Small areas of leaching and staining throughout both elevations
3. All arch rings have seperated from the spandrel wall with spalling surrounding the cracking

EAST ELEVATION

Scale 1:100

Essex County Council
Transportation & Operational Services

WS Atkins

SCALES		SURVEYED	LEVELLED	DESIGNED	DRAWN/TRACED	CHECKED	AUTHORISED
1:100	INITIALS	JF	JF		SD		
CAD FILE N:AI1877-62-01	DATE	OCT 99	OCT99		NOV 99		

REVISION NOTES | REVISION | CHECKED

DESCRIPTION OF DRAWING

PAINTERS BRIDGE
ELEVATION DEFECT DIAGRAMS

Sheet 1 of 1

SCHEME TITLE

ECC ASSESSMENT PACKAGE 3
RAIL PROPERTY Ltd BRIDGES

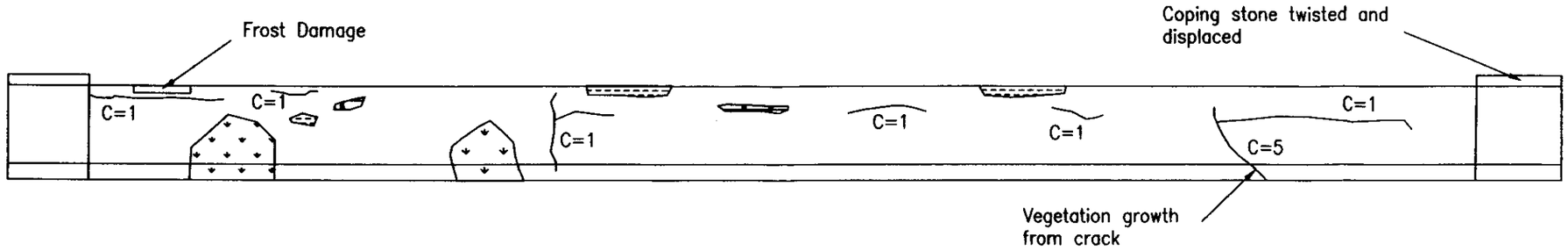
DRAWING NO. A11877/DWGS/1018/FIG 04

DO NOT SCALE

ECC Bridge No. 1018
Rail Property Baord No. AEB/2122

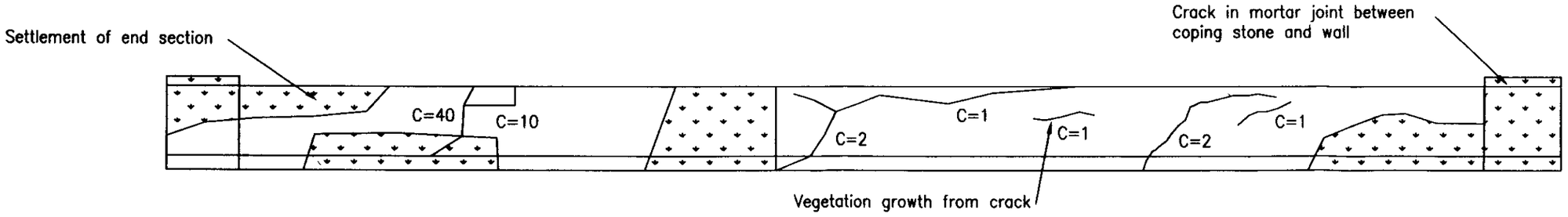
Notes:

Small area of leaching and staining on both parapets



EAST PARAPET CARRIAGEWAY FACE

Scale 1:100



WEST PARAPET CARRIAGEWAY FACE

Scale 1:100

Essex County Council
Transportation & Operational Services

WS Atkins

SCALES		SURVEYED	LEVELLED	DESIGNED	DRAWN/TRACED	CHECKED	AUTHORISED
1:100	INITIALS	JF	JF		SD		
CAD FILE N:AI1877-62-01	DATE	OCT 99	OCT99		NOV 99		
	REVISION NOTES			REVISION		CHECKED	

DESCRIPTION OF DRAWING

PAINTERS BRIDGE
PARAPET DEFECT DIAGRAMS

Sheet 1 of 1

SCHEME TITLE

ECC ASSESSMENT PACKAGE 3
RAIL PROPERTY Ltd BRIDGES

DRAWING NO. A11877/DWGS/1018/FIG 05

APPENDIX C

Statutory Undertakers

New Roads and Street Works Act (NRSWA) notices have been issued to the following companies. The responses are summarised below:

Company	Service
Anglian Water	No existing plant within the vicinity of the bridge.
British Telecom	Overhead lines over east edge of structure
Mercury Communications	No existing plant within the vicinity of the bridge.
Telewest Communications	No existing plant within the vicinity of the bridge.
Transco	No existing plant within the vicinity of the bridge.
Eastern Electricity	No existing plant within the vicinity of the bridge.
Essex & Suffolk Water Company	No existing plant within the vicinity of the bridge.
Energis	No existing plant within the vicinity of the bridge
National Grid	No existing plant within the vicinity of the bridge.
Serco Gulf Engineering	Oil pipeline runs along line of old railway line.
Street Lighting	No existing plant within the vicinity of the bridge.
English Nature	No comment.
Environment Agency	No comment.

ESSEX COUNTY COUNCIL
ASSESSMENT CONTRACT 3

ASSESSMENT REPORT FOR THE ASSESSMENT OF PAINTERS BRIDGE

ECC BRIDGE NO. 1018
RAIL PROPERTY Ltd BRIDGE NO. AEB/2122

[redacted]

Date : 22 May 2000

[redacted]

e: 30/3/00

te: 30/3/00

te: 15/05/00

g..MICE....

Essex County Council
Transportation and Operational Services Division
County Hall
Chelmsford
Essex
CM1 1QH

WS Atkins Consultants - Essex
Threadneedle House
9 - 10 Market Road
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Essex
CM1 1JQ

Rail Property Ltd
Room C5
Hudson House
York
YO1 6HP

Copy No. 1
Version No. 1.0

B1204/1018/ASSESS

Assessment Report Index

EXECUTIVE SUMMARY

Painters Bridge, Saffron Walden has been assessed in accordance with the Approval in Principle dated 21 February 2000. This is situated in appendix C of this report.

The structure is a three span brick arch with brick piers, abutments and parapets. The south, central and north arches have skew spans of 7.486m, 8.110m and 7.950m respectively, and all three arches are skewed at 23°. There is no weight restriction on the structure.

Overall the structure is in poor condition.

The results for the whole structure are based on the MULTI mechanism method computer program. Results for the individual arches are based on the modified MEXE method, detailed in BD 21/97 and BA 16/97, and the ARCHIE computer program. The MEXE results have been be adopted where the fill depth is less than or equal to the barrel thickness, otherwise the ARCHIE result is adopted. The values obtained from MEXE for individual arches are considered as upper bound solutions. The abutments, wing walls and foundations have been assessed qualitatively.

OVERALL STRUCTURAL CAPACITY	13 TONNES

The load carrying capacity of the main structural elements is listed below.

Spans 1 to 3

Arches:	40 Tonnes Assessment Live Loading
Piers:	13 Tonnes Assessment Live Loading

Sub-structures, foundations, wingwalls and spandrel walls:

A qualitative assessment of the abutments, foundations and wingwalls indicate that they are adequate to carry the present traffic loading. According to Clause 8.5 of BD21/97, they may be assumed to be adequate for 40 Tonne assessment loading without further assessment.

Strengthening Requirements

It is recommended that backing be placed above both piers to sufficiently increase pier capacity and strength the structure as a whole.

Consideration should also be given to demolishing the structure and filling the resultant void as an alternative to the above strengthening recommendation.

FORM 'BA' (BRIDGES)

GC/TP0356
Appendix: 5
Issue: 1
Revision: A
Date: Feb 93

CERTIFICATION FOR ASSESSMENT CHECK

STRUCTURE / LINE NAME PAINTERS BRIDGE CATEGORY OF CHECK 2

ELR / STRUCTURE NO AEB/2122

I 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 21 February 2000

(2) It has been checked for compliance with the following principle British Standards, Codes of Practice and Assessment standards. (SEE TAS SCHEDULE IN AIP)

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

[redacted] (ASSESSOR) 14 March 2000

(ASSESSMENT CHECKER) 14 March 2000

DIRECTOR OF THE FIRM OF CONSULTING ENGINEERS TO WHOM THE ASSESSOR / CHECKER IS RESPONSIBLE

CATEGORY 2 AND 3 (NOTE: CATEGORY 1 CHECK MUST ALSO BE SIGNED)

ASSESSMENT

NAME SIGNATURE

[redacted] (ASSESSOR) 14 March 2000

DIRECTOR OF THE FIRM OF CONSULTING ENGINEERS TO WHOM THE ASSESSOR IS RESPONSIBLE

(b) CHECK

[redacted] SSESSMENT CHECKER) 14 March 2000

RECTOR OF THE FIRM OF CONSULTING NGINEERS TO WHOM CHECKER IS ESPONSIBLE

FORM 'BAA' (BRIDGES)

CERTIFICATION FOR ASSESSMENT CHECK

NOTIFICATION OF ASSESSMENT CHECK

STRUCTURE NAME / ROAD NO. PAINTERS BRIDGE

LINE NAME (DISUSED)

ELR CODE / STRUCTURE NO. AEB/2122 ESSEX COUNTY COUNCIL No. 1018

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

13 tonnes

Critical member/s: PIERS

RECOMMENDED LOADING RESTRICTIONS

A 13 tonne weight restriction should be implemented.

DESCRIPTION OF STRUCTURAL DEFICIENCIES AND RECOMMENDED STRENGTHENING

The piers were found to be inadequate for 40 tonnes assessment live loading due to the absence of backing material above them.

It is recommended that backing be placed above both piers to sufficiently increase pier capacity and strength the structure as a whole.

Consideration should also be given to demolishing the structure and filling the resultant void as an alternative to the above strengthening recommendation.

Name: [redacted] Engineer

Name:

6/6/2001

1.0 INTRODUCTION

1.1 Essex County Council (ECC) entered into an agreement with Rail Property Ltd to assess Rail Property Ltd owned bridges carrying publicly maintainable highways. WS Atkins Consultants Ltd – Essex (WSAE) have been appointed by ECC to carry out the visual inspections and assessments of the bridges.

1.2 An Approval in Principle document was submitted and approved on 21 February 2000. This includes a detailed inspection for assessment report. This assessment report should be read in conjunction with the Approval in Principle and Inspection for Assessment Report.

1.3 An inspection of the structure was carried out on 19 October 1999. The inspection included a visual inspection, dimension survey and intrusive investigation works to confirm structural details. The weather was sunny and cold during the inspection. The results of the inspection are presented in the inspection for assessment report which forms part of the Approval in Principle dated 21 February 2000.

1.4 A summary of the inspection report findings are listed in section 2 of this assessment report. This includes details of the defects to the bridge which affect the load carrying assessment of the structure.

1.5 Painters Bridge carries an unclassified road over a dismantled railway line in Saffron Walden, Essex OS Ref. TL 56403 39955.

1.6 The structure is a three span brick arch with brick piers, abutments and parapets. The south, central and north arches have skew spans of 7.486m, 8.110m and 7.950m respectively, and all three arches are skewed at 23°.

1.7 The carriageway has an average width of 7.07m. The east and west grass verges have an average width of 1.98m and 1.92m respectively. The vertical alignment over the bridge is level and the horizontal alignment straight.

1.8 There is no weight restriction on the structure.

2.0 CONCLUSIONS OF INSPECTION REPORT

Details of the key dimensions of the structure are shown on drawings AI1877/DWGS/1018/FIG 01 and FIG 02. These are included in the Approval in Principle document.

Details of the defects in the structure are shown on drawings AI1877/DWGS/1018/FIG 03 to FIG 05. These are situated in the inspection for assessment report which forms an appendix to the Approval in Principle.

The following is a summary of the defects listed in the inspection for assessment report.

2.1 Overall, the bridge is generally in poor condition.

2.2 A reduction in the Allowable Axle Load in accordance with Annex G of BA 16/97 has been adopted for the assessment of the north arch, assuming that one arch ring has separated. The extent of this ring separation needs to be confirmed by further site investigations.

2.3 Based on a visual inspection and the recommendations of BA 16/97 Annex D, the following factors for the Modified MEXE Method were adopted:

		ARCH		
		SOUTH	CENTRAL	NORTH
Condition Factor	F_c	0.9	0.95	0.85
Barrel Factor	F_b	1.0	1.0	1.0
Fill Factor	F_f	0.7	0.7	0.7
Width Factor	F_w	0.9	0.9	0.9
Mortar Factor	F_{mo}	0.9	0.9	0.9
Depth Factor	F_d	0.9	0.8	0.9

For alternative analysis by the ARCHIE and MULTI computer programs, the overall condition factor F_c, based on the above factors and the recommendations of BD 21/97 6.21, has been adopted.

These factors were decided upon by the Engineer based on the inspection and the Standards listed in the Approval in Principle.

2.4 For the assessment axle lift-off need not be considered.

2.5 The weathered, eroded and missing areas of brickwork require replacement or repair. All cracking to the structure needs to be monitored and repaired as necessary.

2.6 The north arch requires special consideration in terms of maintenance. Several bricks are dropping dangerously from this arch. A detailed inspection of this defect is required and repairs carried out where necessary.

2.7 The spandrel walls require monitoring for further lateral movement.

2.8 The abutments, wing walls and foundations showed little signs of distress and were assumed to be in sound condition.

3.0 ASSESSMENT METHODS AND FINDINGS

3.1 The assessment of Painters Bridge, Saffron Walden has been carried out in accordance with the approval in principle dated 21 February 2000. The following drawings, included in the Approval in Principle document have been used.

AI1877/DWGS/1018/FIG 01	General arrangement & arch levels
AI1877/DWGS/1018/FIG 02	Cross section and levels

3.2 The following assumptions have been made regarding material strengths.

Masonry Strength	2.3 N/mm2

3.3 Detailed results tables are situated in appendix A of this assessment report. Copies of the assessment calculations are situated in appendix B.

ARCHES

3.4 The individual arches have been analysed using the modified MEXE method, detailed in BD 21/97 and BA 16/97, and the ARCHIE computer program. The MEXE results were adopted where the fill depth was less than or equal to the barrel thickness; otherwise the ARCHIE results were used.

3.5 A reduction in the Allowable Axle Load in accordance with Annex G of BA 16/97 has been adopted for the assessment of the north arch, assuming that one arch ring has separated.

3.6 For the assessment axle lift-off has not been considered.

3.7 The arches were assessed at **40 TONNES** Assessment Live Loading.

INTERMEDIATE PIERS

3.8 The whole structure was analysed as a multi span arch using the MULTI mechanism method computer program.

3.9 The piers were assessed at **13 TONNES** Assessment Live Loading.

ABUTMENTS, WING WALLS AND FOUNDATIONS

3.10 A qualitative assessment of the abutments, wing walls and foundations indicate that they are adequate to carry the present traffic loading. According to Clause 8.5 of BD21/97, they may be assumed to be adequate for 40 Tonne assessment loading without further assessment.

4.0 CONCLUSIONS

4.1 Painters Bridge, Saffron Walden has been assessed in accordance with the Approval in Principle dated 21 February 2000.

4.2 The results for the whole structure are based on the MULTI mechanism method computer program. Results for the individual arches are based on the modified MEXE method, detailed in BD 21/97 and BA 16/97, and the ARCHIE computer program. The MEXE results have been be adopted where the fill depth is less than or equal to the barrel thickness, otherwise the ARCHIE result is adopted. A summary of the results is listed below.

4.3 Spans 1 to 3

Arches:	40 tonnes
Piers:	13 tonnes
Parapets:	The parapets do not conform to current standards and have not been assessed.

4.4 Abutments, wing walls and foundations

A qualitative assessment of the abutments, wing walls and foundations indicate that they are adequate to carry the present traffic loading. According to Clause 8.5 of BD21/97, they may be assumed to be adequate for 40 Tonne assessment loading without further assessment. Spandrel walls are assessed also at 40 Tonne.

4.5 The inspection for assessment showed that the structure requires areas of repair, monitoring and special investigation. Details are included in section 7 of the inspection report.

4.6 Strengthening Requirements

It is recommended that backing be placed above both piers to sufficiently increase pier capacity and strength the structure as a whole.

Consideration should also be given to demolishing the structure and filling the resultant void as an alternative to the above strengthening recommendation.

APPENDIX A

SUMMARY RESULTS TABLES

Rail Property Ltd
ECC Bridge Assessment Contract No. 3
Rail Property Bridge No. AEB/2122 Structure: Painters Bridge
ECC Bridge No. 1018 Date: May-2000

Analysis Results: Masonry Arch Analysis.

Span Reference		North Arch	North Arch	Central Arch	Central Arch
Method Used		MEXE	ARCHIE/ MULTI	MEXE	ARCHIE/ MULTI

Single Span Analysis

Allowable Axle Loads	Single Axle Load	33.1t	>11.5t	28.6t	>11.5t
	Double Axle Load	22.8t	>10t	19.7t	>10t
	Triple Axle Load	21.7t	>8t	18.7t	>8t

Multi Span Analysis (Assuming Slender Piers)

Overall Global Capacity	N/A	12.5t	N/A	12.5t

Maximum Gross Vehicle Weight	40t	12.5t	40t	12.5t
Assessment Live Load Rating	40t	13t	40t	13t
HB Rating	N/A	N/A	N/A	N/A

Comments

- Axle lift off not considered.
- In the above results, separation of one ring of the north arch barrel has been accounted for by reducing the allowable axle load in accordance with annex G of BA 16/97.

Rail Property Ltd
ECC Bridge Assessment Contract No. 3
Rail Property Bridge No. AEB/2122 — Structure: Painters Bridge
ECC Bridge No. 1018 — Date: May-2000

Analysis Results: Masonry Arch Analysis.

Span Reference	South Arch	South Arch		
Method Used	MEXE	ARCHIE/ MULTI		

Single Span Analysis

Allowable Axle Loads	Single Axle Load	26.0t	>11.5t		
	Double Axle Load	17.9t	>10t		
	Triple Axle Load	17.0t	>8t		

Multi Span Analysis (Assuming Slender Piers)

Overall Global Capacity	N/A	12.5t		

Maximum Gross Vehicle Weight	40t	12.5t		
Assessment Live Load Rating	40t	13t		
HB Rating	N/A	N/A		

Comments

- Axle lift off not considered.

APPENDIX B

ASSESSMENT CALCULATIONS

WS/Atkins

CALCULATION INDEX

PROJECT: ELC ASSESSMENT CONTRACT 3

FILE NAME: PAINTERS BRIDGE

FILE NO: A1 1877-62 -

C = Calculation
S = Sketch
D = Data

Page

INDEX NO	CALCULATION/SKETCH/DATA	ORIGINATOR	DATE
1	SUMMARY	JF	1/00
2-3	ARCH ANALYSIS DATA	JF	1/00
4-16	NORTH ARCH - MEXE AND ARCHIE	JF	1/00
17-21	CENTRAL ARCH - MEXE AND ARCHIE	JF	1/00
22-26	SOUTH ARCH - MEXE AND ARCHIE	JF	1/00
27-37	MULTI ANALYSIS	JF	1/00

Continued on Sheet

WS/Atkins	Project: ECL CONTRACT 3	Job ref: A11877/62
	Part of structure: PAINTEN BRIDGE	Calc sheet no / rev /
	Drawing ref	Calc by: JF; Date: 01/00
		Check by; Date

Ref	Calculations	Output

SUMMARY

WEIGHT RESTRICTION

MEYE ANALYSIS

NORTH ARCH - NO RING SEPARATED	40T
- ONE RING SEPARATED	40T
- TWO RINGS SEPARATED	40T
CENTRAL ARCH	40T
SOUTH ARCH	40T

ARCHIE ANALYSIS

NORTH ARCH - NO RINGS SEPARATED	40T
- ONE RING SEPARATED	40T
- TWO RINGS SEPARATED	13T
CENTRAL ARCH	40T
SOUTH ARCH	40T

MULTI ANALYSIS

PIERS	13T

REQUIRED WEIGHT RESTRICTION = 13T

(due to capacity of piers)

(40T capacity of arch barrel) assuming no more than one ring has separated).

WS Atkins	Project: ECC CONTRACT 3	Job ref: A1 1877 /62
	Part of structure: PAINTERS BRIDGE	Calc sheet no / rev: / 2 /
	Drawing ref	Calc by: JF; Date: 01/06; Check by; Date

Ref	Calculations	Output

ARCH ANALYSIS

The following information has been taken from the AIP.

	SOUTH ARCH	CENTRAL ARCH	NORTH ARCH
Skew span (L)	7.950m	8.110m	7.486m
Skew angle (α)	23°	23°	23°
Rise of the arch barrel(r_c)	1.659m	1.786m	1.667m
Rise at quarter points (r_q)	1.321m	1.389m	1.340m

		SOUTH ARCH	CENTRAL ARCH	NORTH ARCH
Condition Factor	F_c	0.9	0.95	0.85
Barrel Factor	F_b	1.0	1.0	1.0
Fill Factor	F_f	0.7	0.7	0.7
Width Factor	F_w	0.9	0.9	0.9
Mortar Factor	F_{mo}	0.9	0.9	0.9
Depth Factor	F_d	0.9	0.8	0.9

For alternative analysis by the ARCHIE and MULTI computer programs, the overall condition factor F_c, based on the above factors and the recommendations of BD 21/97 6.21, would be appropriate.

South Arch

Barrel thickness (d)	=470mm
Fill depth including servicing (h)	=430mm (avg)
Depth of surfacing	=100mm

Central Arch

Barrel thickness (d)	=470mm
Fill depth including servicing (h)	=475mm (avg)
Depth of surfacing	=100mm

North Arch

Barrel thickness (d)	=480mm
Fill depth including servicing (h)	=645mm (avg)
Depth of surfacing	=100mm

ARCH ANALYSIS

Based on the inspection and intrusive investigation the arch barrel has the following properties:

Barrel thickness (south & central spans)	=470mm
Barrel thickness(north span)	=480mm
Masonry strength	=2.3N/mm^2

(BD 21/97 fig 4.2, London Stocks & lime mortar)
No structurally significant longitudinal cracking.
Arch separation evident to the north arch.

With reference to BA16/97 and BD 21/97 the shew span shall be used in the assessment with no shew enhancement.

This is a conservative check!

For South arch; fill depth < barrel depth

∴ Take greatest capacity from MEXE and ARCHIE.

For North and Central Arch; fill depth > barrel depth

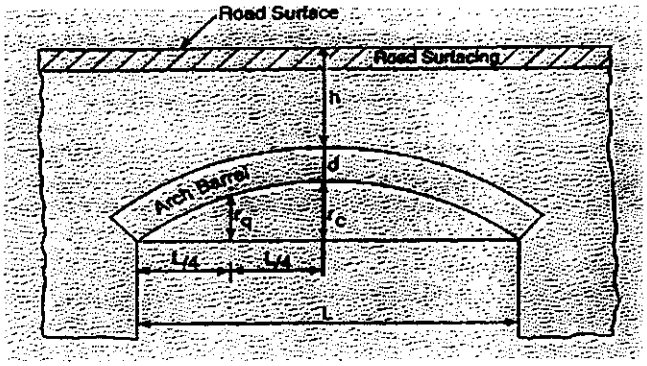
∴ Take lesser capacity from MEXE and ARCHIE.

WS/Atkins

ARCH ASSESSMENT TO MODIFIED MEXE (BA 16/97)

Structure Name: PAINTERS BRIDGE - NORTH ARCH - NO REDUCTION DUE TO RING SEPARATION

1. DIMENSIONS



L = 7.486m (SKEW)
rc = 1.667m
rq = 1.340m
d = 0.480m
h = 0.645m
h + d = 1.125m

2. PROVISIONAL ASSESSMENT LOADING (Fig. 3/1)

PAL = 68.4 Tonne

3. SPAN / RISE FACTOR

$\frac{L}{rc} = \frac{7.486}{1.667} = 4.49$ (Fig. 3/3) Fsr = 0.93

4. PROFILE FACTOR

$\frac{rq}{rc} = \frac{1.340}{1.667} = 0.80$ (Fig. 3/4) Fp = 0.87

5. MATERIAL FACTOR

(Tables 3/1 & 3/2)

$Fm = \frac{(Fb.d) + Ff.h)}{d + h} = \frac{(1.0 \times 0.48) + (0.7 \times 0.645)}{0.480 + 0.645}$ Fm = 0.83

6. JOINT FACTOR

(Tables 3/3, 3/4 & 3/5)

Fj = Fw.Fd.Fmo = 0.9 x 0.9 x 0.9 Fj = 0.73

7. CONDITION FACTOR

(Para. 3.17 to 3.23)

Fc = 0.85

8. MODIFIED AXLE LOAD

MAL = PAL x Fsr x Fp x Fm x Fj x Fc

MAL = 28.5 Tonne

9. AXLE LIFT-OFF FACTOR

(Fig. 3/5)

NO AXLE LIFT OFF - SINGLE AXLE Af = 1.45

TRIPLE AXLE Af = 0.95

10. WEIGHT LIMIT ON ARCH (MAX GROSS VEHICLE WEIGHT)

(Table 3/6)

40 Tonne

11. CONCLUSIONS:

ADEQUATE CAPACITY FOR 40 TONNES LIVE LOAD

Assessed By: J FRITH Date: 24/1/2000

Signed:

WS/Atkins	Project: ECC CONTRACT 3			Job ref: A1 1877 /62
	Part of structure: PAINTERS BRIDGE			Calc sheet no / rev: / 5 /
	Drawing ref	Calc by: JF	Date: 12/99	Check by / Date

Ref	Calculations	Output
BD16/97 ANNEX G	NORTH ARCH - RING SEPARATION The AIP states that a reduction in the allowable load should be applied for a reduction in barrel thickness. For a barrel with 4 rings, the reduction factor, R_{4rings} is equal to the following: $R_{4rings} = 1 - 0.2N$ where N equals the number of separated rings. ∴ For $N = 0$, $R_{4rings} = 1.0$ $N = 1$, $R_{4rings} = 0.8$ $N = 2$, $R_{4rings} = 0.6$ MEXE ANALYSIS From MEXE analysis sheet for north arch with no rings separated; MAL = 28.5 tonnes. No axle lift off - Single Axle N = 1; Allowable Axle Load $28.5 \times 1.45 \times 0.8 = 33.1$ tonnes N = 2; Allowable Axle load $= 28.5 \times 1.45 \times 0.6 = 24.8$ tonnes No axle lift off - Triple Axle N = 1; Allowable Axle Load $= 28.5 \times 0.95 \times 0.8 = 21.7$ tonnes N = 2; Allowable Axle Load $= 28.5 \times 0.95 \times 0.6 = 16.2$ tonnes ∴ ADEQUATE CAPACITY FOR 40 TONNES LIVE LOAD	

WS Atkins	Project: ECC CONTRACT 3	Job ref: A1 1877 /62
	Part of structure: PAINTERS BRIDGE	Calc sheet no / 6 / rev
	Drawing ref	Calc by: JF; Date: 1/00
		Check by; Date

Ref	Calculations	Output

NORTH ARCH - RING SEPARATION CONTINUED

ARCHIE ANALYSIS

Condition factor; $F_c = F_{cm} \times F_j$

$F_c = 0.85 \times 0.73 = 0.62$

Lane width;

Unfactored = 1.5 + 1.8 + h

h = 0.645m (= 1.122m at quarter point)

Unfactored effective width = 1.5 + 1.8 + 0.645 = 3.945m (4.422 at 1/4)

For ARCHIE analysis, the lane width will be factored by condition factor and ring separation reduction factor.

For N = 0; Lane width = 3.945 × 0.62 × 1.0 = 2.446m (2.742m)

N = 1; Lane width = 3.945 × 0.62 × 0.8 = 1.957m (2.193m)

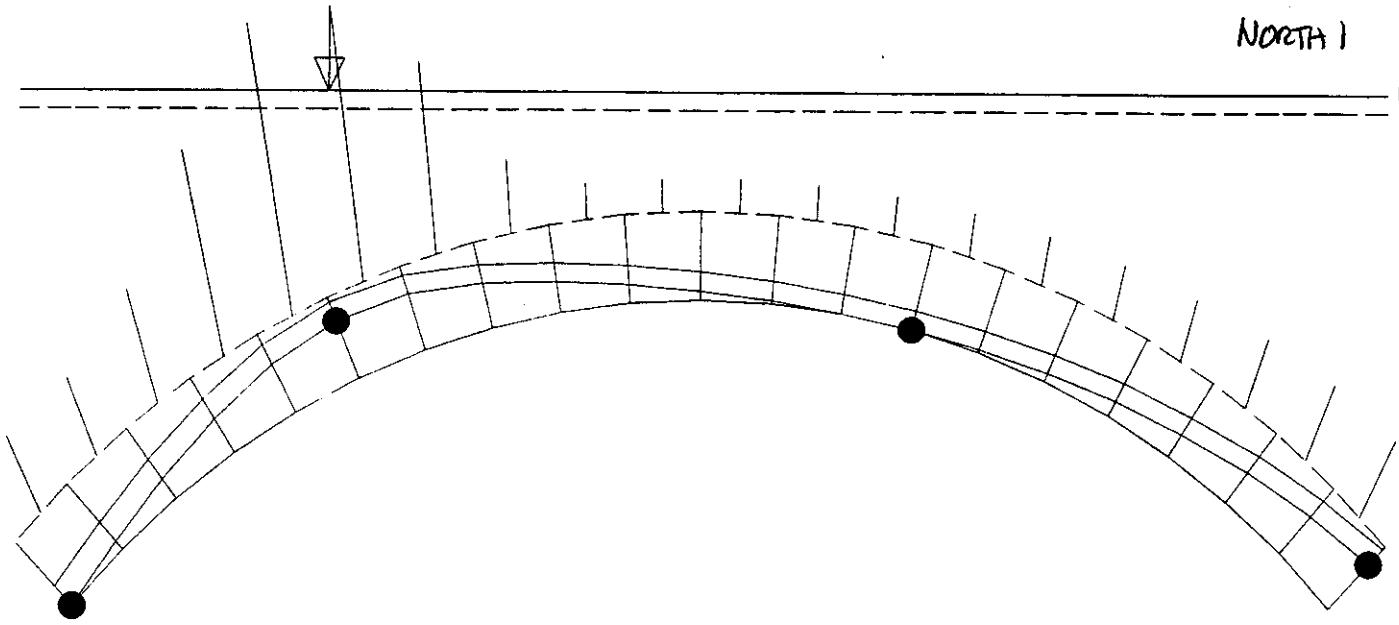
N = 2; Lane width = 3.945 × 0.62 × 0.6 = 1.468m (1.645m)

Refer to ARCHIE outputs;

	F.O.S FOR "N" RINGS SEPARATED		
LOADCASE	N = 0	N = 1	N = 2
11.5T SINGLE AXLE	1.05	1.02	0.88
10.5T SINGLE AXLE			0.92
SINGLE AXLE (13T REST)			1.00
20T DOUBLE	1.04	1.03	N/A
24T TRIPLE	1.08	1.06	
CAPACITY	40T	40T	13T

NORTH 1

(7)



62_north - NO RINGS SEPARATED

()

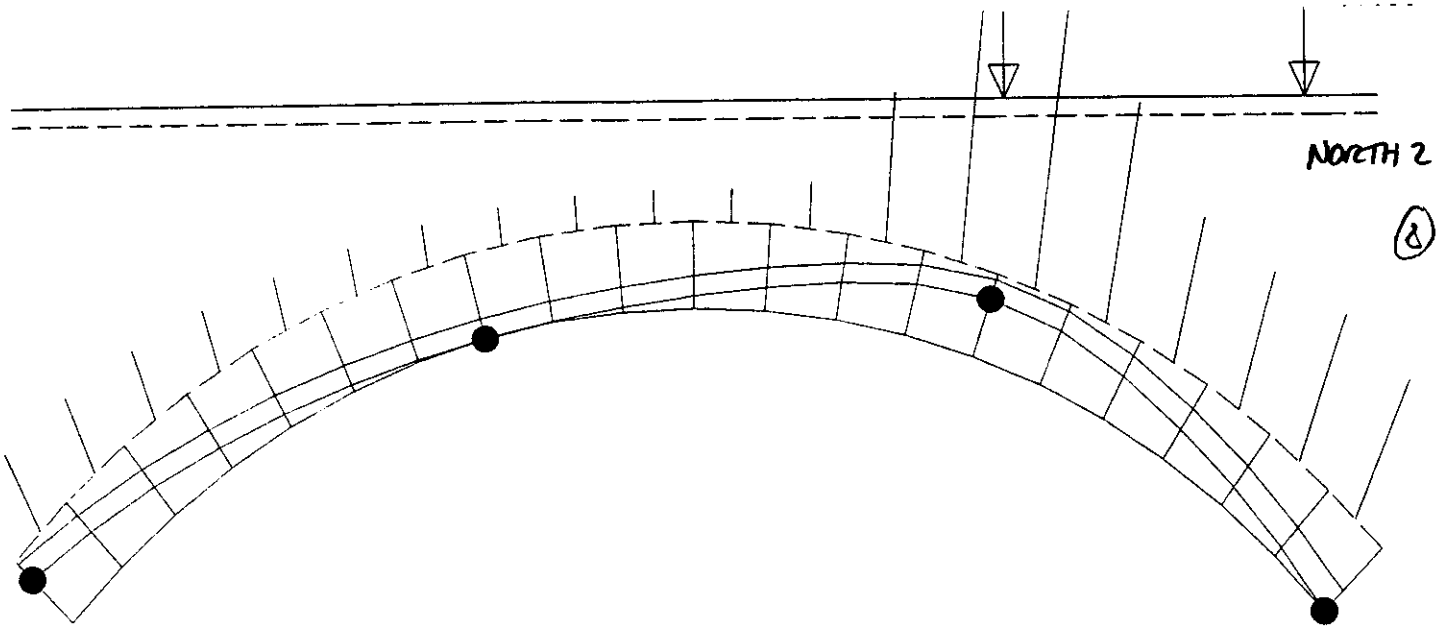
Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 1500		
Lane width	2446mm		
Required ring depth	459 mm	Geometric F.O.S	1.05
H Left	190 kN/m	H Right	214 kN/m
V Left	281 kN/m	V Right	172 kN/m
Comp. zone at hinge 2	119 mm	Factor on pass. press.	.1

Hinges

1 AT 1	2 AT 6	3 AT 14	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	0
2	-5	-13.8	6	-.4	.1	0
3	-5	-12.6	4.6	-8.2	2	0
4	-5	-11.4	3.5	-26.2	5.3	0
5	-5	-10.1	2.5	-43.2	7.1	0
6	-5	-8.9	1.8	-44.7	5.9	0
7	-5	-7.9	1.2	-27.3	2.8	0
8	-5	-7	.7	-6.3	.4	0
9	-5	-6.4	.4	0	0	0
10	-5	-6.1	.1	0	0	0
11	-5	-6.1	-.1	0	0	0
12	-5	-6.4	-.4	0	0	0
13	-5	-7	-.7	0	0	0
14	-5	-7.9	-1.2	0	0	0
15	-5	-8.9	-1.8	0	0	0
16	-5	-10.1	-2.5	0	0	0
17	-5	-11.4	-3.5	0	0	0
18	-5	-12.6	-4.6	0	0	0
19	-5	-13.8	-6	0	0	0
20	-4.9	-14.1	-7.2	0	0	0



62_north - NO RINGS SEPARATED

()

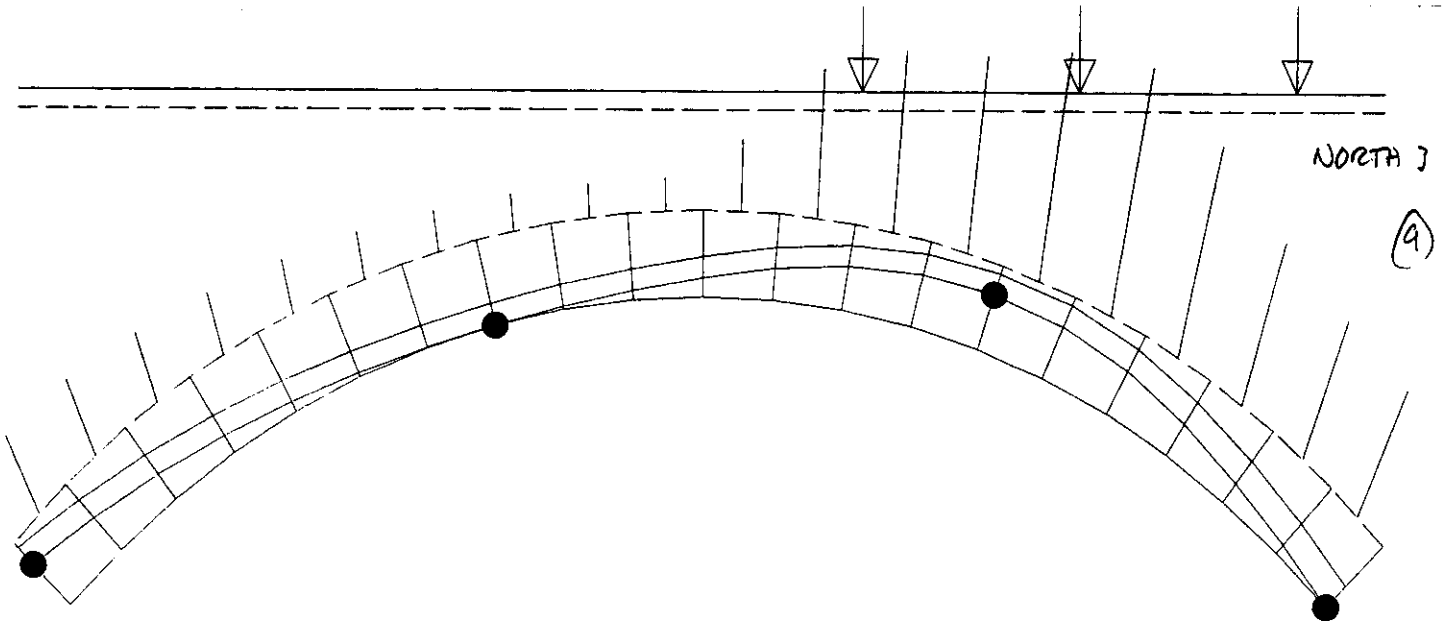
Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20t:Left Heavy at 6250		
Lane width	2446mm		
Required ring depth	459 mm	Geometric F.O.S	1.04
H Left	227 kN/m	H Right	196 kN/m
V Left	178 kN/m	V Right	308 kN/m
Comp. zone at hinge 2	124 mm	Factor on pass. press.	.1

Hinges

1 AT 1	2 AT 8	3 AT 15	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	0
2	-5	-13.8	6	0	0	0
3	-5	-12.6	4.6	0	0	0
4	-5	-11.4	3.5	0	0	0
5	-5	-10.1	2.5	0	0	0
6	-5	-8.9	1.8	0	0	0
7	-5	-7.9	1.2	0	0	0
8	-5	-7	.7	0	0	0
9	-5	-6.4	.4	0	0	0
10	-5	-6.1	.1	0	0	0
11	-5	-6.1	-.1	0	0	0
12	-5	-6.4	-.4	-2.2	-.1	0
13	-5	-7	-.7	-20.1	-1.4	0
14	-5	-7.9	-1.2	-41.1	-4.2	0
15	-5	-8.9	-1.8	-44.1	-5.8	0
16	-5	-10.1	-2.5	-30	-5	0
17	-5	-11.4	-3.5	-15.5	-3.1	0
18	-5	-12.6	-4.6	-12.7	-3.1	0
19	-5	-13.8	-6	-13.1	-3.8	0
20	-4.9	-14.1	-7.2	-11.1	-3.8	0



62_north - NO RINGS SEPARATED

()

Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Triple Axle:24t:No Lift-off at 6000		
Lane width	2446mm		
Required ring depth	445 mm	Geometric F.O.S	1.08
H Left	244 kN/m	H Right	212 kN/m
V Left	189 kN/m	V Right	324 kN/m
Comp. zone at hinge 2	133 mm	Factor on pass. press.	.1

Hinges

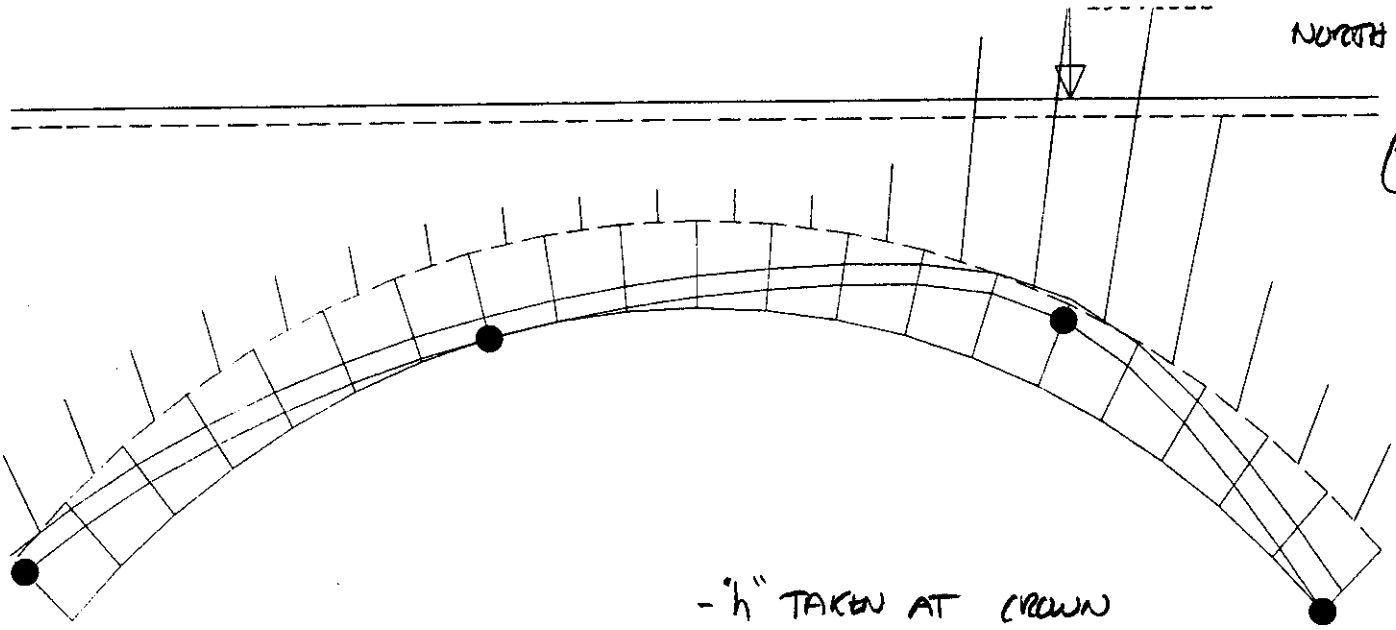
1 AT 1	2 AT 8	3 AT 15	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	0
2	-5	-13.8	6	0	0	0
3	-5	-12.6	4.6	0	0	0
4	-5	-11.4	3.5	0	0	0
5	-5	-10.1	2.5	0	0	0
6	-5	-8.9	1.8	0	0	0
7	-5	-7.9	1.2	0	0	0
8	-5	-7	.7	0	0	0
9	-5	-6.4	.4	0	0	0
10	-5	-6.1	.1	-.2	0	0
11	-5	-6.1	-.1	-7.4	-.1	0
12	-5	-6.4	-.4	-21.1	-.9	0
13	-5	-7	-.7	-26.4	-1.9	0
14	-5	-7.9	-1.2	-28.4	-2.9	0
15	-5	-8.9	-1.8	-33.2	-4.4	0
16	-5	-10.1	-2.5	-35.6	-5.9	0
17	-5	-11.4	-3.5	-27.6	-5.6	0
18	-5	-12.6	-4.6	-17	-4.1	0
19	-5	-13.8	-6	-11.2	-3.2	0
20	-4.9	-14.1	-7.2	-8.8	-3	0

NORTH 4

(10)



- 'h' TAKEN AT CROWN

62_north - 1 No RING SEPARATED

()

Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 6000		
Lane width	1957mm		
Required ring depth	515 mm	Geometric F.O.S	.93
H Left	238 kN/m	H Right	208 kN/m
V Left	178 kN/m	V Right	314 kN/m
Comp. zone at hinge 2	128 mm	Factor on pass. press.	.1

Hinges

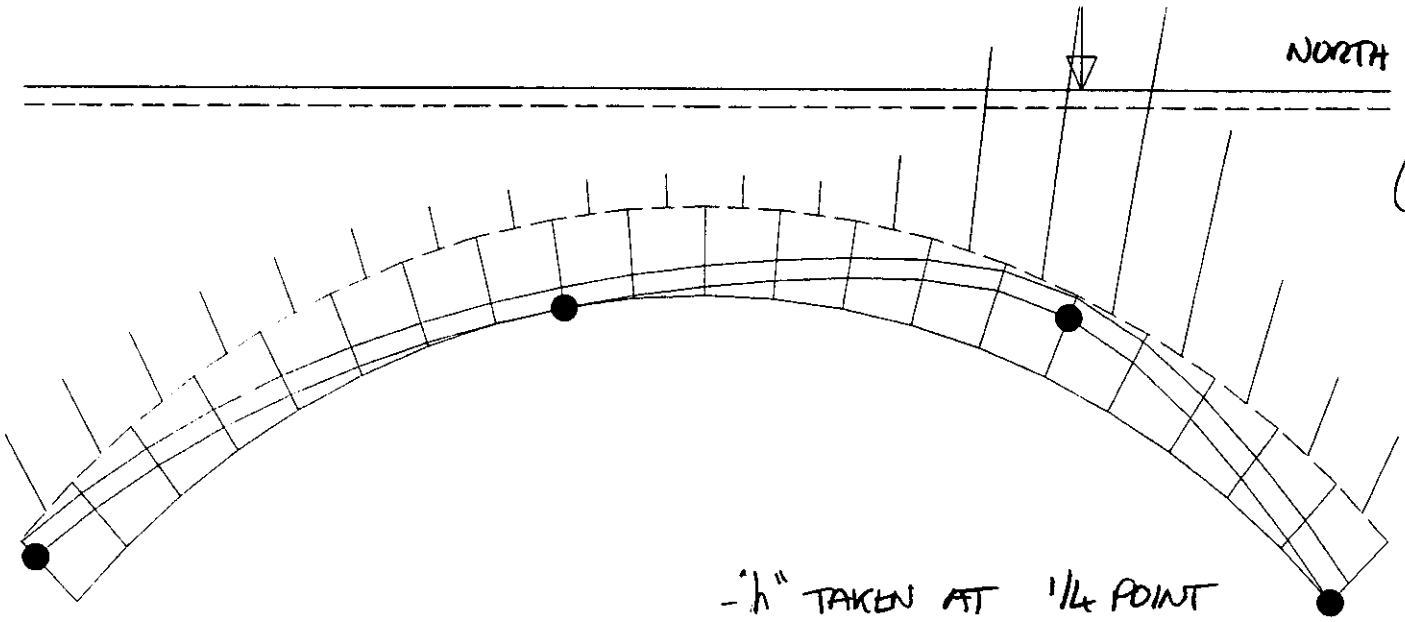
1 AT 1	2 AT 8	3 AT 16	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	0
2	-5	-13.8	6	0	0	0
3	-5	-12.6	4.6	0	0	0
4	-5	-11.4	3.5	0	0	0
5	-5	-10.1	2.5	0	0	0
6	-5	-8.9	1.8	0	0	0
7	-5	-7.9	1.2	0	0	0
8	-5	-7	.7	0	0	0
9	-5	-6.4	.4	0	0	0
10	-5	-6.1	.1	0	0	0
11	-5	-6.1	-.1	0	0	0
12	-5	-6.4	-.4	0	0	0
13	-5	-7	-.7	-7.4	-.5	0
14	-5	-7.9	-1.2	-33.2	-3.4	0
15	-5	-8.9	-1.8	-55.2	-7.3	0
16	-5	-10.1	-2.5	-54.2	-8.9	0
17	-5	-11.4	-3.5	-33.6	-6.8	0
18	-5	-12.6	-4.6	-11	-2.7	0
19	-5	-13.8	-6	-.7	-.2	0
20	-4.9	-14.1	-7.2	0	0	0

NORTH 5

(11)



-"h" TAKEN AT 1/4 POINT

62_north -1 No RING SEPARATED

()

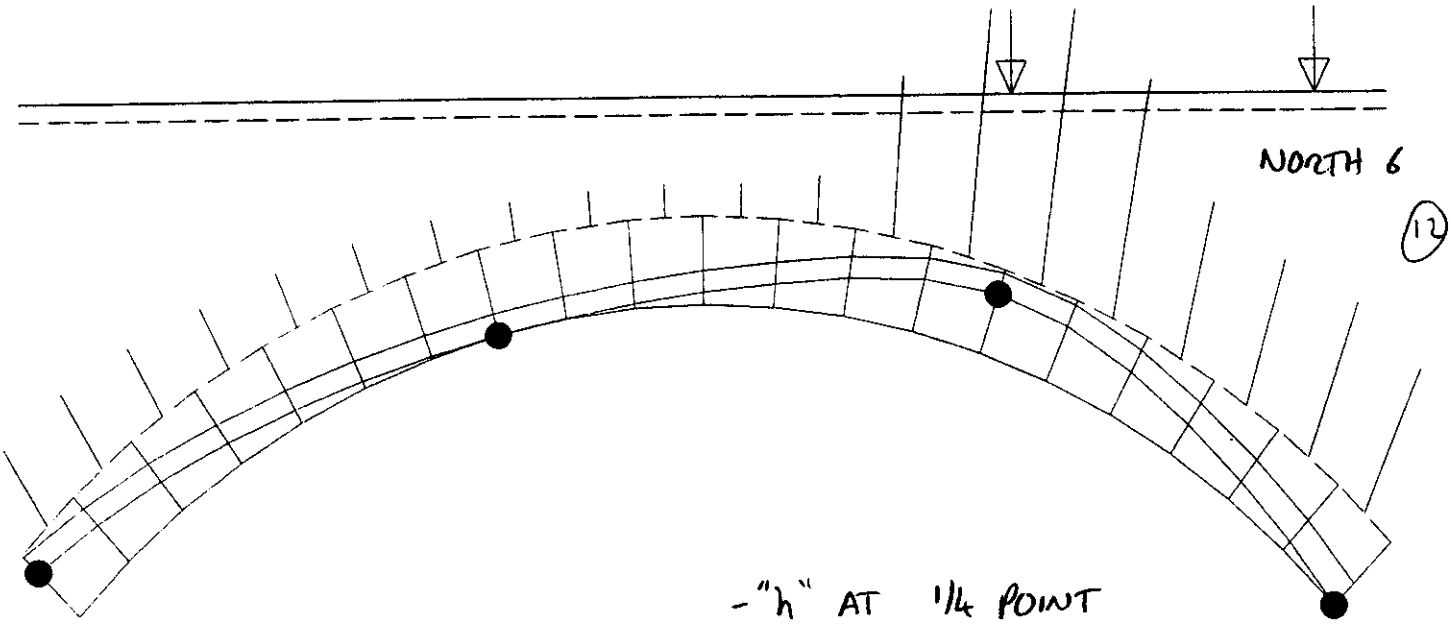
Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 6000		
Lane width	2193mm		
Required ring depth	468 mm	Geometric F.O.S	1.02
H Left	216 kN/m	H Right	202 kN/m
V Left	173 kN/m	V Right	297 kN/m
Comp. zone at hinge 2	120 mm	Factor on pass. press.	.3

Hinges

1 AT 1 2 AT 9 3 AT 16 4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	1.3
2	-5	-13.8	6	0	0	2.1
3	-5	-12.6	4.6	0	0	2.2
4	-5	-11.4	3.5	0	0	2.1
5	-5	-10.1	2.5	0	0	1.7
6	-5	-8.9	1.8	0	0	1.3
7	-5	-7.9	1.2	0	0	.9
8	-5	-7	.7	0	0	.6
9	-5	-6.4	.4	0	0	.2
10	-5	-6.1	.1	0	0	0
11	-5	-6.1	-.1	0	0	0
12	-5	-6.4	-.4	0	0	0
13	-5	-7	-.7	-6.6	-.5	0
14	-5	-7.9	-1.2	-29.7	-3	0
15	-5	-8.9	-1.8	-49.3	-6.5	0
16	-5	-10.1	-2.5	-48.4	-8	0
17	-5	-11.4	-3.5	-30	-6.1	0
18	-5	-12.6	-4.6	-9.9	-2.4	0
19	-5	-13.8	-6	-.6	-.2	0
20	-4.9	-14.1	-7.2	0	0	0



62_north - IN: RING SEPARATED

()

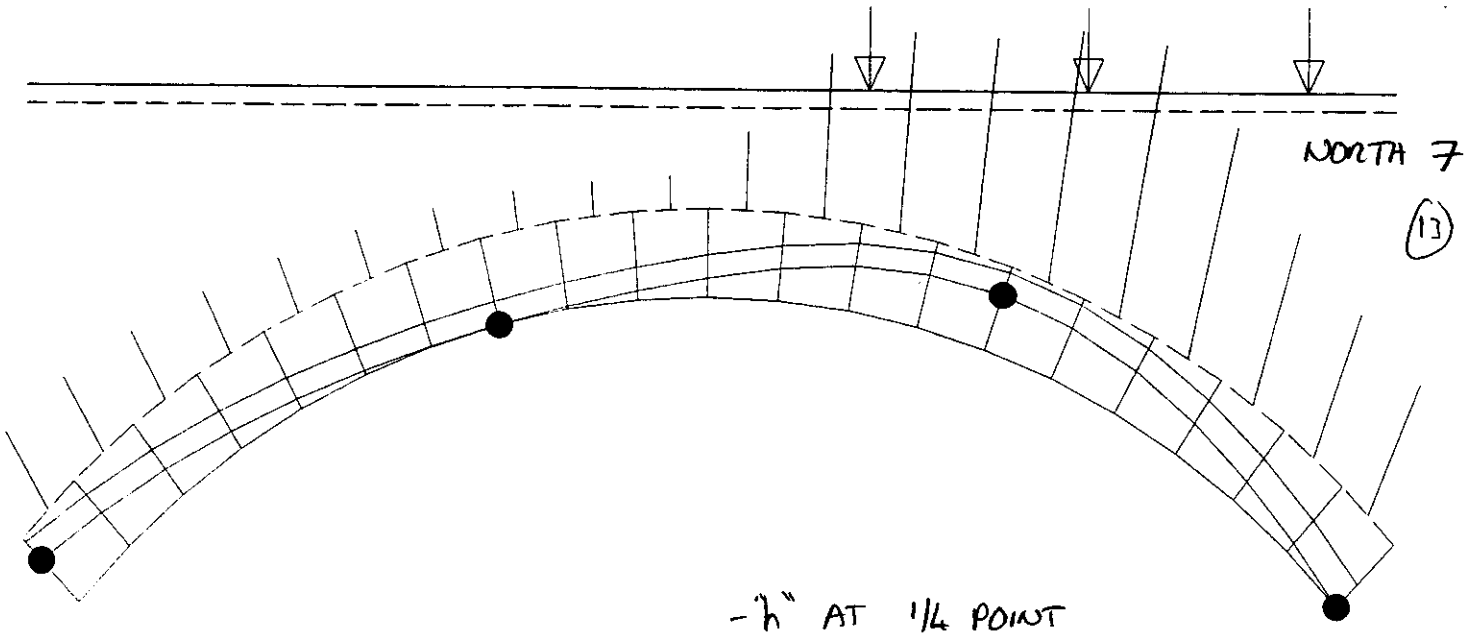
Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20t:Left Heavy at 6250		
Lane width	2193mm		
Required ring depth	467 mm	Geometric F.O.S	1.03
H Left	230 kN/m	H Right	210 kN/m
V Left	181 kN/m	V Right	327 kN/m
Comp. zone at hinge 2	126 mm	Factor on pass. press.	.3

Hinges

1 AT 1	2 AT 8	3 AT 15	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	1.5
2	-5	-13.8	6	0	0	2.3
3	-5	-12.6	4.6	0	0	2.5
4	-5	-11.4	3.5	0	0	2.3
5	-5	-10.1	2.5	0	0	1.8
6	-5	-8.9	1.8	0	0	1.4
7	-5	-7.9	1.2	0	0	1
8	-5	-7	.7	0	0	.4
9	-5	-6.4	.4	0	0	.1
10	-5	-6.1	.1	0	0	0
11	-5	-6.1	-.1	0	0	0
12	-5	-6.4	-.4	-2.4	-.1	0
13	-5	-7	-.7	-22.5	-1.6	0
14	-5	-7.9	-1.2	-45.8	-4.6	0
15	-5	-8.9	-1.8	-49.2	-6.5	0
16	-5	-10.1	-2.5	-33.5	-5.5	0
17	-5	-11.4	-3.5	-17.3	-3.5	0
18	-5	-12.6	-4.6	-14.1	-3.4	0
19	-5	-13.8	-6	-14.6	-4.2	0
20	-4.9	-14.1	-7.2	-12.4	-4.2	0



-½" AT 1/4 POINT

62_north - 1 No RING SEPARATED

()

Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Triple Axle:24t:No Lift-off at 6000		
Lane width	2193mm		
Required ring depth	452 mm	Geometric F.O.S	1.06
H Left	249 kN/m	H Right	227 kN/m
V Left	192 kN/m	V Right	346 kN/m
Comp. zone at hinge 2	136 mm	Factor on pass. press.	.3

Hinges

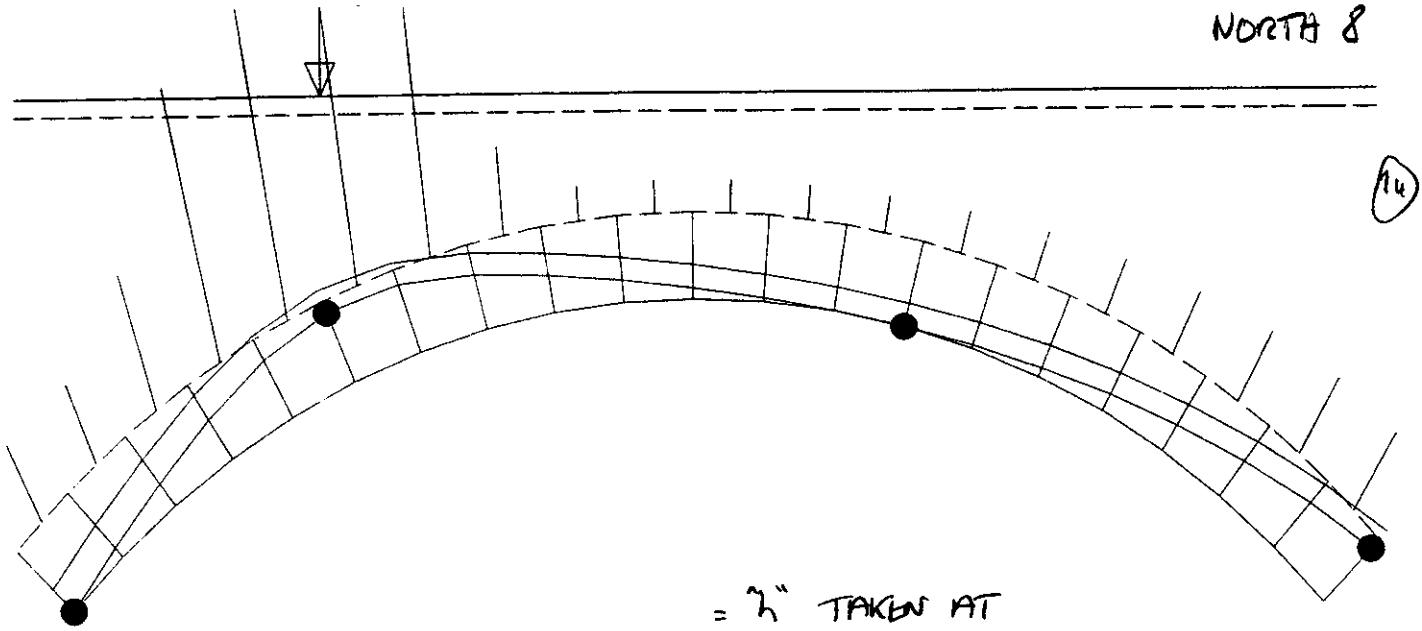
1 AT 1 2 AT 8 3 AT 15 4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	1.5
2	-5	-13.8	6	0	0	2.3
3	-5	-12.6	4.6	0	0	2.5
4	-5	-11.4	3.5	0	0	2.3
5	-5	-10.1	2.5	0	0	1.8
6	-5	-8.9	1.8	0	0	1.4
7	-5	-7.9	1.2	0	0	1
8	-5	-7	.7	0	0	.4
9	-5	-6.4	.4	0	0	.1
10	-5	-6.1	.1	-.2	0	0
11	-5	-6.1	-.1	-8.2	-.1	0
12	-5	-6.4	-.4	-23.5	-1	0
13	-5	-7	-.7	-29.5	-2.1	0
14	-5	-7.9	-1.2	-31.7	-3.2	0
15	-5	-8.9	-1.8	-37.1	-4.9	0
16	-5	-10.1	-2.5	-39.7	-6.5	0
17	-5	-11.4	-3.5	-30.8	-6.2	0
18	-5	-12.6	-4.6	-19	-4.6	0
19	-5	-13.8	-6	-12.5	-3.6	0
20	-4.9	-14.1	-7.2	-9.8	-3.3	0

NORTH 8

14



= 2" TAKEN AT

62_north - 2 N° RINGS SEPARATED

()

Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 1500		
Lane width	1645mm		
Required ring depth	545 mm	Geometric F.O.S	.88
H Left	230 kN/m	H Right	252 kN/m
V Left	346 kN/m	V Right	183 kN/m
Comp. zone at hinge 2	135 mm	Factor on pass. press.	.3

Hinges

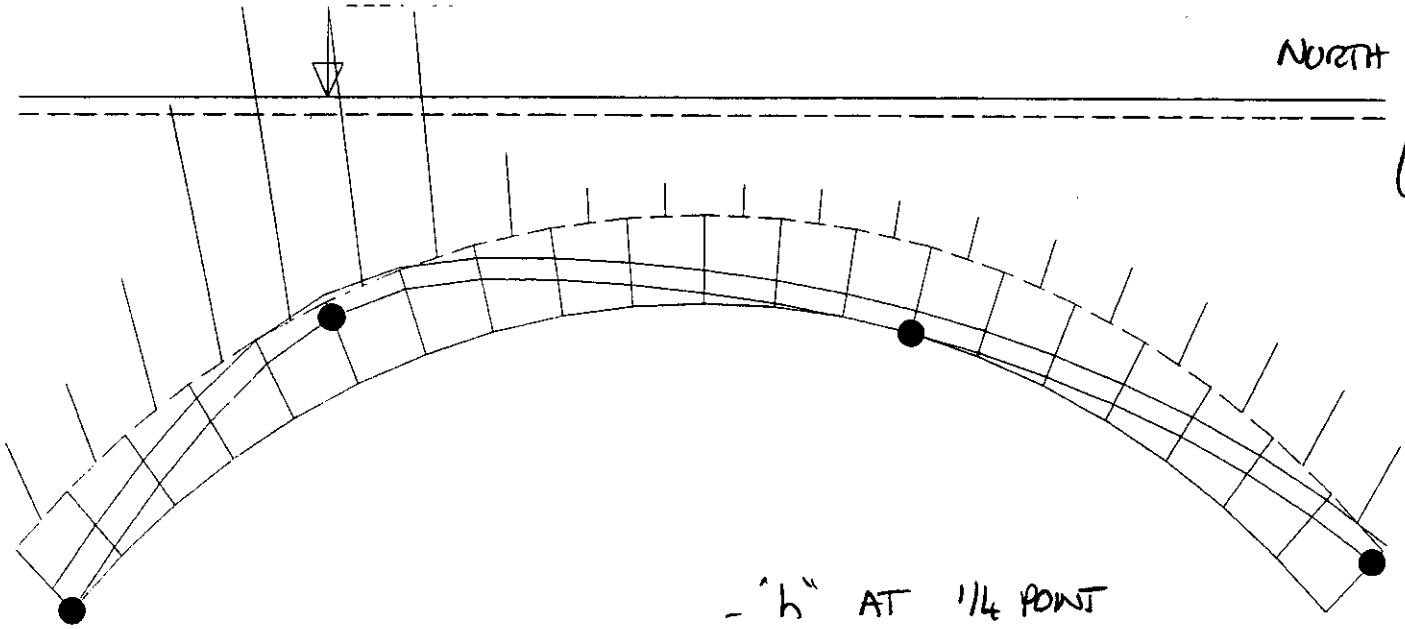
1 AT 1	2 AT 6	3 AT 14	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	0
2	-5	-13.8	6	-.6	.2	0
3	-5	-12.6	4.6	-12.3	3	0
4	-5	-11.4	3.5	-39	7.9	0
5	-5	-10.1	2.5	-64.2	10.6	0
6	-5	-8.9	1.8	-66.4	8.8	0
7	-5	-7.9	1.2	-40.6	4.1	0
8	-5	-7	.7	-9.4	.7	0
9	-5	-6.4	.4	0	0	0
10	-5	-6.1	.1	0	0	0
11	-5	-6.1	-.1	0	0	0
12	-5	-6.4	-.4	0	0	-.1
13	-5	-7	-.7	0	0	-.4
14	-5	-7.9	-1.2	0	0	-1
15	-5	-8.9	-1.8	0	0	-1.4
16	-5	-10.1	-2.5	0	0	-1.8
17	-5	-11.4	-3.5	0	0	-2.3
18	-5	-12.6	-4.6	0	0	-2.5
19	-5	-13.8	-6	0	0	-2.3
20	-4.9	-14.1	-7.2	0	0	-1.5

NORTH 9

(15)



- 'h' AT 1/4 POINT

62_north - 2Nº RINGS SEPARATED

()

Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	SA:10.5t (33-17t rest) at 1500		
Lane width	1645mm		
Required ring depth	520 mm	Geometric F.O.S	.92
H Left	221 kN/m	H Right	240 kN/m
V Left	329 kN/m	V Right	180 kN/m
Comp. zone at hinge 2	129 mm	Factor on pass. press.	.3

Hinges

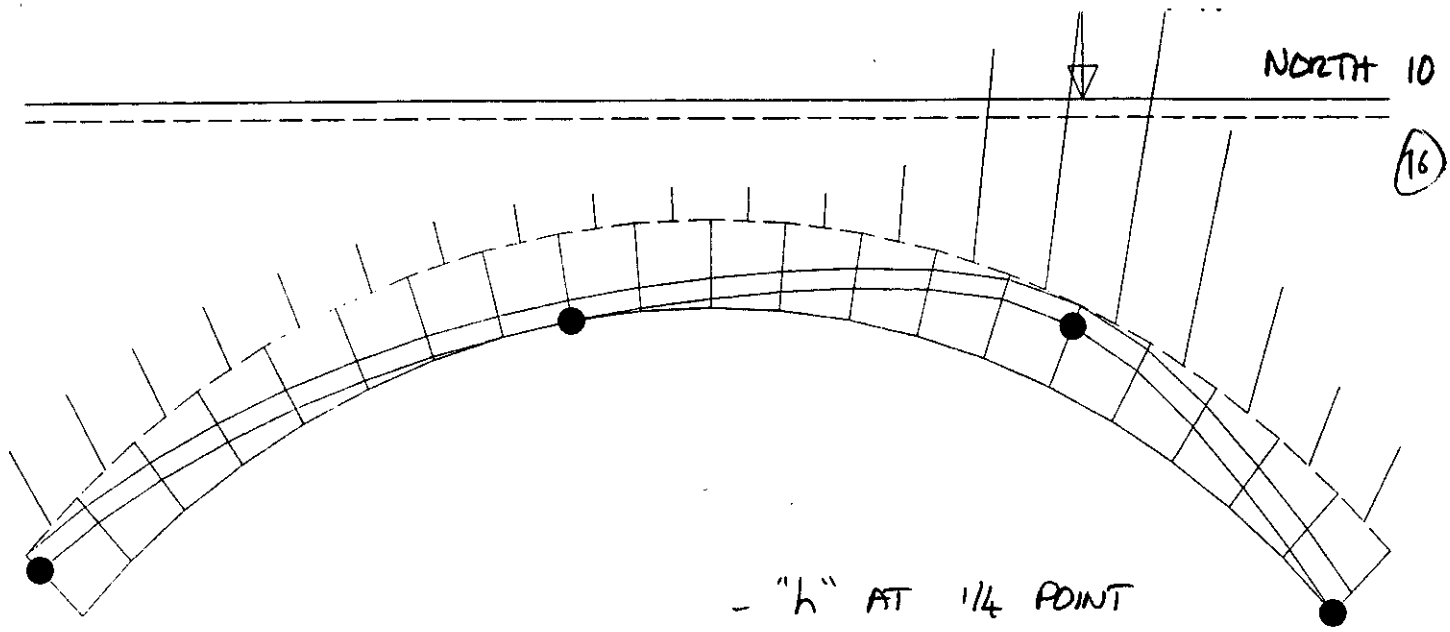
1 AT 1	2 AT 6	3 AT 14	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	0
2	-5	-13.8	6	-.6	.2	0
3	-5	-12.6	4.6	-11.2	2.7	0
4	-5	-11.4	3.5	-35.7	7.2	0
5	-5	-10.1	2.5	-58.8	9.7	0
6	-5	-8.9	1.8	-60.8	8	0
7	-5	-7.9	1.2	-37.2	3.8	0
8	-5	-7	.7	-8.6	.6	0
9	-5	-6.4	.4	0	0	0
10	-5	-6.1	.1	0	0	0
11	-5	-6.1	-.1	0	0	0
12	-5	-6.4	-.4	0	0	-.1
13	-5	-7	-.7	0	0	-.4
14	-5	-7.9	-1.2	0	0	-1
15	-5	-8.9	-1.8	0	0	-1.4
16	-5	-10.1	-2.5	0	0	-1.8
17	-5	-11.4	-3.5	0	0	-2.3
18	-5	-12.6	-4.6	0	0	-2.5
19	-5	-13.8	-6	0	0	-2.3
20	-4.9	-14.1	-7.2	0	0	-1.5

NORTH 10

(16)



- "h" AT 1/4 POINT

62_north - 2 Nº RINGS SEPARATED

()

Span	7486 mm	Rise	1667 mm
Depth of fill	645 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	SA (13t rest) at 6000		
Lane width	1645mm		
Required ring depth	480 mm	Geometric F.O.S	1
H Left	221 kN/m	H Right	206 kN/m
V Left	175 kN/m	V Right	304 kN/m
Comp. zone at hinge 2	121 mm	Factor on pass. press.	.3

Hinges

1 AT 1	2 AT 9	3 AT 16	4 AT 21

Param(mm).segment

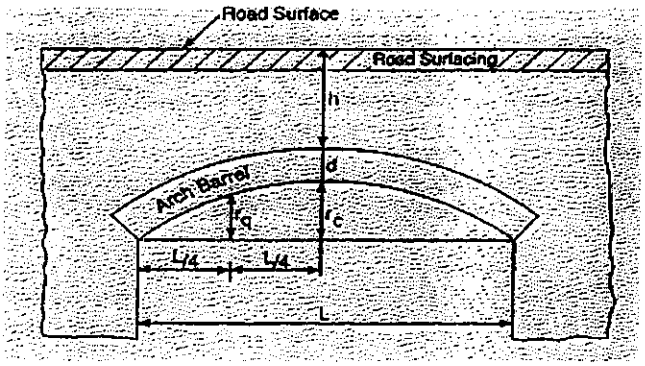
	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	1.3
2	-5	-13.8	6	0	0	2.1
3	-5	-12.6	4.6	0	0	2.2
4	-5	-11.4	3.5	0	0	2.1
5	-5	-10.1	2.5	0	0	1.7
6	-5	-8.9	1.8	0	0	1.3
7	-5	-7.9	1.2	0	0	.9
8	-5	-7	.7	0	0	.6
9	-5	-6.4	.4	0	0	.2
10	-5	-6.1	.1	0	0	0
11	-5	-6.1	-.1	0	0	0
12	-5	-6.4	-.4	0	0	0
13	-5	-7	-.7	-6.9	-.5	0
14	-5	-7.9	-1.2	-31	-3.1	0
15	-5	-8.9	-1.8	-51.5	-6.8	0
16	-5	-10.1	-2.5	-50.6	-8.3	0
17	-5	-11.4	-3.5	-31.3	-6.3	0
18	-5	-12.6	-4.6	-10.3	-2.5	0
19	-5	-13.8	-6	-.6	-.2	0
20	-4.9	-14.1	-7.2	0	0	0

WS/Atkins

ARCH ASSESSMENT TO MODIFIED MEXE (BA 16/97)

Structure Name: PAINTERS BRIDGE - CENTRAL ARCH

1. DIMENSIONS



L = 8·110m (SKEW)
rc = 1·786m
rq = 1·389m
d = 0·470m
h = 0·475m
h + d = 0·945m

2. PROVISIONAL ASSESSMENT LOADING (Fig. 3/1)

PAL = 43·5 Tonne

3. SPAN / RISE FACTOR

$\frac{L}{rc} = \frac{8·110}{1·786} = 4·54$ (Fig. 3/3) Fsr = 0·93

4. PROFILE FACTOR

$\frac{rq}{rc} = \frac{1·389}{1·786} = 0·78$ (Fig. 3/4) Fp = 0·93

5. MATERIAL FACTOR

(Tables 3/1 & 3/2)

$Fm = \frac{(Fb.d) + Ff.h)}{d + h} = \frac{(1·0 \times 0·47) + (0·7 \times 0·475)}{0·470 + 0·475}$ Fm = 0·85

6. JOINT FACTOR

(Tables 3/3, 3/4 & 3/5)

Fj = Fw.Fd.Fmo = 0·9 x 0·9 x 0·8 Fj = 0·65

7. CONDITION FACTOR

(Para. 3.17 to 3.23) Fc = 0·95

8. MODIFIED AXLE LOAD

MAL = PAL x Fsr x Fp x Fm x Fj x Fc

MAL = 19·7 Tonne

9. AXLE LIFT-OFF FACTOR

(Fig. 3/5) - NO LIFT OFF - SINGLE AXLE, Af = 1·45
TRIPLE AXLE Af = 0·95

10. WEIGHT LIMIT ON ARCH (MAX GROSS VEHICLE WEIGHT)

(Table 3/6) 40 Tonne

11. CONCLUSIONS:

ADEQUATE CAPACITY FOR 40 TONNES LIVE LOAD

Assessed By: [redacted] Date: 24/1/2000

Signed: [redacted]

WS Atkins	Project: ECL CONTRACT 3			Job ref: A1 1877 /62
	Part of structure: PAINTERS BRIDGE			Calc sheet no / 18 / rev /
	Drawing ref	Calc by: VF	Date: 12/99	Check by	Date

Ref	Calculations	Output

CENTRAL ARCH

ARCHIE ANALYSIS

Condition factor; $F_c = F_{cm} \times F_j$

$F_c = 0.95 \times 0.65 = 0.62$

Lane width;

Unfactored = 1.5 + 1.8 + h

h = 0.475m (0.981m at quarter point)

Effective width = 3.775m (4.281m " ")

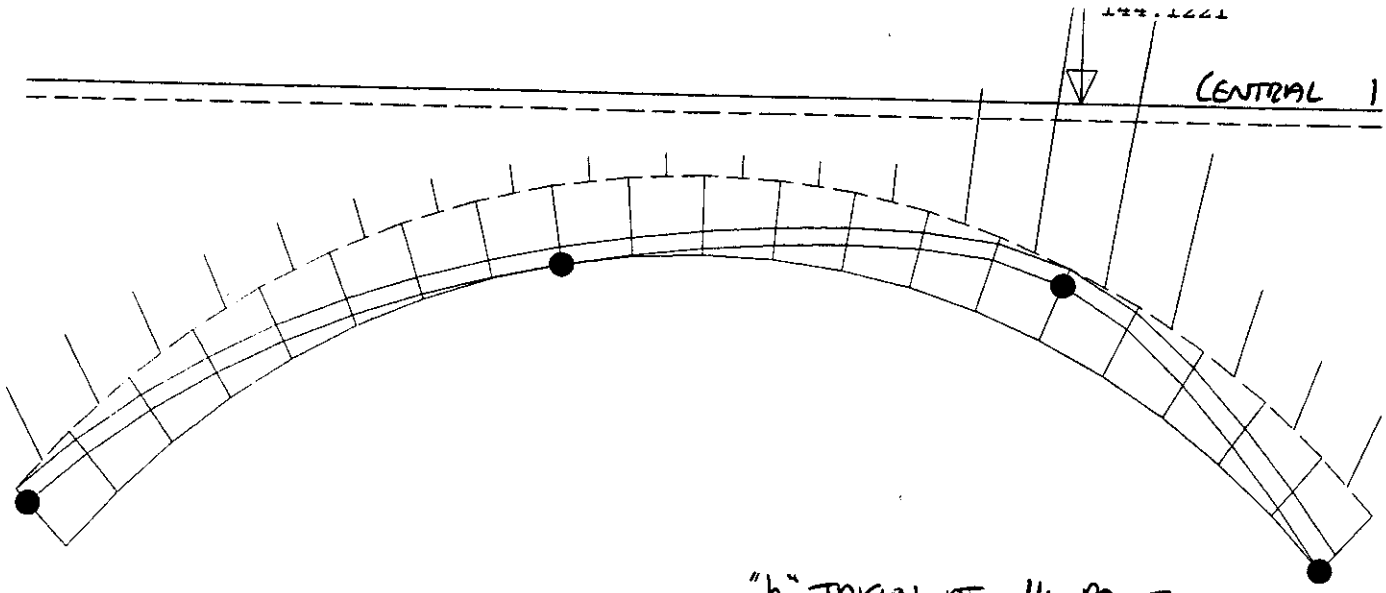
For analysis factor effective lane width by condition factor.

∴ Factored width = $3.775 \times 0.62 = 2.341$m. (2.654m at 1/4 point)

Refer to ARCHIE outputs;

LOADCASE	F.O.S.	PASS
11.5T SINGLE AXLE	1.00	YES
20T DOUBLE AXLE	1.01	YES
24T TRIPLE AXLE	1.04	YES

∴ ADEQUATE CAPACITY FOR 40T LIVE LOADING



- "h" TAKEN AT 1/4 POINT

62centr

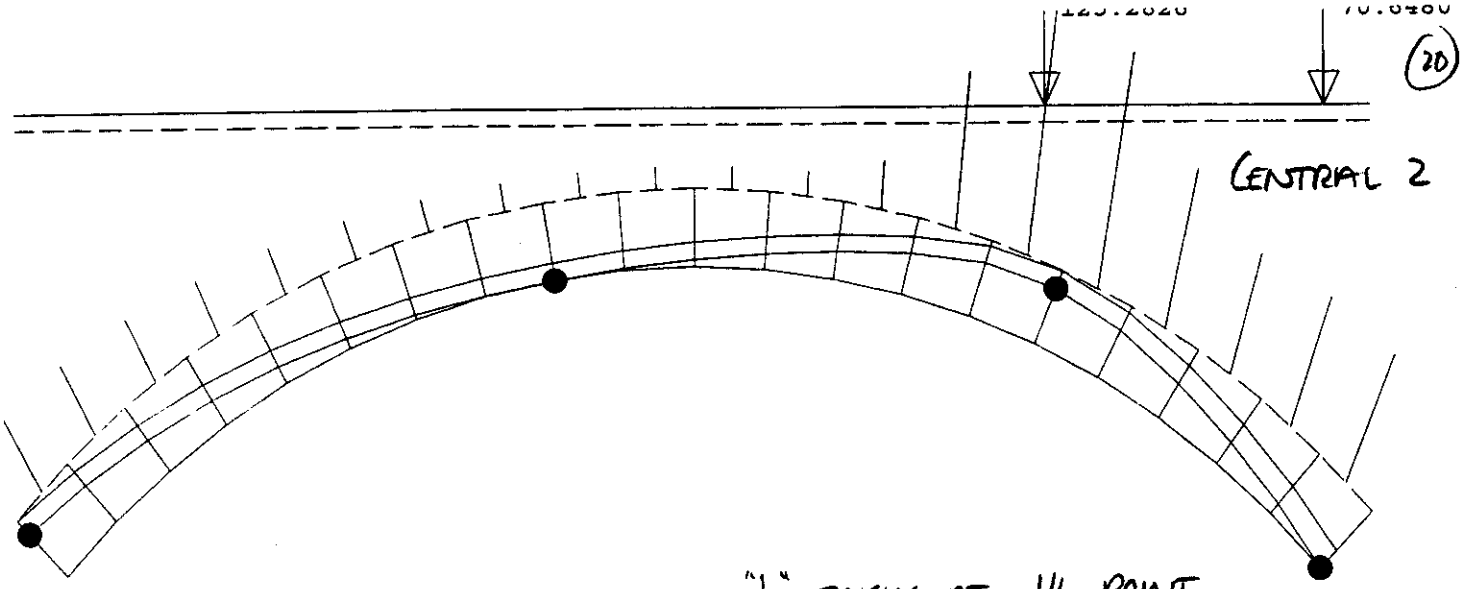
()

Span	8110 mm	Rise	1786 mm
Depth of fill	475 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 6500		
Lane width	2654mm		
Required ring depth	469 mm	Geometric F.O.S	1
H Left	196 kN/m	H Right	187 kN/m
V Left	166 kN/m	V Right	271 kN/m
Comp. zone at hinge 2	111 mm	Factor on pass. press.	.3

Hinges
1 AT 1 2 AT 9 3 AT 16 4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5.1	-14.8	7.4	0	0	1.4
2	-5.3	-14.2	6.1	0	0	2.1
3	-5.3	-12.8	4.6	0	0	2.2
4	-5.3	-11.2	3.4	0	0	2
5	-5.3	-9.7	2.4	0	0	1.6
6	-5.2	-8.2	1.6	0	0	1.2
7	-5.3	-7	1.1	0	0	.8
8	-5.3	-6	.6	0	0	.5
9	-5.2	-5.3	.3	0	0	.2
10	-5.3	-4.9	.1	0	0	0
11	-5.3	-4.9	-.1	0	0	0
12	-5.2	-5.3	-.3	0	0	0
13	-5.3	-6	-.6	-1.9	-.1	0
14	-5.3	-7	-1.1	-21.2	-2.1	0
15	-5.2	-8.2	-1.6	-44.4	-5.8	0
16	-5.3	-9.7	-2.4	-45.6	-7.4	0
17	-5.3	-11.2	-3.4	-25.4	-5.1	0
18	-5.3	-12.8	-4.6	-5.5	-1.3	0
19	-5.3	-14.2	-6.1	0	0	0
20	-5.1	-14.8	-7.4	0	0	0



(20)

- "h" TAKEN AT 1/4 POINT

62centr

()

Span	8110 mm	Rise	1786 mm
Depth of fill	475 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20t:Left Heavy at 7000		
Lane width	2654mm		
Required ring depth	467 mm	Geometric F.O.S	1.01
H Left	199 kN/m	H Right	182 kN/m
V Left	168 kN/m	V Right	296 kN/m
Comp. zone at hinge 2	113 mm	Factor on pass. press.	.3

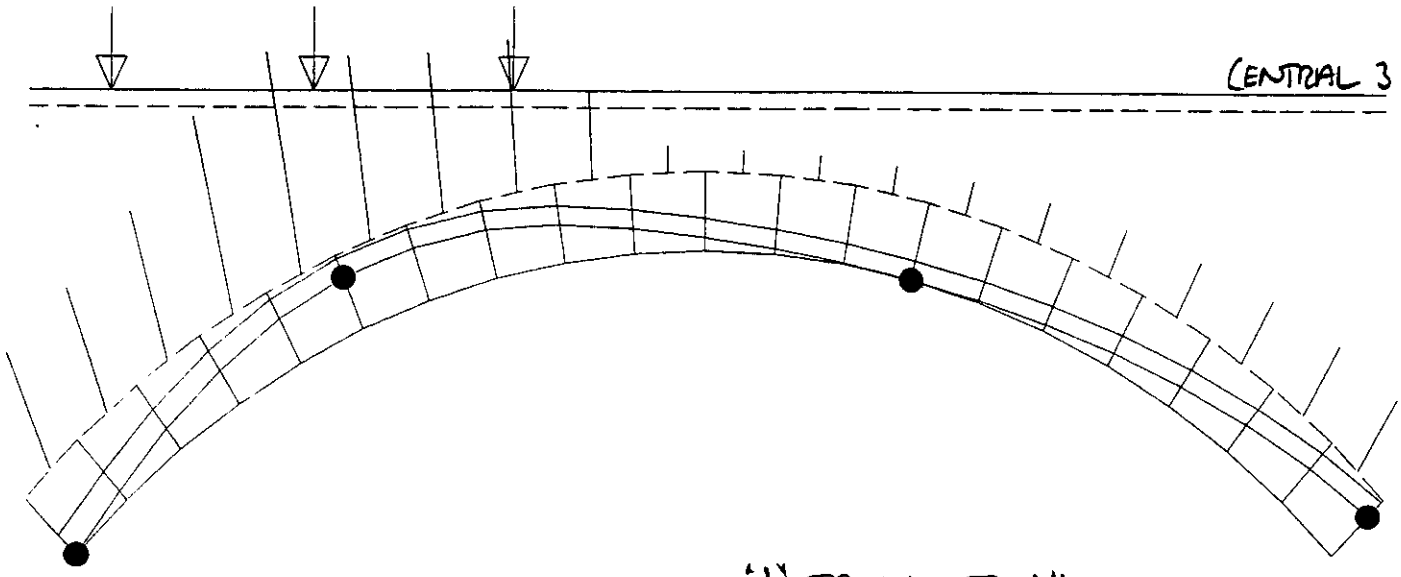
Hinges

1 AT 1	2 AT 9	3 AT 16	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5.1	-14.8	7.4	0	0	1.4
2	-5.3	-14.2	6.1	0	0	2.1
3	-5.3	-12.8	4.6	0	0	2.2
4	-5.3	-11.2	3.4	0	0	2
5	-5.3	-9.7	2.4	0	0	1.6
6	-5.2	-8.2	1.6	0	0	1.2
7	-5.3	-7	1.1	0	0	.8
8	-5.3	-6	.6	0	0	.5
9	-5.2	-5.3	.3	0	0	.2
10	-5.3	-4.9	.1	0	0	0
11	-5.3	-4.9	-.1	0	0	0
12	-5.2	-5.3	-.3	0	0	0
13	-5.3	-6	-.6	-4.1	-.3	0
14	-5.3	-7	-1.1	-25.9	-2.6	0
15	-5.2	-8.2	-1.6	-43.6	-5.7	0
16	-5.3	-9.7	-2.4	-39.3	-6.4	0
17	-5.3	-11.2	-3.4	-21.8	-4.4	0
18	-5.3	-12.8	-4.6	-12	-2.9	0
19	-5.3	-14.2	-6.1	-12.4	-3.5	0
20	-5.1	-14.8	-7.4	-11.3	-3.8	0

CENTRAL 3



'h' TAKEN AT 1/4 POINT

62centr

()

Span	8110 mm	Rise	1786 mm
Depth of fill	475 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Triple Axle:24t:No Lift-off at 1500		
Lane width	2654mm		
Required ring depth	454 mm	Geometric F.O.S	1.04
H Left	201 kN/m	H Right	220 kN/m
V Left	314 kN/m	V Right	179 kN/m
Comp. zone at hinge 2	123 mm	Factor on pass. press.	.3

Hinges

1 AT 1	2 AT 6	3 AT 14	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5.1	-14.8	7.4	-8.9	3	0
2	-5.3	-14.2	6.1	-11.4	3.2	0
3	-5.3	-12.8	4.6	-17.8	4.3	0
4	-5.3	-11.2	3.4	-29.6	5.9	0
5	-5.3	-9.7	2.4	-36.2	5.9	0
6	-5.2	-8.2	1.6	-29.9	3.9	0
7	-5.3	-7	1.1	-26.4	2.7	0
8	-5.3	-6	.6	-25.7	1.8	0
9	-5.2	-5.3	.3	-13.5	.6	0
10	-5.3	-4.9	.1	-.9	0	0
11	-5.3	-4.9	-.1	0	0	0
12	-5.2	-5.3	-.3	0	0	-.1
13	-5.3	-6	-.6	0	0	-.4
14	-5.3	-7	-1.1	0	0	-.8
15	-5.2	-8.2	-1.6	0	0	-1.3
16	-5.3	-9.7	-2.4	0	0	-1.7
17	-5.3	-11.2	-3.4	0	0	-2.2
18	-5.3	-12.8	-4.6	0	0	-2.5
19	-5.3	-14.2	-6.1	0	0	-2.4
20	-5.1	-14.8	-7.4	0	0	-1.6

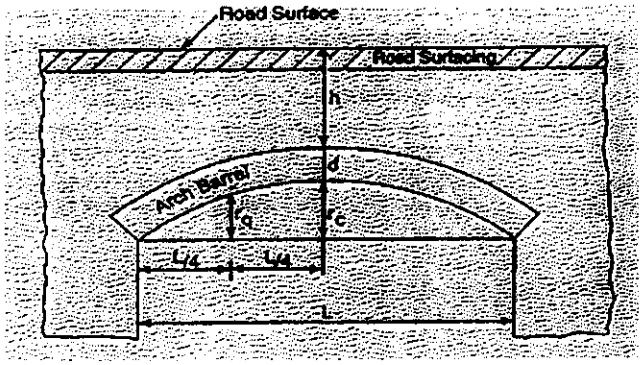
WS/Atkins

(12)

ARCH ASSESSMENT TO MODIFIED MEXE (BA 16/97)

Structure Name: PAINTERS BRIDGE - SOUTH ARCH

1. DIMENSIONS



L = 7.950m (SKEW)
rc = 1.659m
rq = 1.321m
d = 0.470m
h = 0.430m
h + d = 0.900m

2. PROVISIONAL ASSESSMENT LOADING (Fig. 3/1)

PAL = 40.5 Tonne

3. SPAN / RISE FACTOR

$\frac{L}{rc} = \frac{7.950}{1.659} = 4.79$ (Fig. 3/3) Fsr = 0.88

4. PROFILE FACTOR

$\frac{rq}{rc} = \frac{1.321}{1.659} = 0.796$ (Fig. 3/4) Fp = 0.89

5. MATERIAL FACTOR

(Tables 3/1 & 3/2)

$Fm = \frac{(Fb.d) + Ff.h)}{d + h} = \frac{(1.0 \times 0.47) + (0.7 \times 0.43)}{0.47 + 0.43}$ Fm = 0.86

6. JOINT FACTOR

(Tables 3/3, 3/4 & 3/5)

Fj = Fw.Fd.Fmo = 0.9 x 0.9 x 0.9 Fj = 0.73

7. CONDITION FACTOR

(Para. 3.17 to 3.23) Fc = 0.90

8. MODIFIED AXLE LOAD

MAL = PAL x Fsr x Fp x Fm x Fj x Fc

MAL = 17.9 Tonne

9. AXLE LIFT-OFF FACTOR

(Fig. 3/5)

- NO LIFT OFF - SINGLE AXLE Af = 1.45
- TRIPLE AXLE Af = 0.95

10. WEIGHT LIMIT ON ARCH (MAX GROSS VEHICLE WEIGHT)

(Table 3/6) 40 Tonne

11. CONCLUSIONS:

ADEQUATE CAPACITY FOR 40 TONNES LIVE LOAD

Assessed By: [redacted] Date: 24/1/00

Signed: [redacted]

WS/Atkins

Project	Job ref
ECC CONTRACT 3	A1 1877/62
Part of structure: PAINTERS BRIDGE	Calc sheet no / rev: / 23 /

Drawing ref	Calc by	Date	Check by	Date
	JF	1/00		

Ref	Calculations	Output

SOUTH ARCH

ARCHIE ANALYSIS

Condition factor, $F_c = F_{cm} \times F_j$

$= 0.90 \times 0.73 = 0.66$

Lane width;

Unfactored $= 1.5 + 1.8 + h$

$= 1.5 + 1.8 + 0.430$ (At 1/4 point $h = 0.897$m)

Unfactored effective width = 3.730m (4.197m at 1/4 point)

For analysis factor effective lane width by condition factor

∴ Factored width $= 3.730 \times 0.66 = 2.462$m (2.770m at 1/4 point)

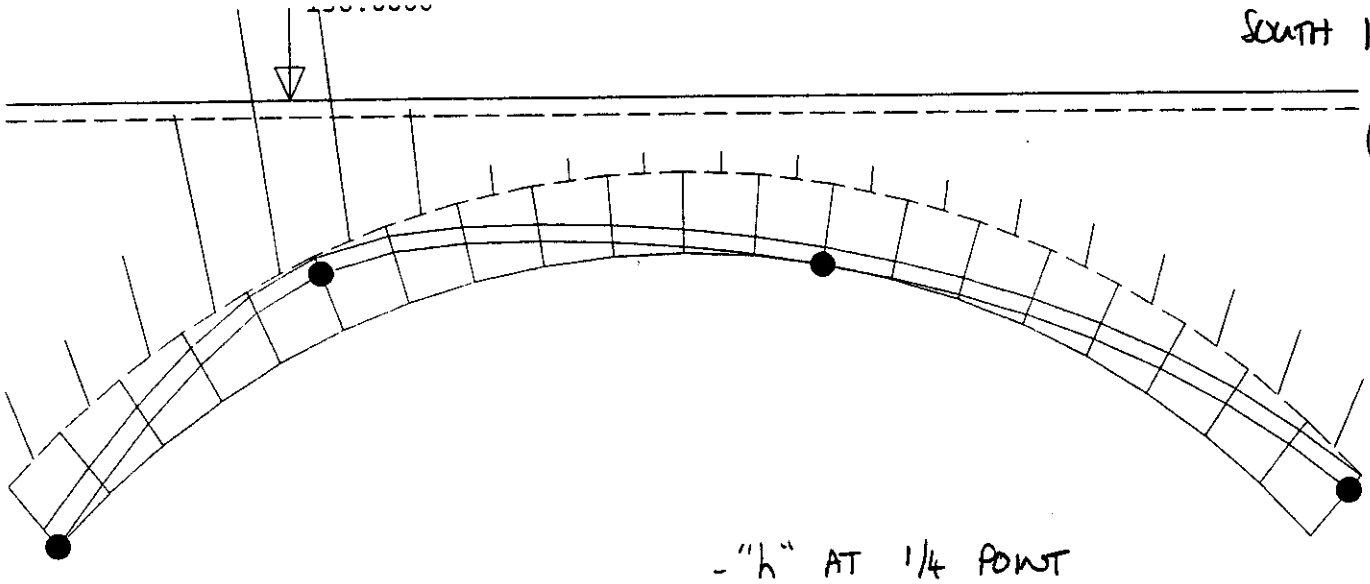
Refer to ARCHIE output;

LOADCASE	F.O.S.	PASS
11.5T SINGLE AXLE	1.01	YES
20.0T DOUBLE AXLE	1.02	YES
24.0T TRIPLE AXLE	1.05	YES

∴ ADEQUATE FOR 40T LIVE LOADING

SOUTH 1

24



- "h" AT 1/4 POINT

62south

()

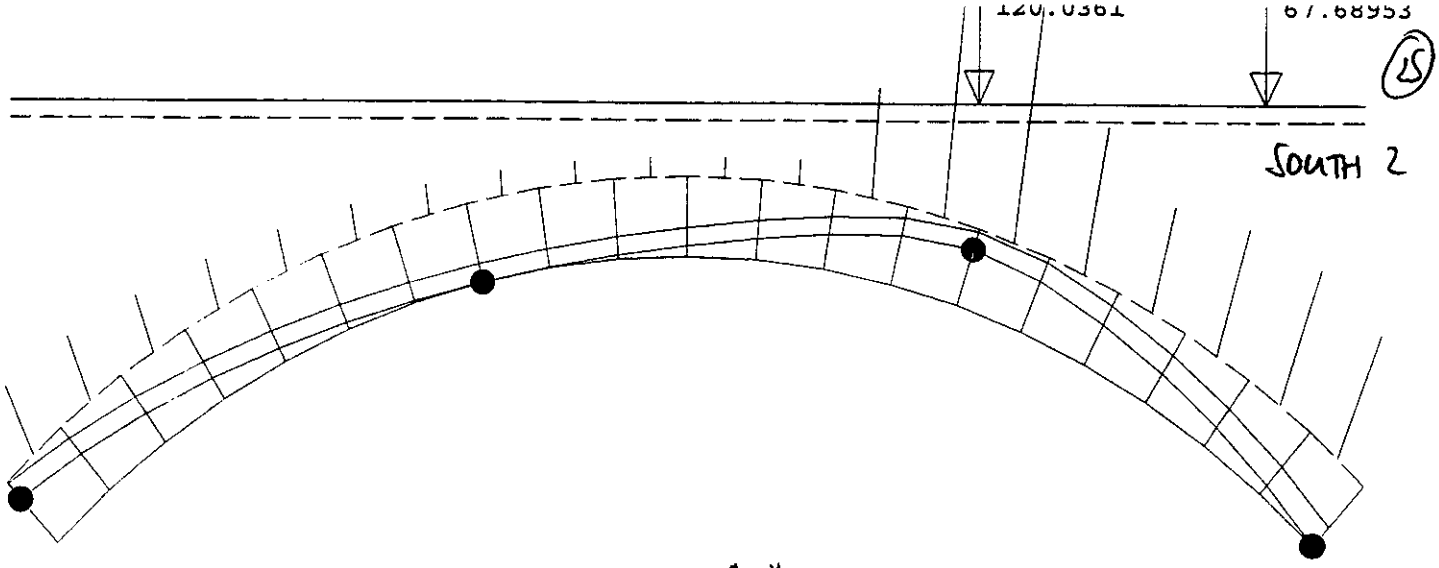
Span	7950 mm	Rise	1659 mm
Depth of fill	430 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 1500		
Lane width	2770mm		
Required ring depth	467 mm	Geometric F.O.S	1.01
H Left	182 kN/m	H Right	203 kN/m
V Left	255 kN/m	V Right	155 kN/m
Comp. zone at hinge 2	110 mm	Factor on pass. press.	.1

Hinges

1 AT 1	2 AT 6	3 AT 13	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5	-13.7	6.4	0	0	0
2	-5.1	-13	5.2	-.3	.1	0
3	-5.1	-11.6	3.9	-8.9	2	0
4	-5.1	-10.1	2.9	-29.5	5.6	0
5	-5.1	-8.7	2	-45.3	7	0
6	-5.1	-7.4	1.4	-38.6	4.8	0
7	-5.1	-6.2	.9	-14.9	1.4	0
8	-5.1	-5.3	.5	-.7	0	0
9	-5.1	-4.7	.3	0	0	0
10	-5.1	-4.3	.1	0	0	0
11	-5.1	-4.3	-.1	0	0	0
12	-5.1	-4.7	-.3	0	0	0
13	-5.1	-5.3	-.5	0	0	0
14	-5.1	-6.2	-.9	0	0	0
15	-5.1	-7.4	-1.4	0	0	0
16	-5.1	-8.7	-2	0	0	0
17	-5.1	-10.1	-2.9	0	0	0
18	-5.1	-11.6	-3.9	0	0	0
19	-5.1	-13	-5.2	0	0	0
20	-5	-13.7	-6.4	0	0	0



62south - "h" AT 1/4 POINT

()

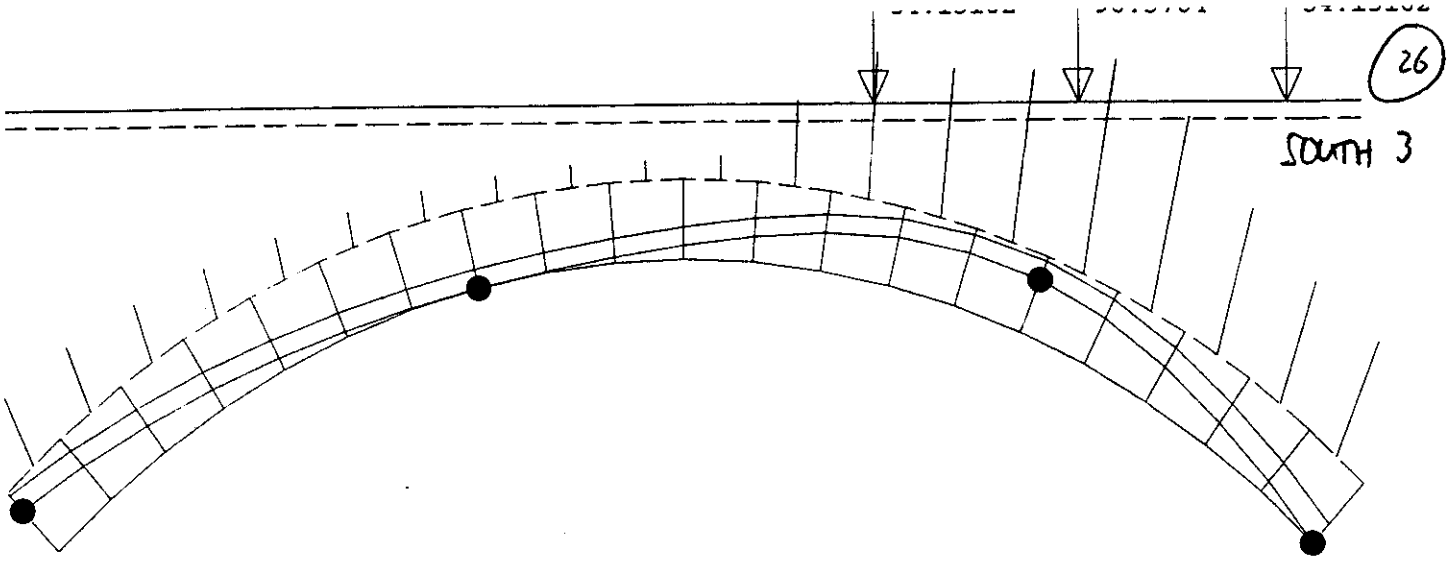
Span	7950 mm	Rise	1659 mm
Depth of fill	430 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20t:Left Heavy at 6500		
Lane width	2770mm		
Required ring depth	462 mm	Geometric F.O.S	1.02
H Left	223 kN/m	H Right	196 kN/m
V Left	164 kN/m	V Right	283 kN/m
Comp. zone at hinge 2	119 mm	Factor on pass. press.	.1

Hinges

1 AT 1	2 AT 8	3 AT 15	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5	-13.7	6.4	0	0	0
2	-5.1	-13	5.2	0	0	0
3	-5.1	-11.6	3.9	0	0	0
4	-5.1	-10.1	2.9	0	0	0
5	-5.1	-8.7	2	0	0	0
6	-5.1	-7.4	1.4	0	0	0
7	-5.1	-6.2	.9	0	0	0
8	-5.1	-5.3	.5	0	0	0
9	-5.1	-4.7	.3	0	0	0
10	-5.1	-4.3	.1	0	0	0
11	-5.1	-4.3	-.1	0	0	0
12	-5.1	-4.7	-.3	-.6	0	0
13	-5.1	-5.3	-.5	-17.1	-1.1	0
14	-5.1	-6.2	-.9	-43.4	-4.1	0
15	-5.1	-7.4	-1.4	-42.7	-5.3	0
16	-5.1	-8.7	-2	-21.3	-3.3	0
17	-5.1	-10.1	-2.9	-11.3	-2.1	0
18	-5.1	-11.6	-3.9	-14	-3.2	0
19	-5.1	-13	-5.2	-14.1	-3.7	0
20	-5	-13.7	-6.4	-10.8	-3.4	0



62south - 'h' AT 1/4 POINT

()

Span	7950 mm	Rise	1659 mm
Depth of fill	430 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Triple Axle:24t:No Lift-off at 6500		
Lane width	2770mm		
Required ring depth	449 mm	Geometric F.O.S	1.05
H Left	228 kN/m	H Right	200 kN/m
V Left	168 kN/m	V Right	295 kN/m
Comp. zone at hinge 2	122 mm	Factor on pass. press.	.1

Hinges

1 AT 1	2 AT 8	3 AT 16	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5	-13.7	6.4	0	0	0
2	-5.1	-13	5.2	0	0	0
3	-5.1	-11.6	3.9	0	0	0
4	-5.1	-10.1	2.9	0	0	0
5	-5.1	-8.7	2	0	0	0
6	-5.1	-7.4	1.4	0	0	0
7	-5.1	-6.2	.9	0	0	0
8	-5.1	-5.3	.5	0	0	0
9	-5.1	-4.7	.3	0	0	0
10	-5.1	-4.3	.1	0	0	0
11	-5.1	-4.3	-.1	-.7	0	0
12	-5.1	-4.7	-.3	-12.7	-.5	0
13	-5.1	-5.3	-.5	-24.3	-1.6	0
14	-5.1	-6.2	-.9	-23.9	-2.2	0
15	-5.1	-7.4	-1.4	-27.3	-3.4	0
16	-5.1	-8.7	-2	-34.5	-5.4	0
17	-5.1	-10.1	-2.9	-29.1	-5.5	0
18	-5.1	-11.6	-3.9	-17.9	-4	0
19	-5.1	-13	-5.2	-11.3	-3	0
20	-5	-13.7	-6.4	-9.1	-2.8	0

WS/Atkins	Project: ECC CONTRACT 3	Job ref: N/1877/62
	Part of structure: PAINTERS BRIDGE	Calc sheet no / rev: 1 27 1
	Drawing ref	Calc by: JF; Date: 1/00; Check by; Date

Ref	Calculations	Output

MULTI ANALYSIS

To assess the capacity of the piers the MULTI computer program was used

The heights of the piers used were those measured on site plus 0.5m (This is to allow for length of pier surrounded by loose fill).

As the critical loading for the two piers was always over the central span the full depth and condition factors for the central span were adopted.

These values input into a spreadsheet to calculate loadings for MULTI.

This spreadsheet, the input data for MULTI and the output from MULTI can be found on the following pages

The skew span and skew pier widths were adopted

RESULTS

The overall capacity of the piers in assessment live loading. **13 TONNES**

N.B.

On site holes were drilled above springing level to try to locate any backing. None was located. However, a more detailed testing system may locate some backing directly above piers. ie in areas not accessable by the drilling method.

A quick check indicated that even a small depth of backing would significantly increase pier capacity.

28

arch width	7.090 m
Fill Depth	0.475 m
width2 (2 lanes loaded)	3.138 m
width1 (1 lane loaded)	3.775 m
gfl1 (BD 21/97, cl 6.20)	3.400
gfl2 (BD 21/97, cl 6.20)	1.900
Fcm	0.950
Fj	0.650
g	9.810

HB parameters
3.545 m
4.975 m
2.000

Lift-Off Factors (BD 21/97, Table 6.2)	
dlift1*	1.28
dlift2	0.50
tlifta1	1.50
tlifta2*	1.00
tlifta3	0.50
tliftb1*	1.28
tliftb2	1.00
tliftb3	0.50

HB units	Axle load (kN/m)	
	1 lane	2 lanes
15.00	97.65	137.05
20.00	130.21	182.73
25.00	162.76	228.41
30.00	195.31	274.09
35.00	227.86	319.78
40.00	260.41	365.46
45.00	292.96	411.14

AAL (t)		No-Lift Off		Lift-Off	
		Axle load (kN/m)		Axle load (kN/m)	
		1 lane	2 lanes	1 lane	2 lanes
11.50 SA		164.55	197.98	164.55	197.98
10.50 SA		150.24	180.77	150.24	180.77
9.00 SA		128.78	154.94	128.78	154.94
7.00 SA		100.16	120.51	100.16	120.51
5.50 SA		78.70	94.69	78.70	94.69
2.00 SA		28.62	34.43	28.62	34.43
10.00 DA	Heavy Axle*	143.08	172.16	183.15	220.36
	Light Axle	79.96	96.21	39.98	48.10
9.50 DA	Heavy Axle*	135.93	163.55	173.99	209.34
	Light Axle	75.96	91.40	37.98	45.70
9.00 DA	Heavy Axle*	128.78	154.94	164.83	198.33
	Light Axle	71.96	86.59	35.98	43.29
	Out Axle 1	63.97	76.96		
8.00 TA (a)	Mid Axle 2*	114.47	137.73		
1300	Out Axle 3	63.97	76.96		
	Out Axle 1	59.97	72.15	89.95	108.23
7.50 TA (a)	Mid Axle 2*	107.31	129.12	107.31	129.12
1350	Out Axle 3	59.97	72.15	29.98	36.08
	Out Axle 1	47.98	57.72	71.96	86.59
6.00 TA (a)	Mid Axle 2*	85.85	103.29	85.85	103.29
700	Out Axle 3	47.98	57.72	23.99	28.86
	Out Axle 1*	114.47	137.73		
8.00 TA (b)	Mid Axle 2	63.97	76.96		
1300	Out Axle 3	63.97	76.96		
	Out Axle 1*	107.31	129.12	137.36	165.27
7.50 TA (b)	Mid Axle 2	59.97	72.15	59.97	72.15
1350	Out Axle 3	59.97	72.15	29.98	36.08
	Out Axle 1*	85.85	103.29	109.89	132.22
6.00 TA (b)	Mid Axle 2	47.98	57.72	47.98	57.72
700	Out Axle 3	47.98	57.72	23.99	28.86

PAINTERS BRIDGE - MULTI LOAD CASE SET

29

paintlds.txt

```
No-Lift Off 1 lane
0
*
SA:11.5t (40/44t)
165.34
*
DA 20t (38-40/44t)
143.77
1000
80.34
*
DA 20t (38-40/44t)
143.77
1300
80.34
*
DA 20t (38-40/44t)
143.77
1800
80.34
*
TA (a) 24t (38-40/44t)
64.27
1300
115.02
1300
64.27
*
TA (a) 22.5t (38-40/44t)
60.26
1350
107.83
1350
60.26
*
TA (a) 18t (38-40/44t)
48.21
700
86.26
700
48.21
*
TA (b) 24t (38-40/44t)
115.02
1300
64.27
1300
64.27
*
TA (b) 22.5t (38-40/44t)
107.83
1350
```

60.26
1350
60.26
*
TA (b) 18t (38-40/44t)
86.26
700
48.21
700
48.21
*
DA 19t (33t restrict)
136.58
1000
76.33
*
DA 19t (33t restrict)
136.58
1300
76.33
*
DA 19t (33t restrict)
136.58
1800
76.33
*
DA 18t (25t restrict)
129.39
1000
72.31
*
DA 18t (25t restrict)
129.39
1300
72.31
*
DA 18t (25t restrict)
129.39
1800
72.31
*
SA:10.5t (17t-33t restrict)
150.96
*
SA:9t (13t restrict)
129.39
*
SA:7t (10t restrict)
100.64
*
SA:5.5t (7.5t restrict)
79.07

*
SA:2t (3t restrict)
28.75
*□

62north.dat

```
62north
 1667
 7486
 20
 480
 1
 0
 23.5
 19.6
 30
 1
 588
 2.3
 8000
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 0
 100
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956,825,2789
1316,1044,2789
1694,1231,2788
2087,1387,2787
2490,1509,2786
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3743,1667,2784
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62centr.dat

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 19.6
 30
 1
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 8000
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1840,1320,2748
2264,1486,2744
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3147,1710,2735
3599,1767,2730
4055,1786,2725
4511,1767,2715
4963,1710,2705
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62south.dat

```
62SOUTH
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 19.6
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 619
 2.3
 8000
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323,302,2640
669,577,2630
1036,824,2620
1420,1041,2610
1821,1228,2600
2236,1382,2590
2661,1502,2579
3094,1589,2569
3533,1642,2559
3975,1659,2549
4417,1642,2518
4856,1589,2487
5289,1502,2456
5714,1382,2425
6129,1228,2394
6530,1041,2363
6914,824,2332
7281,577,2301
7627,302,2270
7950,0,2240
*
 -2.407
```

WORST VEHICLE POSITIONS - COPY OF MULTI OUTPUT

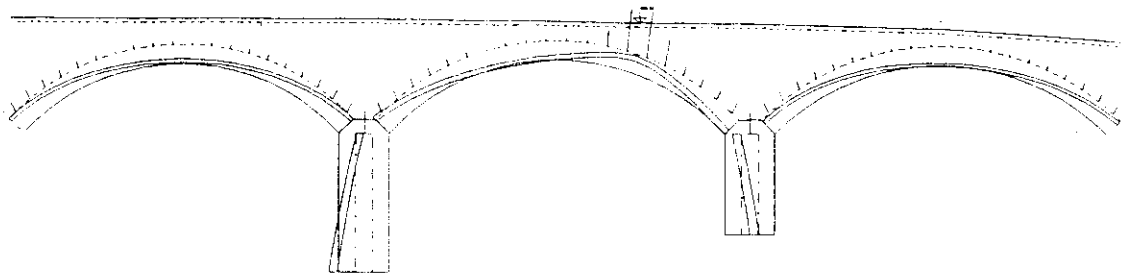
```
                    Hit enter to continue

          Worst case load positions for all load cases

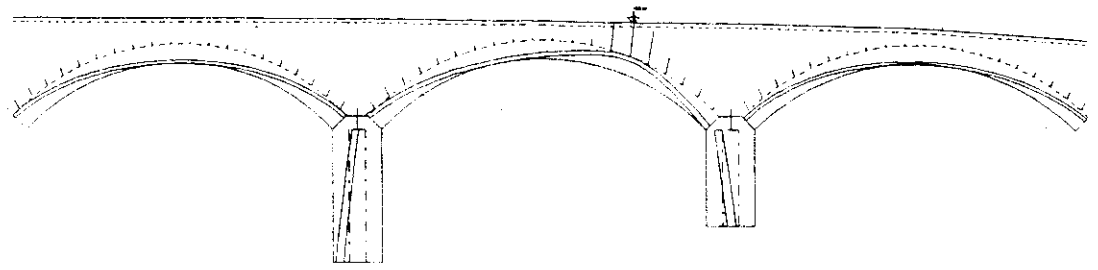
SA:11.5t (40/44t)          @ 14750       DA 20t (38-40/44t)        @ 14750
DA 20t (38-40/44t)         @ 14750       DA 20t (38-40/44t) @ 14500
TA (a) 24t (38-40/44t) @ 14750           TA (a) 22.5t (38-40/44t) @ 14750
TA (a) 18t (38-40/44t) @ 15000           TA (b) 24t (38-40/44t) @ 14500
TA (b) 22.5t (38-40/44t) @ 14500         TA (b) 18t (38-40/44t) @ 15000
DA 19t (33t restrict) @ 14750            DA 19t (33t restrict) @ 14750
DA 19t (33t restrict) @ 14500            DA 18t (25t restrict) @ 14750
DA 18t (25t restrict) @ 14750            DA 18t (25t restrict) @ 14500
SA:10.5t (17t-33t restrict) @ 15000      SA:9t (13t restrict) @ 15000
SA:7t (10t restrict) @ 14500             SA:5.5t (7.5t restrict) @ 3000
SA:2t (3t restrict) @ 3000
```

PAINTERS BRIDGE – MULTI ANALYSIS

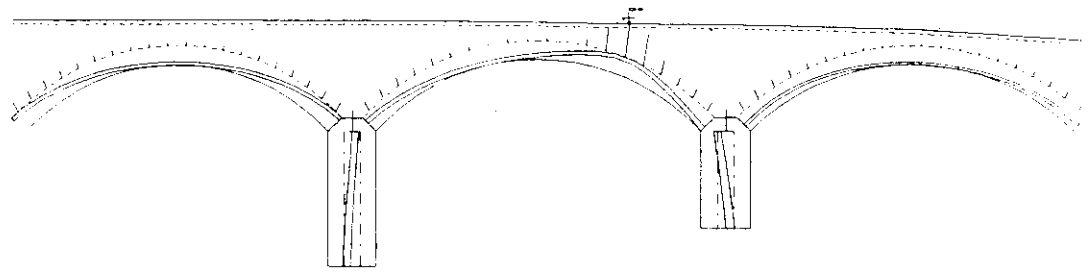
11.5t Single Axle – FAILS



10.5t Single Axle – FAILS



9t Single Axle – PASSES



Centroid of thrust lines within middle third of piers ∴ passes.

9f Single Axle - Tabulated Results – NO TENSION - PROOF

HIT ENTER TO CONTINUE

Left H kN	Span V kN	No	Pier Force	Right H kN	span V kN	Offset from L	Load kN	E kN/mm^2	σB kN/m^2
170	147	1	0	197	171	455	446	688	102
181	249	2	0	123	136	715	485	172	637

No tension ∴ Passes

Abutment reactions

Left H = 169 kN V = 148 kN at 455 mm from springing.

Right H = 128 kN V = 126 kN at 196 mm from springing.

WS/Atkins

CALCULATION INDEX

PROJECT: ECC ASSESSMENT CONTRACT 2

FILE NAME: PAINTERS BRIDGE - CHECK CALCS.

FILE NO: A118770-62--

C = Calculation
S = Sketch
D = Data

Page

INDEX NO	CALCULATION/SKETCH/DATA	ORIGINATOR	DATE
1	SOUTH ARCH - MEXE	DL	2/00
2	NORTH ARCH - MEXE	DL	2/00
3	CENTRAL ARCH - MEXE	DL	2/00
4-10	NORTH ARCH - ARCHIE	DL	2/00
11-13	CENTRE SPAN - ARCHIE	DL	2/00
14-17	SOUTH SPAN - ARCHIE	DL	2/00
18-27	MULTI ANALYSIS	DL	2/00

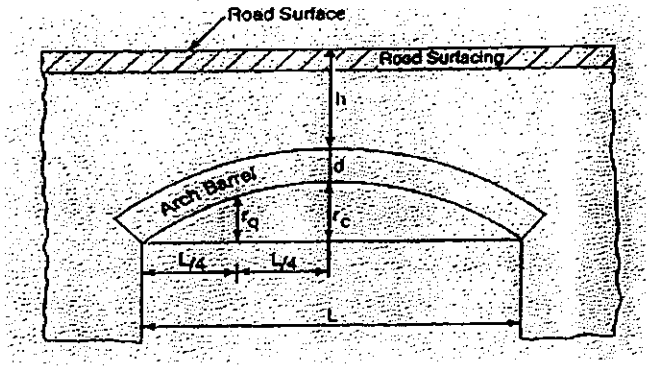
Continued on Sheet

WS/Atkins CHECK 01

ARCH ASSESSMENT TO MODIFIED MEXE (BA 16/97)

Structure Name: Painters Bridge (South Arch.) Skew = 23°
Ref AI 1877/62 use Skew Span (No correction)

1. DIMENSIONS



L = 7.95
rc = 1.659
rq = 1.321
d = .47
h = .43
h + d = .90

2. PROVISIONAL ASSESSMENT LOADING (Fig. 3/1)

PAL = 40.48 Tonne

3. SPAN / RISE FACTOR

$\frac{L}{rc} = \frac{7.95}{1.659} = 4.792$ (Fig. 3/3) Fsr = 0.89

4. PROFILE FACTOR

$\frac{rq}{rc} = \frac{1.321}{1.659} = 0.796$ (Fig. 3/4) Fp = 0.90

5. MATERIAL FACTOR

(Tables 3/1 & 3/2)

$Fm = \frac{(Fb.d) + Ff.h)}{d + h} = \frac{1.0 \times .47 + 0.7 \times .43}{.47 + .43}$ Fm = 0.857

6. JOINT FACTOR

(Tables 3/3, 3/4 & 3/5)

Fj = Fw.Fd.Fmo = 0.9 x 0.9 x 0.9 Fj = 0.729

7. CONDITION FACTOR

(Para. 3.17 to 3.23) Fc = 0.9

8. MODIFIED AXLE LOAD

MAL = PAL x Fsr x Fp x Fm x Fj x Fc MAL = 18.23 Tonne

9. AXLE LIFT-OFF FACTOR

(Fig. 3/5) No uplift. Af = 1.0

10. WEIGHT LIMIT ON ARCH (MAX GROSS VEHICLE WEIGHT)

(Table 3/6) 40/44 Tonne

11. CONCLUSIONS:

[redacted]

~~Assessed~~ Checked By:

Signed:

Date: 7/2/00

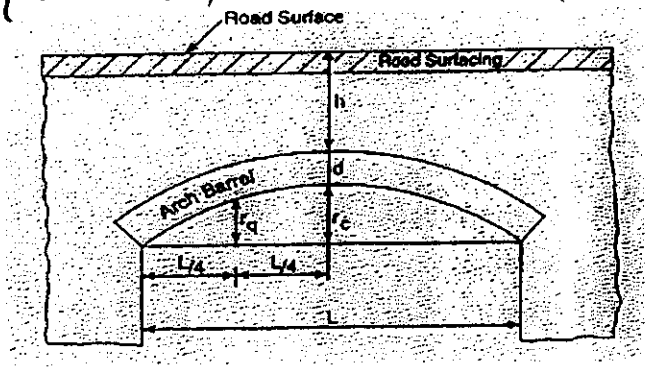
WS/Atkins

02

ARCH ASSESSMENT TO MODIFIED MEXE (BA 16/97)

Structure Name: Painters Bridge (North Arch)
Ref AI 1877/62 (use skew span no correction)

1. DIMENSIONS



L = 7.486
rc = 1.667
rq = 1.340
d = 0.480
h = 0.645
h + d = 1.125

2. PROVISIONAL ASSESSMENT LOADING (Fig. 3/1)

PAL = 68.39 Tonne

3. SPAN / RISE FACTOR

$\frac{L}{rc} = \frac{7.486}{1.667} = 4.49$ (Fig. 3/3) Fsr = 0.925

4. PROFILE FACTOR

$\frac{rq}{rc} = \frac{1.340}{1.667} = 0.804$ (Fig. 3/4) Fp = 0.88

5. MATERIAL FACTOR

(Tables 3/1 & 3/2)

$Fm = \frac{(Fb.d) + Ff.h)}{d + h} = \frac{1.0 \times 0.9 + 0.7 \times 0.645}{0.48 + 0.645}$ Fm = 1.20

6. JOINT FACTOR

(Tables 3/3, 3/4 & 3/5)

Fj = Fw.Fd.Fmo = 0.9 x 0.9 x 0.9 Fj = 0.729

7. CONDITION FACTOR

(Para. 3.17 to 3.23) Fc = 0.85

8. MODIFIED AXLE LOAD

MAL = PAL x Fsr x Fp x Fm x Fj x Fc

MAL = 41.39 Tonne

9. AXLE LIFT-OFF FACTOR

No Lift Off.

(Fig. 3/5) Af = 1

10. WEIGHT LIMIT ON ARCH (MAX GROSS VEHICLE WEIGHT)

(Table 3/6) 40/44 Tonne

Annex 4 Ring separation $R_{+} = 1.02 \times 1 = 0.8$

11. CONCLUSIONS:

[redacted] ration (One Number)

Checked

Assessed By: [redacted] Date: 7/2/09

Signed: [redacted]

WS/Atkins

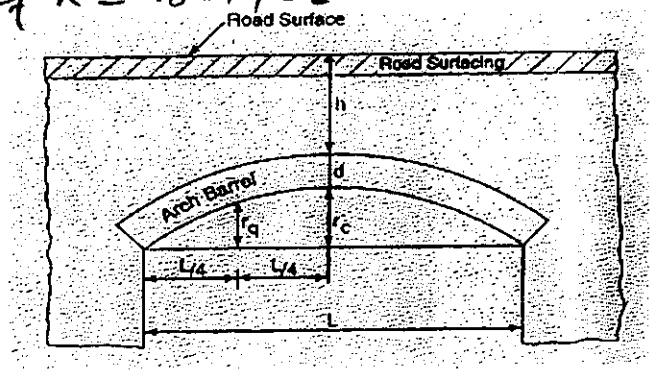
03

ARCH ASSESSMENT TO MODIFIED MEXE (BA 16/97)

Structure Name: Painters' Bridge (Central Arch) (Use skew span no correction)

Ref AI 1877/62

1. DIMENSIONS



L = 8.11
rc = 1.786
rq = 1.389
d = 0.47
h = 0.475
h + d = 0.945

2. PROVISIONAL ASSESSMENT LOADING (Fig. 3/1)

PAL = 43.49 Tonne

3. SPAN / RISE FACTOR

$\frac{L}{rc} = \frac{8.11}{1.786} = 4.54$ (Fig. 3/3) Fsr = 0.92

4. PROFILE FACTOR

$\frac{rq}{rc} = \frac{1.389}{1.786} = 0.778$ (Fig. 3/4) Fp = 0.93

5. MATERIAL FACTOR

(Tables 3/1 & 3/2)

$Fm = \frac{(Fb.d) + Ff.h)}{d + h} = \frac{1.0 \times .47 + 0.7 \times 0.475}{0.47 + 0.475}$ Fm = 0.849

6. JOINT FACTOR

(Tables 3/3, 3/4 & 3/5)

Fj = Fw.Fd.Fmo = 0.9 x 0.8 x 0.9 Fj = 0.648

7. CONDITION FACTOR

(Para. 3.17 to 3.23)

Fc = 0.95

8. MODIFIED AXLE LOAD

MAL = PAL x Fsr x Fp x Fm x Fj x Fc

MAL = 19.45 Tonne

9. AXLE LIFT-OFF FACTOR

(Fig. 3/5) No Lift off

Af = 1.0

10. WEIGHT LIMIT ON ARCH (MAX GROSS VEHICLE WEIGHT)

(Table 3/6)

40/44 Tonne

11. CONCLUSION

[redacted]

~~Assessed~~ Checked By:

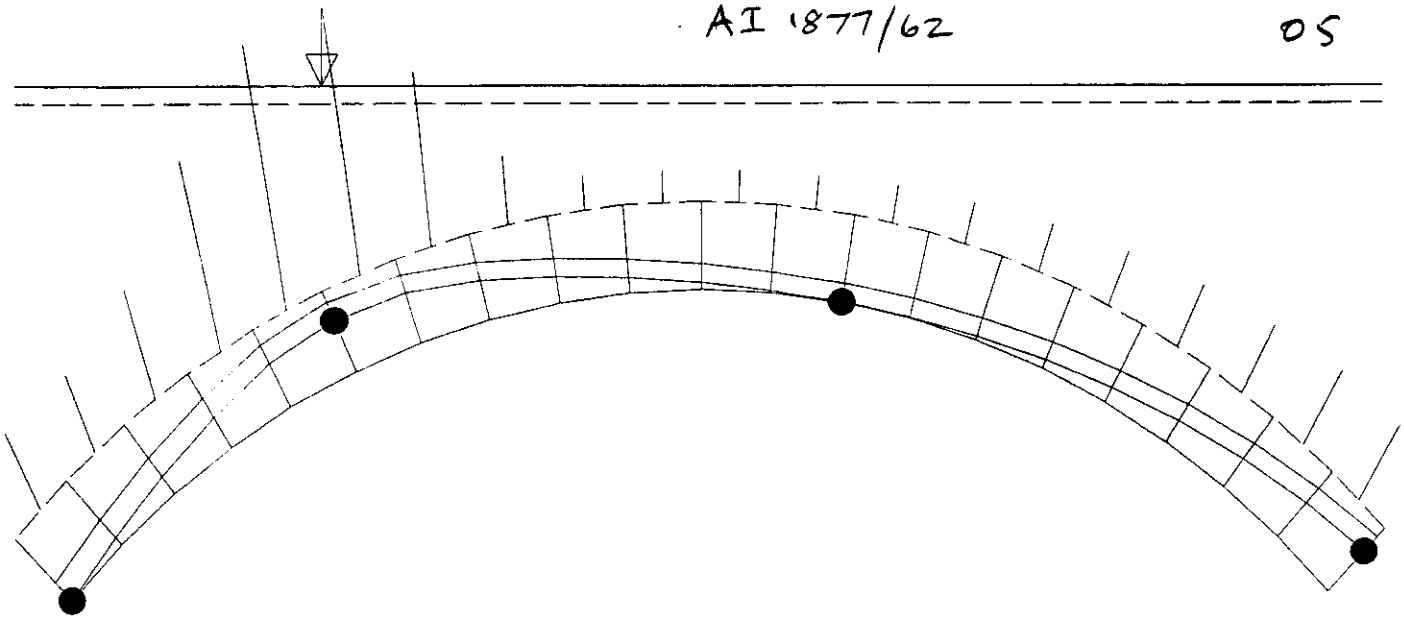
Signed:

Date: 7/2/00

WS Atkins	Project ECC CONTRACT 3 PAINTERS BRIDGE			Job ref AI/1677/62
	Part of structure "ARCHIE"			Calc sheet no 104 rev /
	Drawing ref	Calc by	Date	Check by RTL Date 9/2/00

Ref	Calculations	Output
	North Span. Full nr quadrant pr = 111.8 nr. Lane width = 1.8 + 1.5 + 111.8 = 4.418 m. Factor Lane width by Condition and Joint factors Fc = 0.85 Fj = 0.729 Give Lane Width ⇒ 2.738 m FOR RING SEPARATION Assume Annex G of BA 16/97 is applicable For 4 Ring 1 separated Reduction factor = 1.0 − 0.2×1 = 0.8 Give Lane Width ⇒ 2.190 m For 4 Ring 2 separated Reduction factor = 1.0 − 0.2×2 = 0.6 Give Lane width ⇒ 1.643 m. * 16 has been assumed that only ONE heavy load can be present on the width of the bridge as there is only approx 2.8 m of metalled C'way and approx 2No 2 m soft verges.	

AI 1877/62 05



62north

()

Span	7486 mm	Rise	1667 mm
Depth of fill	637 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 1500		
Lane width	2738mm		
Required ring depth	417 mm	Geometric F.O.S	1.15 Passes
H Left	186 kN/m	H Right	194 kN/m
V Left	267 kN/m	V Right	167 kN/m
Comp. zone at hinge 2	111 mm	Factor on pass. press.	.3

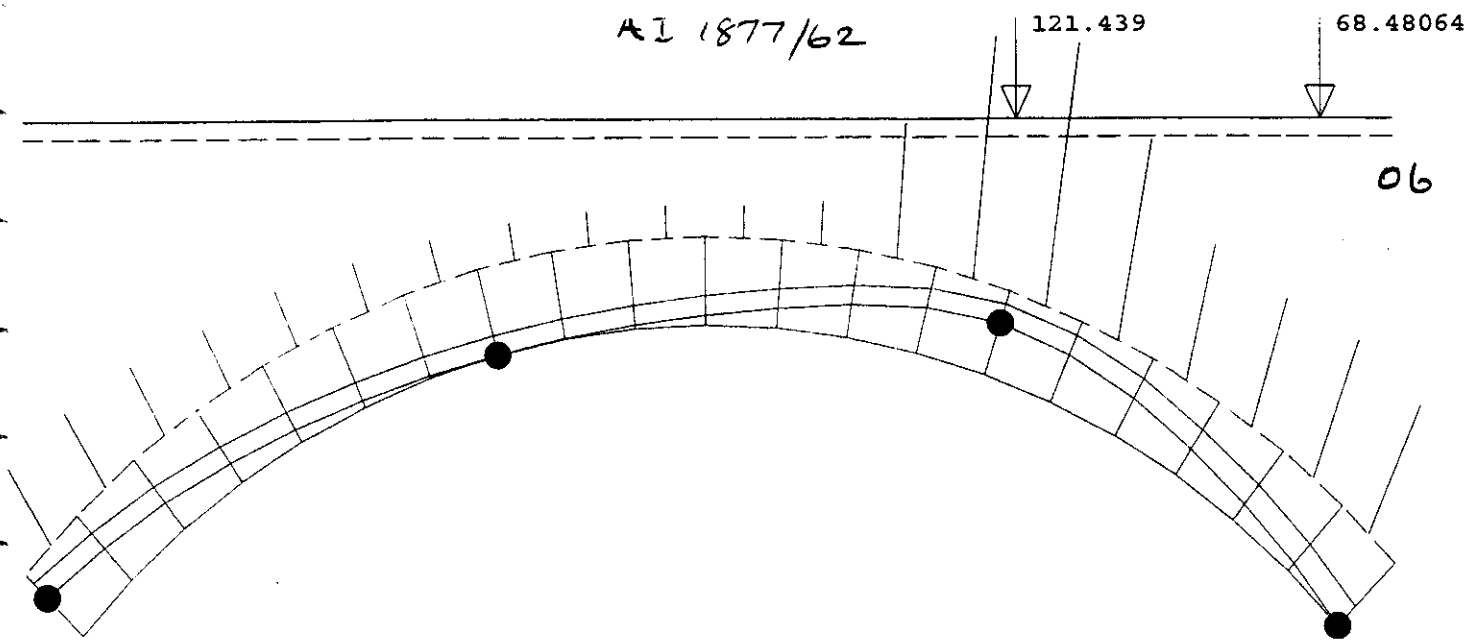
Hinges

1 AT 1	2 AT 6	3 AT 13	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	0
2	-5	-13.8	6	-.4	.1	0
3	-5	-12.6	4.6	-7.3	1.8	0
4	-5	-11.4	3.4	-23.4	4.7	0
5	-5	-10.1	2.5	-38.6	6.4	0
6	-5	-8.9	1.8	-40	5.3	0
7	-5	-7.8	1.2	-24.4	2.5	0
8	-5	-7	.7	-5.6	.4	0
9	-5	-6.4	.4	0	0	0
10	-5	-6	.1	0	0	0
11	-5	-6	-.1	0	0	0
12	-5	-6.4	-.4	0	0	-.2
13	-5	-6.9	-.7	0	0	-.6
14	-5	-7.8	-1.2	0	0	-.9
15	-5	-8.8	-1.7	0	0	-1.3
16	-5	-10	-2.5	0	0	-1.7
17	-5	-11.3	-3.4	0	0	-2.1
18	-5	-12.5	-4.6	0	0	-2.2
19	-5	-13.7	-5.9	0	0	-2.1
20	-4.9	-14	-7.1	0	0	-1.3

AI 1877/62



62north

()

Span	7486 mm	Rise	1667 mm
Depth of fill	637 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20t:Left Heavy at 6250		
Lane width	2738mm		
Required ring depth	413 mm	Geometric F.O.S	1.16 Passes
H Left	205 kN/m	H Right	191 kN/m
V Left	173 kN/m	V Right	291 kN/m
Comp. zone at hinge 2	116 mm	Factor on pass. press.	.3

Hinges

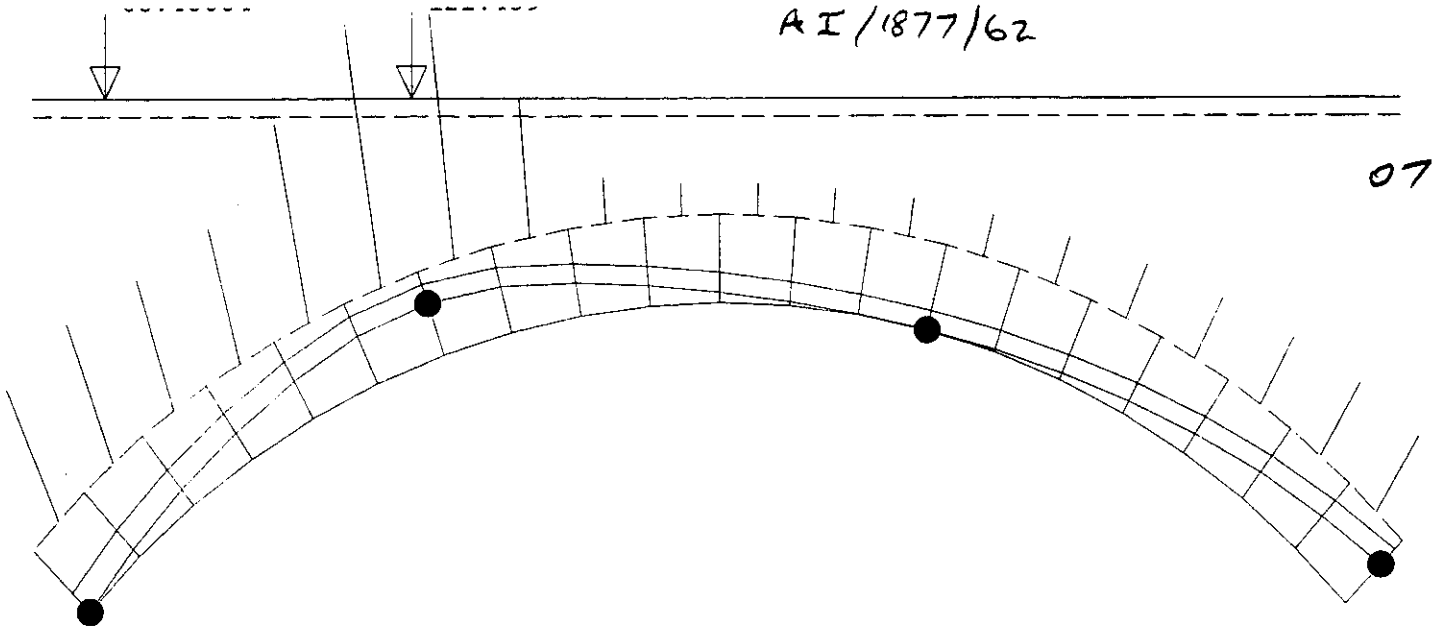
1 AT 1	2 AT 8	3 AT 15	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	1.5
2	-5	-13.8	6	0	0	2.3
3	-5	-12.6	4.6	0	0	2.5
4	-5	-11.4	3.4	0	0	2.3
5	-5	-10.1	2.5	0	0	1.8
6	-5	-8.9	1.8	0	0	1.4
7	-5	-7.8	1.2	0	0	.9
8	-5	-7	.7	0	0	.4
9	-5	-6.4	.4	0	0	.1
10	-5	-6	.1	0	0	0
11	-5	-6	-.1	0	0	0
12	-5	-6.4	-.4	-1.8	-.1	0
13	-5	-6.9	-.7	-17.9	-1.3	0
14	-5	-7.8	-1.2	-36.9	-3.7	0
15	-5	-8.8	-1.7	-39.5	-5.2	0
16	-5	-10	-2.5	-26.7	-4.4	0
17	-5	-11.3	-3.4	-13.7	-2.8	0
18	-5	-12.5	-4.6	-11.4	-2.8	0
19	-5	-13.7	-5.9	-11.8	-3.4	0
20	-4.9	-14	-7.1	-10	-3.4	0

AI/1877/62

07



62north

()

Span	7486 mm	Rise	1667 mm
Depth of fill	637 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20t:Right Heavy at 1250		
Lane width	2738mm		
Required ring depth	415 mm	Geometric F.O.S	1.16
H Left	192 kN/m	H Right	206 kN/m
V Left	292 kN/m	V Right	173 kN/m
Comp. zone at hinge 2	116 mm	Factor on pass. press.	.3

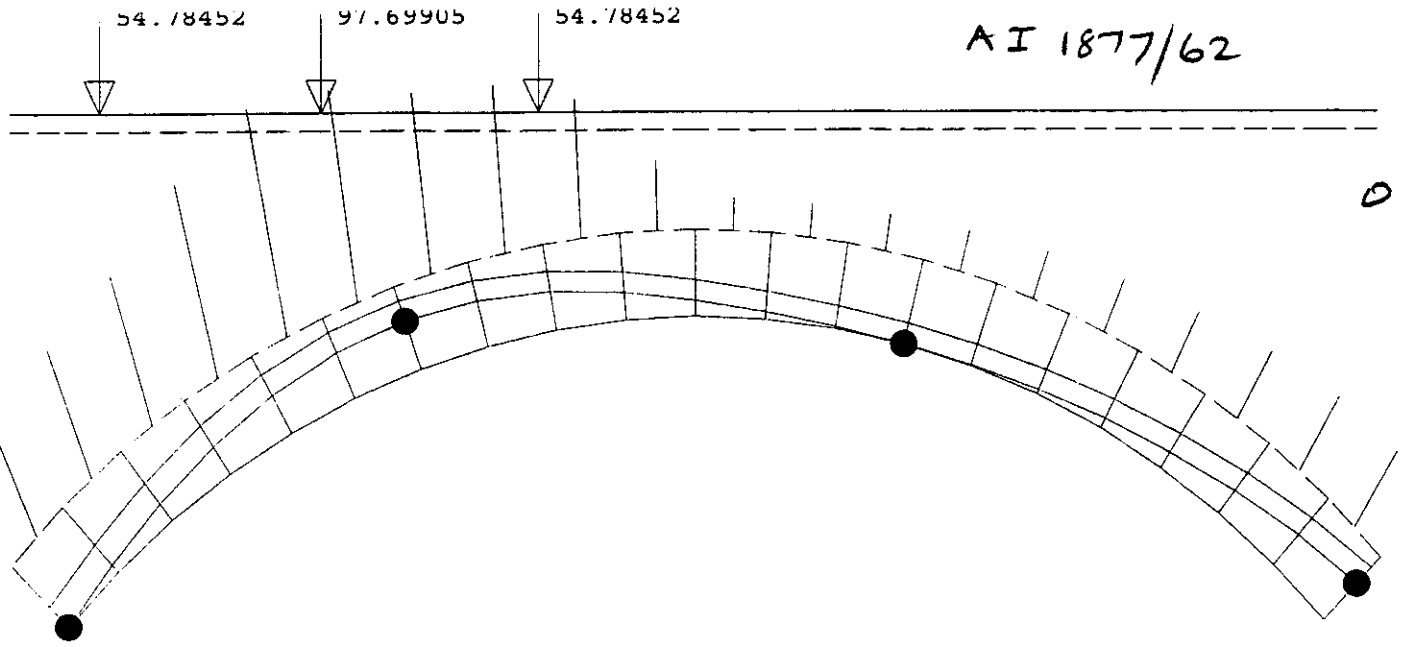
Passes

Hinges

1 AT 1	2 AT 7	3 AT 14	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	-9.9	3.4	0
2	-5	-13.8	6	-11.8	3.4	0
3	-5	-12.6	4.6	-11.4	2.8	0
4	-5	-11.4	3.4	-13.5	2.7	0
5	-5	-10.1	2.5	-26.2	4.3	0
6	-5	-8.9	1.8	-39.3	5.2	0
7	-5	-7.8	1.2	-37.3	3.8	0
8	-5	-7	.7	-18.6	1.3	0
9	-5	-6.4	.4	-2.1	.1	0
10	-5	-6	.1	0	0	0
11	-5	-6	-.1	0	0	0
12	-5	-6.4	-.4	0	0	-.1
13	-5	-6.9	-.7	0	0	-.4
14	-5	-7.8	-1.2	0	0	-.9
15	-5	-8.8	-1.7	0	0	-1.4
16	-5	-10	-2.5	0	0	-1.8
17	-5	-11.3	-3.4	0	0	-2.2
18	-5	-12.5	-4.6	0	0	-2.5
19	-5	-13.7	-5.9	0	0	-2.3
20	-4.9	-14	-7.1	0	0	-1.5



AI 1877/62

08

62north

()

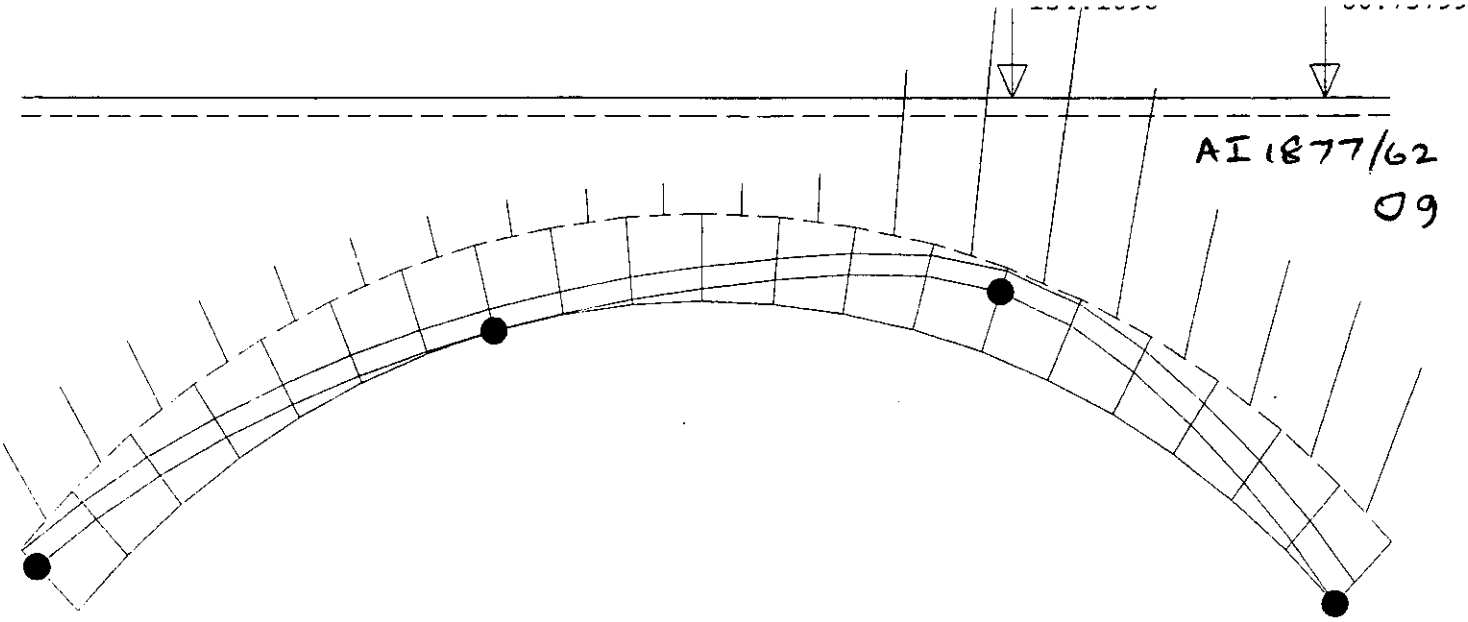
Span	7486 mm	Rise	1667 mm
Depth of fill	637 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Triple Axle:24t:No Lift-off at 1500		
Lane width	2738mm		
Required ring depth	403 mm	Geometric F.O.S	1.19 Passes
H Left	206 kN/m	H Right	221 kN/m
V Left	307 kN/m	V Right	183 kN/m
Comp. zone at hinge 2	124 mm	Factor on pass. press.	.3

Hinges

1 AT 1	2 AT 7	3 AT 14	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	-7.8	2.7	0
2	-5	-13.8	6	-10	2.9	0
3	-5	-12.6	4.6	-14.9	3.6	0
4	-5	-11.4	3.4	-24.4	4.9	0
5	-5	-10.1	2.5	-31.8	5.2	0
6	-5	-8.9	1.8	-30	3.9	0
7	-5	-7.8	1.2	-25.4	2.6	0
8	-5	-7	.7	-23.7	1.7	0
9	-5	-6.4	.4	-19.2	.8	0
10	-5	-6	.1	-6.9	.1	0
11	-5	-6	-.1	-.2	0	0
12	-5	-6.4	-.4	0	0	-.1
13	-5	-6.9	-.7	0	0	-.4
14	-5	-7.8	-1.2	0	0	-.9
15	-5	-8.8	-1.7	0	0	-1.4
16	-5	-10	-2.5	0	0	-1.8
17	-5	-11.3	-3.4	0	0	-2.2
18	-5	-12.5	-4.6	0	0	-2.5
19	-5	-13.7	-5.9	0	0	-2.3
20	-4.9	-14	-7.1	0	0	-1.5



AI 1877/62
09

62north

()

Span	7486 mm	Rise	1667 mm
Depth of fill	637 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20.3t:Left Heavy at 6250		
Lane width	2190mm		
Required ring depth	470 mm	Geometric F.O.S	1.02
H Left	231 kN/m	H Right	211 kN/m
V Left	181 kN/m	V Right	328 kN/m
Comp. zone at hinge 2	127 mm	Factor on pass. press.	.3

Hinges

1 AT 1	2 AT 8	3 AT 15	4 AT 21

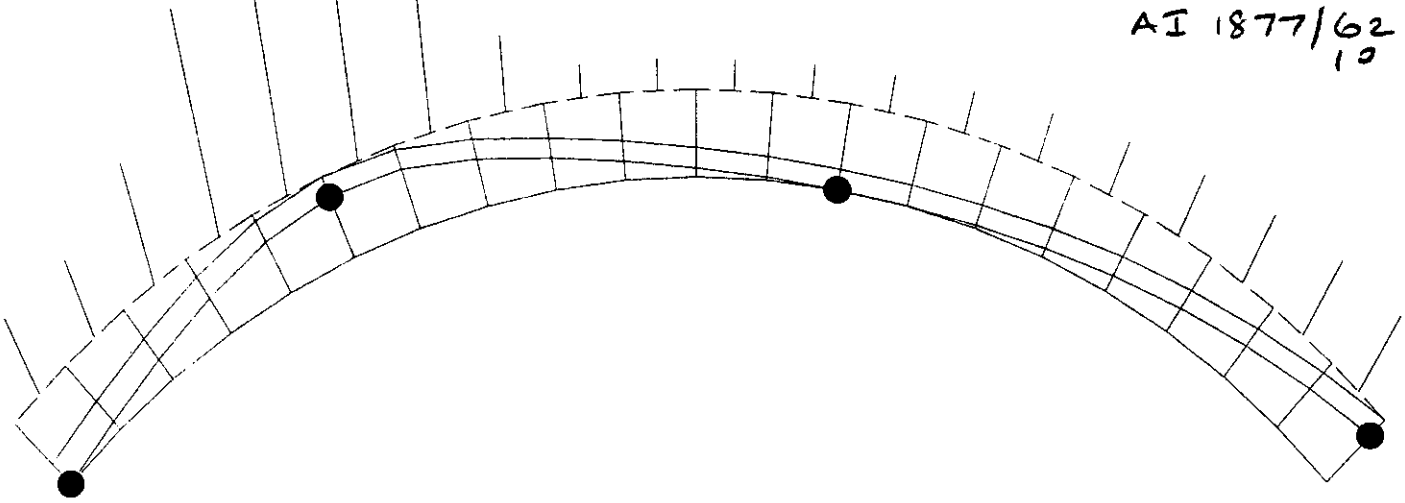
Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	1.5
2	-5	-13.8	6	0	0	2.3
3	-5	-12.6	4.6	0	0	2.5
4	-5	-11.4	3.4	0	0	2.3
5	-5	-10.1	2.5	0	0	1.8
6	-5	-8.9	1.8	0	0	1.4
7	-5	-7.8	1.2	0	0	.9
8	-5	-7	.7	0	0	.4
9	-5	-6.4	.4	0	0	.1
10	-5	-6	.1	0	0	0
11	-5	-6	-.1	0	0	0
12	-5	-6.4	-.4	-2.6	-.1	0
13	-5	-6.9	-.7	-23.7	-1.7	0
14	-5	-7.8	-1.2	-47.5	-4.8	0
15	-5	-8.8	-1.7	-49.7	-6.6	0
16	-5	-10	-2.5	-32.5	-5.4	0
17	-5	-11.3	-3.4	-16.2	-3.3	0
18	-5	-12.5	-4.6	-14	-3.4	0
19	-5	-13.7	-5.9	-14.8	-4.2	0
20	-4.9	-14	-7.1	-12.7	-4.3	0

4 Rings One Separated.

182.3708 kN/m = 7 × 4.81 × 3.4 / 1.645 — Effective Lane Width

AI 1877/62
10



62north

()

Span	7486 mm	Rise	1667 mm
Depth of fill	637 mm	Depth of surfacing	100 mm
Ring depth	480 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	SA (13t rest) at 1500		
Lane width	1645mm		
Required ring depth	481 mm	Geometric F.O.S	1 Passes
H Left	206 kN/m	H Right	221 kN/m
V Left	303 kN/m	V Right	174 kN/m
Comp. zone at hinge 2	121 mm	Factor on pass. press.	.3

Hinges

1 AT 1	2 AT 6	3 AT 13	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-4.9	-14.1	7.2	0	0	0
2	-5	-13.8	6	-.5	.1	0
3	-5	-12.6	4.6	-9.5	2.3	0
4	-5	-11.4	3.4	-30.6	6.2	0
5	-5	-10.1	2.5	-50.5	8.3	0
6	-5	-8.9	1.8	-52.2	6.9	0
7	-5	-7.8	1.2	-31.8	3.2	0
8	-5	-7	.7	-7.3	.5	0
9	-5	-6.4	.4	0	0	0
10	-5	-6	.1	0	0	0
11	-5	-6	-.1	0	0	0
12	-5	-6.4	-.4	0	0	-.2
13	-5	-6.9	-.7	0	0	-.6
14	-5	-7.8	-1.2	0	0	-.9
15	-5	-8.8	-1.7	0	0	-1.3
16	-5	-10	-2.5	0	0	-1.7
17	-5	-11.3	-3.4	0	0	-2.1
18	-5	-12.5	-4.6	0	0	-2.2
19	-5	-13.7	-5.9	0	0	-2.1
20	-4.9	-14	-7.1	0	0	-1.3

4 Rings — 2 Separated

WS/Atkins	Project ECC CONTRACT 3 PAINTERS BRIDGE			Job ref AI/1877/6
	Part of structure "ARCH 1 E"			Calc sheet no / 11 / rev
	Drawing ref	Calc by	Date	Check by BHC / Date 9/2/0

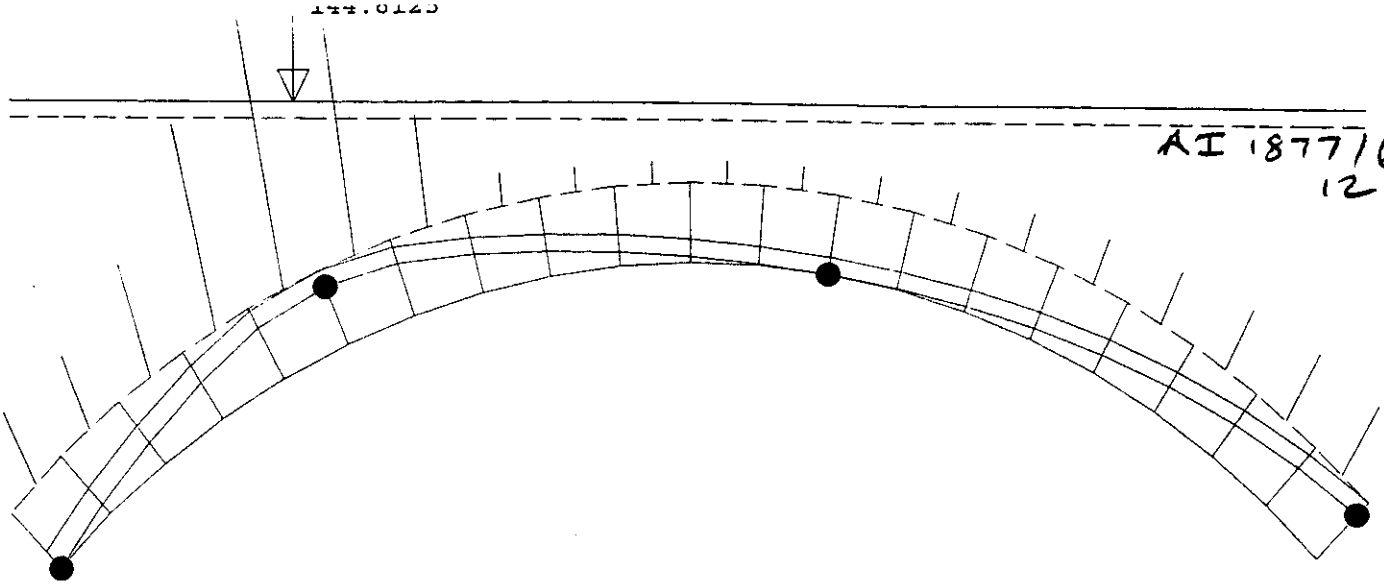
Ref	Calculations	Output

Centre Span

Full at quarter pt = 998
Lane width = 1.8 + 1.5 + 0.998
= 4.298 m.

Factored Lane width by condition factor + joint factor

FC = 0.95
Fj = 0.648 ⇒ 2.645 m.



AI 1877/62
12

62centr

()

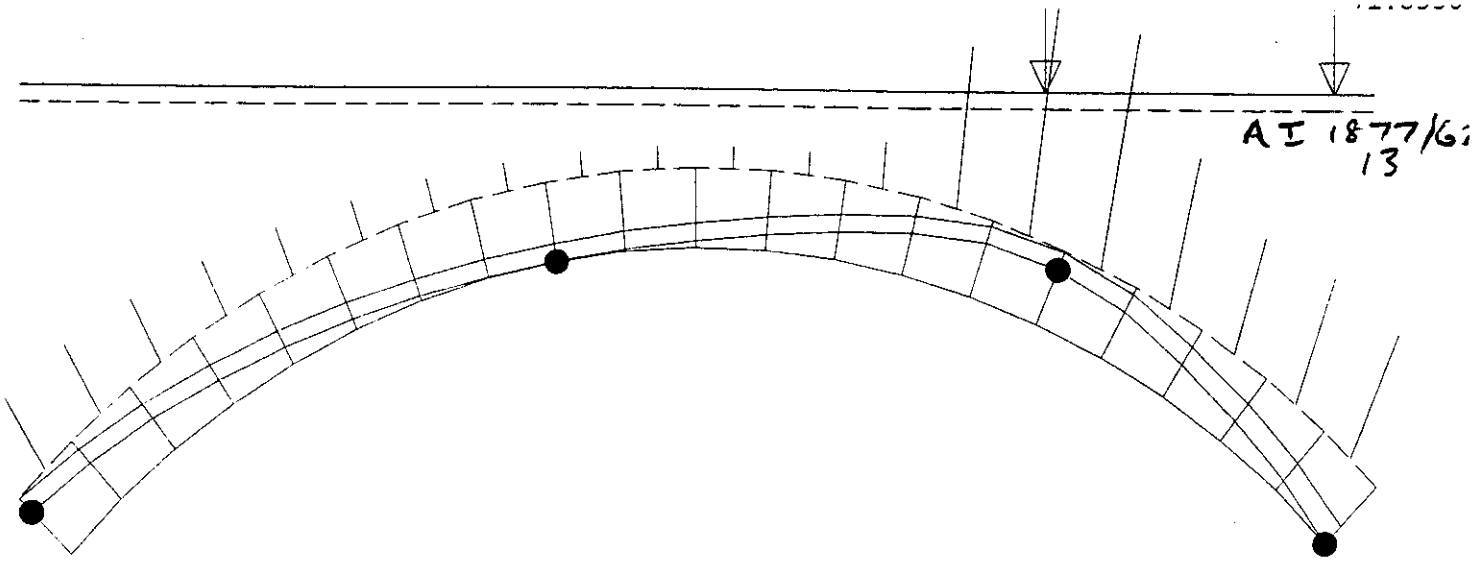
Span	8110 mm	Rise	1786 mm
Depth of fill	469 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 10186		
Lane width	2645mm		
Required ring depth	477 mm	Geometric F.O.S	.99
H Left	180 kN/m	H Right	193 kN/m
V Left	274 kN/m	V Right	162 kN/m
Comp. zone at hinge 2	109 mm	Factor on pass. press.	.3

Hinges

1 AT 1	2 AT 6	3 AT 13	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5.1	-15.1	7.6	0	0	0
2	-5.3	-14.5	6.2	-.6	.2	0
3	-5.3	-13	4.7	-10.5	2.5	0
4	-5.3	-11.4	3.4	-31.1	6.2	0
5	-5.3	-9.9	2.4	-45.9	7.5	0
6	-5.2	-8.4	1.6	-39.3	5.1	0
7	-5.3	-7.1	1.1	-16.2	1.6	0
8	-5.3	-6	.6	-1	.1	0
9	-5.2	-5.3	.3	0	0	0
10	-5.3	-4.9	.1	0	0	0
11	-5.3	-4.8	-.1	0	0	0
12	-5.2	-5.1	-.3	0	0	-.2
13	-5.3	-5.7	-.6	0	0	-.5
14	-5.3	-6.6	-1	0	0	-.8
15	-5.2	-7.8	-1.5	0	0	-1.2
16	-5.3	-9.3	-2.3	0	0	-1.6
17	-5.3	-10.8	-3.2	0	0	-1.9
18	-5.3	-12.3	-4.4	0	0	-2.2
19	-5.3	-13.8	-5.9	0	0	-2
20	-5.1	-14.3	-7.2	0	0	-1.4



AI 1877/6: 13

62centr

()

Span	8110 mm	Rise	1786 mm
Depth of fill	469 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20.3t:Left Heavy at 15686		
Lane width	2645mm		
Required ring depth	465 mm	Geometric F.O.S	1.01
H Left	199 kN/m	H Right	183 kN/m
V Left	169 kN/m	V Right	294 kN/m
Comp. zone at hinge 2	113 mm	Factor on pass. press.	.3

Passed.

Hinges

1 AT 1	2 AT 9	3 AT 16	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5.1	-15.1	7.6	0	0	1.4
2	-5.3	-14.5	6.2	0	0	2.2
3	-5.3	-13	4.7	0	0	2.3
4	-5.3	-11.4	3.4	0	0	2.1
5	-5.3	-9.9	2.4	0	0	1.7
6	-5.2	-8.4	1.6	0	0	1.2
7	-5.3	-7.1	1.1	0	0	.8
8	-5.3	-6	.6	0	0	.5
9	-5.2	-5.3	.3	0	0	.2
10	-5.3	-4.9	.1	0	0	0
11	-5.3	-4.8	-.1	0	0	0
12	-5.2	-5.1	-.3	0	0	0
13	-5.3	-5.7	-.6	-4	-.3	0
14	-5.3	-6.6	-1	-27.2	-2.7	0
15	-5.2	-7.8	-1.5	-45.7	-6	0
16	-5.3	-9.3	-2.3	-39.5	-6.5	0
17	-5.3	-10.8	-3.2	-20.3	-4.1	0
18	-5.3	-12.3	-4.4	-11.5	-2.8	0
19	-5.3	-13.8	-5.9	-12.6	-3.6	0
20	-5.1	-14.3	-7.2	-11.6	-3.9	0

WS/Atkins

Project	Job ref
ECC CONTRACT 3 PAINTERS BRIDGE	AI/1877/62
Part of structure: "ARCHIE"	Calc sheet no / 14 / rev
Drawing ref / Calc by / Date	Check by TL / Date 9/2/00

Ref	Calculations	Output

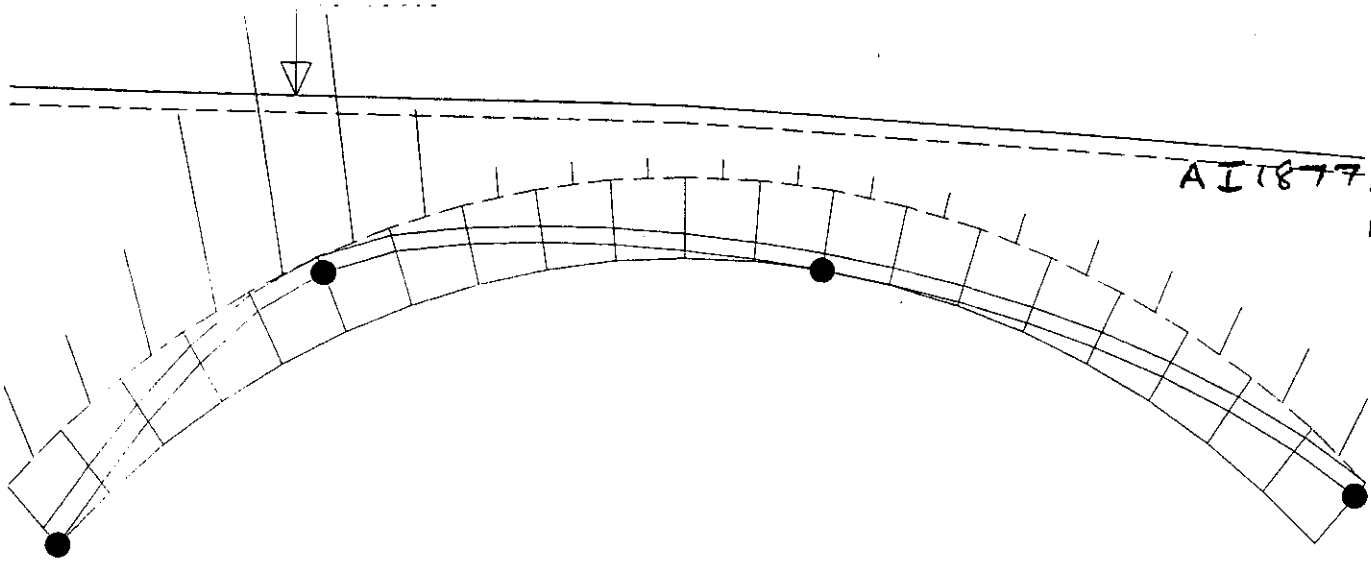
South Span.

Fascia or quarter point = 0.938 m

Lane width = 1.8 + 1.5 + 0.938 = 4.238 m

Factored Lane width by $F_c = 0.9 + F_j = 0.729$

Lane width $\Rightarrow$ 2.781 m.



AI1877/62
15

62south

()

Span	7950 mm	Rise	1659 mm
Depth of fill	420 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Single Axle:11.5t at 19496		
Lane width	2781mm		
Required ring depth	477 mm	Geometric F.O.S	.99
H Left	178 kN/m	H Right	195 kN/m
V Left	256 kN/m	V Right	143 kN/m
Comp. zone at hinge 2	104 mm	Factor on pass. press.	.3

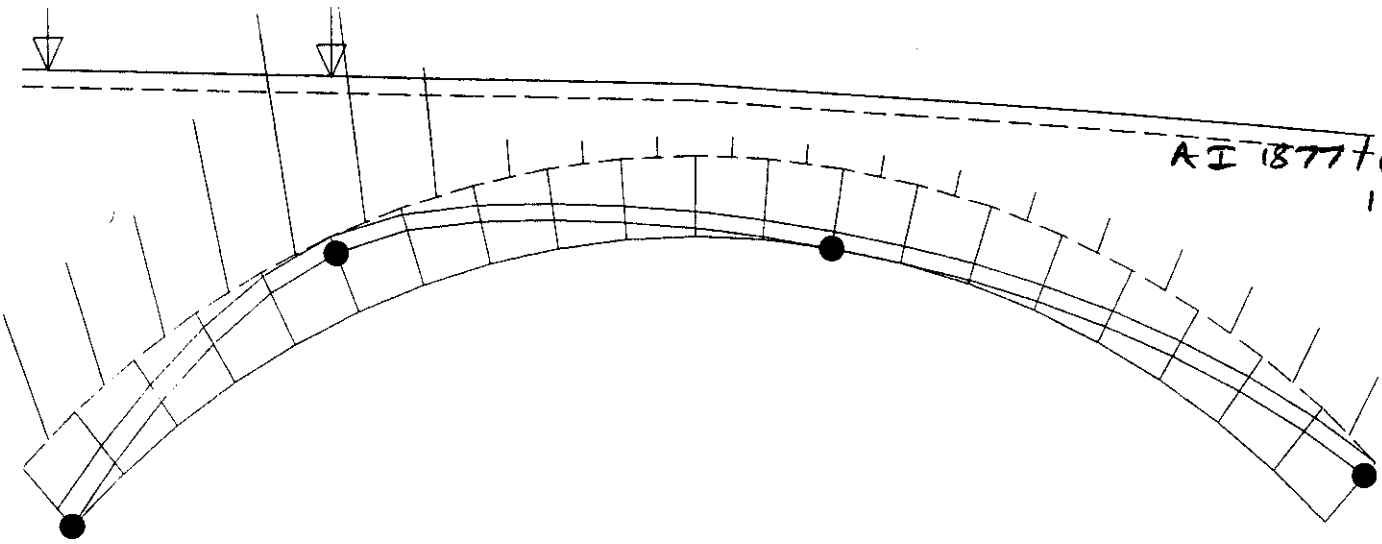
just fails/ passes

Hinges

1 AT 1	2 AT 6	3 AT 13	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5	-14.3	6.7	0	0	0
2	-5.1	-13.6	5.4	-.4	.1	0
3	-5.1	-12.1	4.1	-9.4	2.1	0
4	-5.1	-10.6	3	-29.3	5.5	0
5	-5.1	-9.1	2.1	-44.1	6.9	0
6	-5.1	-7.7	1.4	-38	4.7	0
7	-5.1	-6.4	.9	-15.4	1.4	0
8	-5.1	-5.4	.5	-.9	.1	0
9	-5.1	-4.7	.3	0	0	0
10	-5.1	-4.3	.1	0	0	0
11	-5.1	-4.1	-.1	0	0	0
12	-5.1	-4.1	-.3	0	0	-.1
13	-5.1	-4.5	-.4	0	0	-.4
14	-5.1	-5.1	-.7	0	0	-.6
15	-5.1	-6.1	-1.1	0	0	-.8
16	-5.1	-7.2	-1.7	0	0	-1.1
17	-5.1	-8.4	-2.4	0	0	-1.4
18	-5.1	-9.7	-3.3	0	0	-1.6
19	-5.1	-11	-4.4	0	0	-1.5
20	-5	-11.7	-5.5	0	0	-1



AI 1877/62
16

62south

()

Span	7950 mm	Rise	1659 mm
Depth of fill	420 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Double Axle:20t:Right Heavy at 18996		
Lane width	2781mm		
Required ring depth	473 mm	Geometric F.O.S	.99
H Left	175 kN/m	H Right	197 kN/m
V Left	276 kN/m	V Right	144 kN/m
Comp. zone at hinge 2	105 mm	Factor on pass. press.	.3

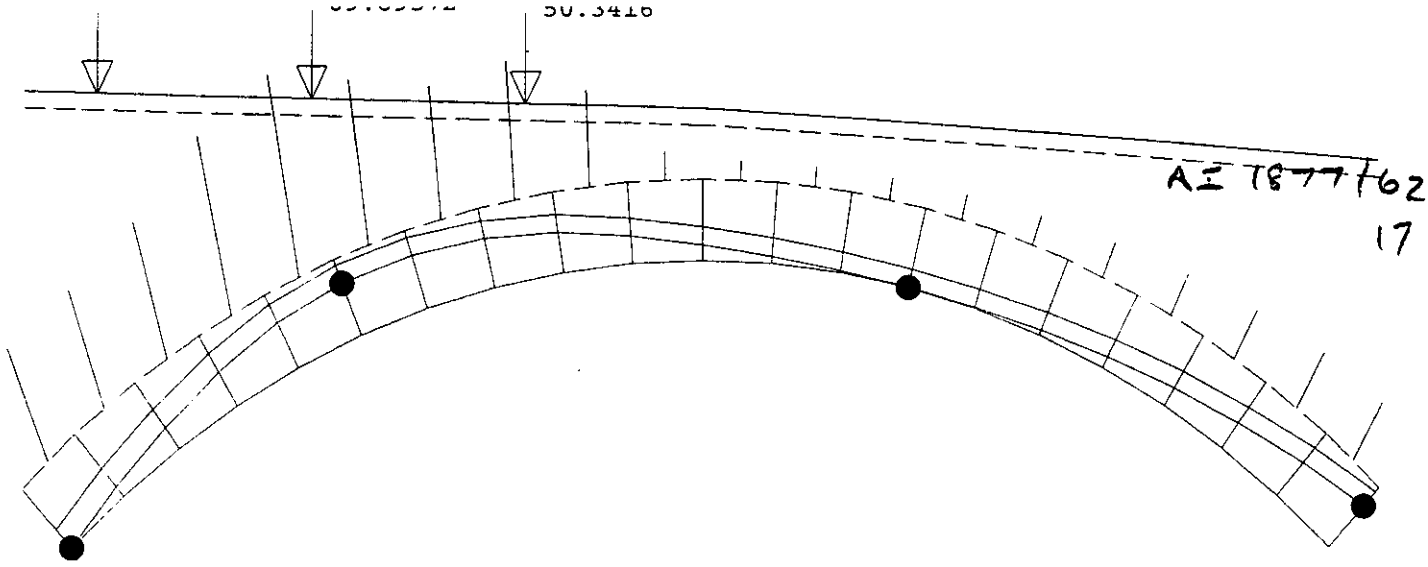
just fails / passes.

Hinges

1 AT 1	2 AT 6	3 AT 13	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5	-14.3	6.7	-10.8	3.4	0
2	-5.1	-13.6	5.4	-11.2	3	0
3	-5.1	-12.1	4.1	-12.3	2.8	0
4	-5.1	-10.6	3	-24.5	4.6	0
5	-5.1	-9.1	2.1	-39.2	6.1	0
6	-5.1	-7.7	1.4	-38.8	4.8	0
7	-5.1	-6.4	.9	-19.8	1.9	0
8	-5.1	-5.4	.5	-2.2	.1	0
9	-5.1	-4.7	.3	0	0	0
10	-5.1	-4.3	.1	0	0	0
11	-5.1	-4.1	-.1	0	0	0
12	-5.1	-4.1	-.3	0	0	-.1
13	-5.1	-4.5	-.4	0	0	-.4
14	-5.1	-5.1	-.7	0	0	-.6
15	-5.1	-6.1	-1.1	0	0	-.8
16	-5.1	-7.2	-1.7	0	0	-1.1
17	-5.1	-8.4	-2.4	0	0	-1.4
18	-5.1	-9.7	-3.3	0	0	-1.6
19	-5.1	-11	-4.4	0	0	-1.5
20	-5	-11.7	-5.5	0	0	-1



62south

()

Span	7950 mm	Rise	1659 mm
Depth of fill	420 mm	Depth of surfacing	100 mm
Ring depth	470 mm	Ring depth factor	1
Position of backing	0	Depth of mortar loss	0 mm
Fill density	19.6 kN/m^3	Masonry density	23.5 kN/m^3
Surfacing density	24 kN/m^3		
Phi for fill	30 deg	Masonry strength	2.3 N/mm^2
Load	Triple Axle:22.5t:No Lift-off at 19496		
Lane width	2781mm		
Required ring depth	437 mm	Geometric F.O.S	1.08
H Left	193 kN/m	H Right	214 kN/m
V Left	284 kN/m	V Right	155 kN/m
Comp. zone at hinge 2	114 mm	Factor on pass. press.	.3

Passed

Hinges

1 AT 1	2 AT 6	3 AT 14	4 AT 21

Param(mn).segment

	Stone Weight	Vertical Dead Load	Horizontal Deadload	Vertical Live Load	Horizontal Live Load	Additional Pass Press
1	-5	-14.3	6.7	-8.3	2.6	0
2	-5.1	-13.6	5.4	-10.1	2.7	0
3	-5.1	-12.1	4.1	-15.3	3.4	0
4	-5.1	-10.6	3	-25.6	4.8	0
5	-5.1	-9.1	2.1	-31.8	4.9	0
6	-5.1	-7.7	1.4	-25.8	3.2	0
7	-5.1	-6.4	.9	-20.7	1.9	0
8	-5.1	-5.4	.5	-22.8	1.5	0
9	-5.1	-4.7	.3	-15.1	.6	0
10	-5.1	-4.3	.1	-1.7	0	0
11	-5.1	-4.1	-.1	0	0	0
12	-5.1	-4.1	-.3	0	0	-.1
13	-5.1	-4.5	-.4	0	0	-.3
14	-5.1	-5.1	-.7	0	0	-.6
15	-5.1	-6.1	-1.1	0	0	-.9
16	-5.1	-7.2	-1.7	0	0	-1.2
17	-5.1	-8.4	-2.4	0	0	-1.5
18	-5.1	-9.7	-3.3	0	0	-1.8
19	-5.1	-11	-4.4	0	0	-1.7
20	-5	-11.7	-5.5	0	0	-1.2

WS Atkins	Project E.C.C. CONTRACT 3			Job ref AI/1877/62
	Part of structure MULTI PAINTERS BRIDGE CHECK			Calc sheet no / 18 / rev
	Drawing ref	Calc by DLC	Date 8/2/03	Check by / Date

Ref	Calculations	Output

It has been assumed that only ONE vehicle (truck) can be present on the width of the bridge as there is only approx 2.8 m of metalled c'way and approx 2 x 2 m soft verges.

From Fig 6.4 For single Veh.

Effective width $= 1.8 + \left(\frac{1.5}{2} + \frac{h}{2}\right)^2$

$= 1.8 + 1.5 + h = 3.9$ m.

Where h is the depth at the axle position

The worst load position is at Ch 14750 for the 13T Restricted case. Here h = 475 + 169 − 20 − 20 say

= 600 say.

For 13T Restriction (9T Axle)

$$\text{Load/m} = \frac{9.0^{T}_{HL} \times 9.81 \times 3.4 \times 2.5}{2.5 \times 0.95 \times 3.9 \times 0.648} = 125 \text{ kN/m}$$

(from; 2 lane width Fj)

Just passes ∴ OK for 13T

WS/Atkins	Project ECC CONTRACT 3			Job ref AI 1877/62
	Part of structure MULTI PAINTER BRIDGE			Calc sheet no / 19 / rev
	Drawing ref	Calc by	Date	Check by BGL / Date 8/2/00

Ref	Calculations	Output

WORST Load Positions for all Loads

SA	10T	at	14750
DA	16.3t	RH at	14750
DA	20.3t	RH at	14750
TA	22.5t	N.L.O.	14750
DA	16t	LH at	15000
DA	18t	LH	14750
DA	20t	LH	15000
TA	24t	NLO	14750 0
SA	10t	restriction	14500
SA	3t	"	3000
DA	16.3t	LH	15000
DA	20.3t	LH	15000
TA	18.0t	NLO	15000
SA	11.5t		15000
DA	16t	RH	14750
DA	18t	RH	14750
AA	20t	RH	14500
SA	13t	Rear	14500
SA	7.5t	Rear	300

Special Loads at 14500

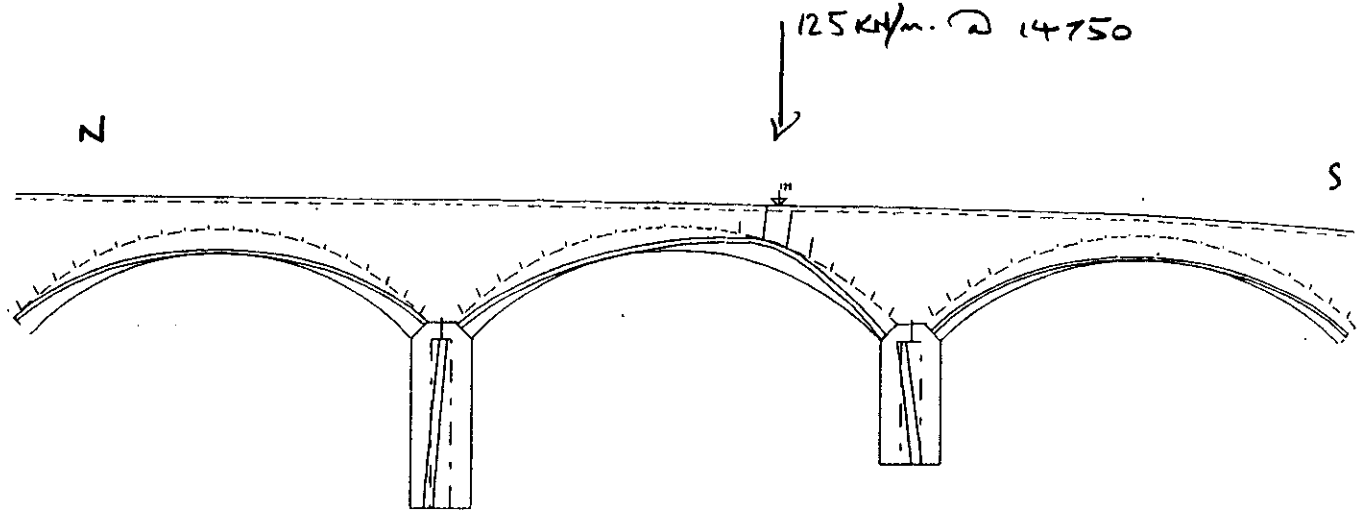
From Multi output using skew dimensions for spans and piers.

AI 1877/62 PAINTERS BRIDGE

CHECK

13T Restriction

MULTI



Checkers Print

[redacted]

20

Thrust lines within middle third.

AI 877/62

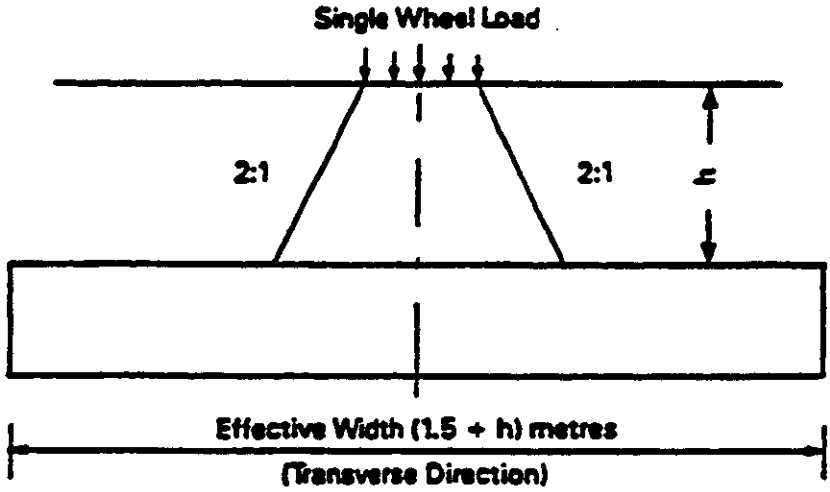


Figure 6.3 Effective Width Under a Wheel Load

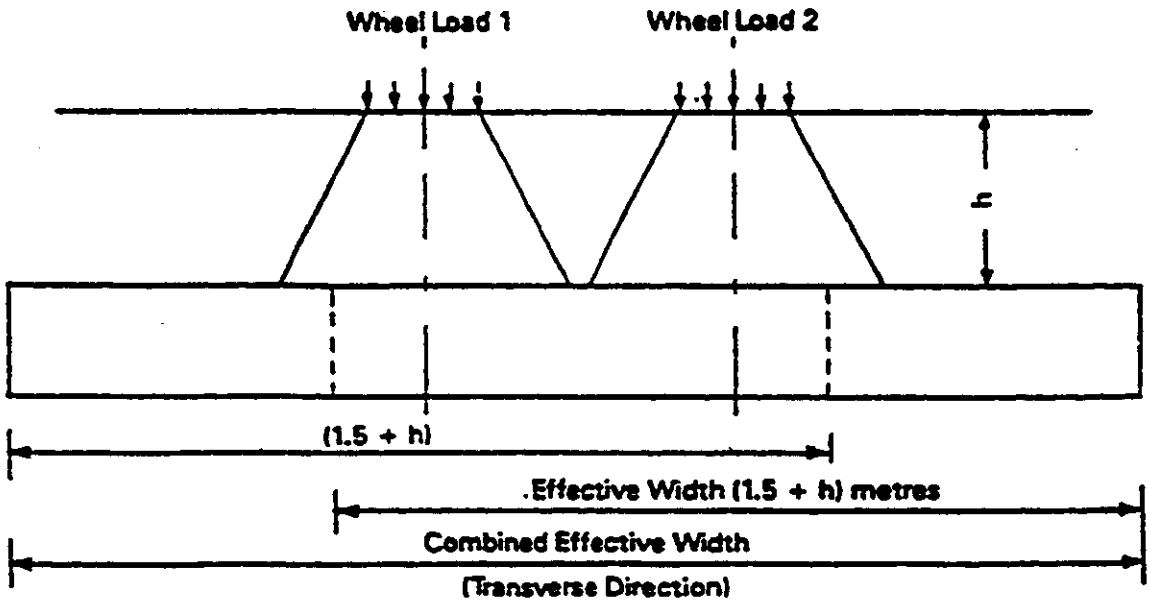


Figure 6.4 Combined Effective Width

Essex County Council
Transportation & Operational Services

[redacted]

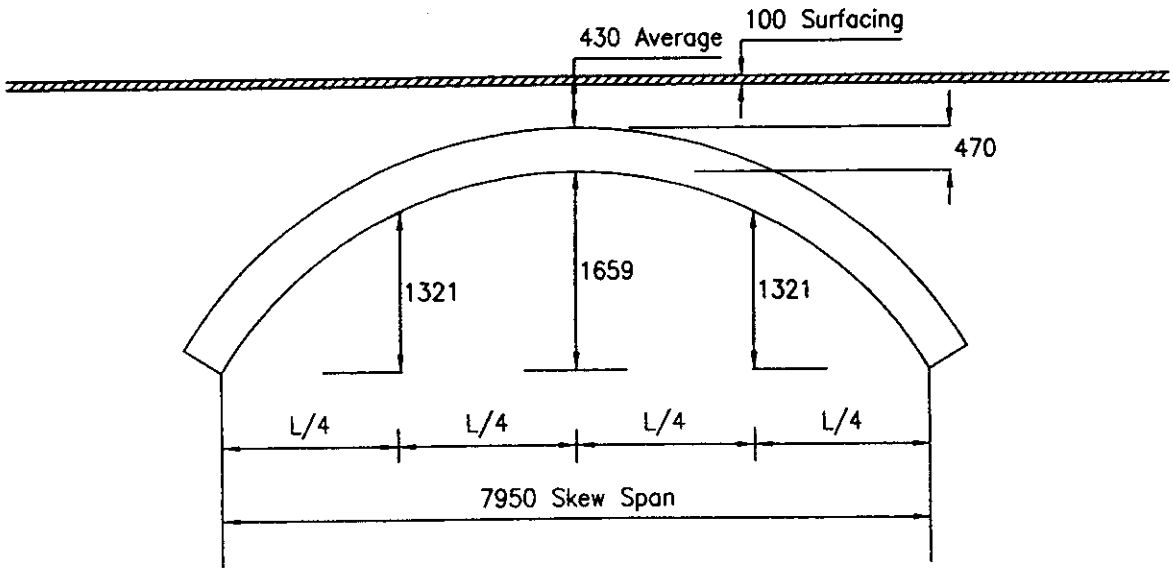
WS Atkins

ECC Bridge No. 1018
Rail Property Board No. AEB/2122

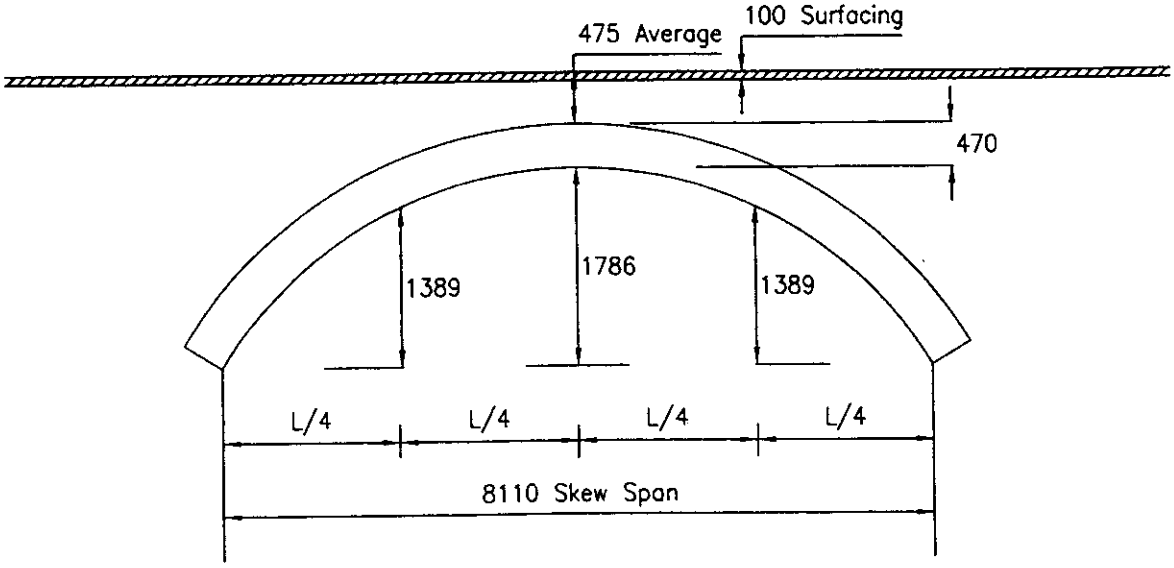
PAINTERS BRIDGE CHECK
TGL 8/2/00

AI/1877/62

22



SOUTH ARCH
N.T.S



CENTRAL ARCH
N.T.S

DRWG.NO. AI1877/DWGS/1018/06	
CAD NO. N:AI1877-66-01	
SCALES N.T.S	
DATE NOV 99	DRAWN/TRACED SD
DATE NOV 99	CHECKED TGL
DATE 7/2/00	AUTHORISED

SCHEME TITLE ECC ASSESSMENT CONTRACT 3
PAINTERS BRIDGE
IDEALISATION DIAGRAM

Essex County Council
Transportation & Operational Services

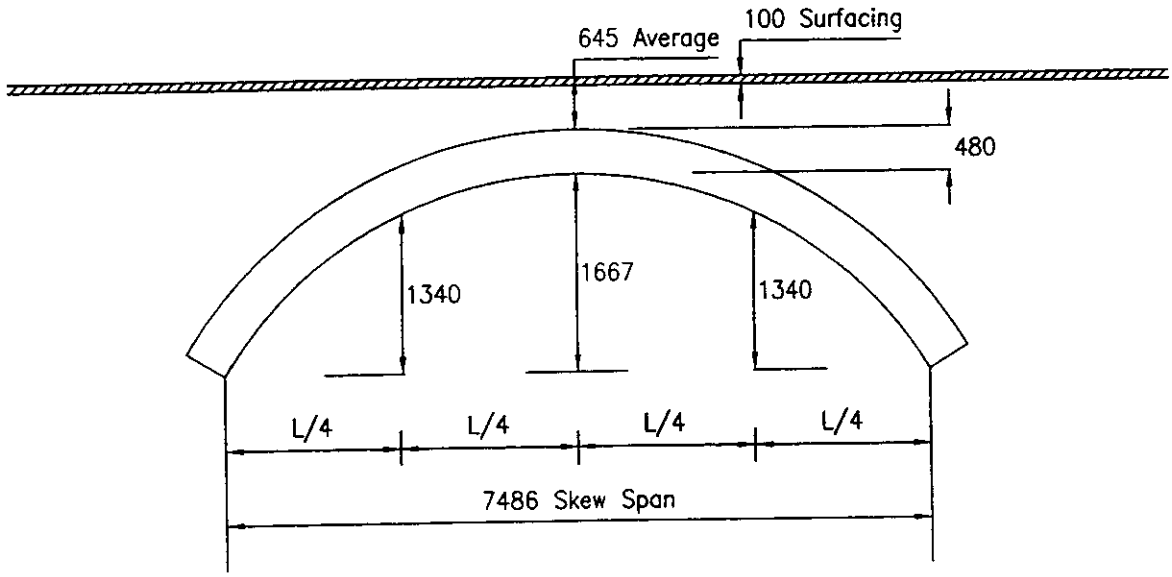
[redacted]

WS Atkins

ECC Bridge No. 1018
Rail Property Board No. AEB/2122

PAINTERS BRIDGE CHECK
AI 1877/62
DYL 8/2/00

23



NORTH ARCH
N.T.S

DRWG.NO. AI1877/DWGS/1018/07	
CAD NO. N:AI1877-66-01	
SCALES N.T.S	
DATE NOV 99	DRAWN/TRACED SD
DATE NOV 99	CHECKED DYL
DATE 7/2/00	AUTHORISED

SCHEME TITLE ECC ASSESSMENT CONTRACT 3
PAINTERS BRIDGE
IDEALISATION DIAGRAM

AI 1877/62

24

62centr.dat

```
62CENTR
 1786
 8110
 20
 470
 1
 0
 23.5
 19.6
 30
 1
 636
 2.3
 8000
 8.686 m
 0
 100
 24
0,0,2773
321,323,2768
669,619,2763
1039,885,2758
1430,1119,2753
1840,1320,2748
2264,1486,2744
2701,1617,2739
3147,1710,2735
3599,1767,2730
4055,1786;2725 -
4511,1767,2715 -
4963,1710,2705 -
5409,1617;2695 -
5846,1486,2690
6270,1320,2685
6680,1119,2680
7071,885,2675
7441,619,2670
7789,323,2665
8110,0,2660
62south
 -3.327
```

1786

1617

> 169 mm difference.

Page 1

Data OK

checked [redacted] 2/00

AI 1877/62

25

62south.dat

```
62SOUTH
 1659
 7950
 20
 470
 1
 0
 23.5
 19.6
 30
 1
 619
 2.3
 8000
 17.996
 0
 100
 24
0,0,2650
323,302,2640
669,577,2630
1036,824,2620
1420,1041,2610
1821,1228,2600
2236,1382,2590
2661,1502,2579
3094,1589,2569
3533,1642,2559
3975,1659,2549
4417,1642,2518
4856,1589,2487
5289,1502,2456
5714,1382,2425
6129,1228,2394
6530,1041,2363
6914,824,2332
7281,577,2301
7627,302,2270
7950,0,2240
*
 -2.407
```


Data OK

Checke[redacted]

RI 1877/62

26

62north.dat

```
62north
 1667
 7486 Skew Span.
 20
 480
 1
 0
 23.5
 19.6
 30
 1
 588
 2.3
 8000
 0
 0
 100
 24
0,0,2792
295,301,2791
614,577,2790
956,825,2789
1316,1044,2789
1694,1231,2788
2087,1387,2787
2490,1509,2786
2903,1596,2785
3322,1649,2784
3743,1667,2784
4164,1649,2783
4583,1596,2782
4996,1509,2781
5399,1387,2780
5792,1231,2779
6170,1044,2778
6530,825,2778
6872,577,2777
7191,301,2776
7486,0,2775
62centr
 0
```


Data OK

Checked [redacted] 100

AI 1877/62

[redacted]

no1	Bridge or arch name
1390	Rise
2780	Span
20	Number of segments
350	Ring thickness
1	Ring thickness factor
5	Backing level
20	Masonry Self weight kN/m^3
18	Fill self weight
35	Φ for fill
1	Passive pressure coefficient (*10)
218	Segment length
3	Masonry strength
8000	A notional E value for later developments
0	Chainage of start of arch in m
1.64	Height of springing in m
100	Surfacing depth
20	Surfacing density
-1390,0,2020	intrados x,y and surface y in mm origin at
-1373,217,2020	centre of span
-1322,430,2020	
-1238,631,2020	
-1125,817,2020	
-983,983,2020	
-817,1125,2020	
-631,1238,2020	
-430,1322,2020	
-217,1373,2020	
0,1390,2020	
217,1373,2020	
430,1322,2020	
631,1238,2020	
817,1125,2020	
983,983,2020	
1125,817,2020	
1238,631,2020	
1322,430,2020	
1373,217,2020	
1390,0,2020	
no2	Next span file name for multi, * for last span
0	Pier base height in m

DATA "CHECK" SHEET

APPENDIX C

APPROVAL IN PRINCIPLE

AND

INSPECTION FOR ASSESSMENT

APPENDIX C

APPROVAL IN PRINCIPLE

AND

INSPECTION FOR ASSESSMENT