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BRB (Residuary) Ltd
Major Works Programme 2004/2007

BE4 ASSESSMENT AND INSPECTION REPORT

A697, WOOLER, NORTHUMBERLAND

BRIDGE REF: AKC/35

May 2007

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Client BRB (Residuary) Ltd

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Contents

1 Introduction

This report outlines the reassessment to BE4 of bridge AKC/35 on the A697 to the south of Wooler in Northumberland. This is a heavily skewed half through bridge with skew span of 32 metres

A BE4 assessment carried out by Carl Bro in 2002 highlighted a number of shortcomings with the structure which appeared contrary to the perceived performance of the bridge These could only be resolved by further site investigation which was eventually included in the 2006/2007 site programme Following this the bridge was reassessed.

Comparisons were made with the previous assessment and explanations given where the results differed significantly Comments made by Northumberland CC in their BD21 assessment were also reviewed

2 General Description and Structural Details

2.1 Location and General Description

Bridge AKC/35 carries the A697 over the track bed of the former Alnwick to Cornhill line to the south of the village of Wooler, Northumberland The track bed is now being used as access to a farm and storage buildings to the east The carriageway is 6 94m wide with a grass verge on the east side and a footway on the west side The footway is 2 235m and the verge 2.3m wide The road is a main through route from the Scottish Borders region to Newcastle and the south and is frequently used by HGVs; estimated frequency is about 30 per hour.

The OS grid reference is NT 998274

2.2 Construction type

The structure is a very highly skewed half through girder bridge. The longitudinally spanning riveted wrought iron edge girders are 2485mm deep and have multiple plate flanges with splice plates The flange plates are configured to take account of the high skew of the bridge (see Appendix G for further details of plate thicknesses and lengths). The girder has stiffeners at 32" centres and every third one is gusseted

The edge girders support 40 No. riveted wrought iron transverse girders of varying length. Due to the large skew, each transverse girder is supported at one end by an edge girders and the other on an abutment The skew is such that no single transverse girder spans between edge girders The transverse girders are not built into the abutments and are simply supported on the bearing shelf (photo 11) The transverse girders are riveted to the web of the edge girders mid way between the stiffeners The eight longest transverse girders (9 4 to 11 4m long) are propped by timber trestles located approximately 2m from the abutment Two trestles support four girders each Each girder is supported by a 14" x 14" timber strut The four columns are diagonally cross-braced and connected by horizontal members at the top and the bottom

Buckle plates span between the transverse girders and are connected to the top flanges by a single line of rivets at 8" centres. The buckle plates are ⅜" thick and rectangular such that they span 52" between the edges of the transverse girders and are 40" wide between connections of adjacent plates They are connected to each other by 6"x 3"x ⅜" tees

The deck plating terminates with a flat plate about 12" wide installed between the inside edge of the main gusset plates and the last buckle plate The flat plate is connected to the buckle plate with a 6"x 3"x ⅜" tee The gaps between the flat plate and the edge girder webs have been infilled with timber planks.

3 Existing Information Search

3.1 Service Search

Documentation obtained by Structural Soils Ltd is included in Appendix B

3.2 SI Results

Two trial pits were excavated as part of the survey located in the east verge at approximately third-span exposing the top of the concrete cover, one above the crown of the buckle plate and one above the adjacent transverse girder

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

3.3 Existing Drawings

There is a detailed historic survey drawing (drawing no B/A697/25/2) which is reproduced in Appendix G and drawings produced by Carl Bro which were used in conjunction with the current survey to confirm the details of the bridge

4 Structure Condition

4.1 General

The inspection for BE4 reassessment was undertaken on Tuesday 7 November 2006 Weather on the day of inspection was cloudy and dry, with temperature about 8C

Parking was available on the grass verge in front of the access road about 10m southeast of the bridge Access to the formation was gained down the access roads southeast and northwest of the bridge The track bed is used as access to the farm to the east All of the bridge could be accessed and the formation was firm and fairly flat

4.2 Main Superstructure

4.2.1 Edge girders

The edge girders are in good condition There are small areas of surface corrosion on the inside face of the web at the level of the timbers however this is deemed to be negligible The protective paint has deteriorated quite extensively throughout the edge girders and there is some yellow staining on the outside face of both girders that could be remnants of an old coating. There are some large bushes growing in the east verge near to the edge girder (photo 2)

4.2.2 Transverse girders

The transverse girders are in a good condition with most of the protective coating intact throughout all the girders. It is estimated that, in the worst case, there is about 20% section loss on the underside of the top flange. This occurs near the joints in the buckle plates and extends about 7" either side of the centreline of the joint (photo 6)

Fig 1· Corroded section of cross girder at centreline of tees

4.2.3 Timber trestles

The eight central transverse girders are supported by two timber trestles (photo 4) each made up of four diagonally braced columns It is not known exactly what grade of timber the columns are but there appear to be very solid, possibly hardwood, with no notching Both trestles are in very good condition with no signs of dampness or decay The columns appear to be carrying load. The deck does not appear to be jacked up over the trestles.

4.2.4 Buckle plates

The buckle plates are in a fair condition The underside of the buckle plates are corroded over an area that slightly extends beyond the area underneath the connecting tees There are calcareous stalactites emanating from the connections in these areas suggesting that seepage through the connections is causing the corrosion (photo 6) The corrosion in this area is estimated to be about 10 to 20% of the buckle plate thickness The rivet heads in these areas are completely corroded All the buckle plates are similar.

The most badly corroded flat plates are in a similar condition to the buckle plates with corrosion at the joints between buckle plates (photo 5, fig 2)

The timber planks that infill the area between inside facing gusset plates are in poor condition on the west side of the bridge In some areas the timber has disintegrated completely and daylight can be seen through the deck from the underside of the bridge (photo 5) It appears that much of the timber has been exposed to weathering from the top This may have happened when the footway was laid Orange plastic mesh fencing has been strung along the inside face of the east girder to stop pedestrians, animals and objects from falling through the gaps (photo 3) On the east side of the bridge the timber was in a good condition where the trial pit was dug. The timber is completely buried under the soil and is probably in a good condition throughout.

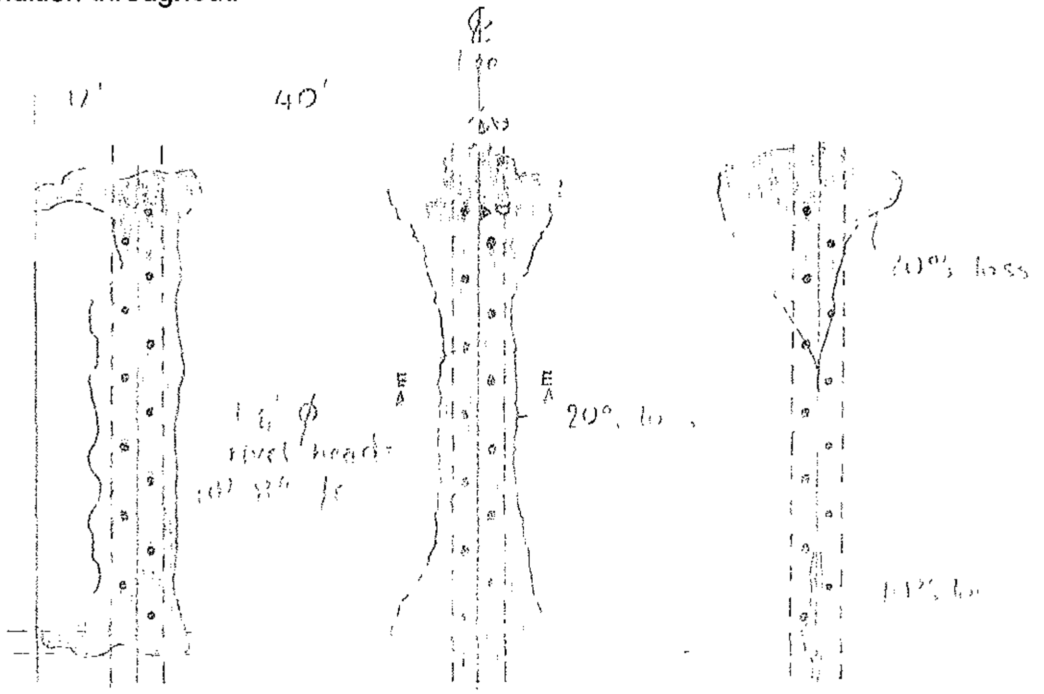


Fig 2 Plan view of buckle plate corrosion

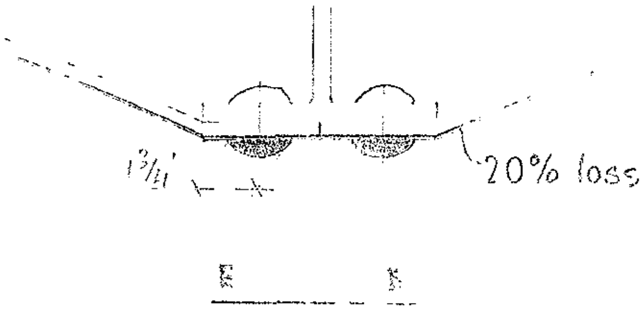


Fig 3 Corroded section of buckle plate

4.2.5 Tee sections

The tee sections could not be inspected The tees are surrounded by concrete and the buckle plates below and therefore are assumed to be intact

4.3 Abutments

No major defects were found on either of the abutments and they appear to be in good condition

4.4 Wingwalls

All four wingwalls appear to be in good condition There are a few stones missing on the top of the southwest pilaster and there are also some areas of mortar loss (photo 9)

4.5 Parapets

The edge girders act as the parapets. See 4 2 1 for condition of edge girders.

4.6 Road Surface

The road surface is in a reasonable condition There are some cracks on the northeast side of the carriageway that are near the end of span and are probably due to thermal expansion of the bridge (photo 10). There are also a series of small bumps that are clearly visible on the east side of the carriageway near the verge (photo 2).

4.7 Formation

The formation is reasonably flat. There are small machinery parts and some wooden palettes that have been dumped under the bridge (photo 1) The formation is used as access to the adjacent farm and storage units but there is another access road south east of the bridge

5 Assessment to BE4

5.1 Principal results of new Jacobs BE4 assessment

Following acquisition of additional data from site, Jacobs carried out a full BE4 reassessment. The results obtained are listed below

Summary of calculations

Element **Main girders**

Action	Location	Dead load effect	Full C&U load effect	Total load effect	Assessed resistance	Live load capacity
Bending	Single plate 2 81m from end	652 ton ft	130 ton ft	782 ton ft	1848 ton ft	24 tons C&U
Bending	Double plate 5 67m from end	1523 ton ft	374 ton ft	1897 ton ft	2956 ton ft	24 tons C&U
Bending	Three plate 14 72 m from end (max.)	2693 ton ft	500 ton ft	2966 ton ft	4079 ton ft	24 tons C&U
Shear	Obtuse support	116 ton	32 ton	148 ton	184 ton	24 tons C&U
Bearing stiffeners	Obtuse support	116 ton	32 ton	148 ton	279 tons	24 tons C&U

Element **Transverse girder No.20 (longest propped girder)**

Action	Location	Dead load effect	Full C&U load effect	Total load effect	Assessed resistance	Live load capacity
Bending	Sagging in span	141 ton ft	39 ton ft	180 ton ft	234 ton ft	Full C&U axle load
Bending	Hogging over support	0	49 ton ft	49 ton ft	234 ton ft	Full C&U axle load
Shear	Support	16 ton	11 ton	37 ton	53 ton	Full C&U axle load
*Flange splice, rivet shear (⅞")	Mid-span	2 47 ton/rivet	0 85 ton/rivet	3 32 ton/rivet	3 75 ton/rivet	Full C&U axle load
*Flange splice, rivet shear (¾")	Mid-span	2 47 ton/rivet	0 85 ton/rivet	3 32 ton/rivet	3 24 ton/rivet	8 ton axle load

* This effect relates to Girder No 18 which is the longest girder with a single splice at mid-span Girders No 19 and 20, although longer, have two splices at the third points and hence the effects are considerably reduced Rivet size at the splice has not been precisely determined on site, though the standard angle to flange plate rivets are ¾"

Element **Transverse girder No.16 (longest unpropped girder – type 2)**

Action	Location	Dead load effect	Full C&U load effect	Total load effect	Assessed resistance	Live load capacity
Bending	Mid-span	91 ton ft	99 ton ft	190 ton ft	216 ton ft	Full C&U axle load
Shear	Support	13 ton	16 ton	29 ton	48 ton	Full C&U axle load

Element **Transverse girder No.8 (longest type 3 girder with flange angles only)**

Action	Location	Dead load effect	Full C&U load effect	Total load effect	Assessed resistance	Live load capacity
Bending	Mid-span	25 ton ft	19 ton ft	44 ton ft	118 ton ft	Full C&U axle load
Shear	Support	7 ton	4 ton	11 ton	48 ton	Full C&U axle load

Element **Buckle Plates**

The buckle plates are rectangular spanning 57" between the transverse girders and connected with a tee connector at 40" centres laterally. The plates have ample capacity for C&U 5 ton wheel load when considered spanning on their long axis between the transverse girders, by the BA56/96 arch catenary method The rivet connections to the girders are also satisfactory

As with other buckle plate construction, rigorous proof that the connecting members perform satisfactorily is beyond the scope of simple analysis Finite element work that has been done previously on this by Jacobs is not conveniently applicable to these rectangular plates

Element **Substructure**

Based on qualitative assessment only The abutments are in generally good condition and are considered to be adequate for current traffic loadings The wingwalls appear to be stable

The propped transverse girders bear directly above substantial (350 x 350) timber baulks in the trestle arrangement The Carl Bro assessment showed them to have ample capacity. This result is accepted.

5.2 Comments on results

The capacity of the edge girder is dependent on allowing some degree of U-frame action. Two out of three of the transverse girders are, unconventionally, connected to the edge girder webs and only at every third girder to a stiffener A flexibility coefficient is tabulated in the Network Rail standard to account for the web connection, which implies that U-frame action is valid.

The overall U-frame support was derived by averaging the stiffness over three connecting girders. The results obtained demonstrate that the edge girders are capable of supporting the dead load and applied live load which is consistent with their observed performance.

It was noted in the inspection that the props to the transverse girders were located adjacent to the abutment walls rather than at the edge girder end In this configuration they do little to relieve loading on the edge girders which implies the problem they were meant to address was perceived to be with the transverse girders themselves This is confirmed by the assessment which demonstrates that the props are needed to limit the live load bending effects to within the girder capacity

The propped girders are also the only girders with splices The two longest girders have splices at the third points and are not critical for the dead load bending effects The next two girders have their splice at mid-span where the bending effects are most severe The capacity of the splice is determined by shear in the rivets, but the size of these rivets has not been measured If they are standard ¾" rivets assumed to be wrought iron then the capacity of the section will be restricted Even allowing an extra $^{1}/_{16}$" on the rivet diameter, as in Network Rail practice, there is still a marginal deficiency It is possible that larger rivets have been used in the splice If ⅞" rivets are present, then capacity would be adequate

The buckle plate capacity is as always a matter of some conjecture. Simple application of the BA56 arch catenary method would indicate sufficient capacity in the plates.

The flat plates under the verges have not been assessed as they are not subject to BE4 live loading

6 Comparison with previous assessments

6.1 Review of Carl Bro's 2002 BE4 assessment for BRB(R)

In August 2003 Jacobs were requested by BRB(R) to carry out a review of Carl Bro's BE4 Assessment of bridge AKC/35 produced in 2000 Carl Bro's assessment had reported the following principal deficiencies

a) Main girders single flange plate section close to obtuse corner no live load capacity in bending tension
b) Main girders double flange plate section close to obtuse corner 68% of capacity required for 24 ton vehicle train in bending tension
c) Bearing stiffeners: 34% capacity for 14 ton vehicle train = 4 ton vehicle
d) Cross girders (type B) (unpropped) 28% capacity required for 11 ton axle load = 3 ton axle in bending (tension?)
e) Cross girders (type C) (propped) no live load capacity in bending tension at mid-span
f) Cross girder splices. 82% capacity required for total load effect

The main assessment issues covered in the review (August 2003) included:

- Check section properties and that the sections used are correct for the position assumed for loads
- Check that the permissible stresses used are correct
- Confirm that the critical components have been assessed correctly and completely
- Agree that the modelling of the structure accurately reflects the way it behaves in practice
- Have requirements of BS 153 Part 4 and BE4 been interpreted correctly?

The conclusions to the review were

1 Concerns were raised about the application of U-frame action in the main girders and the possible conservative application of dead and superimposed dead loads, but otherwise the Carl Bro BE4 assessment appeared to have been carried out correctly.

2 It was unlikely that the deficient cross-girders could be passed unless a significant reduction in the calculated dead load effects could be achieved

3 If the assumptions regarding the flange plate curtailment were correct, it was unlikely that the defective sections of the main girders could be made to pass Dead load reduction and possible live load reduction from propping could improve the position, but recalculation of the U-frame action may reduce capacity.

Accordingly the following recommendations were made

1 Verify the plate layout on the main girders and details of the cross girder / main girder connections

2 Verify deck dimensions and material densities to make an accurate determination of the structure dead weight

3 Examine the effect on effective length of the main girder compression flange when connection to the smaller U frame stiffeners is taken into account

4 Examine whether propping has been taken into consideration in the transfer of live loads to the main girders

5 Reconsider secondary effects failures, bearing stiffeners and rivet shear

6.2 Comparison of new assessment with Carl Bro 2000 assessment

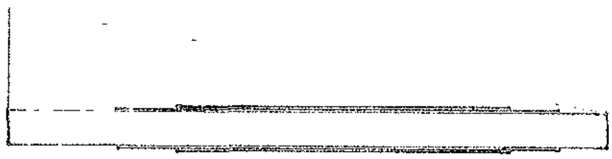
Main Girders:

Load effects

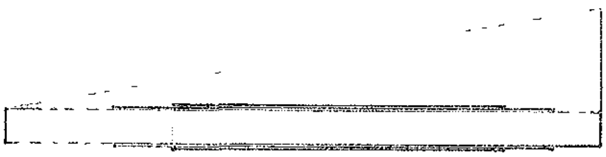
Action	Location	Dead load effect	Dead load effect	Full C&U load effect	Full C&U load effect
		Carl Bro	**Jacobs**	**Carl Bro**	**Jacobs**
Bending	Single plate section	1766 ton ft	652 ton ft	455 ton ft	130 ton.ft
Bending	Double plate section	2544 ton ft	1523 ton ft	658 ton ft	374 ton ft
Bending	Three plate section (max moment)	2953 ton ft	2693 ton ft	746 ton ft	500 ton ft
Shear	Support	123 ton	116 ton	30 7 ton	32 ton

There are differences in effective span, Carl Bro use 33 94m, whereas Jacobs can justify 32 71m, this would make a 7% difference in bending and shear effects. There are also some differences in dead load application These are difficult to compare as CB have applied area loading onto a grillage model, whereas Jacobs looked at loads per unit length transferring to the transverse girders with end reactions transferring to the edge girders This is sufficient to explain the difference in the maximum moment effect in the three plate section, but clearly there is something else amiss in the single and double plate sections

What Carl Bro appear to have done is apply the heavier loading at the wrong end of the girder with respect to the staggered plates



instead of the correct distribution, thus



Using their own grillage results, the amended values in the table above would be:

Action	Location	Dead load effect	Dead load effect
		Carl Bro	**Jacobs**
Bending	Single plate section	511 ton ft	652 ton ft
Bending	Double plate section	1149 ton ft	1523 ton ft
Bending	Three plate section (max moment)	2953 ton ft	2693 ton ft
Shear	Support	123 ton	126 ton

These corrected values alone would have allowed CB to pass all parts of the main girder for 24 ton C&U loads in bending

A similar problem relates to the live loading.

Bearing Stiffeners

The CB assessment appears to use loads enhanced over those from their grillage output for vertical reaction at the support The reason for this is not explained Their capacity is based on a single gusseted stiffener section, but in fact there are at least two stiffeners acting onto the bed plate With reduced loading and increased capacity, the bearing will pass for 24 ton C&U loading.

Transverse Girders

Load effects

Action	Location	Dead load effect	Dead load effect	Full C&U load effect	Full C&U load effect
		Carl Bro	**Jacobs**	**Carl Bro**	**Jacobs**
Bending	Girders 1-8 and 33 - 40	26 3 ton ft	25 ton ft	39 5 ton ft	19 3 ton ft
Bending	Girders 9-16 and 25-32	134 ton ft	91 ton ft	92 ton ft	99 ton ft
Bending	Girders 17-20 and 21-24 (propped)	188 ton ft	141 ton ft	117 ton ft	39 ton ft
Shear	Support	123 ton	116 ton	30 7 ton	32 ton

There is obviously considerable overall discrepancy between the two sets of results which needs explanation

The basic calculation of dead load is very little different between the two assessments, converting the Carl Bro figures to kN/m and hence ton/ft gives 0 93 ton/ft whereas Jacobs obtain 0 954 ton/ft. Thus for the middle range girders with maximum effective span of 27'-8", simple statics gives

$$0\ 954 \times 27\ 66^2 \div 8 = 91\ 2 \text{ ton ft}$$

It is difficult to discern how exactly the dead loads have been applied in the CB grillage model, but it appears from the results that the verge dead loading and the dead loading below the carriageway may both have been applied over the entire deck rather than being applied separately

For the live loads, Carl Bro have not considered any dispersal of the load through the deck, instead they apply 11 ton axle loads to a single girder With the transverse girders spaced at 5' – 4", depth of overburden almost 3' – 0" and 45° dispersal allowed in BE4, it is clear that the axle load will be spread over 2 or 3 girders Jacobs calculate that it is the twin 9 ton axle loads rather than the single 11 ton axle that is critical. This goes some way to explaining the discrepancy in the first group and last group of girders, but the middle group is obviously odd It appears here that Carl Bro have considered these girders as propped, which is incorrect. Only girders 17-20 and 21-24 are propped

Girder Splices

Splices only occur in the eight longest girders The critical girder is No.18 which is the longest girder with a splice at mid-span Provided that ⅞" rivets are provided, the splice plate has adequate capacity

6.3 Comments by Northumberland CC on their BD21 assessment

In a letter dated October 2005 to BRB(R), Northumberland CC outlined the conclusions of their BD21 assessment of the bridge The assessment itself has not been made available to Jacobs

Members considered to pass for 40/44 tonnes live loading were

- All transverse girders in shear and longitudinal shear
- Eight of the ten transverse girder types in bending
- The buckle plates
- Edge girders – longitudinal shear in rivets

Members failing 40/44 tonne loading were

- Edge girders in bending rated at less than dead load
- Edge girders in shear rated at dead load only
- The two longest transverse girders without additional support rated at 7 5 t
- Tee connectors between buckle plates rated at less than dead load

Northumberland make further comments that:

- A number of conservative assumptions have been made
- The restraint to the edge girders is underestimated

Observations on Northumberland BD21 assessment

It has been demonstrated that by considering limited U-frame (L-frame) action that a sensible rating in bending can be obtained for the edge girders Even if a more conservative approach to the U-frame action were taken than has been used in the BE4 assessment, it should still be possible to obtain an appropriate bending capacity

The more rigorous approach to shear in BD56 does limit shear capacity, but a quick calculation indicates a capacity of 1810kN and applying a conservative 1 2 factor on dead load gives a shear load effect of 1387 kN No attempt has been made to evaluate the BD21 loading, but it is clear that there is in fact considerable live load capacity

The reduced rating on the transverse members is not surprising given the onerous axle loading requirements of BD21

The capacity of the tee connectors between the buckle plates raises the usual issues regarding the mechanism of buckle plate construction

7 Conclusions and Recommendations

The assessment has demonstrated that by careful and reasoned analysis the main girders can be shown to have adequate BE4 capacity This concurs with observation of their performance whereby they have continued to carry heavy traffic loading over many years without distortion or distress

Most of the transverse girders have adequate capacity to carry BE4 axle loading given the limitations on vehicle positioning inherent in this standard; the wide verges are not required to carry any live loading The critical girders are the propped girders which display limited capacity in the splices and particularly girders 17, 18, 23 and 24 where the splices are at mid-span It is only the propped girders that have splices Definitive information on the size of rivets in the splice plates was not obtained from the site survey and it is not known whether the flange angles are spliced at the same point. If ¾" rivets are assumed, which is the standard size in the flange / angle connection, then full BE4 C&U capacity is not met The rivets would need to be ⅞" to permit a pass By taking the rivet size as the hole diameter (i e ¾" + $^{1}/_{16}$" = $^{13}/_{16}$") as permitted in the Network Rail assessment standards, the deficiency becomes marginal and would permit a pass on the shorter girders 17 and 24.

The buckle plate arrangement is another area of uncertainty Adopting the standard BA56 approach to the plates themselves, considering them as arched plates spanning between and riveted to the transverse girders, they can be shown to be satisfactory for BE4 wheel loads Proving the adequacy of the connecting tees is not amenable to simple calculation Attempts have been made to pursue the problem with finite element analysis on other bridge assessments with similar details, but obtaining a general solution has proved elusive FE analysis has shown that the buckle plates and tees act together as a strut and tie system and simple static consideration is not valid If the connecting tees were not there, the BA56 arch catenary analysis indicates the plates would still perform adequately spanning on their main axis

Apart from some residual doubts on girders 17, 18, 23 and 24, and acceptance of the buckle plate capacity, the bridge can be rated for full BE4 C&U loading

The principal maintenance defect is the deterioration of the timber planks on the west side of the bridge which fill the gap between the buckle plates and the inside web face of the edge girder This is allowing fill to fall though the deck and holes to appear in the verge Replacing these timbers with something more suitable, for example, Omnia pre-cast concrete planks could be done at relatively modest cost To do this would entail excavating earth fill on the roadside face of the web in which case maintenance painting of the inside face of the web, which is displaying some corrosion, could be carried out.

The issue with the splice plates on the transverse girders could be resolved by replacing the wrought iron rivets as assumed, with HSFG bolts

Appendix A - Photographs

1. East elevation

2. East girder showing vegetation growth and unevenness in road surface

3. Inside face of west edge girder

4. West trestle supporting four largest cross girders on the north

5. View of worst corroded buckle plate/flat plate connection on west side of bridge. Also showing poor condition of timber infill.

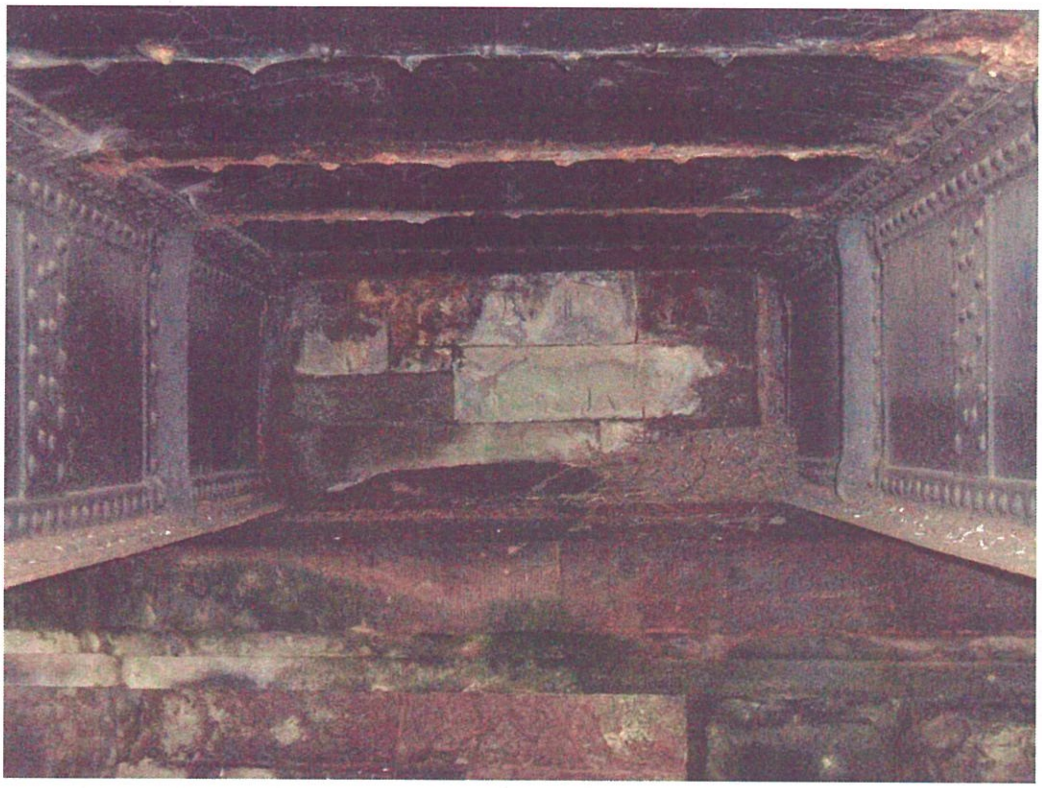
6. Corrosion and seepage through buckle plate connection on east side of bridge.

7. Connection of cross girder the web of edge girder

8. West edge girder south end

9. Southwest pilaster with missing stones and areas of mortar loss

10. Cracking on NE side of carriageway



11. Transverse beams bearing onto abutments. Beams are not built into sandstone face.

Appendix C - Trial Pit and Metal Test Results

STRUCTURAL SOILS

TRIAL PIT LOG

Contract	Client	Trialpit No
BE4 Bridges ACK/35	Jacobs	TP03

Job No	Date	Ground Level	Local Grid Co-Ordinates	Sheet
67109	06.11.06	---	---	1 of 1

Samples and In-situ Tests				Water	Description of Strata	Depth (Thickness)	Legend
Depth	No	Type	Results				
0 00-0 50	1	B			MADE GROUND Firm brown slightly sandy CLAY With some rootlets With some rare cobbles of brick	0.30	
					MADE GROUND Brown black gravelly fine to medium SAND of ash Gravel is angular to subangular fine to coarse of ash and clinker	0.50	
0 50-1 00	2	B			Brown slightly gravelly fine to medium SAND Gravel is round to subrounded fine to coarse of mixed lithologies	1.00	

Plan (Not to Scale)

??? × ???

No Bearing Taken

General Remarks

All dimensions in metres	Method	Logged By	Checked By
Scale 1:25	Hand Dug	ADE	

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STRUCTURAL SOILS

WINDOW SAMPLE LOG

Contract	Client	Window Sample No
BE4 Bridges ACK/35	Jacobs	WS03

Job No	Date	Ground Level	Local Grid Co-Ordinates	Sheet
67109	06.11.06	---	---	1 of 1

Progress: Window Run (size (mm))	Samples / Tests: Depth	No	Type	Results	Water	Instrumentation	Description of Strata	Depth (Thickness)	Legend
	0 00-0 30	1	D				MADE GROUND Firm brown slightly sandy CLAY With some rootlets With some rare cobbles of brick	0.30	
	0 30-0 50	2	D				MADE GROUND Brown black gravelly fine to medium SAND of ash Gravel is angular to subangular fine to coarse of ash and clinker.	0.50	
	0 50-1 00	3	D				Brown slightly gravelly fine to medium SAND Gravel is round to subrounded fine to coarse of mixed lithologies	1.00	
							Window sample terminated at 1 00m depth (refused)		

General Remarks

All dimensions in metres Scale 1:27	Method Tracked Window Sampling	Logged By ADE	Checked By

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STRUCTURAL SOILS

WINDOW SAMPLE LOG

Contract	Client	Window Sample No
BE4 Bridges ACK/35	**Jacobs**	**WS02**

Job No	Date	Ground Level	Local Grid Co-Ordinates	Sheet
67109	**06.11.06**	---	---	**1** of **1**

Progress: Window Run (size (mm))	Samples / Tests: Depth	No	Type	Results	Water	Instrumentation	Description of Strata	Depth (Thickness)	Legend
0 00 - 1 00 (97) 50 % rec	0 00-1 00	1	D				MADE GROUND Firm brown slightly sandy slightly gravelly CLAY Gravel is angular to subangular fine to coarse sandstone and ash With some rare glass fragments	(1 00) 1.00	
1 00 - 1 20 (87) 100 % rec	1 00-1 20	2	D				Brown slightly gravelly fine to medium SAND Gravel is round to subrounded fine to coarse of mixed lithologies.	1.20	
							Window sample terminated at 1 20m depth (refused)		

General Remarks

All dimensions in metres Scale 1:27	Method **Tracked Window Sampling**	Logged By **ADE**	Checked By	AGS

STRUCTURAL SOILS

WINDOW SAMPLE LOG

Contract	Client	Window Sample No
BE4 Bridges ACK/35	Jacobs	WS01

Job No	Date	Ground Level	Local Grid Co-Ordinates	Sheet
67109	06.11.06	---	---	1 of 1

Progress: Window Run (size (mm))	Samples / Tests: Depth	No	Type	Results	Water	Instrumentation	Description of Strata	Depth (Thickness)	Legend
0 00 - 1 00 (97) 100 % rec	0 00-0 80	1	D				MADE GROUND Brown black gravelly fine to medium SAND of ash Gravel is angular to subangular fine to coarse of ash, redbrick, clinker and sandstone	(0 80) 0.80	
	0 80-1 00	2	D				Brown slightly gravelly fine to medium SAND Gravel is round to subrounded fine to coarse sandstone and mudstone.	1.00	
							Window Sample terminated at 1 00m depth (refused)		

General Remarks

All dimensions in metres Scale 1:27	Method: Tracked Window Sampling	Logged By: ADE	Checked By:	AGS

Appendix D - Form AA

FORM 'AA' (BRIDGES)

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

ELR/ Bridge No AKC/35

APPROVAL IN PRINCIPLE FOR ASSESSMENT

Senior Civil Engineer's Comments

None

Proposed Category for Independent Check 1

Superstructure 1

Substructure ...... —

Name of Checker suggested if Cat 2 or 3 ......N/A

Category 1

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

Signed [redacted]

Title Civil Engineer

Date 3/1/2007

Appendix E - Form BA

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

Appendix 4

ELR/ Bridge No AKC/35 Issue 1

Revision. A (Feb 1993)

CERTIFICATION FOR ASSESSMENT CHECK

Assessment Group: Jacobs UK

Bridge/Line Name: A697 Wooler / Alnwick to Cornhill line

Category of Check: 1

ELR/ Bridge No AKC/35

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

(1) It has been assessed in accordance with the Approval in Principle as recorded on Form AA approved on 3 January 2007

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

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

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

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

None

Category 1

Name	Signature	Date	
[redacted]		17/5/07	Assessor
		17/5/07	Assessment Checker
		10 10 07	Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible

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

Appendix 4
Issue 1
Revision A (Feb 1993)

ELR/ Bridge No AKC/35

CERTIFICATION FOR ASSESSMENT CHECK

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

(a) Assessment

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

(b) Check

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

This Certificate is accepted [redacted] (17/10/07)

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

Appendix 4

ELR/ Bridge No AKC/35 Issue. 1

Revision A (Feb 1993)

CERTIFICATION FOR ASSESSMENT CHECK

Notification of Assessment Check

Assessment Group	Jacobs Infrastructure
Bridge Name/Road No.	Iron Bridge, Wooler / A697
Line Name	Alnwick to Cornhill line
ELR Code/Structure No.	AKC/35

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

Main Girders	Full C&U load (24tons)
Transverse girders (Except girders 18 and 23)	Full C&U (2 x 9ton axles)
Transverse girders (18 and 23)	2 x 8 ton axles
Buckle plates (as spanning between transverse girders)	Full C&U (5 ton wheel)
Timber propping trestles	Pass
Substructure	Pass

Recommended Loading Restrictions

As the deficiency is very marginal, a BE4 weight limit not recommended

Description of Structural Deficiencies and Recommended Strengthening

Propped girders 18 and 23 are marginally deficient in consideration of splice capacity when considered with ¾" wrought iron rivets The rivets in the splice were not specifically measured on site and are assumed to be the same as the standard flange/angle rivets This assumption should be verified If still deficient the rivets could be replaced with HSFG bolts

The principal maintenance defect is the deterioration of the timber planks on the west side of the bridge, which fill the gap between the buckle plates and the inside web face of the edge girder Several rotten timbers are allowing fill to fall though the deck and holes to appear in the verge Replacing these timbers with something more suitable, for example, Omnia pre-cast concrete planks, could be done at relatively modest cost To do this would entail excavating earth fill on the roadside face of the web in which case maintenance painting of the inside face of the web, which is displaying some corrosion, could be carried out

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

Appendix 4
Issue 1
Revision A (Feb 1993)

ELR/ Bridge No AKC/35

CERTIFICATION FOR ASSESSMENT CHECK

Name	Signature	Date	
[redacted]		17/5/07	Assessor
		17/5/07	Assessment Checker
		10/10 07	Authorised signatory of the firm of Consulting Engineers to whom Assessor/Checker is responsible

This Certificate is accepted by [redacted] (17/10/07)

Appendix F - Calculations

CALCULATION COVER SHEET

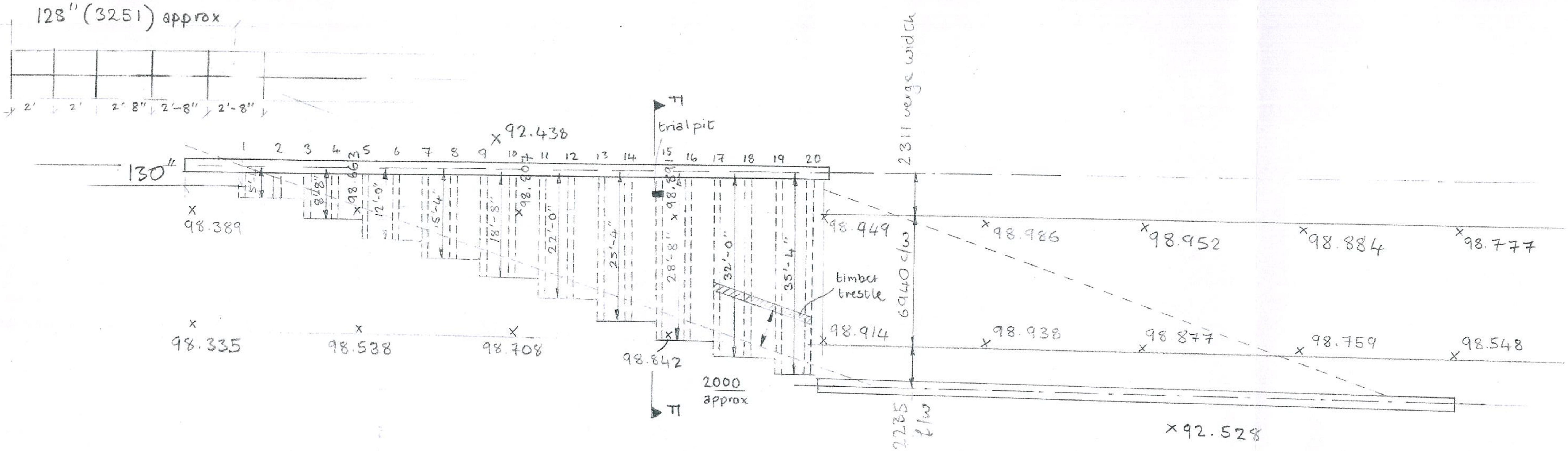
Jacobs
Reading

Project Title	BRB (Residuary) Ltd - Major Works 2004/2007	Calc No	97 1
Job No	J24110JR	File	R11
Project Manager	[redacted]	Subject:	AKC/35
Designer			A697 Wooler
Project Group	31400		Section Properties

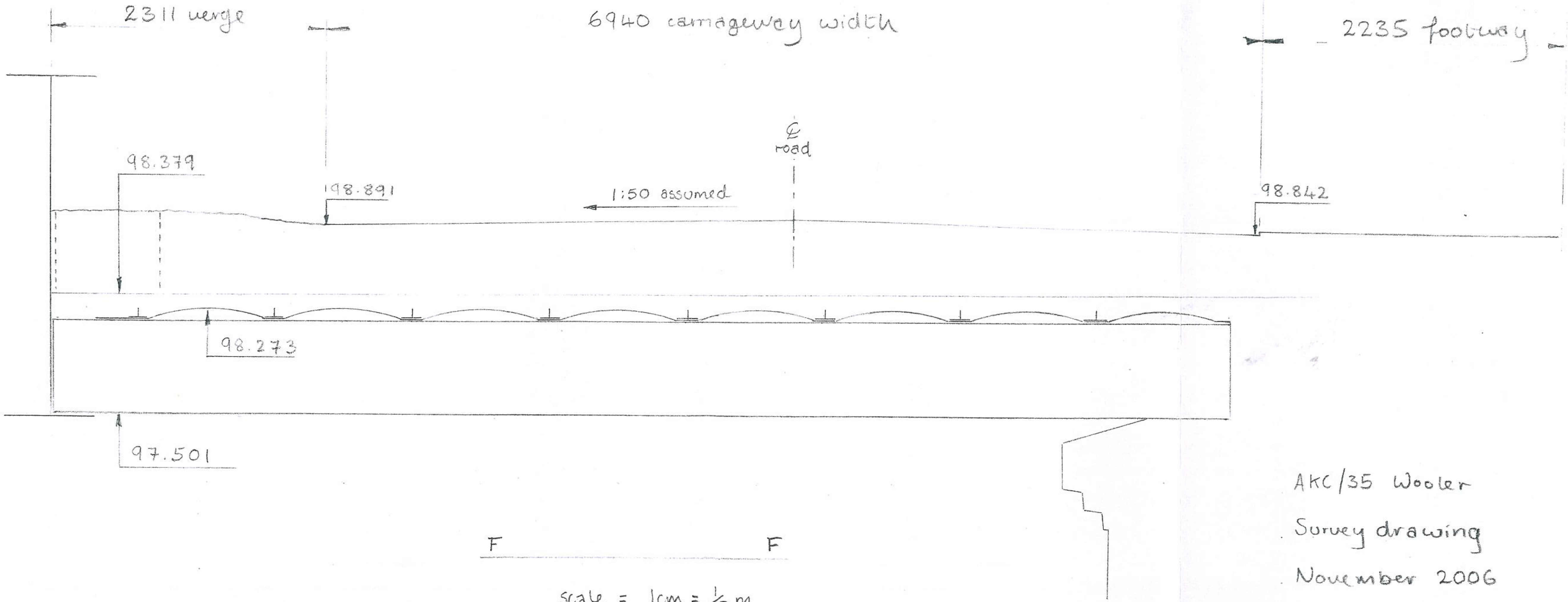
	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	8	[redacted]	Jan-07	[redacted]	Mar-07				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No Date

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



Scale = 1cm = 2.3m



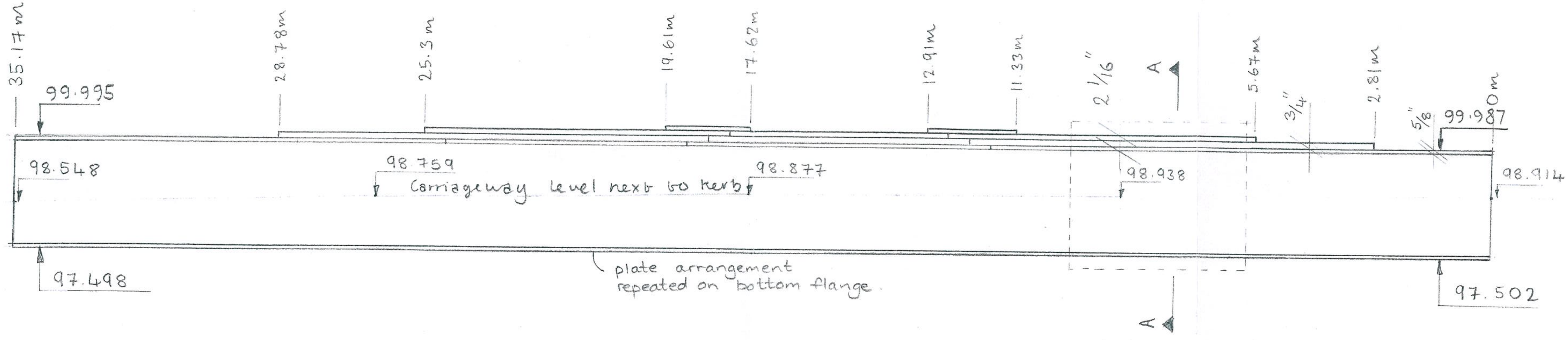
Scale = 1cm = ⅓m

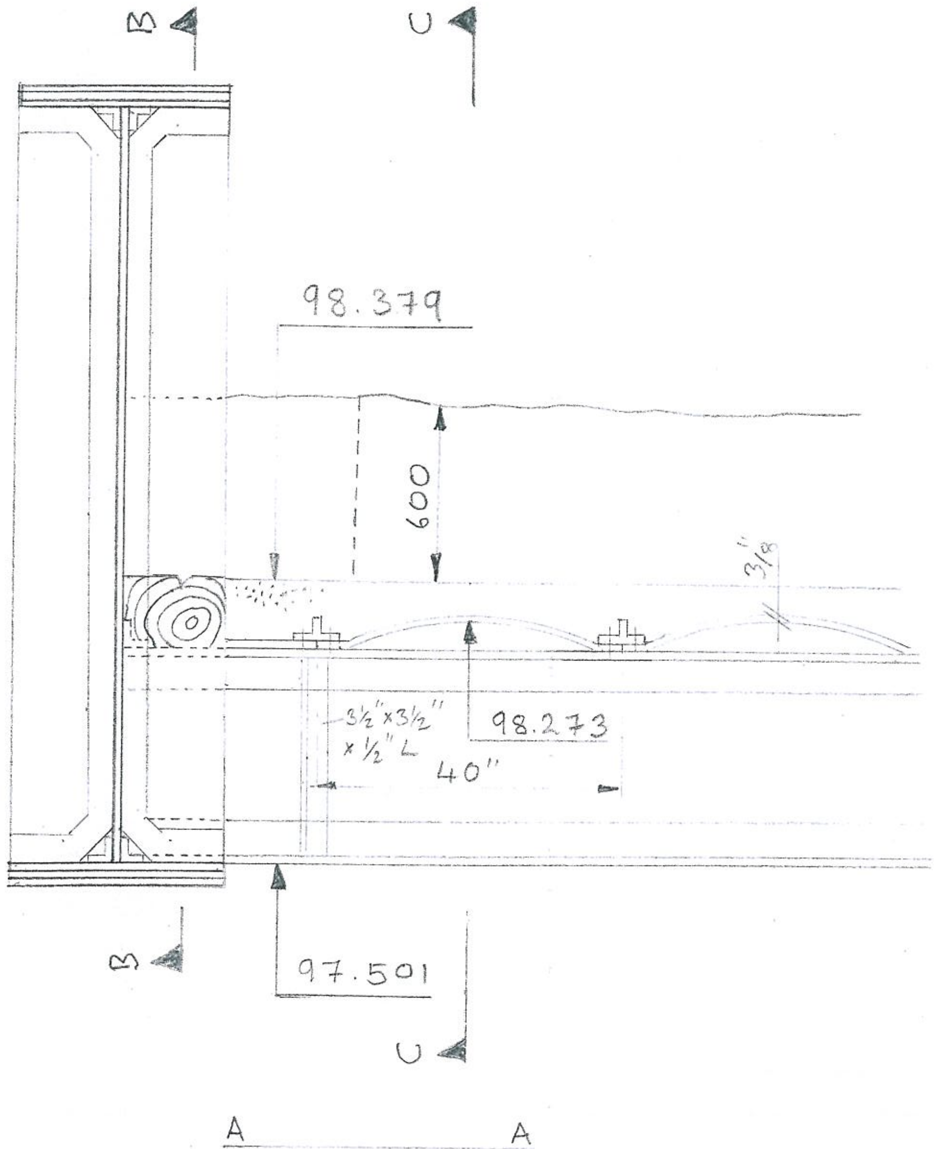
AKC/35 Wooler

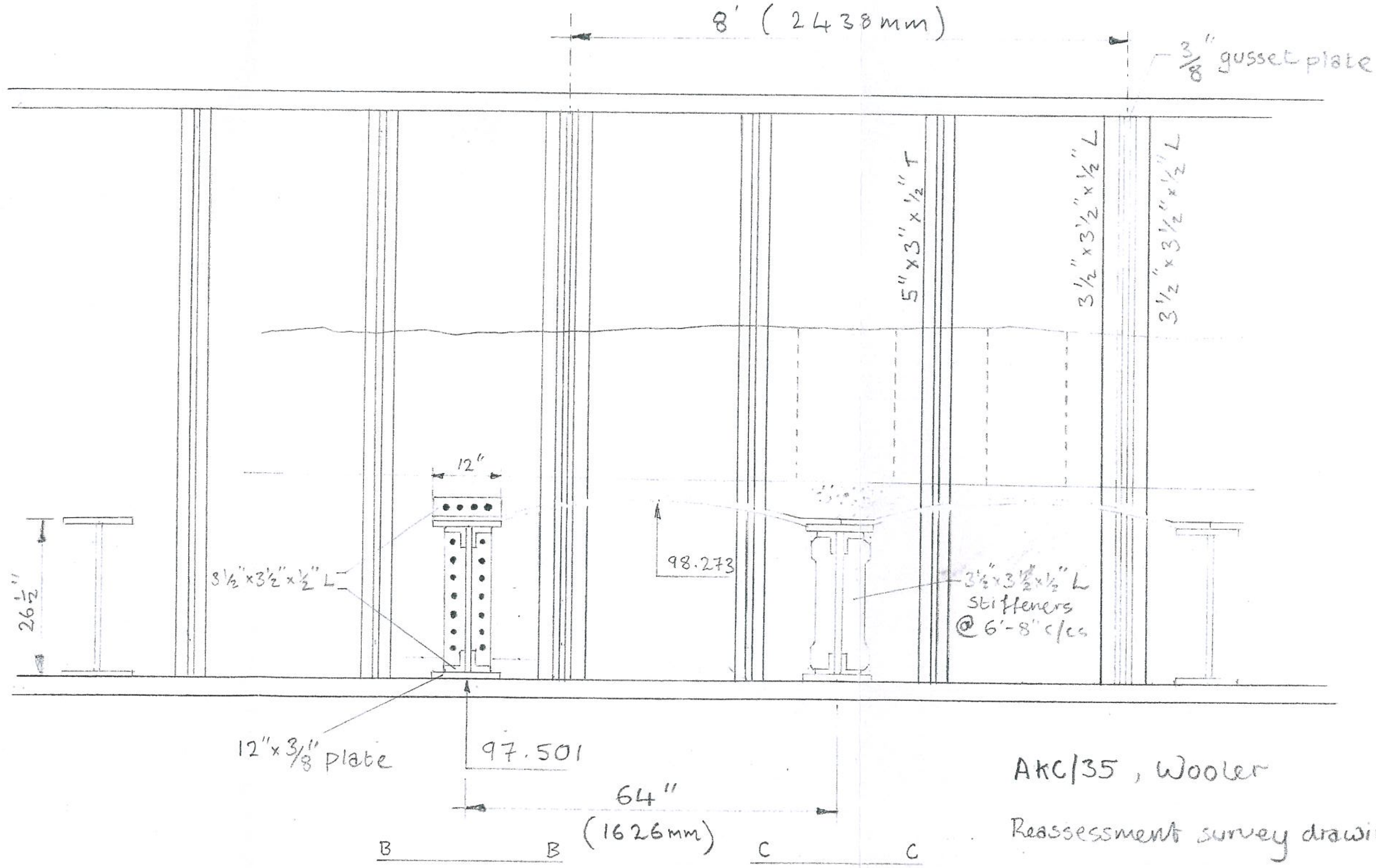
Survey drawing

November 2006

Plan & cross-section







AKC/35, Wooler

Reassessment survey drawing

November 2006

Details

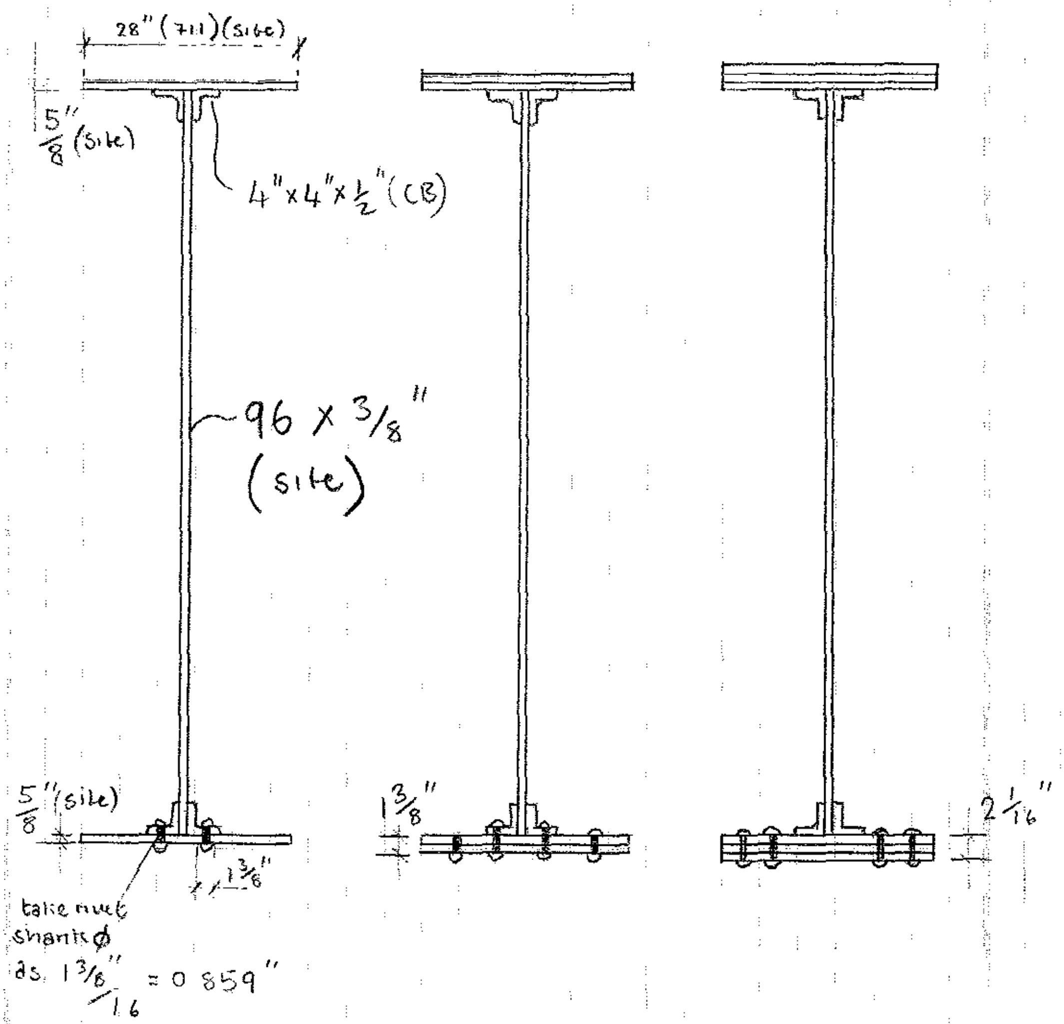
CALCULATION SHEET

JACOBS

Project Title BRB (Residuary) Assessments		Sheet No 1	
Subject AKC/35 . Section properties		Calc No 97.1	
Job No J24110K1/500		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 2/07	Checked By	Date

Edge girder section properties

CB = from Carl bro assessment
site = measured on site



CALCULATION SHEET

JACOBS

Project Title		Sheet No 2
Subject		Calc No
Job No		File
Made By [redacted]	Date 01/07	Revised By	Date
Checked By	Date 2/07	Checked By	Date

Edge Girder - single plate section

Element	Dimension b	d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	**28**	**0.625**	17 50	**0.3125**	5.47	38999 62	0 57
Top angles (hor)	**8**	**0.5**	4 00	**0.875**	3 50	8703 03	0.08
Top angles (vert)	**1**	**3.5**	3 50	**2.875**	10 06	6976 12	3 57
							27648 0
Web	**0.375**	**96**	36.00	**48.625**	1750 50	43.96	0
Bottom angles (vert)	**1**	**3.5**	3 50	**94.375**	330 31	7683 86	3 57
Bottom angles (hor)	**8**	**0.5**	4 00	**96.375**	385 50	9547.24	0 08
Bottom flange	**28**	**0.625**	17 50	**96.9375**	1696 41	42736 53	0 57
Deduct rivets 1	**-0.859**	**1.125**	-0 97	**96.6875**	-93 44	-2336 15	-0 10
Deduct rivets 2	**-0.859**	**1.125**	-0 97	**96.6875**	-93 44	-2336 155	-0 10
NET AREA			84 07		3994 88		
GROSS AREA			86 00				
Depth to Neutral Axis y1		47 52					
					Sum	110018 05	27656.25
		overall depth					
		97 25				Ixx=	137674 30
						Ztop	2897 19
						Zbot	2768 44

$$I_{yy} = 28^3 \times 1.125 \times 2 \times 1/12 + 8.375^3 \times 2 \times 0.5 \times 1/12$$
$$+ 1.375^3 \times 2 \times 3.5 \times 1/12$$
$$= 4116 + 48.95 + 1.516$$
$$= 4166 \text{ in}^4$$

CALCULATION SHEET

JACOBS

Project Title			Sheet No	3
Subject			Calc No	
Job No			File	
Made By	[redacted]	Date 01/07	Revised By	Date
Checked By	[redacted]	Date 2/07	Checked By	Date

Edge Girder - double plate section

Element	Dimension b	d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	**28**	**1.375**	38 50	**0.6875**	26 47	83151 44	6 07
Top angles (hor)	**8**	**0.5**	4 00	**1.625**	6 50	8294 08	0 08
Top angles (vert)	**1**	**3.5**	3 50	**3.625**	12 69	6633 81	3.57
Web	**0.375**	**96**	36 00	**49.375**	1777 50	176 48	27648 00
Bottom angles (vert)	**1**	**3.5**	3 50	**95.125**	332 94	8051 94	3 57
Bottom angles (hor)	**8**	**0.5**	4 00	**97.125**	388 50	9985 64	0 08
Bottom flange	**28**	**1.375**	38 50	**98.0625**	3775 41	99752 42	6 07
Deduct rivets 1	**-1.718**	**1.375**	-2 36	**98.0625**	-231 65	-6120 52	-0 37
Deduct rivets 2	**-1.718**	**1.875**	-3.22	**97.8125**	-315 08	-8264 387	-0 94
NET AREA			122 42		5773.27		
GROSS AREA			128 00				
Depth to Neutral Axis y1		47 16					
					Sum	201660 90	27666 13

Overall depth	98 75	Ixx=	229327 03
		Ztop	4862 65
		Zbot	4445 26

$$I_{yy} = 28^3 \times 2 \times 1.375 \times \tfrac{1}{12} + 8.375^3 \times 2 \times 0.5 \times \tfrac{1}{12} + 1.375^3 \times 2 \times 3.5 \times \tfrac{1}{12}$$

$$= 5031 + 48.95 + 1.516$$

$$= 5081 \text{ in}^4$$

CALCULATION SHEET

JACOBS

Project Title		Sheet No	4
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By	Date 2/07	Checked By	Date

Edge Girder - 3 plate section

Element	Dimension		Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
	b	d					
Top flange	**28**	**2.0625**	57 75	**1.03125**	59 55	126765 28	20 47
Top angles (hor)	**8**	**0.5**	4 00	**2.3125**	9 25	8306 62	0 08
Top angles (vert)	**1**	**3.5**	3 50	**4.3125**	15 09	6644 31	3 57
Web	**0.375**	**96**	36 00	**50.0625**	1802 25	171 04	27648 00
Bottom angles (vert)	**1**	**3.5**	3 50	**95.8125**	335 34	8040 39	3.57
Bottom angles (hor)	**8**	**0.5**	4 00	**97.8125**	391 25	9971 89	0 08
Bottom flange	**28**	**2.0625**	57 75	**99.0938**	5722 67	151453.09	20 47
Deduct rivets 1	**-1.718**	**2.0625**	-3 54	**99.0938**	-351 13	-9292 73	-1 26
Deduct rivets 2	**-1.718**	**2.0625**	-3 54	**99.0938**	-351 13	-9292 729	-1 26
NET AREA			159 41		7633 16		
GROSS AREA			166.50				
Depth to Neutral Axis y1		47 88					
					Sum	292767 15	27693 74
						Ixx=	320460 89
						Ztop	6692 61
						Zbot	6134 14

Overall depth

100 125

$$I_{yy} = 28^3 \times 2 \times 2.062 \times 1/12 + 8\ 375^3 \times 2 \times 0\ 5 \times 1/12$$
$$+ 1.375^3 \times 2 \times 3.5 \times 1/12$$
$$= 7594\ in^4$$

CALCULATION SHEET

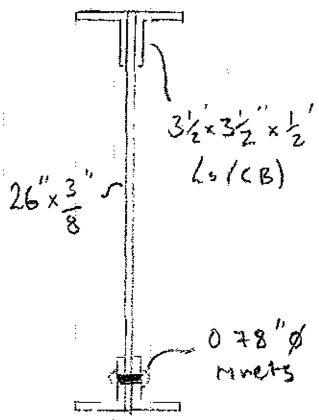
JACOBS

Project Title				Sheet No 5
Subject				Calc No
Job No				File
Made By [redacted]	Date 01/07	Revised By		Date
Checked By [redacted]	Date 2/07	Checked By		Date

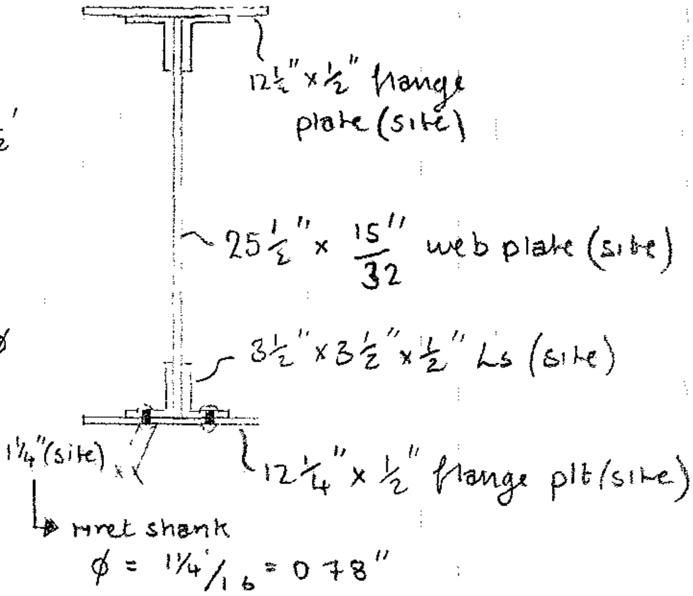
Transverse girder properties.

CB = from Carl Bro Assessment
site = measured on site

girders 1-8 33-40

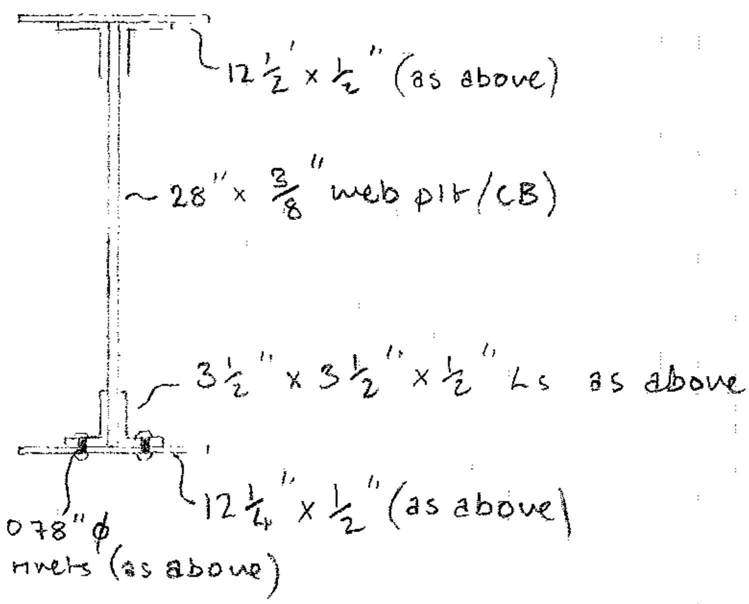


girders 9-16, 25-32



girders

17-20, 21-24



CALCULATION SHEET

JACOBS

Project Title				Sheet No 6
Subject				Calc No
Job No				File
Made By [redacted]	Date 01/07	Revised By		Date
Checked By	Date 2/07	Checked By		Date

Transverse Girders 1 to 8 & 33 to 40

Element	Dimension		Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
	b	d					
Top angles (hor)	**7**	**0.5**	3 50	**0.25**	0 88	521 43	0.07
Top angles (vert)	**1**	**3**	3 00	**2**	6 00	327 97	2 25
Web	**0.375**	**26**	9 75	**13**	126 75	2 89	549 25
Bottom angles (vert)	**1**	**3**	3 00	**24**	72 00	399 81	2 25
Bottom angles (hor)	**7**	**0.5**	3 50	**25.75**	90 13	618 58	0 07
Deduct rivets 1	**-1.375**	**0.78**	-1 07	**24**	-25 74	-142 93	-0 05
NET AREA			21 68		270 01		
GROSS AREA			22 75				
Depth to Neutral Axis							
y1		12 46					
					Sum	1727 74	553 84
		Overall depth				Ixx=	2281 59
		26				Ztop	183 17
						Zbot	168 45

CALCULATION SHEET

JACOBS

Project Title				Sheet No 7
Subject				Calc No
Job No				File
Made By [redacted]	Date 01/07	Revised By		Date
Checked By	Date 2/07	Checked By		Date

Cross girder - 9-16 & 25-32

Element	Dimension b	d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	**12.5**	**0.5**	6 25	**0.25**	1 56	960 77	0 13
Top angles (hor)	**7**	**0.5**	3.50	**0.75**	2 63	495 51	0 07
Top angles (vert)	**1**	**3**	3 00	**2.5**	7 50	308.98	2.25
Web	**0.46875**	**25.5**	11.95	**13.25**	158 38	4 32	647 71
Bottom angles (vert)	**1**	**3**	3 00	**24**	72.00	386 57	2.25
Bottom angles (hor)	**7**	**0.5**	3 50	**25.75**	90 13	600 77	0 07
Bottom flange	**12.25**	**0.5**	6 13	**26.25**	160 78	1133 13	0 13
Deduct rivets 1	**-1.56**	**1**	-1 56	**26**	-40 56	-278 09	-0 13
NET AREA			35.77		452 41		
GROSS AREA			37 33				
Depth to Neutral Axis y1		12 65					
				Sum		3611 96	652 48
	overall depth				Ixx=		4264 44
	26 5				Ztop		337 15
					Zbot		307 87

CALCULATION SHEET

JACOBS

Project Title				Sheet No 8	
Subject				Calc No	
Job No				File	
Made By [redacted]	Date 01/07	Revised By		Date	
Checked By	Date 2/07	Checked By		Date	

Cross girder - 17-20 & 21-24

Element	Dimension		Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
	b	d					
Top flange	**12.5**	**0.5**	6 25	**0.25**	1 56	1149 49	0 13
Top angles (hor)	**7**	**0.5**	3 50	**0.75**	2 63	597 12	0 07
Top angles (vert)	**1**	**3**	3 00	**2.5**	7 50	383 86	2 25
Web	**0.375**	**28**	10 50	**14.5**	152 25	4 98	686 00
Bottom angles (vert)	**1**	**3**	3 00	**26.5**	79 50	482 98	2 25
Bottom angles (hor)	**7**	**0.5**	3 50	**28.25**	98 88	729.63	0 07
Bottom flange	**12.25**	**0.5**	6 13	**28.75**	176 09	1366 82	0 13
Deduct rivets 1	**-1.56**	**1**	-1 56	**28.5**	-44 46	-336 57	-0 13
NET AREA			34 32		473 95		
GROSS AREA			35 88				
Depth to Neutral Axis y1		13 81					
					Sum	4378 32	690 77
		overall depth				Ixx=	5069 09
			29			Ztop	367 02
						Zbot	333 75

CALCULATION COVER SHEET

Jacobs
Reading

Project Title.	BRB (Residuary) Ltd - Major Works 2004/2007	Calc No	97 2
Job No	J24110JR	File	R11

Project Manager	[redacted]	Subject	AKC/35
Designer			A697 Wooler
Project Group	31400		Dead Load Effects

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	8	[redacted]	Jan-07	[redacted]	Mar-07				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No Date

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

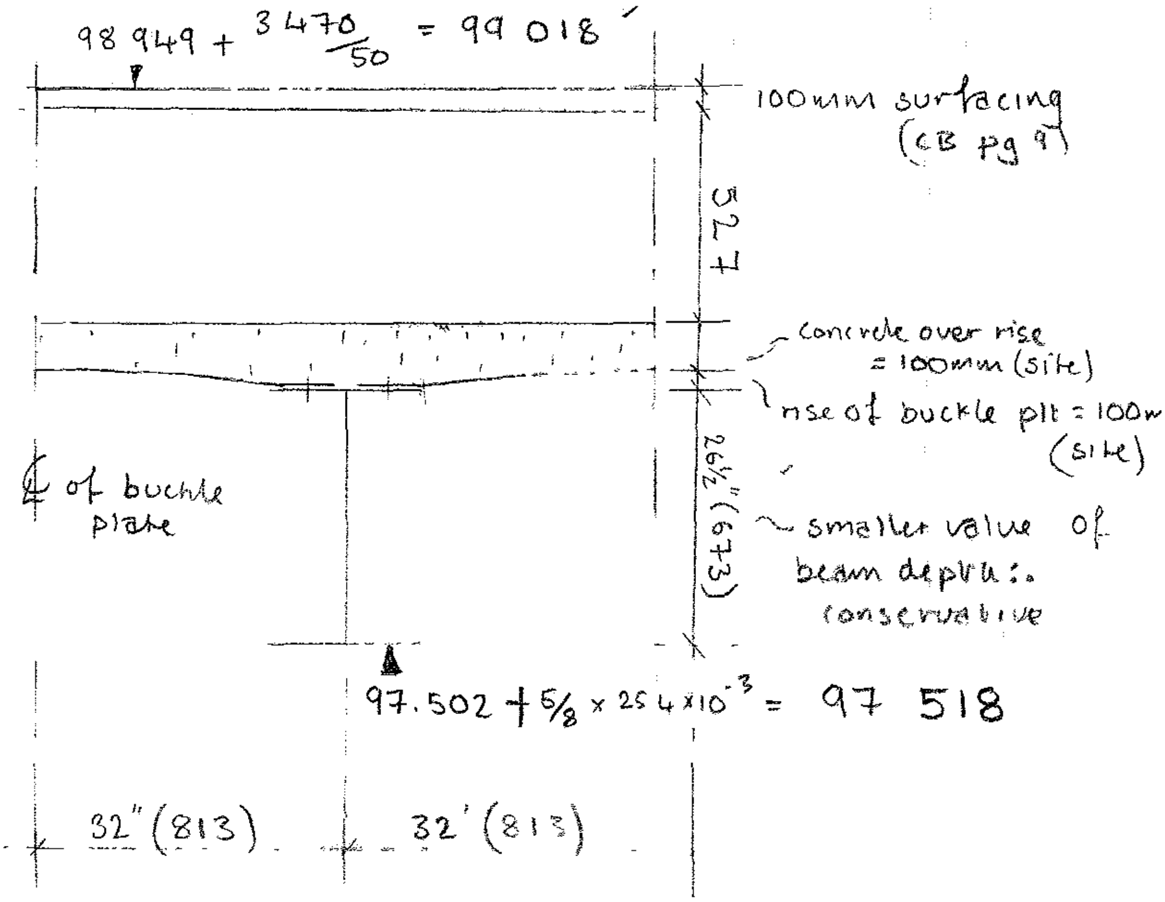
CALCULATION SHEET

JACOBS

Project Title		Sheet No	9
Subject	AKC/35 Dead Loads	Calc No	97·2
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 2/07	Checked By	Date

Transverse girders

Take depth of fill measured at the centre of the bridge and at the centre-line of the road



Dead Loading

self weight of transverse girder

Sht 8/BE4 pg 4 $= 35\,88 \times \frac{1}{12^2} \times 480 \times 1.1 = 132$ lbs/ft

add 10% for stiffeners etc

CALCULATION SHEET

JACOBS

Project Title		Sheet No 10	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

buckle plate

$= 3/8 \times 32 \times 2 \times \frac{1}{12^2} \times 480 = 80$ lbs/ft

Concrete cover

$= (8 \times 12 + 2 \times 26 \times 6) \times \frac{1}{12^2} \times 150 = 425$ lbs/ft

Fill

$= 527 \times \frac{1}{25.4 \times 12} \times \frac{64}{12} \times 135 = 1245$ lbs/ft

Surfacing

$= 4 \times 64 \times \frac{1}{12^2} \times 144 = 256$ lbs/ft

Total Dead Load on transverse girder

$= 132 + 80 + 425 + 1245 + 256$

$= 2138$ lbs/ft $= 0.954$ Ton/ft

Effective length : assume sandstone abutment

BE4 303 (a)(iv) & (i) $=$ clear span $+ \frac{1}{2} \times 28 \times \frac{1}{12} \times \frac{1}{3}$

$=$ clr span $+ 0.389$ ft $(+0.368$ for 26.5" girder)

CALCULATION SHEET

JACOBS

Project Title		Sheet No 11
Subject		Calc No
Job No		File
Made By [redacted]	Date 4/07	Revised By	Date
Checked By [redacted]	Date 04/07	Checked By	Date

Transverse girder dead load effects:

Derive for girders 20, 16 & 8

Take effective length as distance between web of main girder and centre line of bearing plate on abutment.

Girder 20:

Overall length = 35'4"

effective length = 35'4" - 2'/2 = 34'4" (34.33')

Dead load moment without support:

M = 0.954 × 34.33² × 1/8 = 140.5 ton ft ✓

V = 0.954 × 34.33 × 1/2 = 16.38 tons ✓

Girder 16:

Overall length = 28'8"

Effective length = 27'8" (27.67')

M = 0.954 × 27.67² × 1/8 = 91.3 ton ft ✓

V = 0.954 × 27.67 × 1/2 = 13.2 ton ✓

Girder 8.

Overall length = 15'4"

Effective length = 14'4" (14.33')

M = 0.954 × 14.33² × 1/8 = 24.5 ton ft ✓

V = 0.954 × 14.33 × 1/2 = 6.8 ton ✓

CALCULATION SHEET

JACOBS

Project Title			Sheet No 13	
Subject			Calc No	
Job No			File	
Made By [redacted]	Date 01/07	Revised By		Date
Checked By [redacted]	Date 3/07	Checked By		Date

Edge girders

self weight of edge girder

(Revised to 166.5) accept

allow for stiffeners etc

$= 167.25 \times \frac{1}{12^2} \times 480 \times 1.1 = 613.25$ lbs/ft
(0.274 t/ft)

effective length of girder. take bed plate centres.

historic drawing B/A697/25/2 & photos

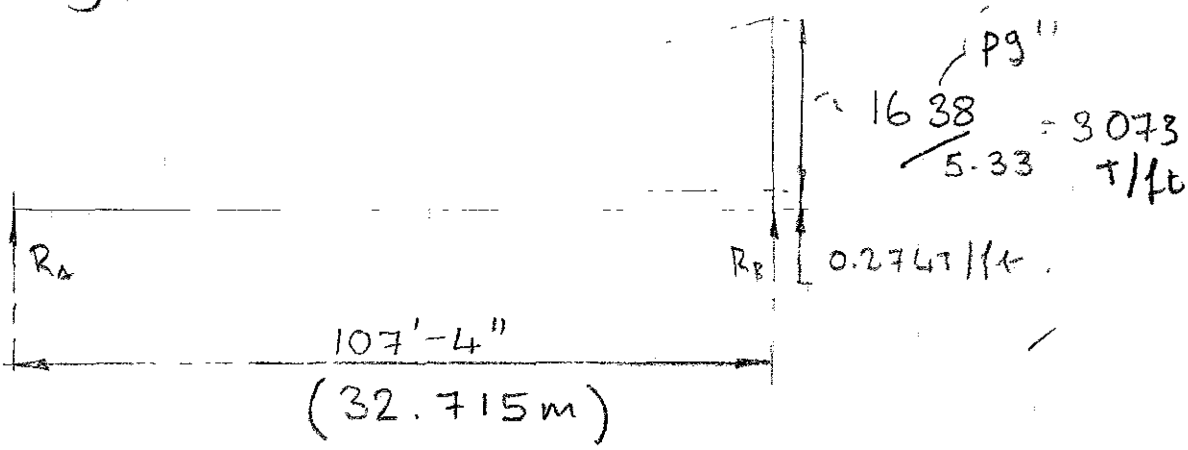
$= 115'-4'' + \left(\frac{4'-8''}{2} + 2'\right) + \left(6' - \frac{4-8''}{2}\right)$

accute corner = 4'-4"

obtuse corner = 3'-8"

$= 107'-4''$

Assume transverse girders apply load as triangular distributed load.



CALCULATION SHEET

JE JACOBS

Project Title				Sheet No 14
Subject				Calc No
Job No				File
Made By [redacted]	Date 01/07	Revised By		Date
Checked By [redacted]	Date 3/07	Checked By		Date

critical points are at :

- 2.81m from end of girder (single plt section)
- 5.67m from " " (double plt section)
- point of max moment

2 81 from end of girder

$= 2.81 - 367/328$

$= 1691$ m from R_B = 5 55 ft

$R_B = (3\,073 \times 107\,33^2 \times \frac{1}{2} \times \frac{2}{3} + 0.274 \times 107\,33^2 \times \frac{1}{2}) \div 107\,33$

= 124.65 ton = shear @ support ✓

$M - 124.65 \times 5\,55 - 0\,274 \times 5.55^2 \times \frac{1}{2}$

~~$- 3\,073 \times \left(\frac{107.33 - 5.55}{107.33}\right) \times 5\,55^2 \times \frac{1}{2}$~~

$\cdot (3.073 \;\; 2\,914) \times 5\,55^2 \times \frac{1}{2} \times \frac{2}{3}$

$= 692 - 4\,22 - 44\,9 - 1\,633$

= 641 ton ft @ 2 81 ft from end of girder (at 1 plt section) ✓

CALCULATION SHEET

JACOBS

Project Title		Sheet No 15	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

5 67 from end of girder

$= 5.67 - 3.67/3.28$

$= 4\ 55\text{ m} = 14\ 93$ ft from R_B

$R_B = 124.65$ ton

$M = 124.65 \times 14\ 93 - 0\ 274 \times 14.93^2 \times \frac{1}{2}$
$- 3\ 073 \times \left(\frac{107.33 - 14.93}{107.33}\right) \times 14.93^2 \times \frac{1}{2}$
$- (3\ 073 - 2.65) \times 14.93^2 \times \frac{1}{2} \times \frac{2}{3}$

$= 1861 - 30.5 - 295 - 31\ 76$ ✓

$= 1503$ Ton ft ✓

Maximum bending moment

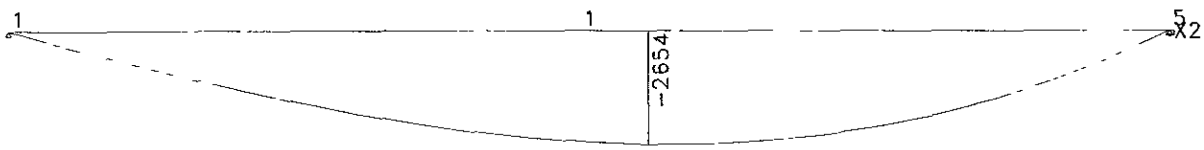
pg 17 $= 2654$ ton ft @ $0\ 55 \times 107\ 33$ ft from R_A
$= 59.032$ ft

✓

AKC/35: Max BM in edge girder (dead loads)

X2 ↑ →X1

SCALE = 1 213	UNITS ton*ft	DATE 13/04/07



M3 MOMENT LOAD NO 1 Dead Load

SHEET No 16
CALC No
FILE
JOB No [redacted]
MADE BY [redacted]
CHECKED BY [redacted]

AKC/35 Max BM in edge girder (dead loads)

Prepared by. [redacted]

Date. 13/04/07

BEAM RESULTS for load no 1 (Units ton, ton*ft)
Dead Load

Bm.	*Node*	*Axial*	*V2*	*M3*
1	1	0 000	69 675	0 000
		fr=0 55	3 614	-2654 000
	5	0 000	124 646	0 000
MAXIMUM		0 000	124 646	-2654 000
Beam no.		1	1	1

SHEET No 17
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED B[redacted]

CALCULATION COVER SHEET

Jacobs
Reading

Project Title	BRB (Residuary) Ltd - Major Works 2004/2007	Calc No	97 3
Job No J24110JR		File	R11
Project Manager	[redacted]	Subject	AKC/35
Designer	[redacted]		A697 Wooler
Project Group	31400		Section capacities

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	15	[redacted]	Jan-07	[redacted]	Mar-07				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

CALCULATION SHEET

JACOBS

Project Title		Sheet No	19
Subject	AKC / 35 : Section Capacities	Calc No	97.3
Job No		File	
Made By [redacted]	Date 05/12/06	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

Determine how much U-frame action is providing restraint to edge girder compression flange buckling

Considerations:

1. transverse girders span from edge girders onto abutments thus giving 'L' frames
2. The ends of the transverse girders are not 'built-in' to the abutment and are only simply supported
3. The transverse girders are offset from the gussetted web stiffeners
4. The length of the transverse girders vary linearly along the whole length of the edge girders, also the 16 shortest girders do not have a flange plate and the four longest have a deeper web

These issues will be dealt with as follows:

point ① : L-frame deflection will be analysed in STRAP

point ② : simply supported connection - no horizontal restraint

RT/CE/C/025 figure A42 point ③ : flexibility coefficient $= 0.8 \times 10^{-4}$ radian/kNm

$\therefore$ spring stiffness $= \frac{1}{0.8 \times 10^{-4}} = 12500$ kNm/radian

CALCULATION SHEET

JACOBS

Project Title		Sheet No	20
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

point ④ - The point of maximum bending moment will not occur at mid-span due to the triangulation effect of the loads. A conservative approach would be to choose the cross member length at 1/4 span

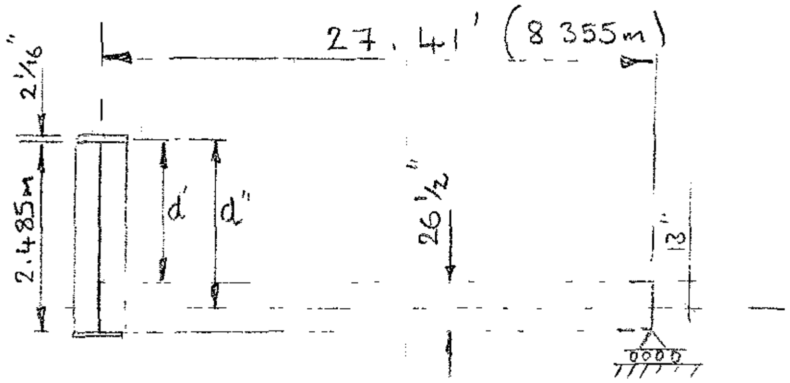
→ girder length = 28'-8" (scaled from dwg)

Clear span of girder = 28'-8" - 2' = 26'-8"

effective length = 26'-8" + 1/3 × 2'-2½"

l_e = 27.41' = 2b ✓

ref BS153 part 4 21b



d' = 2485 - 26½ × 25.4 - ½ × 2 1/16 = 1811 mm

d" = 1811 + 13.0 × 25.4 = 2141.2 mm

ref pg 7 I_2 = 3871 in⁴ = 1.611 × 10⁹ mm⁴

↳ value I calculated from CB dimensions at form AA stage value of I is 4264 in⁴ calculated from site measurements (4264 in⁴ actual)

↳ conservative no need to change

A = 30.88 = 19910 mm²

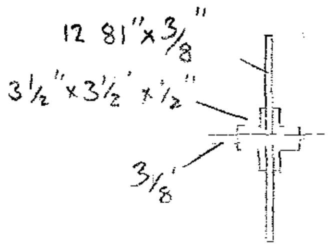
CALCULATION SHEET

JACOBS

Project Title				Sheet No 21
Subject				Calc No
Job No				File
Made By [redacted]	Date 01/07	Revised By		Date
Checked By [redacted]	Date 3/07	Checked By		Date

I, moment of inertia of a pair of stiffeners about the centre of the web

<u>Gusset plate stiffener</u>



$$I_{gusset} = \frac{26^3 \times 3/8}{12} + \frac{7\,3/8^3 \times 1}{12} + \frac{1\,3/8^3 \times 6}{12}$$

$= 549.25 + 33.43 + 1.3$

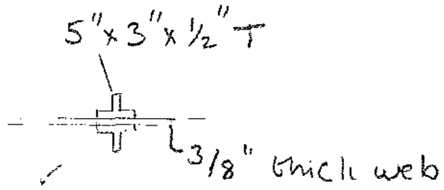
$= 584 \text{ in}^4$

$= 243 \times 10^6 \text{ mm}^4$

$A_{gusset} = 26 \times 3/8 + 7\,3/8 + 1\,3/8 \times 6 = 25\,38 \text{ in}^2$

16371 mm^2

<u>Non-gusset plate stiffener</u>



$$I_{non\text{-}gusset} = \frac{6\,3/8^3 \times 0\,5}{12} + \frac{1\,3/8^3 \times 4\tfrac{1}{2}}{12}$$

$= 10\,8 + 0\,975$

$= 11.77 \text{ in}^4 = 4\,899 \times 10^6 \text{ mm}^4$

$A_{non\text{-}gusset} = 6\,3/8 \times 0.5 + 1\,3/8 \times 4\tfrac{1}{2}$

$= 3.1875 + 6.1875$

$= 9\,375 \text{ in}^2 = 6048 \text{ mm}^2$

CALCULATION SHEET

JACOBS

Project Title		Sheet No	22
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

As there are 2 non-gussetted stiffeners for every one gussetted stiffener the average stiffener I_1 value over an 8' section is:

$$\frac{2 \times 4\,899 \times 10^6 + 243 \times 10^6}{3}$$

$$= 84.266 \times 10^6 \ mm^4$$ ✓

the transverse girder spacings are 5'-4"

∴ the average stiffener I_1 value per transverse girder is:

$$84.266 \times 10^6 \times \frac{5\frac{1}{3}}{8} = \underline{56\,177 \times 10^6 \ mm^4}$$ ✓

similarly the average stiffener area per transverse girder is:

$$\frac{2 \times 6048 + 16371}{3} \times \frac{5\frac{1}{3}}{8} = \underline{6326 \ mm^2}$$

$$\therefore \quad I_1 = 56\,177 \times 10^6 \ mm^4$$

$$A = 6326 \ mm^2$$ ✓

AKC/35 – U – frame action determining comp flange deflection @ 1/4span

X2

X1

SCALE = 1 55	UNITS meter	DATE 22/01/07

VALUES ARE * 10~6

DISPLACEMENTS   LOAD NO 1   unit load applied at comp flange

SHEET No. 23

CALC No

FILE

JOB No

MADE BY [redacted]

CHECKED BY [redacted]

AKC/35 - U - frame action determining comp flange deflection @ 1/4span

Prepared by: [redacted] ***Date:*** 22/01/07

STRAP

TRUCTURAL ANALYSIS PROGRAMS

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

NODAL COORDINATE TABLE (units - meter)

NODE	X1	X2	X3
1	0 000	0.000	0 000
3	0 000	2 141	0 000
4	8.355	0.000	0.000

27.41' pg 20 — d''

NODAL RESTRAINED DOF TABLE

NODE	X1	X2	X3	X4	X5	X6
1	1	1	1	1	1	0
4	0	1	1	1	1	0

MATERIAL TABLE (units - kN meter)

NO	Name	Modulus of Elasticity	Poisson ratio	Density	Thermal coefficient	Shear modulus
1	w i	0 2000E+09	0 300	0 0000E+00	0 00000000	0 7692E+08
2	STEE	0.2100E+09	0.300	0.7850E+02	0.00001000	0.8077E+08

not used

SECTION PROPERTY TABLE (units - mm.)

ROPERTY NO 1

A=0 6326E+04 I2=0 0000E+00 I3=0 5618E+08 J=0 0000E+00 SF2=0 850
aterial = 1 - w i SF3=0 850

verticle girder properties pg 22

ROPERTY NO 2

A=0 1991E+05 I2=0 0000E+00 I3=0 1611E+10 J=0 0000E+00 SF2=0 850
aterial = 1 - w i SF3=0 850

cross girder properties pg 20

SHEET No 24
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED BY [redacted]

AKC/35 - U - frame action determining comp flange deflection @ 1/4span

Prepared by: [redacted] **Date:** 22/01/07

BEAM CONNECTIVITY TABLE														
Beam No.	JA	JB	JC/ Beta	Release AJ	mv	mv	Length	prop no.	mat no.	Beam x2 direction cosines			offs no.
1	3	1	0			s	2 141	1	1	1 000	0 000	0 000	
2	1	4	0				8.355	2	1	0.000	1.000	0.000	

TOTAL BEAMS WEIGHT = 0 000

BEAM END CONDITIONS (units - kN meter)											
Bea no.	Axial	Tors.	JA M2	JA M3	JA V2	JA V3	JB M2	JB M3	JB V2	JB V3
1							Free	S=12500		

pg 19

spring stiffness at node
12500 kN m / radian
≡ flexibility coefficient of
$0{\cdot}8 \times 10^{-4}$ rad / kN m
(reciprocal)

SHEET No. 25
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED BY

Jacobs Gibb Ltd
GIBB House, London Road
Reading RG6 1BL

AKC/35 - U - frame action determining comp flange deflection @ 1/4span

Prepared by. [redacted]

Date. 30/01/07

STATIC DEFLECTIONS for load no 1 (Units meter)
unit load applied at comp flange

Node	*X1*	*X2*	*X6*
1	0 00000	0 00000	-0 0000187
3	0 00070	0 00000	-0 0003940
4	0.00000	0.00000	0.0000091
MAX	0 00070	0 00000	-0 0003940
NODE	3	3	3

SHEET No 2c
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED [redacted]

CALCULATION SHEET

JACOBS

Project Title				Sheet No	27
Subject	AHC/35 · Capacity of edge girder 3 plate flange section			Calc No	
Job No				File	
Made By	[redacted]	Date	01/07	Revised By	Date
Checked By	[redacted]	Date	3/07	Checked By	Date

$\delta = 703 \times 10^{-6}$ m

$= 0.703$ mm $= 0.0277$ in / kN

$= 0.276$ in / ton

BS153 . pt4 21.(b) $\quad l = 2.5 \sqrt[4]{(E I_{c} a \delta)}$

BD21 table 4 2 $\quad E = 200{,}000 \text{ N/mm}^2 = 12945 \text{ ton/in}^2$

$I_c = 2\tfrac{1}{16} \times 28^3 \times \tfrac{1}{12} + 8\tfrac{3}{8}^3 \times \tfrac{1}{2} \times \tfrac{1}{12}$

$= 3773 + 24.5$

$= 3798 \text{ in}^4$

$a = 5\tfrac{1}{3}' = 64$ in

$l = 2.5 \times (12945 \times 3798 \times 64 \times (0.276)^{0.25}$

$= 241.5$ in $= 35.76$ ft (429 in)

28 b (i) A $\quad C_s = \dfrac{170000}{(l/r_y)^2} \sqrt{\left[1 + \dfrac{1}{20}\left(\dfrac{l\,T}{r_y\,D}\right)^2\right]} = A$

$l = 35.76$ ft.

Sht 4 $\quad r_y = \sqrt{\dfrac{I_y}{A_g}} = \sqrt{\dfrac{7594}{166.5}} = 6.75$ in

$T = k_1 \times (2\tfrac{1}{16} \times 23.625 + 2.5625 \times 8.375) \div 28$

$= k_1 \times 2.5$

$= 1.0 \times 2.5$ (flanges equal)

CALCULATION SHEET

JACOBS

Project Title		Sheet No 28	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

$D = 102.125$ in

$$C_s = \frac{170000}{(429/6.75)^2 \sqrt{\left[1 + \frac{1}{20}\left(\frac{241.5 \times 2.5}{6.75 \times 102.125}\right)^2\right]}}$$

$= 44.56$ ton/in² (44.56 ton/in)

Table 8 — $p_{bc} = 8.9$ ton/in²

Table 1 — An increase of 25% (case II a') of allowable stresses is given

BE4 304(b) & Table 1 — $p'_{bc} = 1.25 \times 8.9 \times \frac{10.75}{16} = 7.47$ ton/in²

Table 3 — $d_1 = 98 - 2 \times 4 = 90''$, $t = 3/8''$

$d_1/t = 90/0.375 = 240$

$p_{bt} = 1.25 \times 9.5 \times \frac{10.75}{16} = 7.98$ ton/in²

M_a = lesser of $P_{bc} Z_{top}$ or $P_{bt} Z_{bot}$

Sht 4 — $P_{bc} Z_{top} = 7.47 \times 6693 \times 1/12 = 4166$ ton.ft

" — $P_{bt} Z_{bot} = 7.98 \times 6134 \times 1/12 = 4079$ ton ft

<u>$M_a = 4079$ ton.ft @ point of max moment</u>

CALCULATION SHEET

JACOBS

Project Title				Sheet No 29
Subject: Akc/35: capacity of edge girder 2 plate flange section				Calc No
Job No				File
Made By	[redacted]	Date 01/07	Revised By	Date
Checked By	[redacted]	Date 3/07	Checked By	Date

$I_c = 1\,375 \times 28^3 \times \frac{1}{12} + 8\,\frac{3}{8}^3 \times \frac{1}{2} \times \frac{1}{12}$

$= 2515 + 24.48$

$= 2539 \text{ in}^4$

$a = 5\frac{1}{3}' = 64 \text{ in}$

$\delta = 0\,703 \text{ mm/kN} = 0\,276 \text{ in/ton}$

$E = 12945$

BS153 pt 4 21(b) $l = 2\,5 \sqrt[4]{(E I_c a \delta)}$

$= 2\,5 \sqrt[4]{(12945 \times 2539 \times 64 \times 0\,276)}$

$= 388 \text{ in} = 32 \text{ ft}$

sht 3 $r_y = \sqrt{\frac{I_y}{A_g}} = \sqrt{\frac{5081}{128}} = 6.3 \text{ in}$

$\frac{l}{r_y} = 388/6\,28 = 61\,78$

$D/T = \frac{100\,75}{10 \times (1\,375 \times 23\,625 + 1\,875 \times 8\,375) \div 28}$

$= 100\,75/1.72 = 58\,5$

$C_s = \frac{170000}{61\,78^2} / \left[1 + \frac{1}{20}\left(61.78 \times \frac{1}{58\,5}\right)^2\right]$

$= 45\,77$

CALCULATION SHEET

JACOBS

Project Title			Sheet No 30	
Subject			Calc No	
Job No			File	
Made By [redacted]	Date 01/07	Revised By		Date
Checked By	Date 8/07	Checked By		Date

Table 8 $p_{bc} = 8.9 \text{ ton}/in^2$

BE4 304(b) & table 1 $P_{bc} = 1.25 \times 8.9 \times \frac{10.75}{16} = 7.47 \text{ ton}/in^2$

$d_1/t = 240$

Table 3 $P_{bt} = 1.25 \times 9.5 \times \frac{10.75}{16} = 7.98 \text{ ton}/in^2$

Sht 3 $M_a = P_{bt} Z_{bot} = 7.98 \times 4445 \times \frac{1}{12}$

$= 2956 \text{ ton.ft}$

@ End of 2 plate section

$M_a = P_{bc} Z_{top} = 7.47 \times 4863 \times \frac{1}{12}$

$= 3029 \text{ ton ft}$

tension governs. $M_a = 2956 \text{ ton.ft}$

CALCULATION SHEET

JACOBS

Project Title		Sheet No 30a	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

$I_c = 0\ 625 \times 28^3 \times \frac{1}{12}$

$\quad + 8\ 3/8^3 \times \frac{1}{2} \times \frac{1}{12}$

$= 1168 \text{ in}^4$

$a = 64 \text{ in}$

$E = 12945 \text{ ton/in}^2, \quad \delta = 0\ 276 \text{ in/ton}$

$L = 2.5 \times (12945 \times 1168 \times 64 \times 0.276)^{0\ 25}$

$= 320 \text{ in}$

$r_y = \sqrt{\frac{4166}{86}} = 6\ 96 \text{ in}$

$L/r_y = 320/6\ 96 = 45\ 98$

$D/T = \frac{97\ 25}{10 \times (0\ 625 \times 23\ 625 + 1\ 1625 \times 8.375) - 28}$

111

$C_s = \frac{170000}{45\ 98^2} \sqrt{\left[1 + \frac{1}{20}\left(45\ 98 \times \frac{1}{111}\right)^2\right]}$

$= 80.75$

Table 8 $\quad p_{bc} = 9\ 2 \text{ ton/in}^2$

CALCULATION SHEET

JACOBS

Project Title				Sheet No 31	
Subject ARC/35 : Capacity of edge girder 1 plt flange section				Calc No	
Job No				File	
Made By [redacted]	Date 01/07	Revised By		Date	
Checked By [redacted]	Date 3/07	Checked By		Date	

$$P_{bc} = 1.25 \times 9.2 \times \frac{10.75}{16} = 7.73 \text{ ton/in}^2$$

$$M_a = 7.73 \times 2897.2 \times \frac{1}{12}$$

$$= 1866 \text{ ton ft}$$

$$P_{bt} = 7.98 \text{ ton/in}^2$$

sht 2 $M_a = 7.98 \times 2768 \times \frac{1}{12}$

$$= 1841 \text{ ton ft}$$

@ end of 1 plate section

Shear capacity of edge girder

Table 3 $p_v = 6.0 \text{ ton/in}^2$ (shear)

$$V_a = p_v \times 1.25 \times A_{web} \times 10.75/16$$

sht 2 $= 6^* \times 1.25 \times 97.25 \times 3/8 \times 10.75/16$

$= 184$ tons @ support

* BS 153 : 38 : Clause 29a equation gives $p_v = 6.15$ ton/in^2 ∴ correct to use 6.0 ton/in^2.

CALCULATION SHEET

JACOBS

Project Title				Sheet No 32
Subject ARC/35 Section capacities · Transverse girders.				Calc No
Job No				File
Made By [redacted]	Date 02/07	Revised By		Date
Checked By [redacted]	Date 3/07	Checked By		Date

Section capacities · Transverse girders

All transverse girders are restrained against compression flange buckling by the buckle plate and concrete infill

$P_{bc} = 8.4 \text{ ton/in}^2$

transverse girders 1-8 & 33-40

$d_1 = 26 - 2 \times 3\frac{1}{2} = 19 \text{ in}$

$d_1/t = 19/0.375 = 50.67 \not> 85$

Table 3 $P_{bt} = 1.25 \times 10 \times \frac{10.75}{16} = 8.4 \text{ ton/in}^2$

tension zone governs

Sht 6 $M_a = 8.4 \times 168.45 \times \frac{1}{12} = \underline{118 \text{ ton.ft}}$

(girders 8-1 & 33-40)

$p_v = 6.0 \text{ ton/in}^2$

$V_a = 6 \times 1.25 \times 26 \times \frac{3}{8} \times \frac{10.75}{16} = \underline{49 \text{ tons}}$

(girders 8-1 & 33-40)

CALCULATION SHEET

JACOBS

Project Title				Sheet No 33
Subject				Calc No
Job No				File
Made By [redacted]	Date 02/07	Revised By		Date
Checked By [redacted]	Date 3/07	Checked By		Date

transverse girders 9-16 & 25-32

$M_a = 84 \times 307.87 \times \frac{1}{12} = \underline{216 \text{ ton.ft}}$

$V_a = 6 \times 125 \times 25.5 \times \frac{15}{32} \times \frac{10.75}{16}$

$\underline{= 60.23 \text{ tons}}$

transverse girders 17-20 & 21-24

$M_a = 84 \times 333.75 \times \frac{1}{12} = \underline{234 \text{ ton.ft.}}$

$V_a = 6 \times 125 \times 28 \times 3/8 \times 10.75/16$

$\underline{= 53 \text{ tons}}$

CALCULATION COVER SHEET

Jacobs
Reading

Project Title·	BRB (Residuary) Ltd - Major Works 2004/2007	Calc. No	97 4
Job No·	J24110JR	File	R11
Project Manager	[redacted]	Subject	AKC/35
Designer			A697 Wooler
Project Group	31400		Live Load Effects - Transverse Girders

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	17	JDC	Jan-07	JLR	Mar-07				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

CALCULATION SHEET

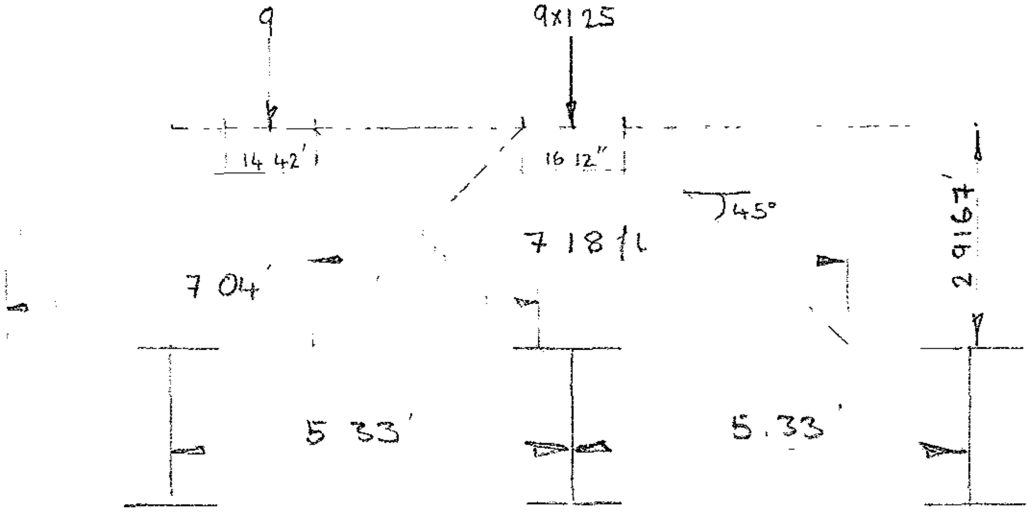
JACOBS

Project Title				Sheet No 34	
Subject	ARC/35 : Live loads on transverse girders			Calc No	
Job No				File	
Made By	[redacted]	Date 02/07	Revised By		Date
Checked By	[redacted]	Date 3/07	Checked By		Date

This type of deck construction (Buckle plates connected to top flanges of cross girders) does not fall under any of the categories listed in 303 (c)(i) therefore distribution of load by structural interaction is not considered

Therefore for load effects on transverse girders both 11 ton and twin 9 ton axles will be considered

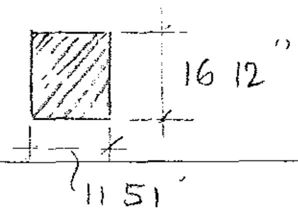
twin 9 ton axles :



impact · wheel contact area ·

302 (e) $= 9 \times 1.25 \times 33 \times \frac{1}{2} = 185.63 \text{ in}^2$

$b = \sqrt{185.63 / 1.4} = 11.51 \text{ in}$



CALCULATION SHEET

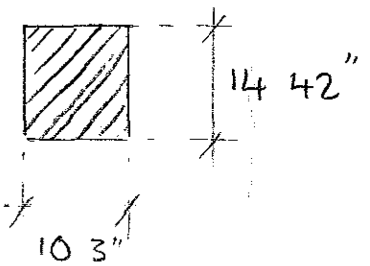
JACOBS

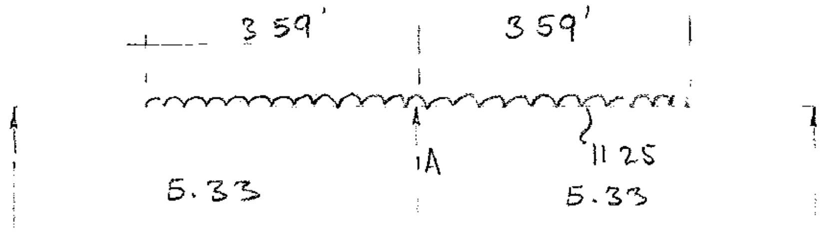
Project Title			Sheet No 35	
Subject			Calc No	
Job No			File	
Made By [redacted]	Date 02/07	Revised By		Date
Checked By [redacted]	Date 3/07	Checked By		Date

9 ton wheel contact area

$= 9 \times 33 \times \frac{1}{2} = 148\ 5\ in^2$

$b = \sqrt{\frac{148.5}{1 \cdot 4}} = 10\ 3\ in$

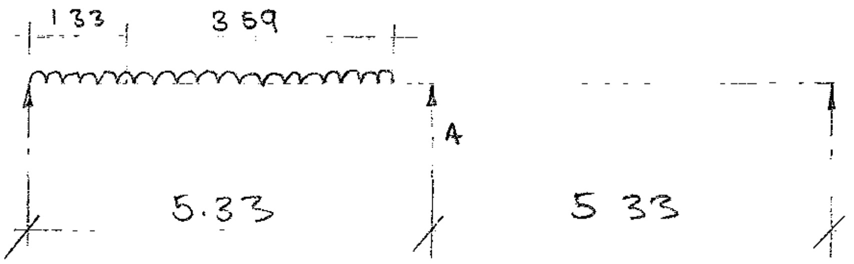




load on A

$11.25 \times \left(5\ 33 - \frac{3\ 59}{2}\right) \div 5\ 33$

= 7 46 tons (5.968 without impact)



load on A

$11\ 25 \times \left(\frac{1\ 33 + 3\ 59}{7\ 04}\right) \times \left(\frac{1\ 33 + 3\ 59}{2}\right) - 5\ 33$

= 3 63 tons

TOTAL on A = 7 46 + 3 63 = 11.1 tons

= 9 6 tons (without impact axle)

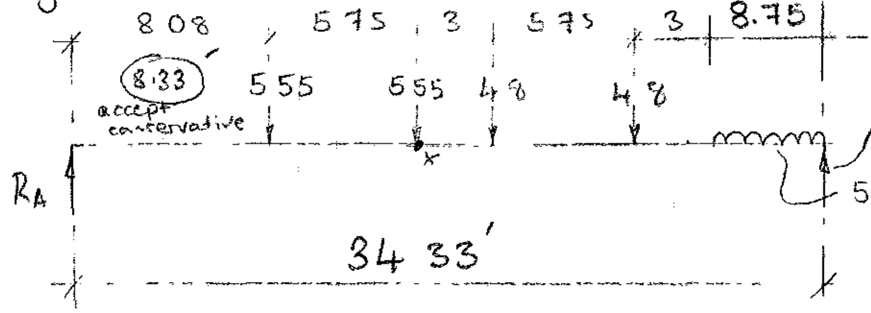
CALCULATION SHEET

JACOBS

Project Title		Sheet No	36
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

girder 20 Unpropped

BE4 302(a)



50 lbs/ft²
= 266 5 lbs/ft
= 0.119 ton/ft

R_A = 0 119 x 8.75² x ½ + 4 8 x (11 75 + 17.5)
+ 5 55 x (20 5 + 26 25) ÷ 34 33
= 11.78 tons (R_B = 9.96) = shear @ support

by inspection point of max moment is at x

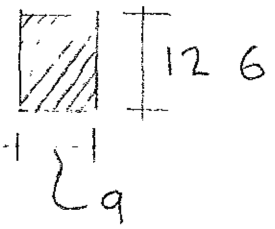
M = 11 78 x 13 83 − 5.55 x 5 75
= 131 ton ft.

Consider 11 ton axle with four wheels

11 ton wheel contact area

= 11 x 125 x 33 x ¼ = 113

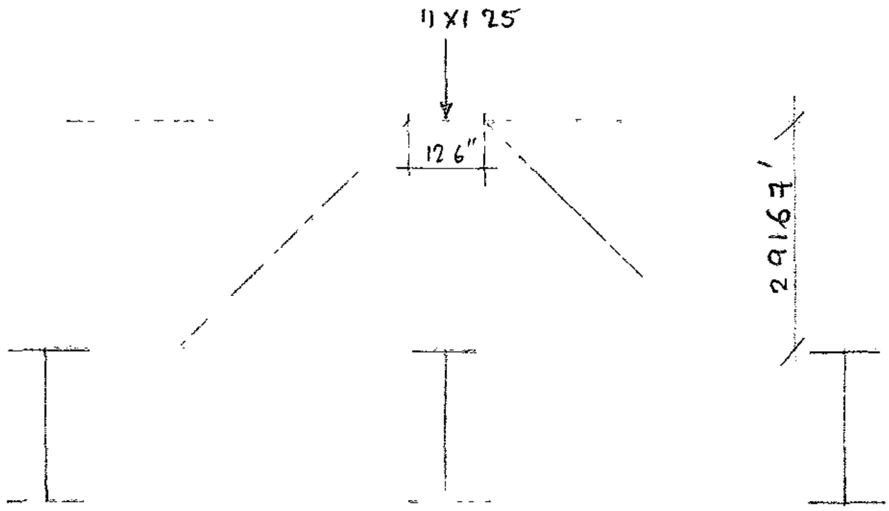
$b = \sqrt{\frac{113\ 44}{14}}$ = 9 in

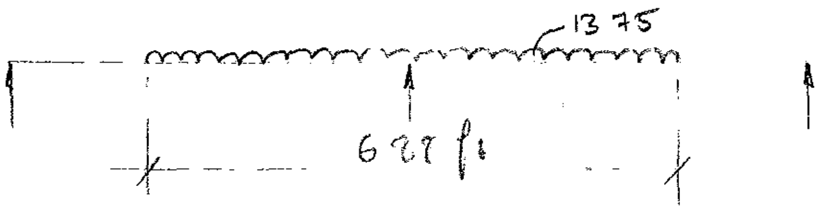


CALCULATION SHEET

JACOBS

Project Title		Sheet No	37
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date





load on A

$= 13.75 \times \left(5.33 - \frac{6.88}{4}\right) \div 5.33$

$= 9.31$ tons < 11.1

By inspection twin 9 ton axles have a greater effect

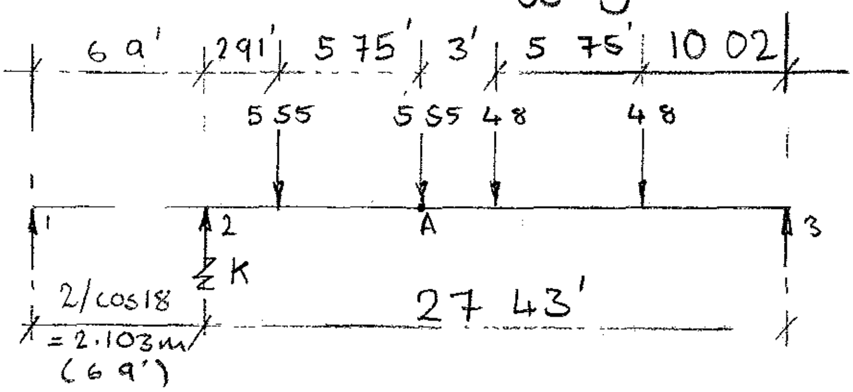
CALCULATION SHEET

JACOBS

Project Title				Sheet No 38
Subject				Calc No
Job No				File
Made By [redacted]	Date 02/07	Revised By		Date
Checked By [redacted]	Date 3/07	Checked By		Date

girder 20 · propped, sagging

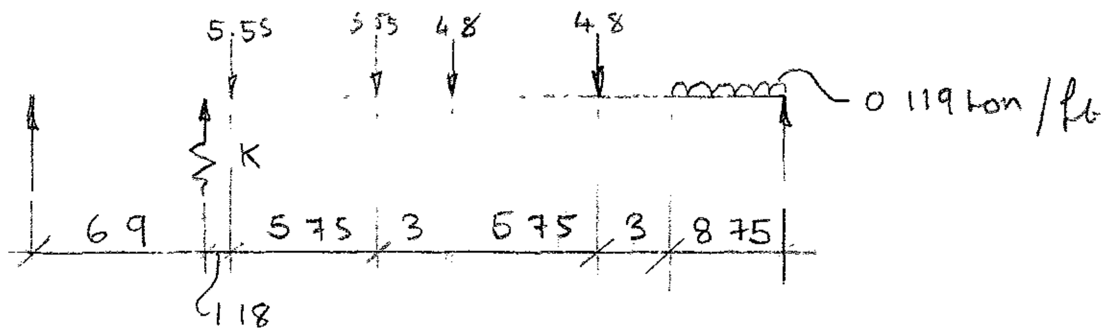
See shts 39 & 40



Apply loads with point A at point of max dead load moment = 8.66' from point 2

girder 20 · propped, hogging

See shts 41 & 42



The stiffness value of K is taken from the carl bro assessment p 15 The trestles are positioned about 2m from the abutment.

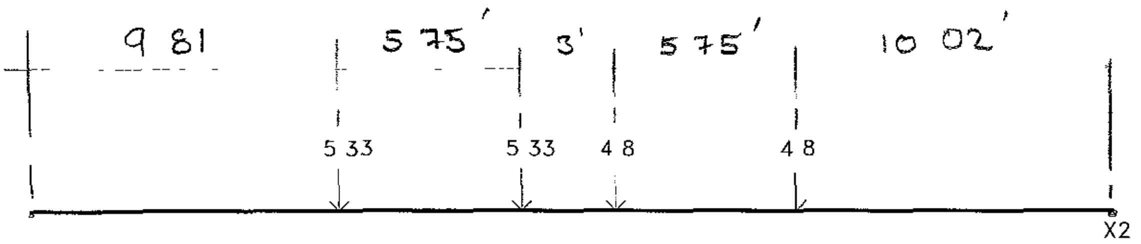
K = 284835 kN/m = 8727 ton/ft

the value of stiffness is very stiff and is effectively acting as a pinned support

AKC/35: L effects for girder20 with trestle support

Load 2: live loading

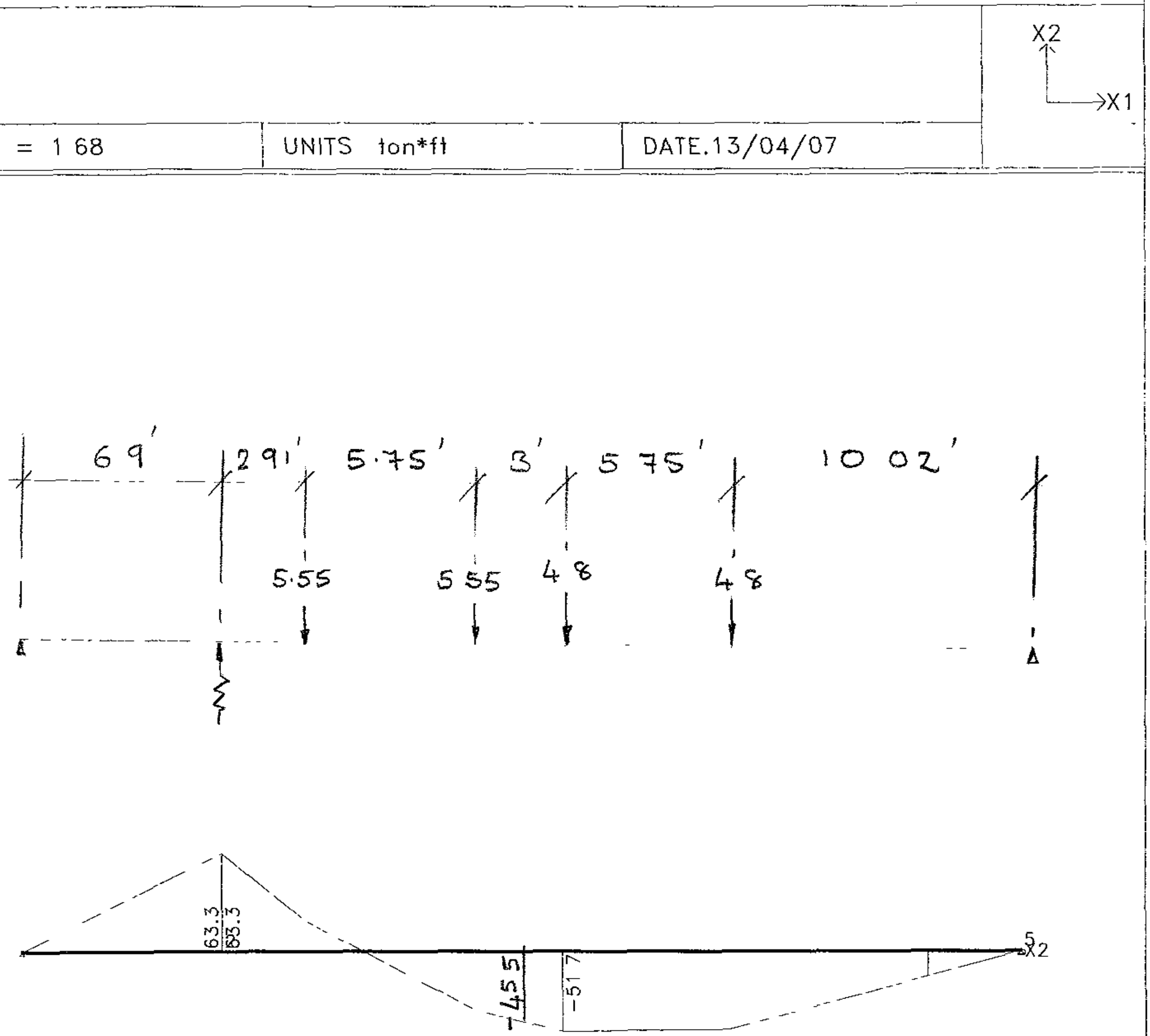
SCALE = 1 73	UNITS ton ft	DATE 13/04/07



SHEET No 38a
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED B[redacted]

AKC/35: L effects for girder20 with trestle support

SCALE = 1 68	UNITS ton*ft	DATE.13/04/07



M3 MOMENT LOAD NO 1 live loading

SHEET No 38b
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED BY [redacted]

AKC/35: L effects for girder20 with trestle support

SCALE = 1 68	UNITS ton*ft	DATE 13/04/07

M3 MOMENT LOAD NO 1 live loading positioned for max hogging

SHEET No 38c
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED BY [redacted]

CALCULATION SHEET

JACOBS

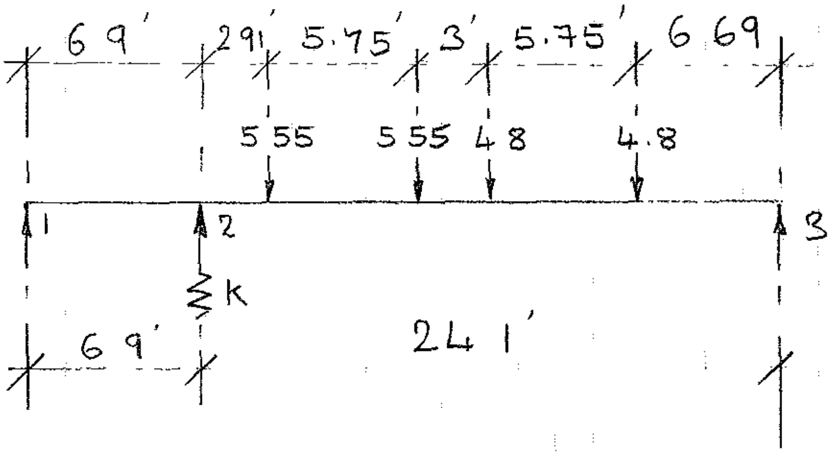
Project Title	Sheet No 38d
Subject	Calc No
Job No	File

Made By [redacted]	Date 04/07	Revised By	Date
Checked By [redacted]	Date 4/07	Checked By	Date

Determine line load effects for girder 18

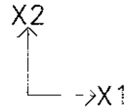
effective length = 32' - 2'/2 = 31'

wheels positioned for maximum sagging effect.

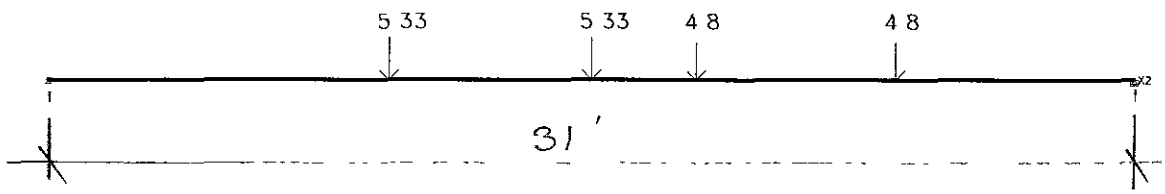


AKC/35: L effects for girder ~~20~~ 18 with trestle support

Load 2: live loading



SCALE = 1 66	UNITS ton ft	DATE 15/02/07

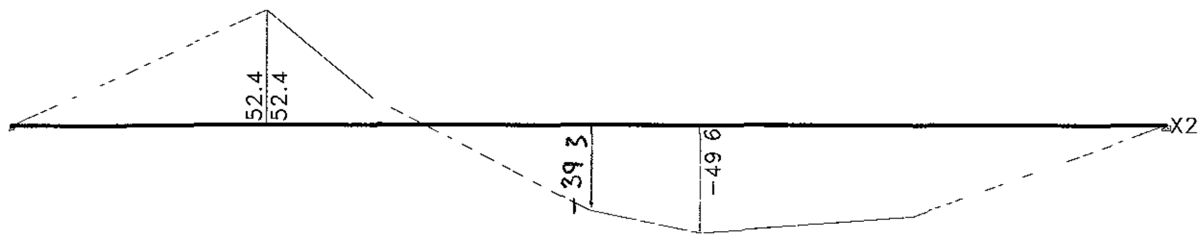


SHEET No. 39
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED BY [redacted]

AKC/35: L effects for girder~~20~~ 18 with trestle support

X2
X1

SCALE = 1 62	UNITS ton*ft	DATE 15/02/07



M3 MOMENT LOAD NO 1 live loading

SHEET No. 40

CALC No

FILE

JOB No

MADE BY [redacted]

CHECKED B[redacted]

Jacobs Gibb Ltd
GIBB House, London Road
Reading RG6 1BL

AKC/35 L effects for girder ~~20~~ 18 with trestle support

Prepared by. [redacted] *Date.* 15/02/07

BEAM RESULTS for load no 1 (Units ton, ton*ft)
live loading

Bm.	*Node*		*Axial*	*V2*	*M3*
1	1		0 000	-7 592	0 000
	2		0 000	7 592	-52 383
2	2		0 000	14 115	52 383
		fr=0 48		-1 345	-49 559
	3		0 000	6 145	0 000
MAXIMUM			0 000	14 115	52 383
Beam no.			2	2	2

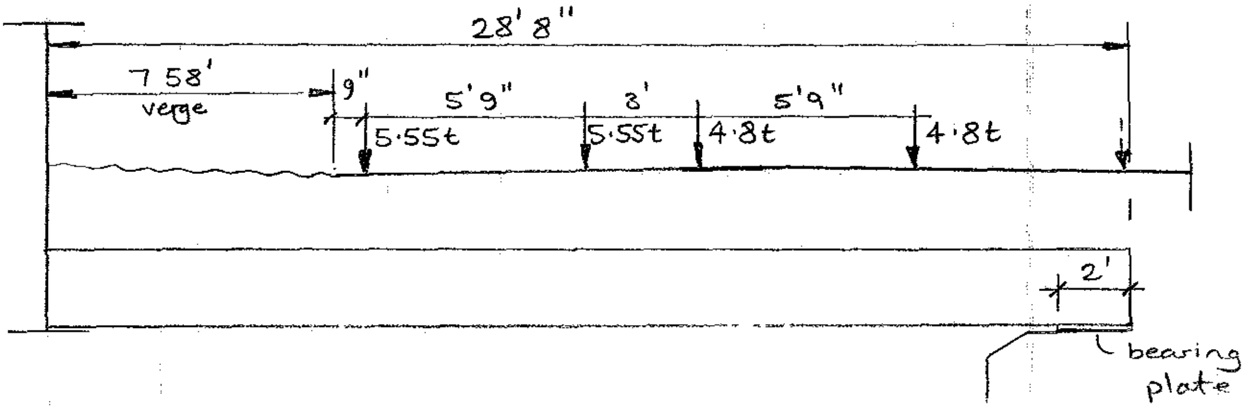
SHEET No 41
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED BY [redacted]

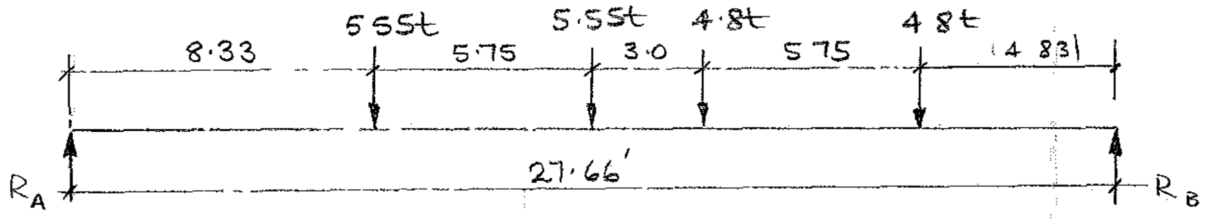
CALCULATION SHEET

JACOBS

Project Title		Sheet No 43	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 3/07	Revised By	Date
Checked By [redacted]	Date 4/07	Checked By	Date

Transverse girder No 16 (longest unpropped)





$R_B = \{5\ 55(8\ 33 + 14\ 08) + 4.8(17.08 + 22\ 83)\} \div 27\ 66$

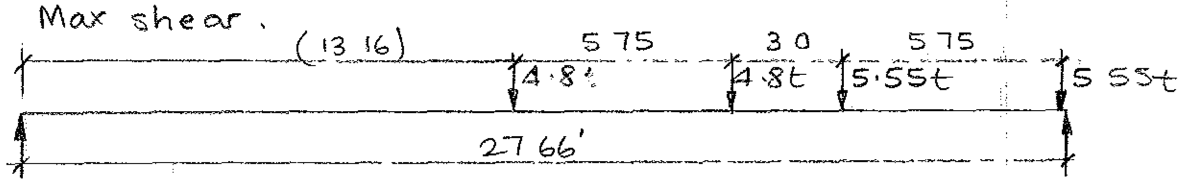
$= 11\ 42$ tons ✓

Approx max moment

$= (11.42 \times 13.58) - 3 \times 4.8 - 8\ 75 \times 4.8$

$=$ <u>98.68 ton ft</u> ✓

Max shear.



$R_B = \{4.8(13.16 + 18.91) + 5\ 55(21.91 + 27.66)\} \div 27.66$

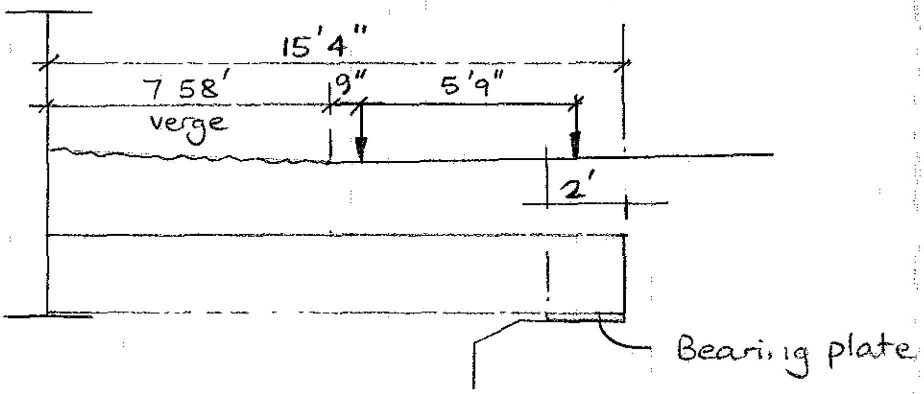
$=$ <u>15.51 tons</u> ✓

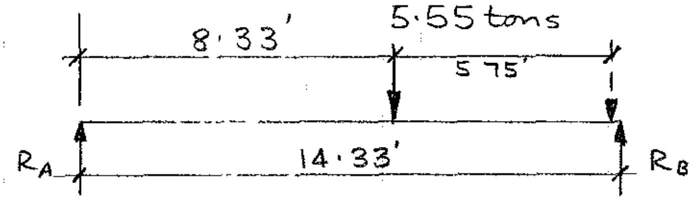
CALCULATION SHEET

JACOBS

Project Title		Sheet No	44
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 3/07	Revised By	Date
Checked By [redacted]	Date 4/07	Checked By	Date

Transverse girder No 8 (longest without flange plate)





$$R_B = 5.55 \times \frac{8.33}{14.33} = 3.22 \text{ tons}$$ ✓

Max live moment

$$= 3\ 22 \times 6 = 19.32 \text{ ton ft}$$ ✓

CALCULATION COVER SHEET

Jacobs
Reading

Project Title	BRB (Residuary) Ltd - Major Works 2004/2007	Calc No.	97 5
Job No	J24110JR	File	R11

Project Manager	[redacted]	Subject	AKC/35
Designer			A697 Wooler
Project Group	31400		Live load effects - main (edge) girders

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	15	[redacted]	Feb-07	[redacted]	Mar-07				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No Date

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

CALCULATION SHEET

JACOBS

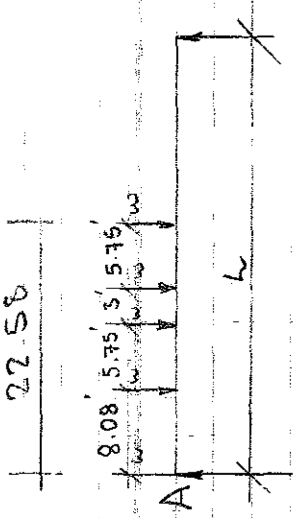
Project Title		Sheet No 45	
Subject AKC/35	Live Loads edge girder	Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

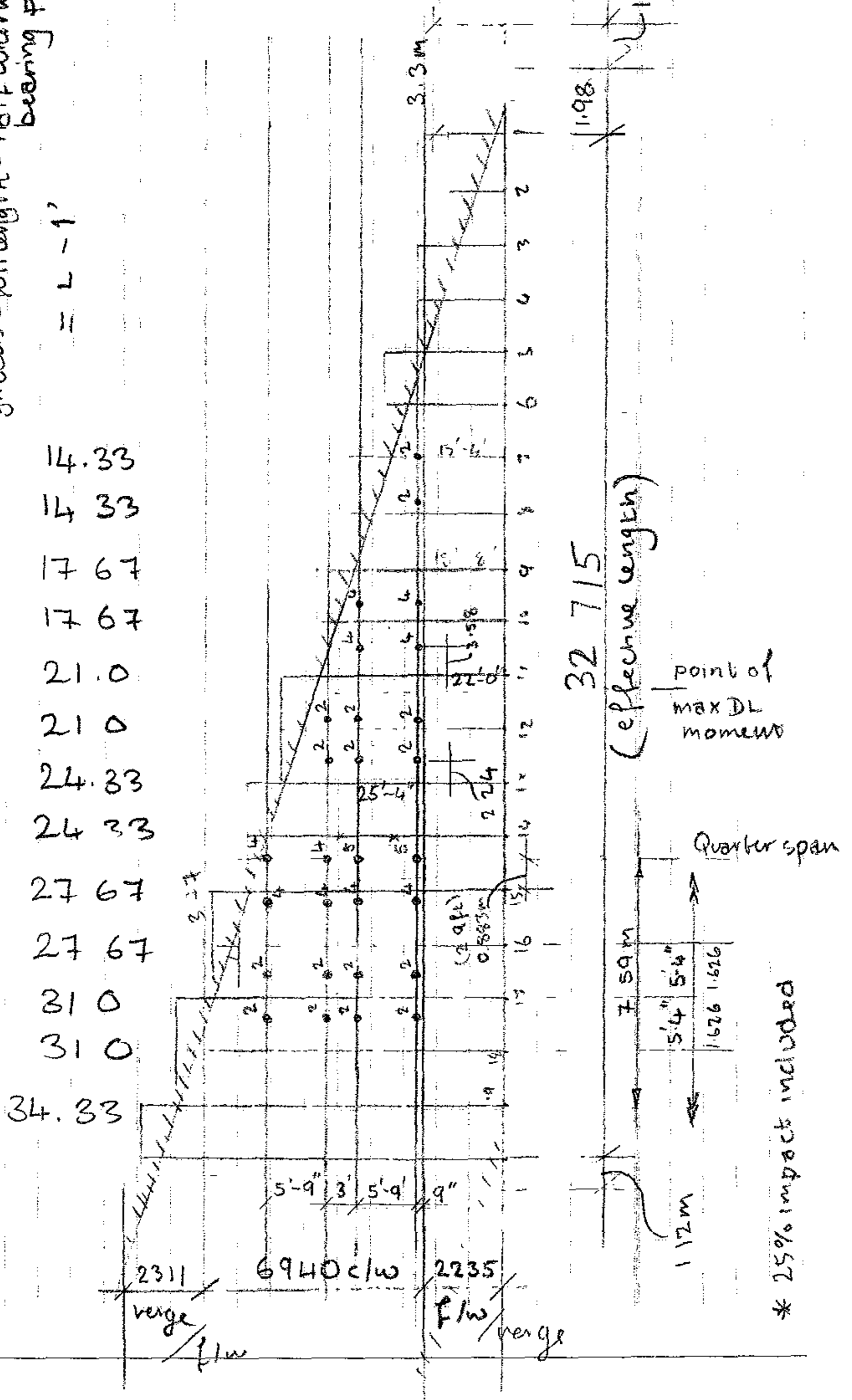
for moments about A multiply w by
4 = = = 61.32
3 = = = 38.74
2 = = = 21.91
1 wheel multiply by 8.08

0.33w = 0.33 × 24
= 7.92 tons/axle

0.167w = 4.008 tons/axle

effective length of transverse girders = full length - half width of bearing plate
= L - 1'





* 25% impact included

JACOBS

CALCULATION SHEET

Project Title		Sheet No	46
Subject		Calc No	
Job No		File	
Made by [redacted]	Date 01/07	Revised	Date
Checked by [redacted]	Date 3/07	Checked by	Date

x-girder length 22 95' (girder 15)

loading from adjacent wheels :- simply distributed

= 2.28 + 2.8 = 5.08 (critical) , 2 28 + 2.24 = 4.52

girder 16 loading

$= 4 - 2\ 8 + 2 \times \frac{(5.33 - 3\ 77)}{5.33} = 1\ 79$ tons

girder 17 loading

$= 2 - 0\ 59 + 2 \times \frac{5\ 33 - 2\ 94}{5\ 33} = 2\ 31$ tons

girder 14 loading

= 5 - 2 8 = 2.2 tons (critical)

= 4 - 2 24 = 1 76 tons

girder 13 loading

$= 2 \times \frac{(5\ 33 - 2.24)}{5\ 33} = 1\ 16$ tons

girder 12 loading

$= 2 - 1\ 159 + 2 \times \frac{5\ 33 - 1\ 41}{5\ 33} = 2\ 31$ tons

girder 11 loading

$= 2 - 1.47 + 4 \times \frac{5\ 33 - 3\ 58}{5.33} = 1\ 84$ tons

girder 10 loading

$= 4 - 1\ 31 + 4 \times \frac{5\ 33 - 2\ 75}{5\ 33} = 4\ 63$ tons

girder 9 loading

= 4 - 1 94 = 2 06 tons

CALCULATION SHEET

JACOBS

Project Title		Sheet No 47	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

girder 8 loading

$$= 2 \times \frac{533-209}{533} = 1.22 \text{ tons}$$

girder 7 loading

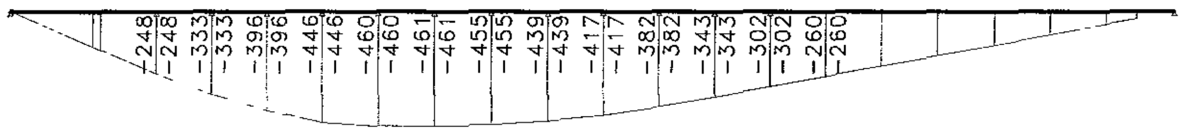
= 2 tons.

girder 18 loading

= 2 − 0.90 = 1.1 tons

AKC/35 grillage model

SCALE = 1 220	UNITS ton*ft	DATE 15/02/07



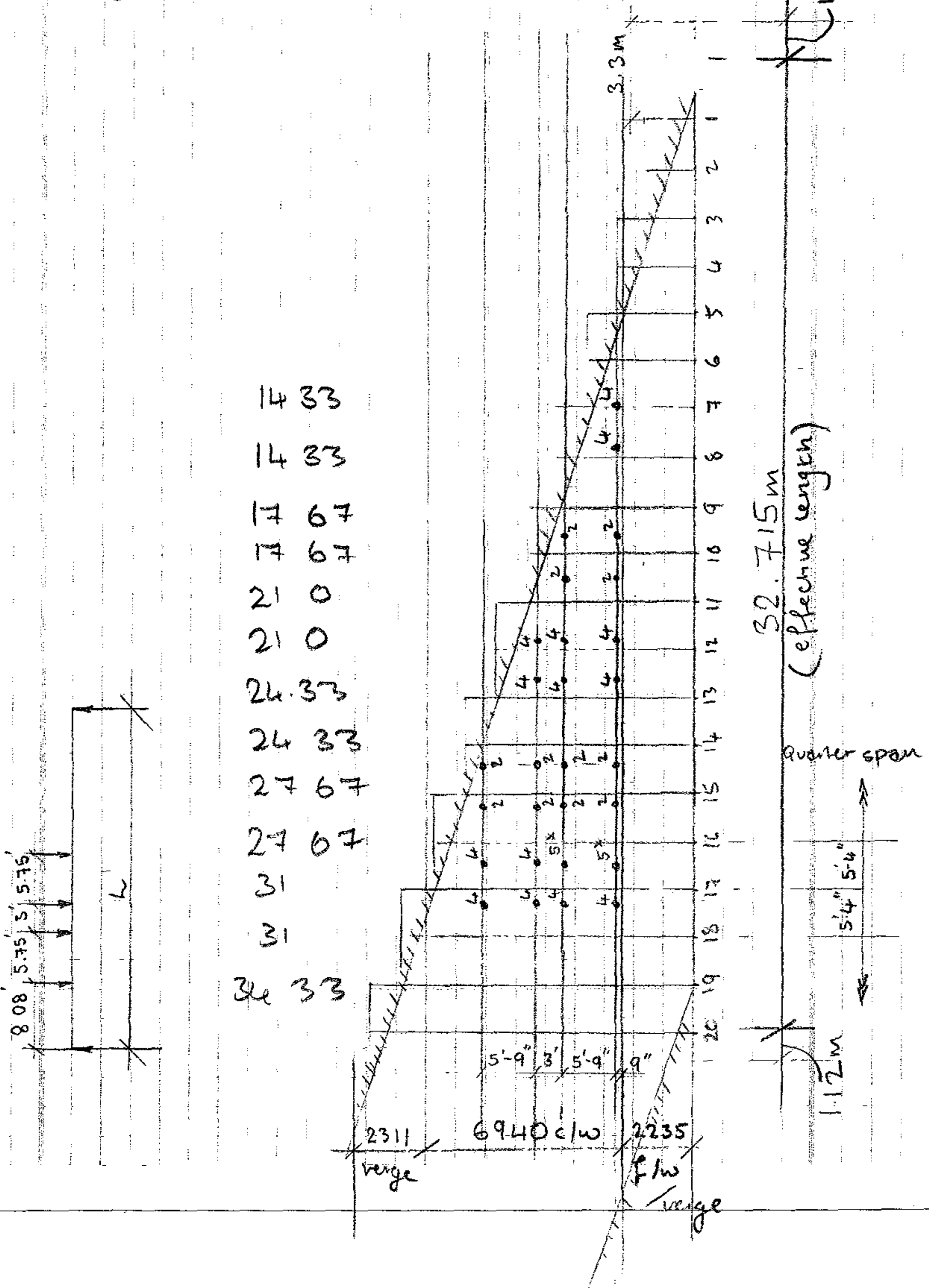
M2 MOMENT LOAD NO 1 24 Ton vehicle positioned for maximum mo

CALCULATION SHEET

JACOBS

Project Title		Sheet No	50
Subject	AKC/35 Live Loads edge girder	Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

Try different wheel pattern



CALCULATION SHEET

JACOBS

Project Title			Sheet No 51
Subject			Calc No
Job No			File
Made By [redacted]	Date 01/07	Revised By	Date
Checked By	Date 3/07	Checked By	Date

loads on cross girder simply distmbuted from adjacent wheels.

wheels are in same position but vehicles are facing the other direction

girder 18

$= 11 \times \frac{4}{2} = 22$ tons

girder 17

$= \frac{5}{2} \times (2 - 0\ 59) + \frac{4}{2} \times \left(2 \times \frac{5.33 - 2\ 94}{5.33}\right)$

$= 3\ 525 + 1\ 794 = 5.32$ tons (critical)

$3\ 525 \times \frac{4}{5} + 1.794 = 4\ 614$ tons

girder 16

$= 1\ 79 \times \frac{5}{2} = 4\ 475$ tons (crinical), $1\ 79 \times \frac{4}{2} = 3\ 58$ tons

girder 15

$= \frac{2}{4} \times 4.52 = 2\ 26$ tons

girder 14

$= \frac{2}{4} \times 1.76 = 0\ 88$ tons

girder 13

$= \frac{4}{2} \times 1\ 16 = 2.32$ tons

girder 12

$= \frac{4}{2} \times 2\ 31 = 4.62$ tons

CALCULATION SHEET

JE JACOBS

Project Title				Sheet No 52	
Subject				Calc No	
Job No				File	
Made By [redacted]	Date 01/07	Revised By		Date	
Checked By	Date 3/07	Checked By		Date	

girder 11

$= (2 - 1.47) \times 4/2 + 2/4 \times \left(4 \times \frac{5.33 - 3.58}{5.33}\right)$

$= 1.06 + 0.164 = 1.22$ tons

girder 10

$= 2/4 \times 4.63 = 2.315$ tons

girder 9

$= 2/4 \times 2.06 = 1.03$ tons

girder 8

$= 4/2 \times 1.22 = 2.44$ tons

girder 7

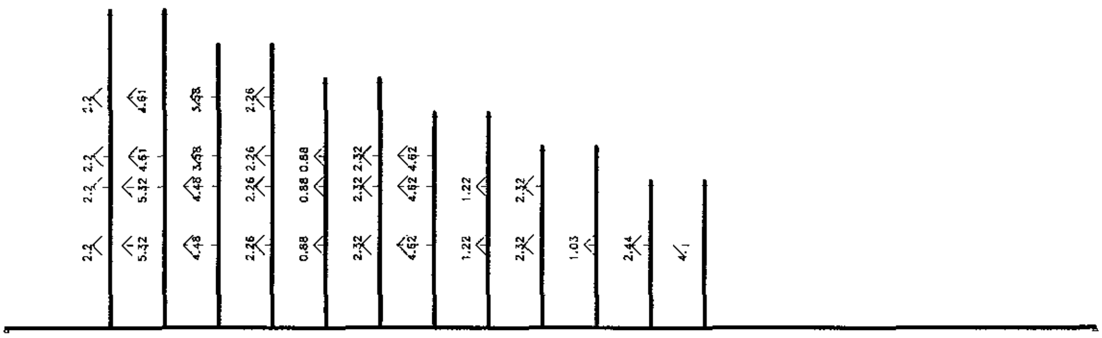
$= 4$ tons

AKC/35 grillage model 2

Load 1: 24 Ton vehicle positioned for maximum moment n

SCALE = 1 227	UNITS ton ft	DATE 13/04/07

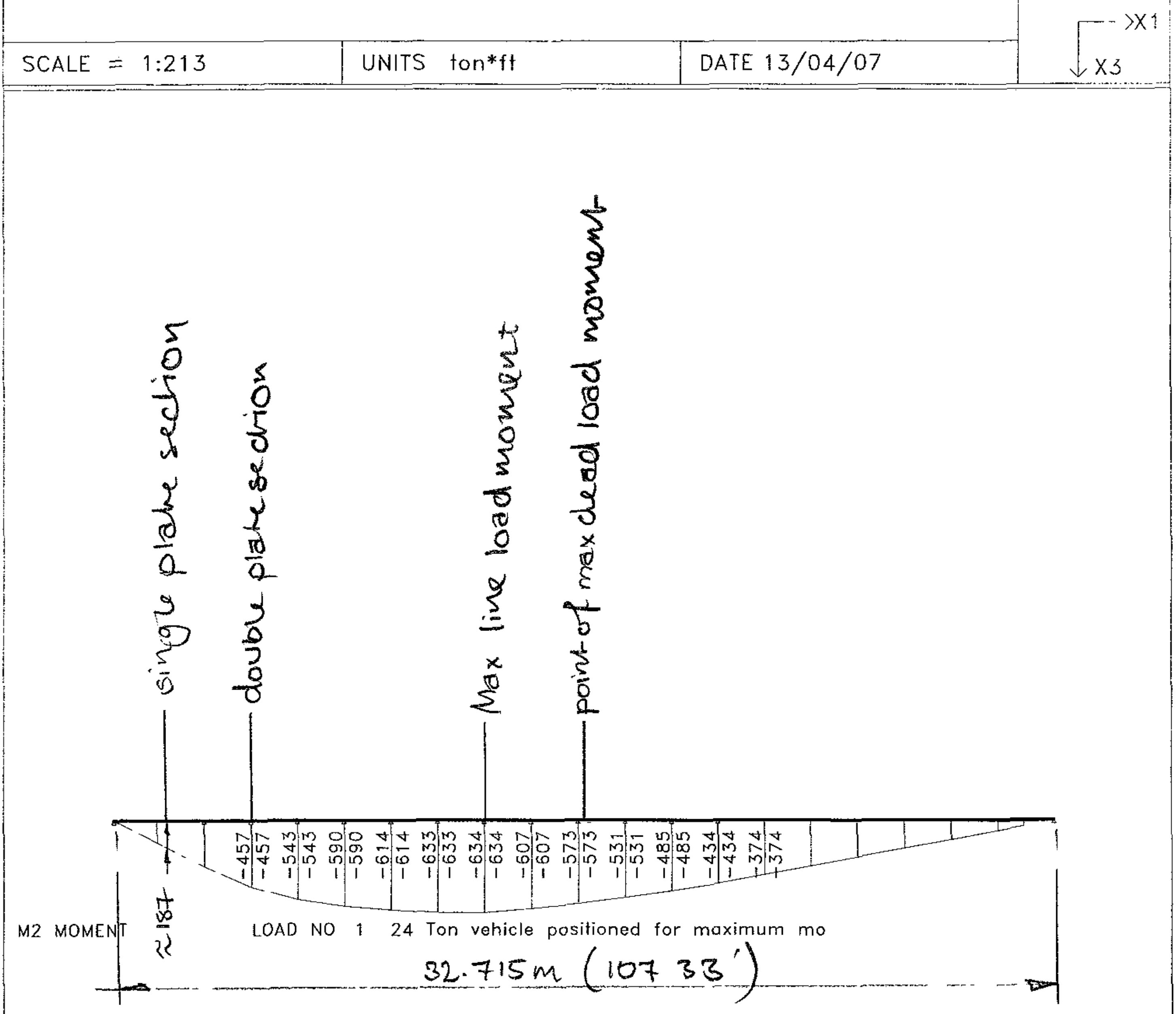
X2 → X1



SHEET No 53
CALC No
FILE
JOB No
MADE BY
CHECKED BY [redacted]

AKC/35 grillage model 2

SCALE = 1:213	UNITS ton*ft	DATE 13/04/07



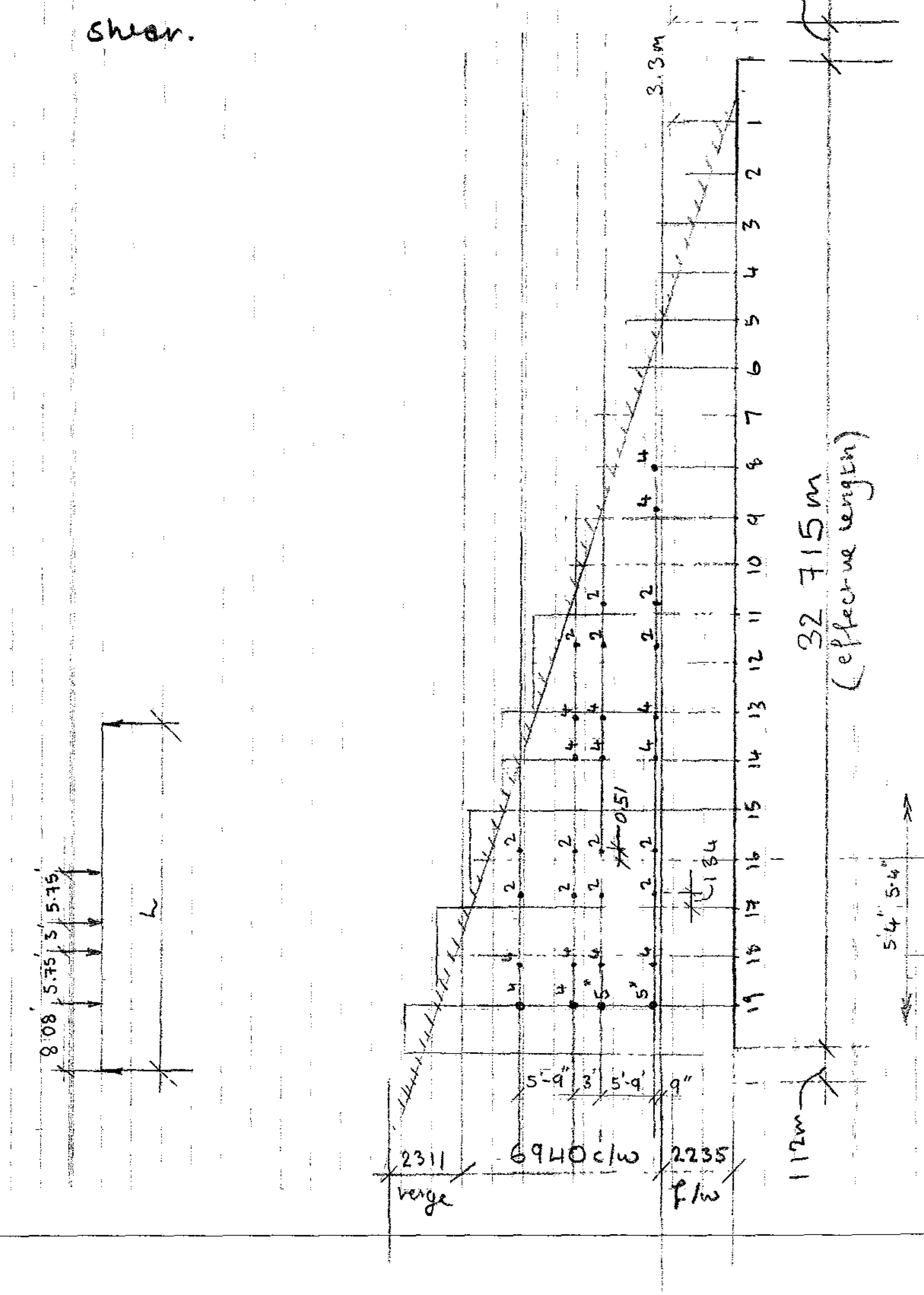
SHEET No 54
CALC No
FILE
JOB No
MADE BY
CHECKED BY [redacted]

CALCULATION SHEET

JACOBS

Project Title		Sheet No	55a
Subject	AKC/35 Live Loads edge girder	Calc No	
Job No		File	
Made By [redacted]	Date 01/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

wheels positioned for maximum shear.



CALCULATION SHEET

JACOBS

Project Title			Sheet No 55b	
Subject			Calc No	
Job No			File	
Made By [redacted]	Date 02/07	Revised By	Date	
Checked By	Date 3/07	Checked By	Date	

loads simply distributed to transverse girders

girder 19

impact $5 + \frac{(5.33 - 4.5)}{5.33} \times 4 = 5.62T$

non impact $4 +$ " $= 4.62T$

girder 18

$4 - 0.62 = 3.38T$

girder 17

$2 \times \frac{(5.33 - 1.34)}{5.33} = 1.5T$

girder 16

$2 - 1.5 + 2 \times \frac{(5.33 - 0.51)}{5.33} = 2.3T$

girder 15

$2 - (2.3 - 0.5) = 0.2T$

girder 14

$4.62T$

girder 13

$= 3.38T$

girder 12

$= 1.5T$

CALCULATION SHEET

JE JACOBS

Project Title				Sheet No	55c
Subject				Calc No	
Job No				File	
Made By [redacted]	Date 2/07	Revised By		Date	
Checked By [redacted]	Date 3/07	Checked By		Date	

girder 11

= 2.3T

girder 10

= 0 2T

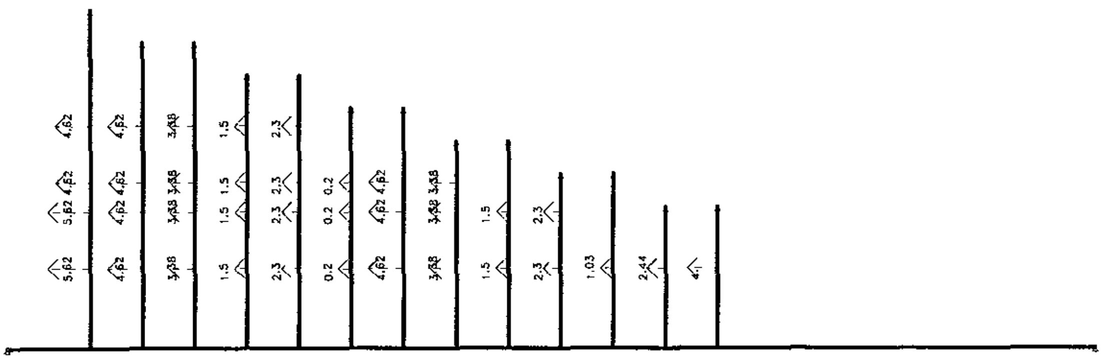
AKC/35 grillage model 2 shear

Load 1: 24 Ton vehicle positioned for maximum shear at

X2

X1

SCALE = 1 235	UNITS ton ft	DATE 13/04/07



SHEET No. 55d

CALC No

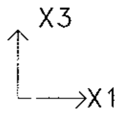
FILE

JOB No

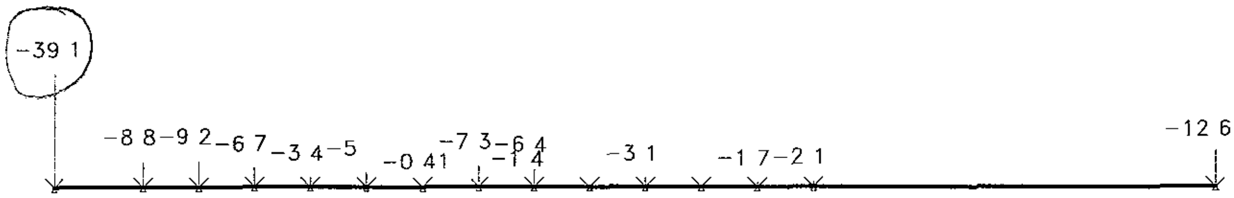
MADE BY [redacted]

CHECKED BY [redacted]

AKC/35 grillage model 2 shear



SCALE = 1 220	UNITS ton	DATE 13/04/07



REACTIONS LOAD NO 1 24 Ton vehicle positioned for maximum sh

SHEET No. 55e
CALC No
FILE
JOB No
MADE BY [redacted]
CHECKED BY [redacted]

CALCULATION SHEET

JACOBS

Project Title		Sheet No	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

Hand check of STRAP model.

$R_{18} = 4 \times 2\ 2 - 2\ 2 \times 61\ 32 / 31 = 4\ 08$ Ton

$R_{17} = 4\ 614 \times (4\ 2 \times 2 + 5\ 75) + 5\ 32 \times (12\ 95 + 18\ 7) \div 26\ 7$

$= 8.73$ Tons

$R_{16} = 3\ 58 \times (2\ 38 \times 2 + 5\ 75) + 4\ 475 \times (8\ 13 + 11\ 13) \div 24.96$

$= 4\ 96$ Tons

$R_{15} = 4 \times 2\ 26 - 2\ 26 \times 61\ 32 / 23\ 45 = 3\ 13$ Tons

$R_{14} = 3 \times 0\ 88 - 0\ 88 \times 38\ 74 / 21\ 62 = 1\ 06$ Tons

$R_{13} = 3 \times 1\ 16 - 1.16 \times 38\ 74 / 20\ 11 = 1\ 25$ Tons

$R_{12} = 3 \times 4\ 62 - 4\ 62 \times 38.74 / 18\ 29 = 4.07$ Tons

$R_{11} = 2 \times 1.22 - 1\ 22 \times 21\ 91 / 16\ 78 = 0\ 85$ Tons

$R_{10} = 2 \times 2.315 - 2\ 315 \times 21\ 9 / 14\ 96 = 1\ 24$ Tons

$R_{9} = 1\ 03 \times \frac{13\ 45 - 8.08}{13\ 45}$ $0\ 41$ Tons

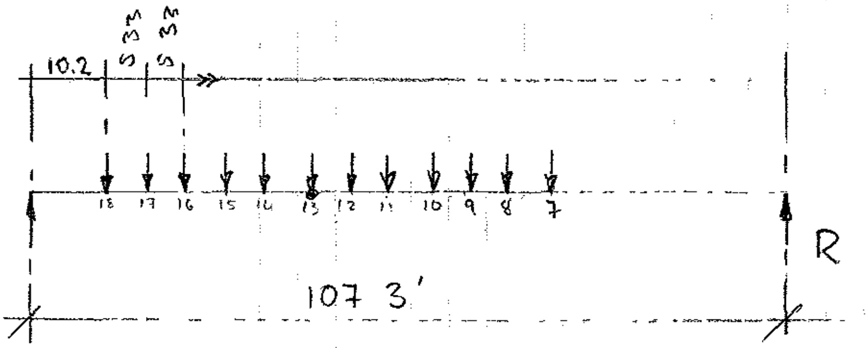
$R_{8} = 2.44 \times (11\ 62 - 8\ 08) / 13\ 45 = 0\ 26$ Tons

$R_{7} = 4 \times (10\ 11 - 8\ 08) / 10\ 11 = 0\ 8$ Tons.

CALCULATION SHEET

JACOBS

Project Title				Sheet No
Subject				Calc No
Job No				File
Made By [redacted]	Date 02/07	Revised By		Date
Checked By [redacted]	Date 3/07	Checked By		Date



$$R = (4\ 03_{(18)} \times 10\ 2 + 8\ 73_{(17)} \times 15\ 53 + 4\ 96_{(16)} \times 20\ 86$$

$$+ 3\ 13_{(15)} \times 26.19 + 1\ 06_{(14)} \times 31\ 52 + 1\ 25 \times 36\ 85$$

$$+ 4\ 07_{(12)} \times 42\ 18 + 0\ 85_{(11)} \times 47\ 51$$

$$+ 1\ 24_{(10)} \times 52\ 84 + 0\ 41_{(9)} \times 58\ 17$$

$$+ 0\ 26_{(8)} \times 63\ 5 + 0\ 8_{(7)} \times 68\ 83) \div 107\ 3$$

$$= 7.59 \text{ Tons}$$

$$M_{13} = 7\ 59 \times (107.3 - 10\ 2 - 5 \times 5\ 33)$$

$$- 4\ 07_{(12)} \times 5\ 33 - 0\ 85 \times 10\ 66 - 1\ 24 \times 15\ 99$$

$$- 0\ 41 \times 20\ 32 - 0\ 26 \times 25\ 65$$

$$- 0\ 8 \times 30\ 98$$

$$= \underline{444 \text{ Ton.ft}}$$

– accept STRAP values

CALCULATION SHEET

JACOBS

Project Title		Sheet No 56	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 07/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

Girder summary Bending Moments.

Edge girders - 3 plate section

pg 28 Bending moment capacity = 4079 ton.ft

pg 15 Dead load moment = 2654 ton.ft

Live load capacity = 1425 ton ft

pg 54 Live load moment (24T) = 634 ton.ft

PASS

Edge girders - 2 plate section

pg 20 Bending moment capacity = 2956 ton.ft

pg 15 Dead load moment 1503 ton ft

Live load capacity = 1453 ton ft

pg 54 Live load moment (24T) = 457 ton ft

PASS

Edge girders - 1 plate section

pg 31 Bending moment capacity = 1841 ton ft

pg 14 Dead load moment = 641 ton.ft

Live load capacity = 1200 ton ft

pg 54 Live load moment (24T) = 187 ton.ft

PASS

CALCULATION SHEET

JACOBS

Project Title		Sheet No 57	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By	Date 3/07	Checked By	Date

Transverse girder 20 (unpropped)

pg 33 Bending moment capacity = 234 ton ft

pg 11 Dead load moment = 140.5 ton ft

Live load capacity = 93.5 ton ft

pg 36 Live load moment (24 T) = 131 ton ft

FAIL

Transverse girder 20 (propped, sagging)

pg 33 Bending moment capacity = 234 ton ft

propping not jacked

pg 11 Dead load moment = 140.5 ton ft

Live load capacity = 93.5 ton ft

pg 38b Live load moment (24 T) = 45.5 ton ft

PASS

Transverse girder 20 (propped, hogging)

pg 33 Bending moment capacity = 234 ton ft

Dead load moment = 0 ton ft

Live load capacity = 234 ton ft

pg 38c Live load moment (24 T) = 57.7 ton ft

PASS

CALCULATION SHEET

JACOBS

Project Title		Sheet No 58	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

Transverse girder 16

Sht 33	Bending moment capacity	=	216 ton.ft
Sht 11	Dead load moment	=	91.3 ton.ft
	Live load capacity	=	124.7 ton ft
Sht 43	Live load moment (24T)	=	98 68 ton ft

PASS

Transverse girder 8

Sht 32	Bending moment capacity	=	118 ton ft
Sht 11	Dead load moment	=	24.5 ton ft
	Live load capacity	=	93 5 ton ft
Sht 44	Live load moment (24T)	=	19.32 ton.ft

PASS

CALCULATION SHEET

JACOBS

Project Title				Sheet No 59
Subject				Calc No
Job No				File
Made By [redacted]	Date 02/07	Revised By		Date
Checked By	Date 3/07	Checked By		Date

Girder summary shear

Edge girders

pg 31 Shear force capacity = 184 Tons

pg 14 Dead load shear = 124 65 Tons

Live load capacity = 59 35 Tons

pg 55d Live load shear (24T) = 39.1 Tons.

PASS

Transverse girder 20

pg 33 Shear force capacity = 53 Tons

pg 11 Dead load shear = 16.38 Tons

Live load capacity = 36 62 Tons

pg 36 Live load shear (24T) = 11.78 Tons

PASS

Transverse girder 16

pg 33 Shear force capacity = 60.23 Tons

pg 11 Dead load shear = 13 2 Tons

Live load shear capacity = 47 Tons

pg 43 Live load shear (24T) = 15.51 Tons

PASS

CALCULATION SHEET

JACOBS

Project Title		Sheet No 60	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

Transverse girder 8

pg 32	Shear force capacity	=	49 Tons
pg 11	Dead load shear	=	6.8 Tons
	Live load capacity	=	42 2 tons
pg 44	Live load shear (24T)	=	3 22 Tons

PASS

CALCULATION COVER SHEET

Jacobs
Reading

Project Title:	BRB (Residuary) Ltd - Major Works 2004/2007	Calc No	97 6
Job No. J24110JR		File	R11
Project Manager	[redacted]	Subject:	AKC/35
Designer			A697 Wooler
Project Group	31400		Buckle plate check

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	5	JDC	Jan-07	JLR	Mar-07				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No Date

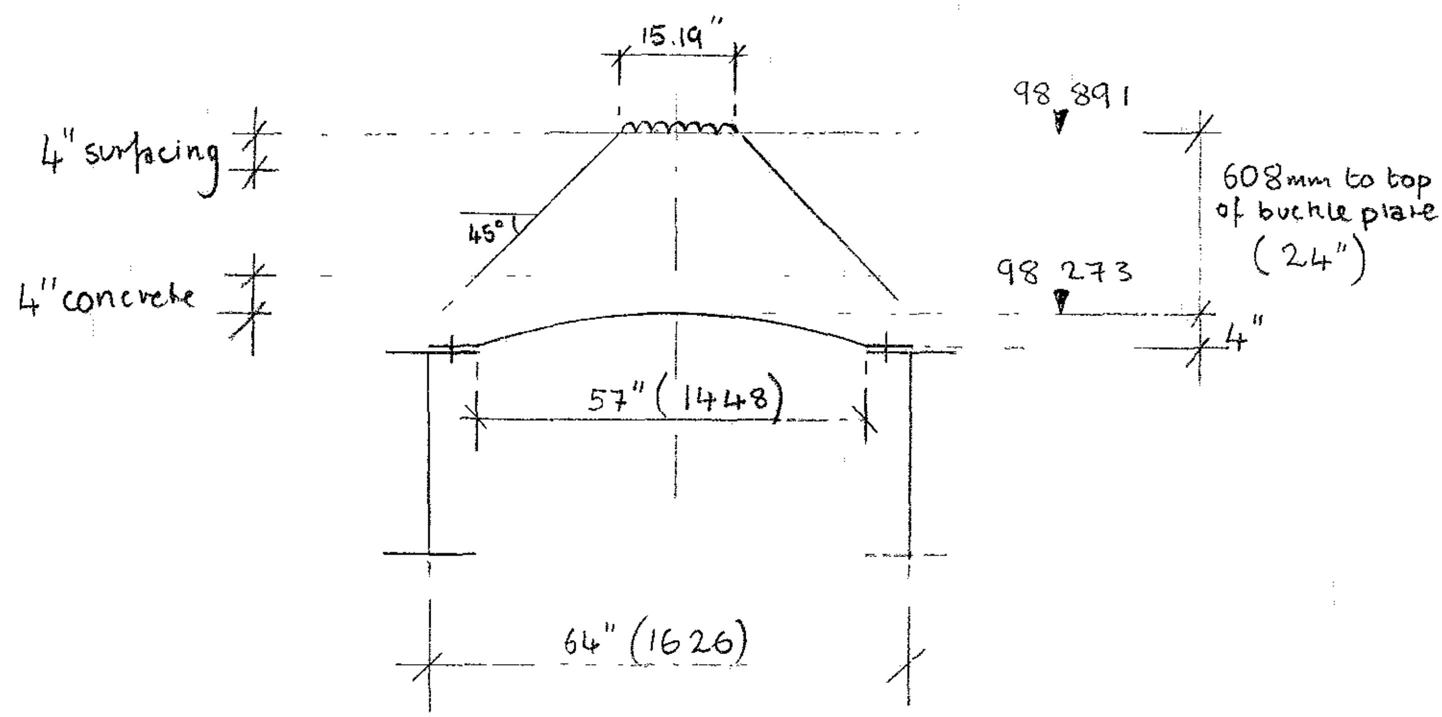
For design criteria, refer to Approval in Principle (Form AA) document

CALCULATION SHEET

JACOBS

Project Title		Sheet No 61	
Subject AKC/35	Buckle plate check	Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

Buckle plates are 64" x 40" centres and are rectangular to an extent that the Jacobs FE analysis (Nov 05) modification cannot be used. Therefore the plates will be assumed to be one-way spanning.

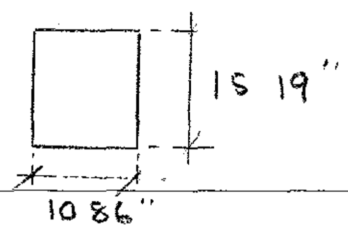


Max weight of single tyre = 5 tons

= 5 x 1.25 = 6.25 ton (with impact)

BE4 302(e) Contact Area of wheel = 33 x 5 = 165 in^2

$b = \sqrt{\frac{165}{14}} = 10.86"$



CALCULATION SHEET

JACOBS

Project Title		Sheet No	62
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By	Date 3/07	Checked By	Date

dispersion is taken as 45° from the edge of the wheel contact area therefore the dispersed length at the level of the highest point of the buckle plate.

$= 15.19 + 2 \times 24 = 63.19$ in

$= 10.8 + 2 \times 24 = 58.8$ in

intensity

$= 5 \times 125 / (58.8 \times 63.19) = 3.77$ lbs/in²

Dead Load

$= 4 \times 144 \times 1/12 + 4 \times 150 \times 1/12 + 16 \times 135 \times 1/12$

$= 278$ lbs/ft²

$= 1.93$ lbs/in²

TOTAL $= 5.7$ lbs/in²

Take as uniform load intensity over plate

BA56 15 2 Thrust $= \frac{WL^2}{8r}$

$= 5.7 \times 64^2 / 8 \times 4 = 730$ lbs/in

distribution extends beyond the clear span of the buckle plate therefore the effective length of the

BD56/96 15.2.2 plate acting as a strut $= l/4$

$l_e = \frac{57}{4} = 14.25$ in

CALCULATION SHEET

JACOBS

Project Title			Sheet No 62a	
Subject			Calc No	
Job No			File	
Made By [redacted]	Date	Revised By	Date	
Checked By [redacted]	Date 3/07	Checked By	Date	

Radius of gyration for plate

$$I = \frac{1 \times 0.375^3}{12} = 0.0044 \text{ in}^4$$

$$A = 0.375 \text{ in}^2$$

$$r = \sqrt{\frac{0.0044}{0.375}} = 0.108 \text{ in}$$

Slenderness ratio

$$l/r = 14.25/0.108 = 132$$

CALCULATION SHEET

JACOBS

Project Title				Sheet No 63
Subject				Calc No
Job No				File
Made By [redacted]	Date 02/07	Revised By		Date
Checked By	Date 3/07	Checked By		Date

BS153 Pt 3B table 4 & BE4 304(b)

$P_{ac} = 3.4 \times \frac{10.75}{16} = 2.28$ ton/in²

Apply case II enhancement

$P_{ac} = 2.28 \times 1.25 = 2.85$ ton/in²

Strut capacity = $P_{ac} \times A$

$= (2.85 \times 0.375 \times 0.8) \times 2240$

$= 1915$ lbs/in (0.8 = 20% corrosion)

1915 > 730 lbs/in

plate is satisfactory for max C & U

Check connecting rivets

Thrust from plate = 730 lbs/in

Rivet spacing = 4 inches

Shear on rivet = 730 × 4 = 2920 lbs = 1.3 tons

Sht 5 — rivet diameter = $1\frac{1/4}{16}$ = 0.78125"

Rivets are likely to be wrought iron

RT/CE/C015 offers a value of permissible stress of wrought iron rivets in shear

RT/CE/C015 section 4 Table 1 — Permissible stress = 5.0 ton/in²

CALCULATION SHEET

JACOBS

Project Title		Sheet No 64	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date 02/07	Revised By	Date
Checked By	Date 3/07	Checked By	Date

Rivet capacity (single shear) $= \frac{\pi \times 0.78125^2}{4} \times 50$

$= 2.4$ tons > 1.3

rivets OK in shear

CALCULATION SHEET

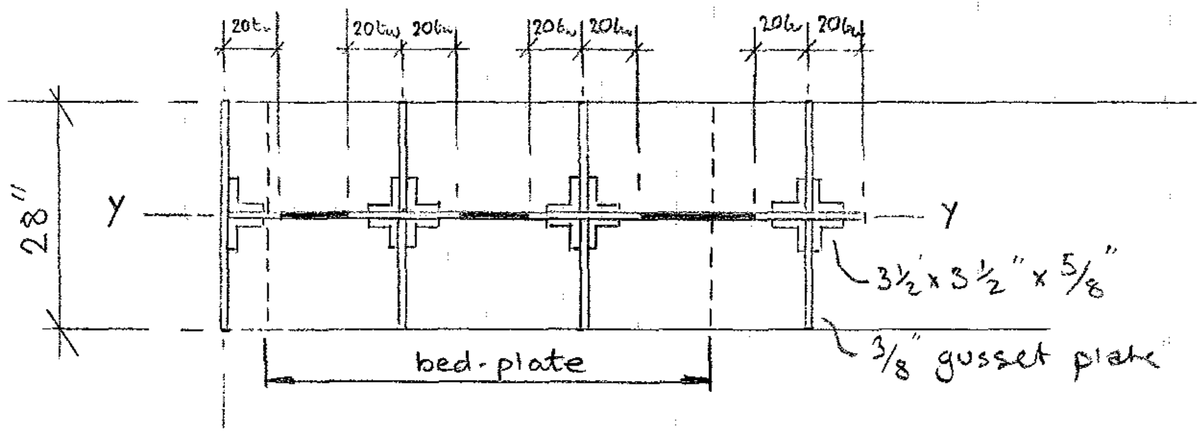
JACOBS

Project Title		Sheet No 65	
Subject AKC/35 Bearing stiffener check		Calc No	
Job No		File	
Made By [redacted]	Date 03/07	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

Capacity of Load Bearing stiffener:

BS 153
27 a

$P_{ac} t B \not< V$



$b_w = 3/8''$

$20 b_w = 7\ 5''$

$r_y = \sqrt{\dfrac{I_{yy}}{A_g}}$ Consider two stiffeners acting:-

$$I_{yy} = 2 \times 28^3 \times \tfrac{3}{8} \times \tfrac{1}{12} + 4 \times 7\tfrac{3}{8}^3 \times \tfrac{5}{8} \times \tfrac{1}{12}$$
$$+ 4 \times 1\tfrac{5}{8}^3 \times 5\ 75 \times \tfrac{1}{12}$$
$$+ 4 \times \tfrac{3}{8}^3 \times (7\ 5 - 3\ 875) \times \tfrac{1}{12}$$
$$= 1464 \text{ in}^4$$

$$A_g = 2 \times 28 \times \tfrac{3}{8} + 4 \times 7\ 5 \times \tfrac{5}{8}$$
$$+ 2\ 875 \times 1\ 25 \times 4 + 4 \times 7\ 5 \times \tfrac{3}{8}$$
$$= 65{\cdot}4 \text{ in}^2$$

CALCULATION SHEET

JACOBS

Project Title		Sheet No 66	
Subject		Calc No	
Job No		File	
Made By [redacted]	Date	Revised By	Date
Checked By [redacted]	Date 3/07	Checked By	Date

$r_y = \sqrt{\frac{1464}{65 \cdot 4}} = 4 \cdot 73$ in

L = 0 7 × length of the stiffener
= 0 7 × 96
= 67.2 in

$L/r_y = 67\ 2/4 \cdot 73 = 14 \cdot 2$

TABLE 4 $P_{ac} = 8 \cdot 95$ ton/in^2

for wrought iron

$P_{ac} = 1\ 25 \times 8\ 95 \times \frac{10\ 75}{16} = 7.52$ ton/in^2

Axial capacity = $P_{ac} \times A$
Case II uplift
= 7·52 × 1·25 × 65·4 = 614·7 tons

p14 Applied dead load = 124.65 Ton
effect at support

p55d Live load = 32 tons

Total 148 tons

148 < 614 tons

∴ Satisfactory for 24 ton C&W load

CALCULATION COVER SHEET

Jacobs
Reading

Project Title	BRB (Residuary) Ltd - Major Works 2004/2007	Calc No	97 7
Job No	J24110JR	File	R11
Project Manager	[redacted]	Subject	AKC/35
Designer			A697 Wooler
Project Group	31400		Bearing stiffener check

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	2	JDC	Jan-07	JLR	Mar-07				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

CALCULATION COVER SHEET

Jacobs
Reading

Project Title	BRB (Residuary) Ltd - Major Works 2004/2007	Calc No	97 8
Job No J24110JR		File	R11
Project Manager [redacted]		Subject	AKC/35
Designer			A697 Wooler
Project Group 31400			Transverse girder splices

	Total Sheets	Made by	Date	Checked by	Date	Reviewed by	Date		
Original	2	JLR	Mar-07	JDC	Mar-07				
Rev									
Rev									
Rev									
Rev									
Rev									

Superseded by Calculation No. Date

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

CALCULATION SHEET

JACOBS

Project Title		Sheet No 67	
Subject TRANSVERSE GIRDER FLANGE SPLICE		Calc No	
Job No J24110JR		File	
Made By [redacted]	Date 3/07	Revised By	Date
Checked By	Date	Checked By	Date

Check transverse girder splices

Splice occur on the 8 longest girders:-

- At approx. mid-span on girders 17 & 18 (23 & 24).
- At approx. 1/3 span on girders 19 & 20 (21 & 22)

i e the propped girders

Check for worst combination of dead and live load (Girder 18 critical)

Effective span = 31 ft.

p 10 Dead load bending = $0.954 \times 31^2 \times \frac{1}{8}$ = 114 ton ft

p 40 Live load bending mid-span (propped) = 39 3 ton.ft

Total bending effect = 153 3 ton ft

Force in flange due to moment:

Average stress in bottom flange

p 8 $\sigma = \frac{My}{I}$

where y = distance from NA to centroid of flange

$$\sigma = \frac{153.3 \times 12 \times (29 - 13.81 - 0.25)}{5069.09} = 5.42 \text{ ton/in}^2$$ ✓

Flange force

= 5.42 × 6 13 = 33.2 tons ✓

RT/CE/C/015 Section 4 Table 1 Permissible load in single 7/8" rivet = 5 ton/in²* × 1 25 × $(7/8)^2 \times \pi/4$ = 3 75 tons

No of rivets each side of connection = 10

Total permissible load = 3 75 × 10 = 37 5 tons. ✓ OK

For 3/4" rivets. $5 \times 1.25 \times (3/4)^2 \times \pi/4$ = 2.76 tons

Permissible load = 27 6 tons. NOT OK

see p 68

CALCULATION SHEET

JE JACOBS

Project Title		Sheet No 68	
Subject		Calc No	
Job No J2411OKI		File	
Made By [redacted]	Date 3/07	Revised By	Date
Checked By	Date	Checked By	Date

Resistance of Girders 17 & 18 considering bottom flange plate to be ineffective due to inadequate splice capacity:

Cross girders 17 & 18 (23 & 24) No bottom flange plate

Element	Dimension b	d	Area	y from top	Ay	A(y-y1)^2	I=bd^3/12
Top flange	**12.5**	**0.5**	6 25	**0.25**	1 56	729 74	0 13
Top angles (hor)	**7**	**0.5**	3 50	**0.75**	2 63	371 71	0 07
Top angles (vert)	**1**	**3**	3 00	**2.5**	7 50	219 59	2 25
Web	**0.375**	**28**	10 50	**14.5**	152 25	124 58	686 00
Bottom angles (vert)	**1**	**3**	3 00	**26.5**	79 50	715 60	2 25
Bottom angles (hor)	**7**	**0.5**	3 50	**28.25**	98 88	1034 78	0 07
Bottom flange	**0**	**0**	0 00	**28.75**	0 00	0 00	0 00
Deduct rivets 1	**-1.56**	**0.5**	-0 78	**28.25**	-22 04	-230 61	-0 02
NET AREA			28 97		320 28		
GROSS AREA			29 75				
Depth to Neutral Axis y1		11 06					
					Sum	2965 39	690 76
		overall depth				Ixx=	3656 15
		28 5				Ztop	330 71
						Zbot	209 59

$M = 8\ 4 \times 209.59 \times 1/12 = 146.7$ ton ft

Considering 3/4" rivets but allowing extra 1/16" for filling hole as allowed in NR assessment standards:

$5.0 \times 1\ 25 \times (13/16)^2 \times \pi/4 = 3.24$ tons

Total permissible load = 32.4 tons

$\text{Load rating} = 9\text{tons} \times \frac{(32.4 - 24\ 68)}{(33.2 - 24\ 68)} = 8.15$ tons

8 ton axle