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# Finchingfield Bridge, Finchingfield, ECC Bridge No. 26

**Option Study Report**

January 2010

*Produced for*
Essex County Council
Highways Department County Hall
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# Document Control Sheet

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**Our Ref** STR/Option Studies 2009-10/GEN

10th May 2010

Dear Sirs

**Option Study Reports 2009-10**

We enclose for your records one copy (already signed by you) of the Option Study Report for the following minor structure:

Finchingfield Bridge ECC No. 26

Yours faithfully

[redacted]

Gordon Thomson

Principal Engineer
*For and on behalf of Mouchel Group*

# Contents

# Executive Summary

- Finchingfield Bridge (ECC Bridge No. 26) is a masonry arch bridge that carries the B1057/B1053 over Finchingfield Brook in Finchingfield, Essex. The ordnance grid reference of the structure is TL 847 284. (Refer to **Appendix B**, *Drawing No. BR26/00-* for the Location Plan of the Bridge)

- Finchingfield is a small village located in the still very rural area between Saffron Walden and Braintree, with a nucleus of listed buildings clustered around St John the Baptist's Church, The Green and the River Blackwater/Finchingfield Brook. The centre of Finchingfield has seen little intrusive modern development and is regarded as one of the county's major cultural and historical attractions. The centre of the village is designated as a conservation area (See **Appendix C.**)

- Finchingfield Bridge was constructed originally as a single span brick arch, but now has a concrete arch extension which is believed to have been added on the south side in 1912. The abutments are of brick construction but the foundation type is unknown. Brick wingwalls retain the carriageway for a considerable distance beyond the arch span.

- Currently the structure has been identified as a weak bridge. A detailed assessment was carried out in November 1994 by Essex Highways Consultancy which found the main body of the deck incapable of carrying 40 tonnes Assessment Live Load at Ultimate Limit State. The calculations showed that the brick arch barrel is only capable of sustaining a modified axle load of 6.0 tonnes which corresponds to vehicles with a gross weight of **7.5 Tonnes**.

- As part of this Option Study an alternative method of analysis has been used to re-assess Finchingfield Bridge, as recommended in the previous assessment of 1994. Finchingfield Bridge has therefore been reanalysed using computer program *ARCHIE* which analyses masonry arches in a more realistic and less simplistic way than the modified MEXE method used in 1994. This further investigation in 2009 still however concluded that the safe working capacity of the masonry arch barrel is only **7.5 Tonnes**. The capacity of the 1912 concrete arch extension is **40 Tonnes**.

- Since the new analysis confirmed that the existing superstructure is not adequate to carry full highway load, and is also unsuitable for its present heavily trafficked use, the simplest option for resolving this situation would be to put a 7.5 Tonnes weight restriction on the present structure, and perhaps also to install a priority traffic system to improve traffic flow over the bridge.

- However the bridge does carry two relatively busy B roads in this part of Essex - the north-south B1057 (Haverhill to Great Dunmow) and the east-west B1053 (Saffron Walden to Braintree). Therefore the option of imposing a weight restriction may not be acceptable as a long term solution.

- This option study has therefore looked at other longer term options for bringing the structural capacity of the bridge up to full highway capacity, and to improve the layout of the bridge to make it safer for road users, while still retaining the present attractive appearance.

- As an alternative to imposing a permanent weight restriction on the bridge, three possible options have been identified for the reconstruction or strengthening of Finchingfield Bridge.

- **Option 1** consists of *strengthening the existing masonry arch using the MARS method, and extending the existing mass concrete arch to the south.*

- **Option 2** consists of *strengthening the existing masonry arch using the MARS method, but replacing the mass concrete arch extension with a wider reinforced concrete arch extension.*

- **Option 3** is the *complete replacement of the structure with a brick-faced concrete arch that would closely match the appearance of the existing bridge.*

- If the decision were taken to proceed with any of these strengthening or replacement options, then it would inevitably be necessary to close the bridge for several months. Since there is no convenient diversion route for traffic, the works would sensibly require the installation of a temporary bridge adjacent to the existing bridge.

- In view of the fact that the existing structure is located within the centre of a picturesque village in a conservation area, *Option 3* - replacement of the entire structure – is likely to be the most controversial of the proposals and cannot therefore easily be recommended.

- *Option 1* would retain all of the existing bridge (including the 1912 concrete extension) apart from the south wingwalls and parapet. These would be replaced with new concrete wingwalls, but faced with brick to closely resemble the present brickwork.

- *Option 2* is very similar to Option 1, the main difference being that the 1912 concrete extension would be demolished, and replaced by a new wider concrete arch extension. The south wingwalls and parapet would again be replaced with new concrete wingwalls, but faced with brick to closely resemble the present brickwork. From a construction point of view, Option 2 would be simpler than Option 1, while visually the result would be much the same. It would also improve the appearance since the present concrete extension does not have the same arch profile as the original masonry arch. Therefore, of the three reconstruction options, Option 2 appears to be the most sensible option for the reconstruction of Finchingfield Bridge.

- However, local opinion may prefer the option of simply applying a weight restriction, despite the long term restrictions on HGV traffic, and the safety issues caused by the narrowness of the present structure.

# 1 Introduction

Finchingfield Bridge (ECC Bridge No. 26) is a masonry arch bridge that carries the B1057/B1053 over Finchingfield Brook in Finchingfield Village, Essex (situated between Saffron Walden and Braintree). The ordnance grid reference number is TL 6847 3284. (Refer to **Appendix B**, Drawing No. BR26/00 for the Location Plan of the Bridge.) The original part of the bridge (believed to be 19th century or earlier) comprises a single masonry arch of span 4.3m, a rise of 1.26m, with an arch barrel thickness of 0.33m. In about 1912 the masonry arch was extended approximately 1.65m to the south with the addition of a concrete arch of the same span 4.3m, but with a shallower rise of only 0.84m, and an approximate thickness of 0.700m. Two tie rods span transversely through the structure, tying the barrels of the original brick arch and the concrete extension together.

*Photo No. 1 - General view of the brick arch bridge from South (upstream)*

A detailed assessment of the structure was carried out in November 1994 by Essex Highway Consultancy. The modified MEXE method (a simple empirical assessment method devised to assess brick arches) was used to establish the capacity of the masonry arch barrel. Due to the lack of information concerning the construction details of the concrete arch extension, the modified MEXE method was also used to obtain an approximate capacity for this part of the structure too. This assessment showed that the masonry arch barrel is only capable of sustaining a modified axle load of **6.0 Tonnes**, which is equivalent to vehicles with a gross weight of 7.5 tonnes.

It was recommended in this 1994 report that the brick arch should be re-assessed using a more precise method of analysis (e.g. the Pippard-MEXE method) and that the compressive strength of the brickwork be determined by testing. Furthermore, it

was suggested that, if such a re-assessment confirmed that the structure is below the full 40 Tonnes Assessment Live Load capacity, the bridge should be considered for either strengthening or having a weight limit imposed. A more comprehensive assessment has however never been undertaken to date prior to this option study, nor has a weight limit been applied, so that the structure continues to be used without restriction by buses and heavy good vehicles. Because of the difficult alignment of the road and the narrowness of the bridge (the carriageway is only 3.82m wide between brick parapets at its narrowest point) the parapets are also frequently struck by vehicles, in some cases causing serious damage.

Because of these issues of both limited structural capacity and difficult access for road users, Essex County Council has appointed Mouchel Group in June 2009 to undertake a study to investigate the options for improving this situation. As part of this Option Study, an alternative method of analysis has first been used to re-assess the structure (in line with the recommendations of the 1994 assessment.) Finchingfield Bridge has therefore been analysed using computer program *ARCHIE* which analyses masonry arches in a more realistic way than the modified MEXE method, and determines the critical load at which the first failure mechanism will occur in the arch barrel. This further investigation carried out by Mouchel Group concluded that, taking the condition of the brickwork into account, the safe working capacity of the masonry arch barrel is still only **7.5Tonnes**. The capacity of the concrete arch, assuming that the barrel thickness is at least equal to that of the masonry barrel, is **40 Tonnes**.


*Photo No. 2 - View of HGV crossing structure*

Since the new analysis confirmed that the existing superstructure is not adequate to carry full highway load, and is also unsuitable for its present heavily trafficked use, the simplest option for resolving this situation would be to put a 7.5 Tonnes weight restriction on the present structure, and perhaps also install a priority traffic system to improve traffic flow over the bridge.

However the bridge does carry two relatively busy B roads in this part of Essex - the north-south B1057 (Haverhill to Great Dunmow) and the east-west B1053 (Saffron Walden to Braintree). Therefore the option of imposing a weight restriction may not be acceptable as a long term solution.

This option study therefore looks at other longer term options for bringing the structural capacity of the bridge up to full highway capacity, and to improve the layout of the bridge to make it safer for road users, while still retaining the present attractive appearance.

Further information on the existing structure is presented in **Section 2** of this report, while the new reassessment of the structure is described in **Section 3**.

**Section 4** of this report describes possible options for strengthening or improving the structure, while still trying to retain the architectural character of the original.

The final recommendations are summarized in **Section 5**.

# 2 Details of Existing Bridge

## 2.1 General Description of Present Structure

**See Appendix B:** *Drawing No. BR026/02* for General Arrangement of existing bridge.

*Photo No. 3 - General view of the brick arch bridge from North (downstream)*

Finchingfield Bridge was constructed originally as a single-span masonry arch (probably in the 19th century) and then, in about 1912, widened on the south side with a concrete arch extension. The bridge carries the B1057 and B1053 over Finchingfield Brook in the centre of Finchingfield Village in North Essex and, together with the adjacent pond, forms an integral feature in this very picturesque village.

Finchingfield is a small village located in the still very rural area between Saffron Walden and Braintree, with a nucleus of listed buildings clustered around St John the Baptist's Church, The Green and the River Blackwater/Finchingfield Brook. The centre of Finchingfield has seen little intrusive modern development and is regarded as one of the county's major cultural and historical attractions. The centre of the village has been designated as a conservation area.

The abutments are of brick construction but the foundation details are unknown. Masonry wingwalls retain the carriageway for a considerable distance beyond the abutments on each side. On the northeast side of the bridge the parapet directly abuts an adjacent building belonging to Funeral Directors G. W. Hardy & Son.

## 2.2 Traffic Flow over the Bridge

Finchingfield Bridge is located within the rural village of Finchingfield, northwest of Braintree, and there is a normal speed restriction of 30 mph imposed upon the bridge and the approach roads. It was estimated in 1994 by Essex Highway Consultancy that less than 7 HGV's crossed the structure per hour, and this is still likely to be true.

The carriageway is however only 3.82m wide between the inner faces of the parapets at its narrowest point over the structure, and there is also a significant hump in the road levels over the structure so that only one-way traffic is possible. The structure is also curved on plan. This combination of circumstances has created a dangerous traffic situation at the bridge as two relatively busy B roads - the north-south B1057 (Haverhill to Great Dunmow) and the east-west B1053 (Saffron Walden to Braintree) - cross over this single-lane structure. Heavy goods vehicles (which are often directed through Finchingfield via Satellite Navigation) and buses/coaches, have particular difficulty in manoeuvring over the narrow structure. (See Photo 2 above.)

The masonry parapets and the adjacent building have therefore been struck and damaged numerous times.

## 2.3 Condition of Structure

### *2.3.1 Arch Barrels*

The original 19th century bridge comprises a single masonry arch of span 4.3m, with a rise of 1.26m, and an arch barrel thickness of 0.33m. In about 1912, the masonry arch was extended approximately 1.63m to the south with the addition of a concrete arch of span 4.3m, a rise of 0.84m, and an approximate barrel thickness of 0.7m.

*Photo No. 4 - View of the original brick arch from North (downstream)*

(It is not clear why the designers of the extension chose not to match the profile of the original brick arch.) Two tie rods span transversely across the structure, tying the older masonry arch barrel and the newer concrete arch barrel together. The structure is heavily buttressed at the abutments with a masonry buttress either side of the downstream arch.

As well as being part of a vital road link, the structure is also an important architectural element in Finchingfield, and, together with the adjacent pond, is a focal point for this picturesque village.

The bridge carries a 3.82m wide carriageway, which, as stated above, is suitable for only one lane of traffic crossing at a time. There is also no footway or even refuge for pedestrians on the bridge; however, a pedestrian footbridge/weir is located on the south side of the pond, approximately 50m south of the structure.

The brickwork forming the arch barrel is weathered by age but in a fair condition (see photos 4 – 6.) The brick arch barrel appears to be generally sound, and both the voussoir and barrel joints have been repaired and repointed fairly recently. There are a number of minor longitudinal cracks through the barrel joints and there are signs of efflorescence and minor leaching. The downstream concrete extension, which has a smaller rise than the masonry arch, is in a good condition and heavily buttressed at the abutments (see Photo 10).

*Photo No. 5 - View of masonry arch springing (west)*

*Photo No. 6 - View of masonry arch springing (east)*

### 2.3.2 *Substructure*

The existing foundations to the arches are buried and are not accessible for inspection. No investigation has been carried out to assess the state of the foundations but the visual inspection of the substructure did not indicate any signs of significant differential settlement. Although there are some minor cracks in the arch barrel, there is no evidence that these are caused by excessive settlement of the foundations.

### 2.3.3 *Parapets and Wingwalls*

The north (upstream) parapet (see Photo 7) is of masonry construction and is believed to be part of the original 19$^{th}$ century construction, although there are clear signs of patch repairs having been carried out periodically. The south (downstream) parapet (see Photos 8 and 9) is a brick-faced reinforced concrete parapet, doweled and resin bonded into the concrete extension below. The parapet was replaced sometime after the concrete arch extension in 1912, possibly during or after the Second World War.

*Photo No. 7 – North Parapet*

The wingwalls either side of the arch extend a considerable distance beyond the abutments, along the north side of the Finchingfield Brook pond. The northwest wingwall is of masonry construction and believed to form part of the original construction. (On the northeast corner, there is no wingwall, and the parapet butts against an adjacent building, the premises of Funeral Directors G. W. Hardy & Son. See Photos 7 and 9.) The southeast wingwall (Photo 9) is also masonry construction, and was constructed as part of the bridge widening scheme in 1912.

The southwest wingwall (Photo 8) was also originally constructed in masonry in 1912, but was replaced later with a new brick-faced reinforced concrete wingwall cast directly against the base of the original wall. The newer wingwall is founded on a reinforced concrete base slab that extends 1.5m south (into the pond.)

*Photo No. 8 – Southwest Wingwall & Parapet*

The parapets and wingwalls all show signs of damage caused by vehicles scraping or gouging the inside face of the brickwork. The corner of the southeast parapet has recently been hit by a speeding vehicle and has sheared off. The gap in the parapet was being protected by a temporary concrete barrier (see Photo 9 taken in autumn 2009) but has since been repaired.

*Photo No. 9 – Southeast Wingwall & Parapet*

*Photo No. 10 - View of Southwest buttress*

## 2.4 Utility Company Plant

A STATS search was undertaken in July 2009 to determine utility companies' plant located within the immediate vicinity of the structure. A summary of the findings is tabulated below;

| **Utility Company** | **Plant Located with vicinity of structure** |
|---|---|
| National Grid | No plant located within the vicinity of the structure. |
| British Telecoms | Underground BT duct crossing Finchingfield Brook beneath footbridge 50m south of Finchingfield Bridge. |
| EDF Energy | Underground electricity cable in steel pipe buried below pedestrian footbridge 50m south of Finchingfield Bridge. |
| Essex and Suffolk Water | Underground 225mm high pressure polyethylene operational potable water pipe and underground decommissioned potable water pipe buried below the middle of Finchingfield pond, approximately 20m from the Finchingfield Bridge. |
| Anglia Water Services Limited | Underground combined fowl sewer buried below pedestrian footbridge 50m south of Finchingfield Bridge. |
| ESP Pipelines | No plant located within the vicinity of the structure. |
| Virgin Media | No plant located within the vicinity of the structure. |

## 2.5 Landowners

The Green, south of Finchingfield Bridge, is believed to be public land owned either by Finchingfield Parish Council or Braintree District Council.

The Manse House, northwest of Finchingfield Bridge, is registered to Mr P. Krochunas and Ms M. Lewis (highlighted in blue on landowners plan).

The land ownership of the majority of buildings northeast of Finchingfield Bridge, including the Funeral Directors G. W. Hardy & Son, are registered to Mr R. Todman, Ms J. Todman, and Mr S. Crowfoot (highlighted in Green on landowners plan). The Riverview, located behind the Funeral Directors premises, is registered to Mr G. Bell and Ms C. Bell (highlighted in red on landowners plan).

(Refer to **Appendix B**, *Drawing Nos. BR26/LP00* for the Land Registry and Highway Boundary Search drawings.)

## 2.6 Planning

Finchingfield is a small village clustered around St John the Baptist's Church, The Green and the River Blackwater/Finchingfield Brook. The village has seen little intrusive modern development within the central core, and there is a mix of buildings from late medieval to 20th century, which gives the village its unique character. Consequently, the majority of Finchingfield falls within a Conservation Area (refer to map of Finchingfield Conservation Boundary in **Appendix C**).

Although Finchingfield Bridge is not a listed structure, additional protection is afforded to unlisted buildings and trees within conservation areas, allowing greater control over the impact of development.

The Swan Pub, to the west of Finchingfield Bridge is Grade 1 Listed, and the buildings to the northeast, including the Funeral Directors premises are designated as 'Buildings of Townscape Merit'. Furthermore, The Green surrounding Finchingfield Bridge is classed as 'Important Green Space' within the conservation area. The Horse Chestnut tree (*Aesculus Hippocastanum*) located behind the northwest boundary wall has a Tree Preservation Order applied to it.

Furthermore, as the structure is located within 3m of the Funeral Directors Building and The Manse Boundary wall, the Party Wall Act 1996 will have to be complied with in dealing with both landowners.

# 3 Structural Assessments of Finchingfield Bridge

## 3.1 1994 Structural Assessment

The last structural assessment of Finchingfield Bridge was carried out by Essex Highways Consulting in November 1994 in accordance with the Department of Transport Design Manual for Roads and Bridges Volume 3 Section 4 Part 3, BA 16/93, and BD21/93.

The modified MEXE method was used for establishing the arch barrel capacity. This is a simple empirical method which is often used to provide a rapid if approximate assessment of masonry arches, and determine whether there might be a potential problem with them.

Due to the lack of information concerning the construction details of the adjacent concrete arch extension, the modified MEXE method was also used to obtain an estimated capacity for that later element. Assessment of the arch extension was carried out assuming conservatively that it was constructed from concrete bricks with a ring thickness of 215mm. (In fact it is likely to be thicker than the 330mm thick masonry arch barrel.)

The structure was assessed for the Ultimate Limit State only. Serviceability-Limit-State checks were not carried out since the structure was more than 25 years old. HB capacity was not determined since the assessed capacity at Ultimate Limit State was found to be less than 40 Tonnes.

The modified MEXE method calculations showed that the brick arch barrel is only capable of sustaining a modified axle load of 6.0 Tonnes which corresponds to vehicles with a gross weight of 7.5 tonne. However, the visual inspection did not reveal any serious defects despite the bridge being regularly used by 4- and 5-axle C&U vehicles.

In conclusion, this option study recommended that the brick arch should be re-assessed using a more accurate method of analysis (i.e. Pippard-MEXE method) and that the compressive strength of the brickwork be determined by testing. Furthermore, it was recommended that should the subsequent re-assessment confirm that the structure is below 40 tonne Assessment Live Load capacity, then the bridge should be considered for either strengthening or having a weight limit imposed.

## 3.2 2009 Structural Reassessment

As part of this Option Study, an alternative method of analysis has been used to re-assess Finchingfield Bridge, as recommended in the original assessment of 1994. Finchingfield Bridge has been analysed using computer program ARCHIE which calculates the first failure mechanism in the arch. The program analyses masonry arches in a more realistic and less simplistic way than the empirical modified MEXE method.

The reassessment did not identify any significantly different results to the original assessment, and confirmed the Assessment Live Load rating of the masonry arch barrel to be **7.5 Tonnes.** The rating of the concrete arch extension was **40 Tonnes.**

The calculations are summarized in **Appendix D** of this report.

# 4 Proposed Options for the Strengthening and Widening of Finchingfield Bridge

## 4.1 General

### 4.1.1 *Applying a Weight Restriction*

Since the new reassessment of 2009 (see Section 3) confirmed that the existing superstructure is not adequate to carry full highway load, and is also unsuitable for its present heavily trafficked use (see Photo 3), the simplest option for resolving this situation would be to put a 7.5 Tonnes weight restriction on the present structure, and perhaps also to install a priority traffic system to improve traffic flow over the bridge.

However the bridge does carry two relatively busy B roads in this part of Essex - the north-south B1057 (Haverhill to Great Dunmow) and the east-west B1053 (Saffron Walden to Braintree). Therefore the option of imposing a weight restriction and leaving the bridge as it is may not be acceptable as a long term solution.

### 4.1.2 *Strengthening and Widening the Bridge to carry Full Highway Load*

This option study has therefore looked at other longer term options for bringing the structural capacity of the bridge up to full highway capacity, and to improve the layout of the bridge to make it safer for road users, while still retaining the present attractive appearance.

In view of the fact that the existing structure is located within the centre of a picturesque village in a conservation area, it is not deemed appropriate to consider options for repair/replacement that would significantly change the appearance of the structure. Although Finchingfield Bridge is not a listed structure, additional protection is afforded to unlisted buildings and trees within conservation areas, allowing greater control over the impact of development. Consequently, the options in this report have been limited to looking at methods of either replacing or strengthening the existing masonry arch, whilst striving to maintain the present appearance.

As an alternative to imposing a permanent weight restriction on the bridge, three possible options are therefore proposed for the reconstruction or strengthening of Finchingfield Bridge.

## 4.2 Proposed Option 1: Strengthening of Masonry Arch and Extension of Mass Concrete Arch

**Refer to Appendix B:** *Drawing No. BR26/03* for details of Option 1

**Option 1** consists of strengthening the existing masonry arch using the Mars System and extending the existing mass concrete extension further to the south with a new extension and wingwalls.

The existing below-strength masonry arch will be retained but will need to be strengthened to withstand 40 tonnes Assessment Live Load at Ultimate Limit State using the MARS system. This strengthening system consists of installing a network of 6mm diameter stainless steel ribbed bars into slots (20mm wide by 40mm deep)

cut circumferentially and transversely in the soffit of the arch. In addition, radial pins are installed at the intersection of the circumferential and transverse reinforcement *(refer to Fig. 1)*. The bars are then bonded using an adhesive (Marsflex) specially developed for the MARS system.

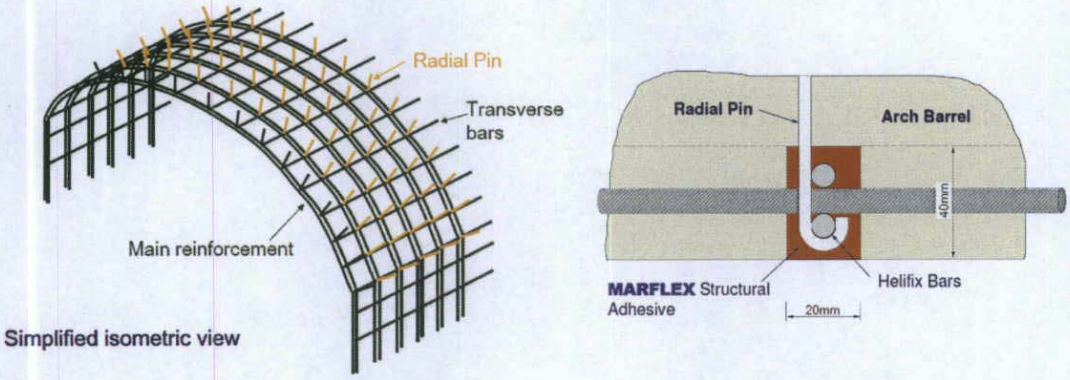


*Figure 1 –Masonry Arch and Repair System (MARS System)*

*Figure 2 – Masonry Arch Repair System (Completed Installation)*

It is also proposed to widen the structure to the south by approximately 1.7m. Currently, the carriageway is only 3.82m wide between brick parapets at its narrowest point over the structure and there is a significant hump in the road levels over the structure. The structure is also curved in plan, which, together with the narrowness of the carriageway, makes it difficult for even single-lane traffic to negotiate the bridge. This has created a significant traffic problem as two relatively busy B roads, the B1057 (Haverhill to Great Dunmow) and the B1053 (Saffron Maldon to Braintree) cross through Finchingfield, intersecting at this single-lane structure.

Consequently a new RC concrete arch will be constructed against the south edge of the existing concrete arch, consisting of PC arch rib units and in-situ concrete infill *(refer to Fig. 3 below)*, founded on new monolithic piled abutments. The tie bars that currently span transversely through the existing structure will be replaced with new tie rods that will extend right through both the new and the original structures

together, ensuring that the new construction is tied firmly to the old, and that the tie rods can be maintained in future years.

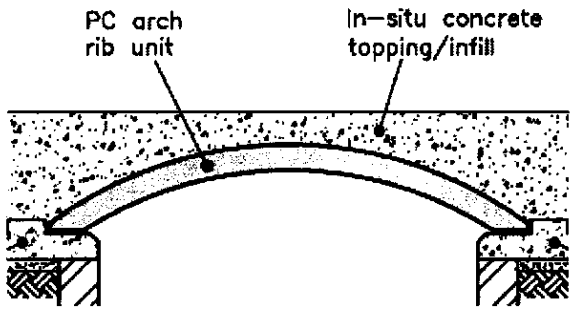


*Figure 3 – PC Arch Rib Unit with In-situ Concrete Topping*

The wingwalls on the south side of the structure will be relocated further to the south. A piled foundation will be constructed for a new brick-faced RC retaining wall to sit upon. The new wingwall will be curved in plan, reducing the sharp kink of the present road alignment over the structure, but will be detailed to look as much like the existing elevation as possible. In order to maintain the appearance of the structure, the buttress features either side of the downstream arch will be duplicated, and the colour of the bricks used in the wingwalls and buttresses will be specified to match the brickwork of the existing structure and adjacent houses.

The existing wingwalls behind will be cut down to below ground level and the lower parts buried below the new fill and surfacing.

Even though the width of the structure will increase, the carriageway will still be limited to a single-lane carriageway. (It would not be possible to construct a two-lane carriageway without increasing the road width to 9m or more and this would change the appearance and character of the bridge significantly.)

A 1.2m footpath will however be installed on the north side of the structure to provide a safe refuge for pedestrians to cross between the west and east sides of Finchingfield. This will also discourage vehicles from gouging the north parapet and adjacent buildings.

Furthermore, it is recommended that 3-way traffic signals are installed over Finchingfield Bridge, positioned on Brent Hall Road, The Causeway and Church Hill Road, to help regulate the flow of traffic over the bridge.

*Advantages of Option 1*

- The appearance of the structure will be maintained.
- The carriageway over the structure will be widened and alignment improved. The hump over the bridge will be reduced in severity, which will contribute to increased visibility and safety over the bridge.
- The original arch structure will be retained, thereby saving on demolition costs and preserving part of the history of the bridge.

- By utilising the MARS system of repair, the road levels/construction depth will not have to be increased in order to improve the strength of the arch.

- Repair work can easily be inspected in future years.

*Disadvantages of Option 1*

- Traffic cannot be maintained over the bridge throughout the works. Either a road closure will have to be provided with a long and inconvenient diversion, or alternatively, a robust temporary Bailey Bridge or similar will have to be installed across the middle of the pond.

- The existing foundations for the present south wingwall extend 1.5m south out into the pond. These foundations will conflict with the proposed piling for the new wingwall and will therefore have to be demolished.

- Piling will have to take place close to the existing structure, therefore driven piles would not be appropriate even though quick to install. CFA piles will take longer but will be quieter and cause no significant vibration.

- The existing anchors spanning transversely through the arches will require extending through the proposed arch. Therefore the structure will have to be temporarily propped whilst the tension is realised.

- The MARS system of arch repair will leave a visible scar on the soffit of the masonry arch, which will take years to weather and blend into the brickwork.

*Estimated Cost of Proposed Option 1*

Approximate estimate **£ 375,000**

## 4.3 Proposed Option 2: Strengthening of Masonry Arch and Replacement of Mass Concrete Arch

**Refer to Appendix B:** *Drawing No. BR26/04* for details of Option 2.

Option 2 is similar to Option 1 except that, instead of extending the existing concrete arch, it is proposed to demolish the 1912 concrete extension completely and to replace it with a new wider reinforced concrete arch.

The current concrete arch would be completely demolished along with the foundations and the south wingwalls. A line of small diameter CFA piles would be installed, and an abutment wall/pile cap cast up to the bearing level of the precast arch. Thin precast concrete arch ribs would then be placed on the abutments, acting as permanent soffit formwork. Reinforcement can then be fixed into position with insitu concrete placed on top *(refer to Fig.3)*. Only the existing masonry arch structure and north wingwalls/parapet would remain in place.

The masonry arch, as in Option 1, would also be strengthened using the MARS System. A reinforced mesh would be chased and drilled into the soffit of the bridge to

increase the assessment live load capacity from 7.5Tonnes to 40Tonnes *(refer to Fig.1 & 2)*.

A new wingwall would be constructed on the south (downstream) side in the same alignment as Option 1. This will increase the width of the carriage and allow for a footpath/refuge on the north side of the structure.

As in the previous option it is strongly recommended that three-way traffic signals are implemented over the structure.

### *4.3.1 Advantages of Option 2*

- The appearance of the structure will be maintained, or perhaps improved. The new concrete extension would be profiled to match the original masonry arch so improving the appearance over Option 1.

- The curve of the carriageway over the structure will be reduced. The width of the carriageway over the structure will be increased. The hump over the bridge will be reduced. All these measures will contribute to increasing road visibility and improve safe road use over the bridge.

- Repair work can easily be inspected in future years.

- By utilising the MARS system of repair, the road levels/construction depth will not have to be increased in order to improve the strength of the arch.

- The new concrete arch and brick cladding will be highly durable and should require no significant maintenance for many years.

### *4.3.2 Disadvantages of Option 2*

- Traffic cannot be maintained over the bridge throughout the works. Either a road closure will have to be provided with a long and inconvenient diversion, or alternatively, a robust temporary Bailey Bridge will have to be installed across the middle of the pond.

- Piling may strike obstructions since the position of the back of the existing abutments is not known precisely.

- Piling will have to take place close to the existing structure, therefore driven piles would not be appropriate even though quick to install. CFA piles will take longer but will be quieter and cause no significant vibration.

- The MARS system of arch repair will leave a visible scar on the soffit of the masonry arch; this will take years to weather and blend into its natural environment.

- Works will take slightly longer than Option 1, with a longer road closure needed

*4.3.3 Estimated Cost of Option 2*

Approximate estimate **£ 400,000.00**

## 4.4 Proposed Option 3: Replacing whole structure with a new masonry arch

Proposed Option 3 consists of completely replacing the entire existing Finchingfield Bridge with a new reinforced concrete arch, faced in brickwork to match the existing structure. The width of the new structure would be the same as proposed Options 1 and 2, with the same widening and realignment of the carriageway and footway.

A line of small diameter CFA piles would be installed, and an abutment wall/pile cap cast up to the springing level either side of the arch. Thin precast concrete arch ribs would then be placed on the abutments, acting as permanent soffit formwork. Reinforcement can then be fixed into position with insitu concrete placed on top *(refer to Fig. 3).*

In order to maintain the appearance of the structure, the buttress features either side of the downstream arch will be duplicated, and the colour of the bricks used in the wingwalls and buttresses will be specified to match the brickwork of the existing structure and adjacent houses.

As in Options 1 and 2 it is strongly recommended that three-way traffic signals are implemented over the structure. Two relatively busy B-roads cross through Finchingfield via the single-lane Finchingfield Bridge. Measures should be taken to regulate the flow of traffic over the structure.

*4.4.1 Advantages of Option 3*

- Although the existing structure will be demolished, the appearance of the replacement structure will closely match the external appearance of the existing structure.
- Requires significantly less maintenance in comparison with the alternative options since the structure will be entirely new.
- Avoids the need for the time-consuming MARS repair system.

*4.4.2 Disadvantages of Option 3*

- Traffic cannot be maintained over the bridge throughout the works. Either a road closure will have to be provided with a long and inconvenient diversion, or alternatively, a robust temporary Bailey Bridge will have to be installed across the middle of the pond.
- It is likely to be extremely difficult to obtain planning approval for the replacement of the entire bridge, as it is located within a conservation area and described as a 'building with townscape merit'.
- Finchingfield Bridge is connected to the Family Funeral Directors G. W. Hardy & Son building. If the structure is demolished temporary works will be

needed to prop the Funeral Directors building and ensure its stability. Furthermore, any excavation or vibration could undermine the stability of the adjacent building.

- Construction time may be longer compared to Option 1 and 2, and therefore a longer road closure will be needed.

- Because of the more complex river works, and the longer duration, this will be more expensive than Option 1 & 2.

### *4.4.3 Estimated Cost of Proposed Option 3*

Approximate estimate **£ 450,000**

# 5 Recommendation

- Since the new reassessment confirmed that the existing superstructure is not adequate to carry full highway load, the simplest option for resolving this situation would be to put a 7.5 Tonnes weight restriction on the present structure, and perhaps also install a priority traffic system to improve traffic flow over the bridge.

- However the bridge does carry two relatively busy B roads in this part of Essex - the north-south B1057 (Haverhill to Great Dunmow) and the east-west B1053 (Saffron Walden to Braintree). Therefore the option of imposing a weight restriction may not be acceptable as a long term solution.

- As an alternative to imposing a permanent weight restriction on the bridge, three possible options are proposed for the reconstruction or strengthening of Finchingfield Bridge.

    - **Option 1** consists of *strengthening the existing masonry arch using the MARS method, and extending the exiting mass concrete arch.*

    - **Option 2** consists of *strengthening the existing masonry arch using the MARS method, but replacing the mass concrete arch with a wider reinforced concrete arch.*

    - **Option 3** is the *complete replacement of the structure with a brick-faced concrete arch that would closely match the appearance of the existing bridge.*

- In view of the fact that the existing structure is located within the centre of a picturesque village in a conservation area, Option 3 - replacement of the entire structure – is likely to be the most controversial of the proposals.

- Option 1 would retain all of the existing bridge (including the 1912 concrete extension) apart from the south wingwalls and parapet. These would be replaced with new concrete wingwalls, but faced with brick to closely resemble the present brickwork.

- Option 2 is very similar to Option 1, the main difference being that the 1912 concrete extension would be demolished, and replaced by a new wider concrete arch. The south wingwalls and parapet would again be replaced with new concrete wingwalls, but faced with brick to closely resemble the present brickwork. From a construction point of view, Option 2 would be perhaps simpler than Option 1, while visually the result would be the same. Therefore, of the three reconstruction options, **Option 2** appears to be the most sensible option for the reconstruction of Finchingfield Bridge.

- If the decision was taken to proceed with any of these strengthening or replacement options, then it would be necessary to close the road for several months. Since there is no convenient diversion route for traffic, the works

would sensibly require the installation of a temporary bridge adjacent to the existing bridge.

- However, local opinion may prefer the option of simply applying a weight restriction, despite the long term restrictions on HGV traffic, and the safety issues caused by the narrowness of the present structure.

- We have used our reasonable endeavours to provide information that is as correct and accurate as possible on the basis of the information available. Having proposed our recommendations, it is for the client to make the final decision.

# 6 List Appendices

**APPENDIX A:** **ACCEPTANCE CERTIFICATE**

**APPENDIX B:** **DRAWINGS**

**APPENDIX C:** **MAP OF CONSERVATION AREA**

**APPENDIX D:** **REASSESSMENT CALCULATIONS**

## APPENDIX A

## ACCEPTANCE CERTIFICATE

**THE ABOVE IS SUBMITTED FOR ACCEPTANCE**

Signed [redacted]

Name Gordon Thomson BSc CEng MICE
Principal Engineer
Mouchel Group plc

Date 01/04/2010

Signed [redacted]

Name R L Strange BSc (Eng) ACGI CEng MICE

Divisional Manager

Mouchel Group plc

Date 01/04/2010

**THIS REPORT IS ACCEPTED BY ESSEX COUNTY COUNCIL, HIGHWAYS & TRANSPORTATION GROUP, SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW**

[redacted]

Signed

Name C.G. Woodhall

Date 5/8/10

## APPENDIX B

## GENERAL ARRANGEMENT DRAWINGS

Drawing No BR026/ 00 – Location Plan

Drawing No BR026/02– General Arrangement of Existing Culvert

Drawing No BR026/03– Reconstruction Option 1 Masonry Arch Strengthening and Extension of Mass Concrete Arch

Drawing No BR026/04– Reconstruction Option 2 Masonry Arch Strengthening and Replacement of Mass Concrete Arch

Drawing No BR26/LP00 – Land Registry Plan and Highway Boundary

Essex County Council

PAUL BIRD,
DIRECTOR FOR DEVELOPMENT,
HIGHWAYS & TRANSPORTATION,
COUNTY HALL, CHELMSFORD. CM1 1QH
Telephone 08457 430430

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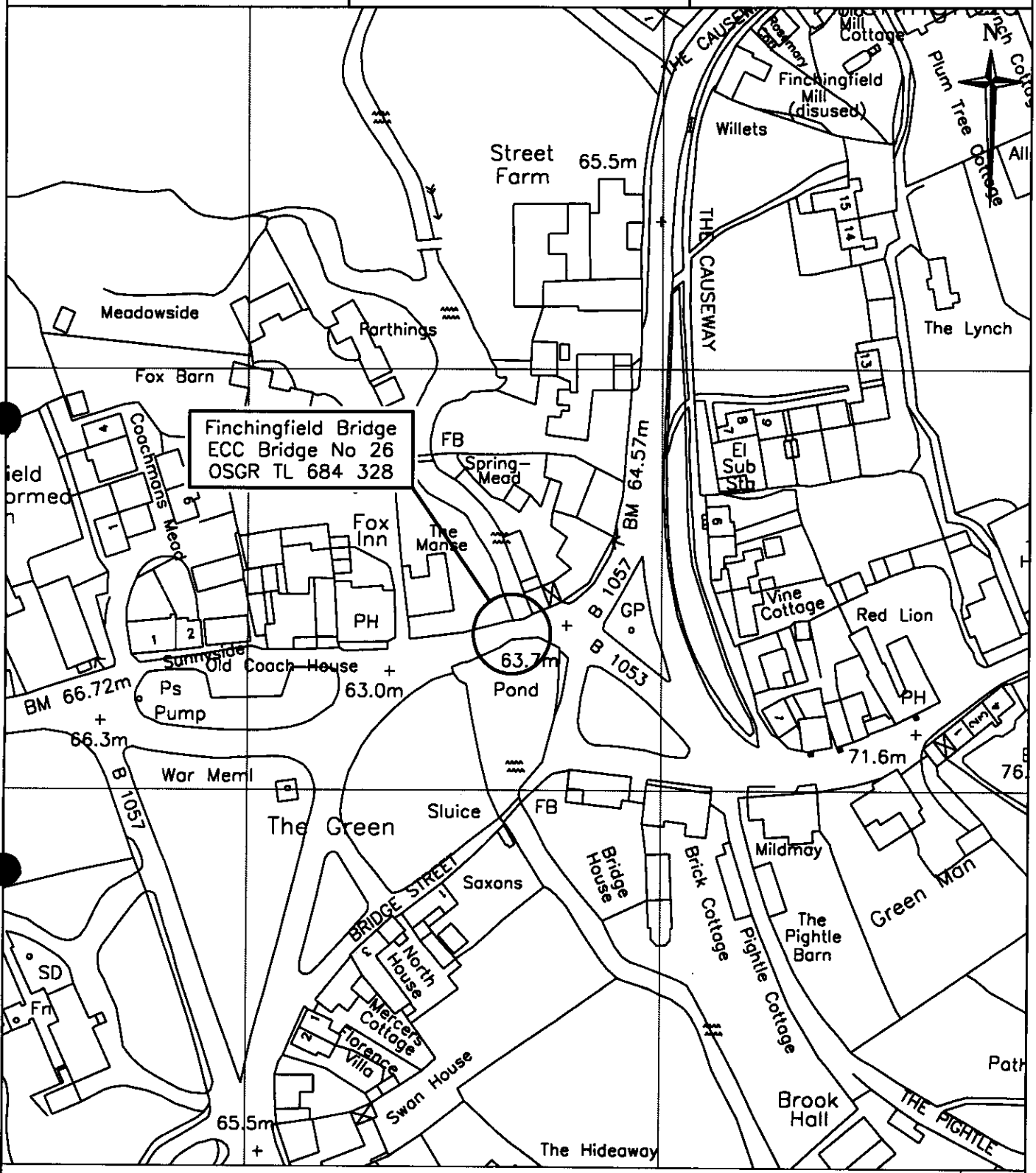





A4

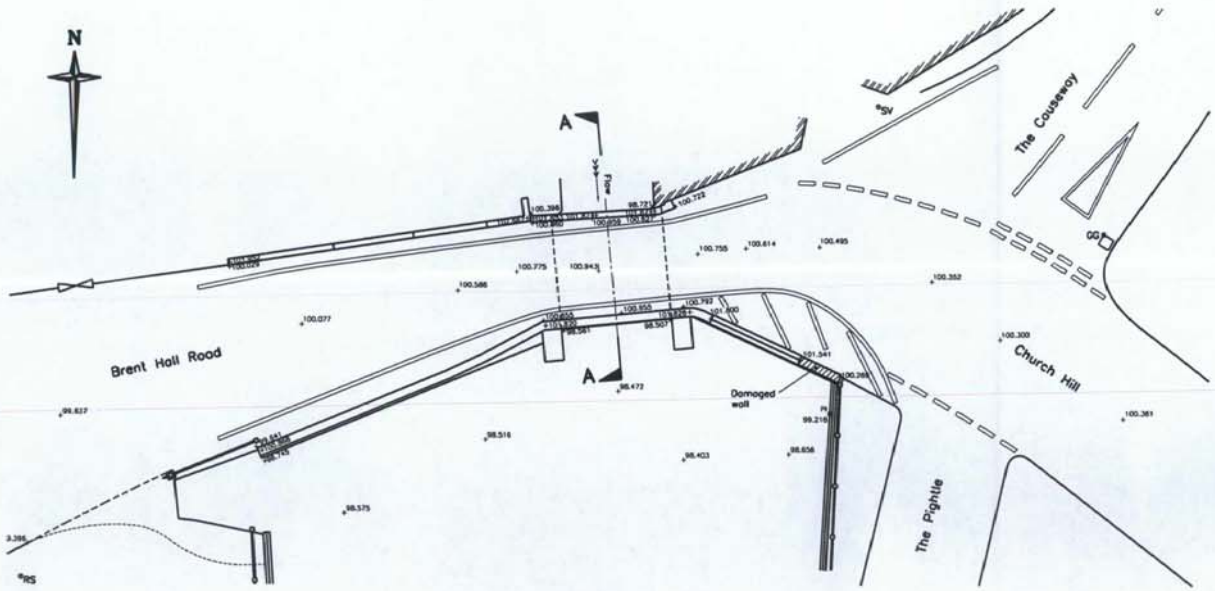
DESCRIPTION OF DRAWING

FINCHINGFIELD BRIDGE
E.C.C. BRIDGE No. 26
LOCATION PLAN

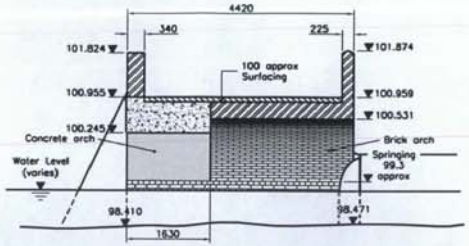
| | | | |
|---|---|---|---|
| DRAWN | KC | DATE | Jul 09 |
| CHECKED | MM | DATE | Jul 09 |
| AUTHORISED | RDBH | DATE | Jul 09 |
| SCALES | 1:1250 | | |
| CAD No. | BR0026-00A | | |
| DRG. No. | BR0026/00A | | |

NOTES

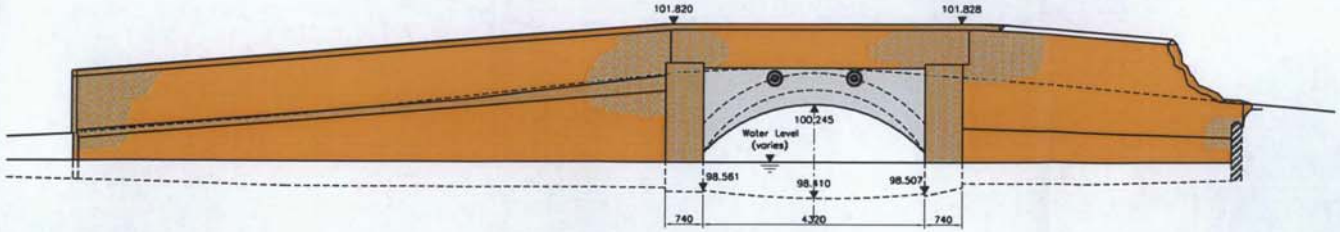
1. All dimensions are in millimetres unless otherwise stated.
2. All levels are in metres above local datum unless otherwise stated.



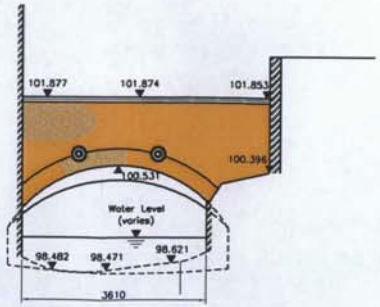

PLAN
Scale 1:100




SECTION A–A
Scale 1:50




SOUTH ELEVATION (SQUARE TO ARCH BARREL)
Scale 1:50




NORTH ELEVATION (SQUARE TO ARCH BARREL)
Scale 1:50

PRELIMINARY

A1



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COUNTY HALL, CHELMSFORD, CM1 1QH
Telephone 08457 430430

mouchel

SCALES: As Shown

CAD FILE: BR0026-02-

| | INITIALS | DATE |
|---|---|---|
| SURVEYED | | |
| LEVELLED | | |
| DESIGNED | | |
| DRAWN | ABC | OCT 09 |
| CHECKED | JS | JAN 10 |
| AUTHORISED | CJT | JAN 10 |

| DESCRIPTION | REVISION SUFFIX | BY | CHECKED DATE | BY |
|---|---|---|---|---|
| | | | | |

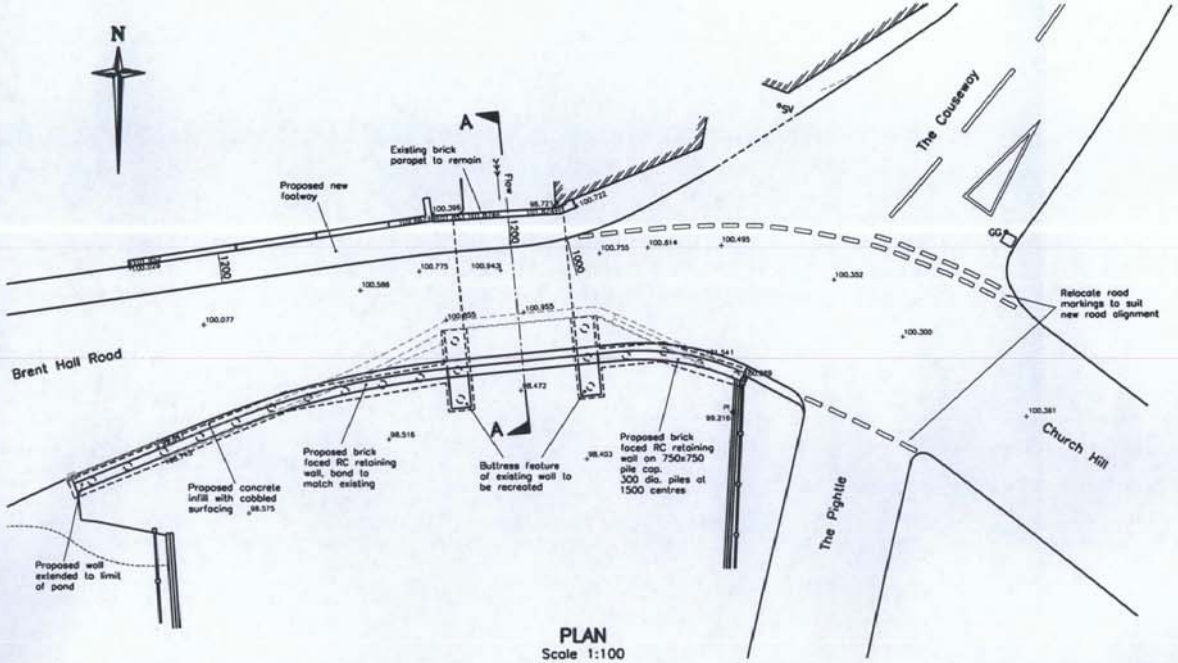
DESCRIPTION OF DRAWING: EXISTING GENERAL ARRANGEMENT

SCHEME TITLE: FINCHINGFIELD BRIDGE
E.C.C. BRIDGE No. 26

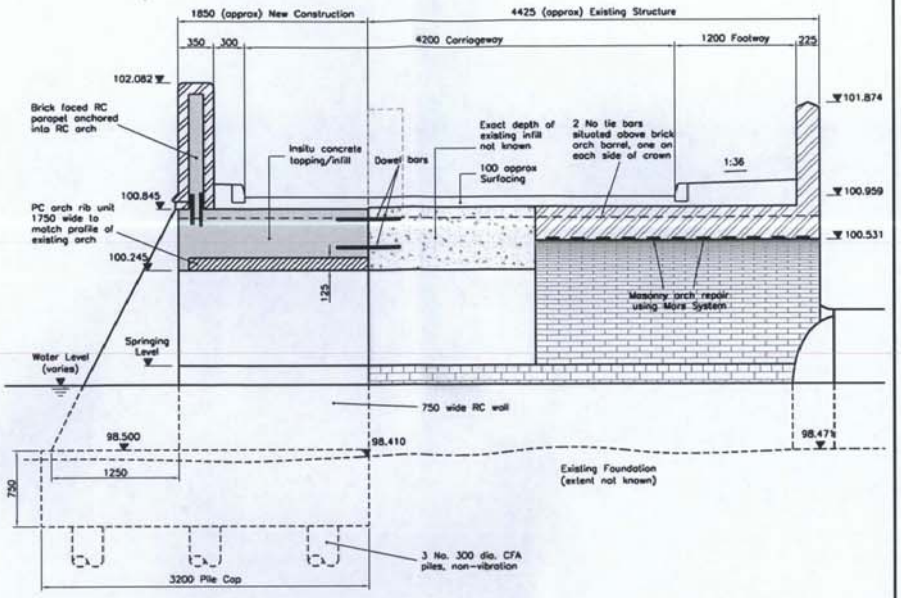
DRAWING No. BR0026/02-

NOTES

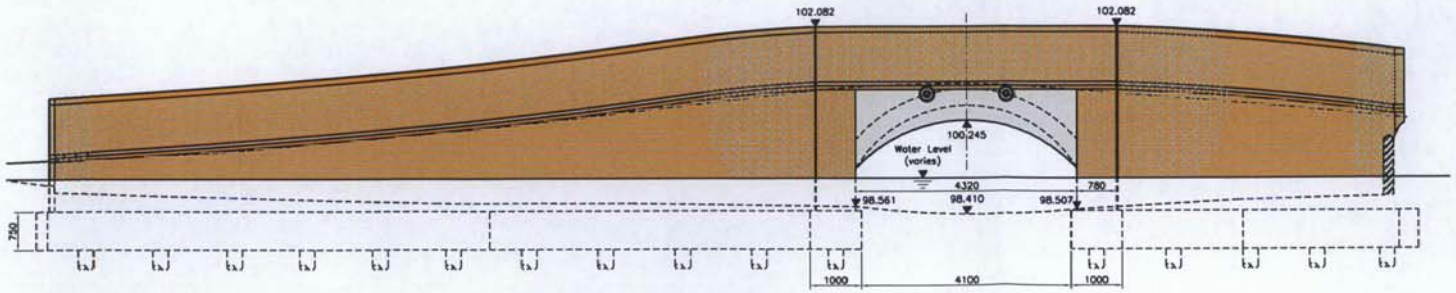
1. All dimensions are in millimetres unless otherwise stated.
2. All levels are in metres above local datum unless otherwise stated.




PLAN
Scale 1:100




SECTION A–A
Scale 1:50




SOUTH ELEVATION (SQUARE TO ARCH BARREL)
Scale 1:50

PRELIMINARY

A1

Essex County Council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| SCALES | CAD FILE |
|---|---|
| As Shown | BR0026-03- |

| | INITIALS | DATE |
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| SURVEYED | | |
| LEVELLED | | |
| DESIGNED | JS | DEC 09 |
| DRAWN | ABC | JAN 10 |
| CHECKED | JS | JAN 10 |
| AUTHORISED | GJT | JAN 10 |

| DESCRIPTION | REVISION SUFFIX | REVISION BY | CHECKED DATE | CHECKED BY |
|---|---|---|---|---|

DESCRIPTION OF DRAWING

PROPOSED OPTION 1:
STRENGTHENING OF MASONRY ARCH AND EXTENSION OF CONCRETE ARCH

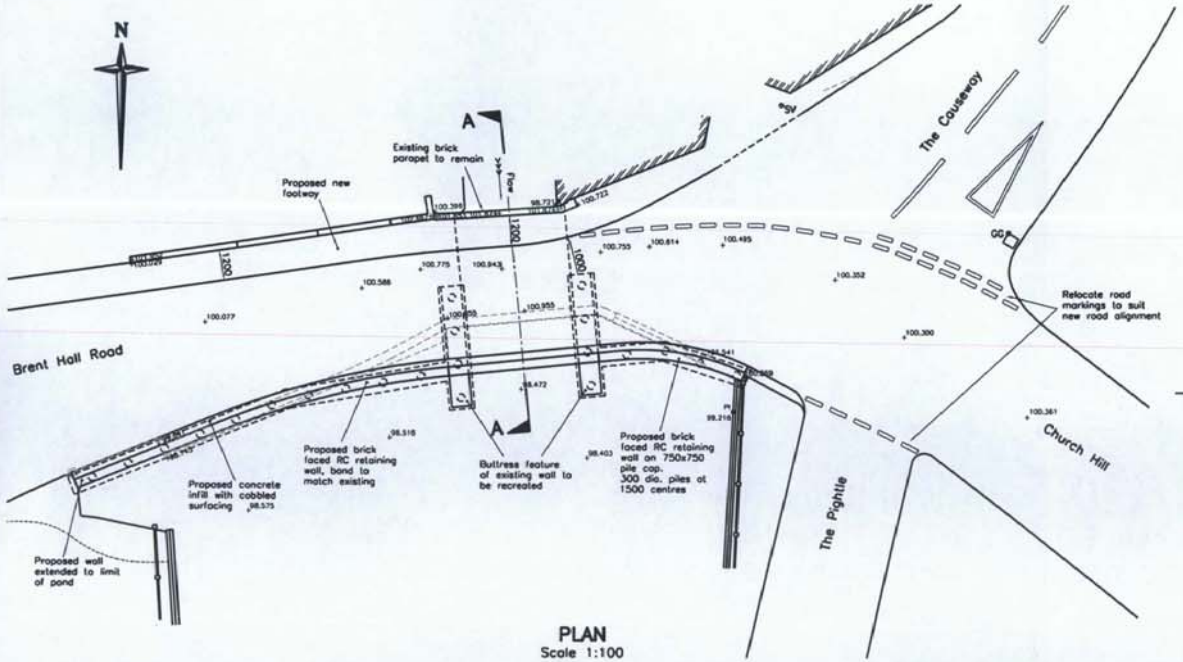
SCHEME TITLE

FINCHINGFIELD BRIDGE
E.C.C. BRIDGE No. 26

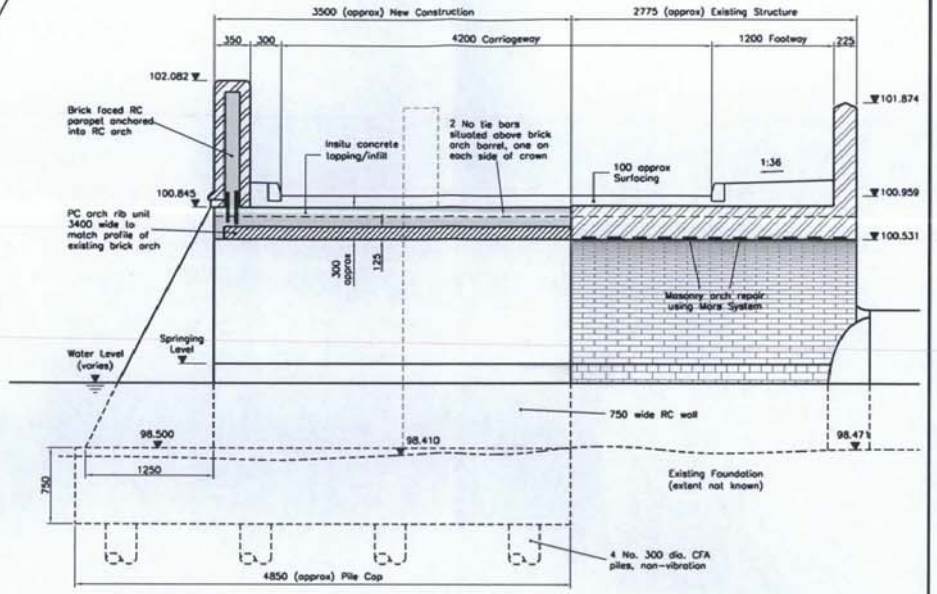
DRAWING No. BR0026/03–

NOTES

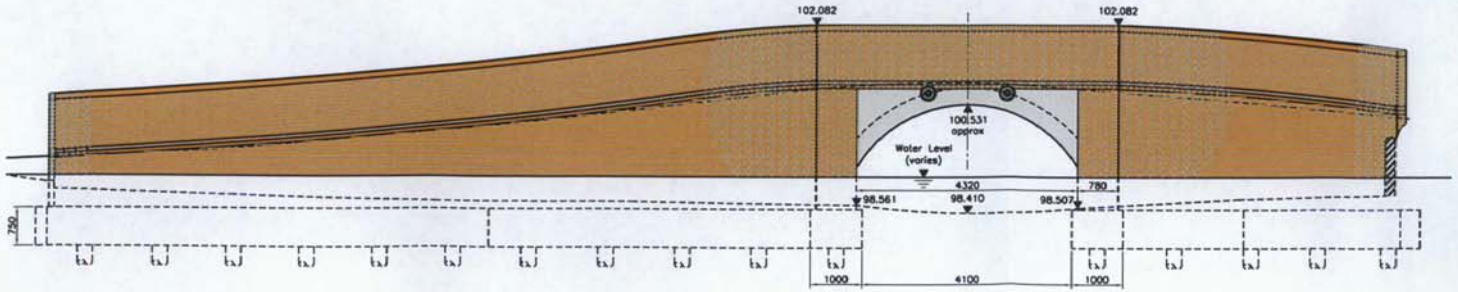
1. All dimensions are in millimetres unless otherwise stated.
2. All levels are in metres above local datum unless otherwise stated.




PLAN
Scale 1:100




SECTION A–A
Scale 1:50




SOUTH ELEVATION (SQUARE TO ARCH BARREL)
Scale 1:50

**PRELIMINARY** A1

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Telephone 08457 430430

mouchel

SCALES: As Shown
CAD FILE: BR0026-04-

| | INITIALS | DATE |
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| SURVEYED | | |
| LEVELLED | | |
| DESIGNED | JS | DEC 09 |
| DRAWN | ABC | JAN 10 |
| CHECKED | JS | JAN 10 |
| AUTHORISED | GJT | JAN 10 |

| DESCRIPTION | REVISION SUFFIX | BY | CHECKED DATE | BY |
|---|---|---|---|---|
| | | | | |

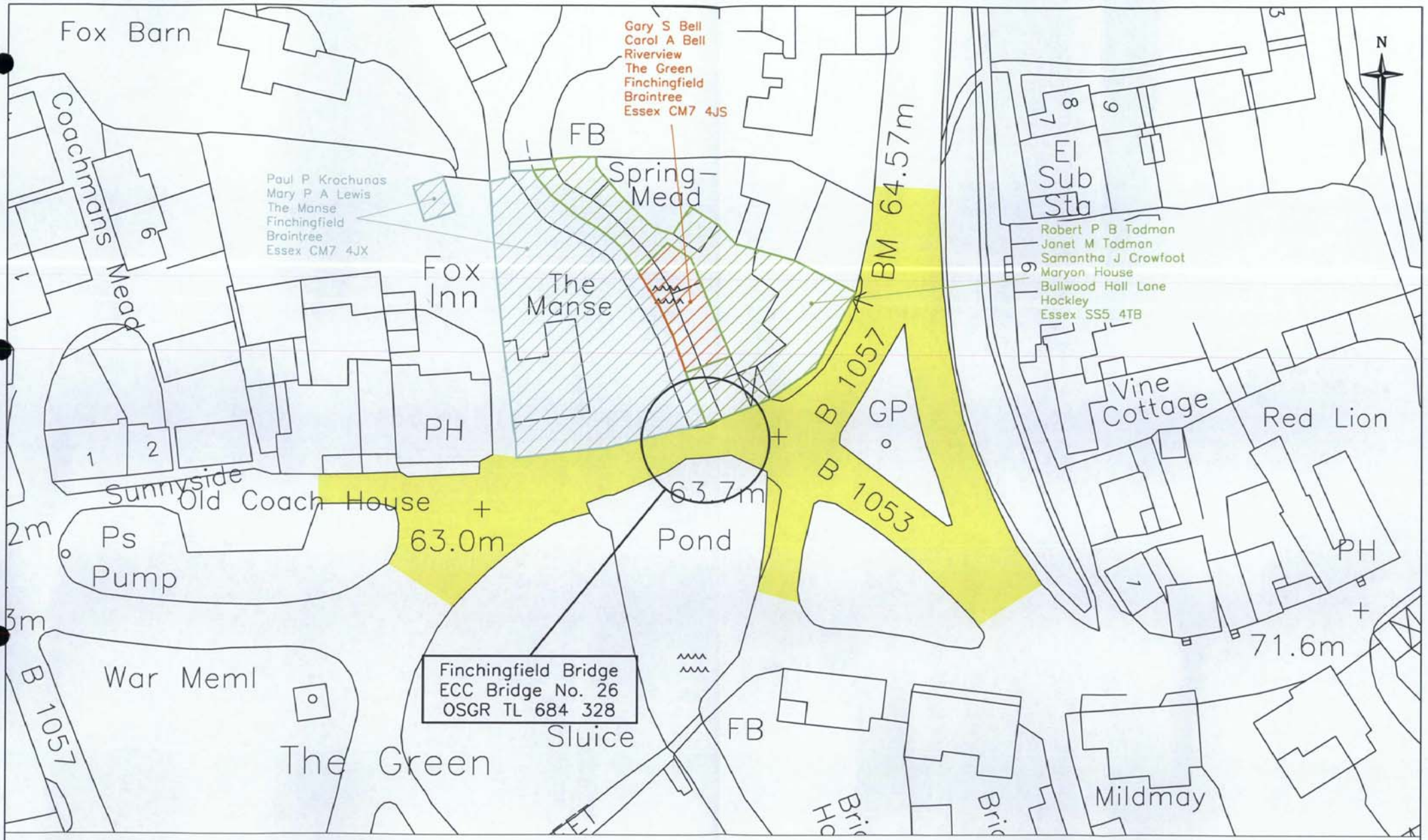
DESCRIPTION OF DRAWING

PROPOSED OPTION 2:
STRENGTHENING OF MASONRY ARCH AND EXTENSION OF CONCRETE ARCH

SCHEME TITLE

FINCHINGFIELD BRIDGE
E.C.C. BRIDGE No. 26

DRAWING No. BR0026/04–






Area of land over which highways rights exist shown thus :

A3

Essex County Council

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HIGHWAYS & TRANSPORTATION,
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Telephone 08457 430430

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| SCALES | CAD FILE |
|---|---|
| 1:500 | BR0026-LP00- |

| | INITIALS | DATE |
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| SURVEYED | | |
| LEVELLED | | |
| DESIGNED | | |
| DRAWN | ABC | SEPT 09 |
| CHECKED | JS | JAN 10 |
| AUTHORISED | GJT | JAN 10 |

| DESCRIPTION | REVISION SUFFIX | BY | CHECKED DATE | BY |
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DESCRIPTION OF DRAWING

ALL LANDOWNERS PLAN

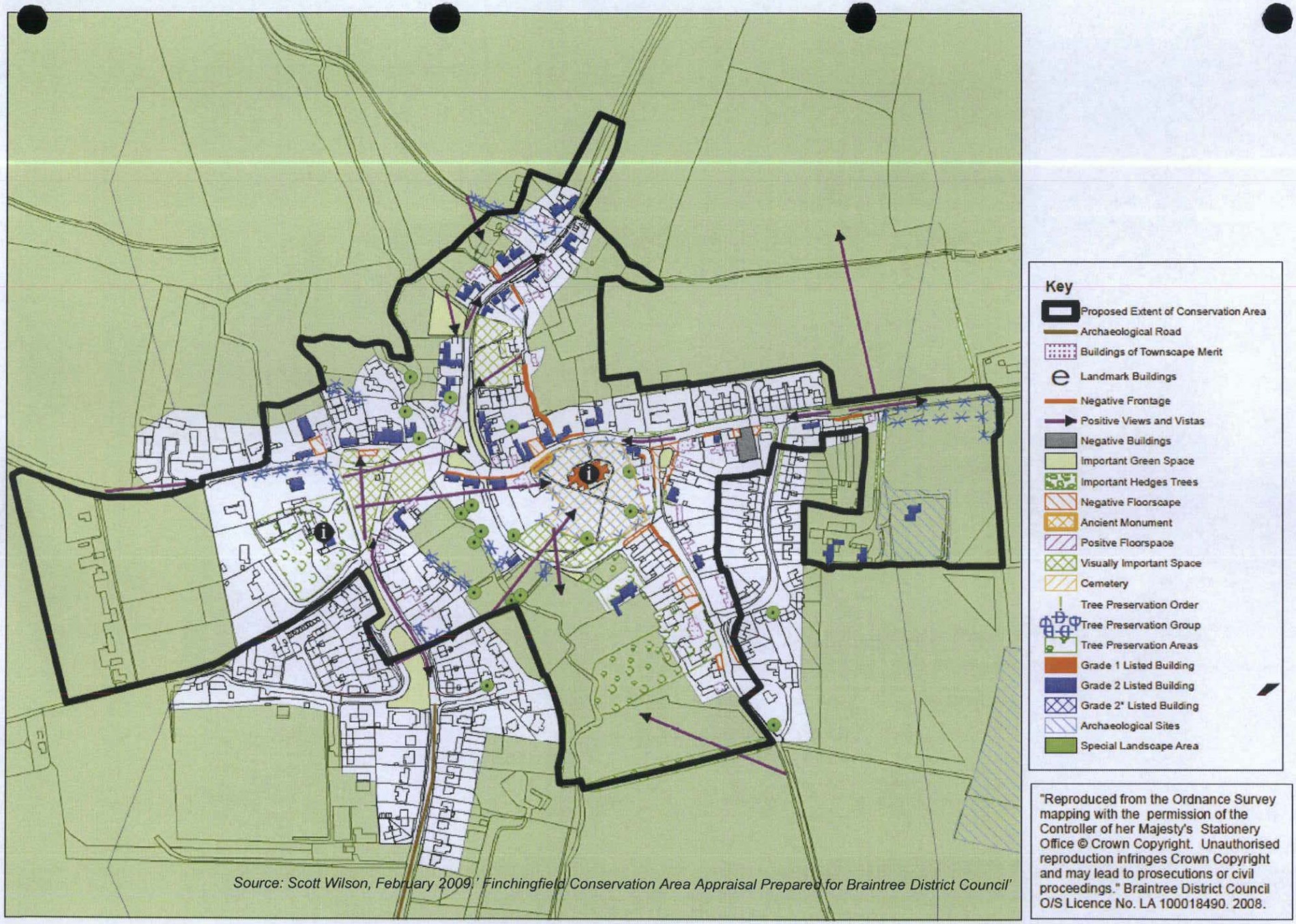
SCHEME TITLE

SCHEME TITLE
FINCHINGFIELD BRIDGE
E.C.C. BRIDGE No. 26

DRAWING No. BR0026/LP00-

## APPENDIX C

## MAP OF FINCHINGFIELD CONSERVATION AREA




*Source: Scott Wilson, February 2009,' Finchingfield Conservation Area Appraisal Prepared for Braintree District Council'*

# APPENDIX D

# REASSESSMENT CALCULATIONS

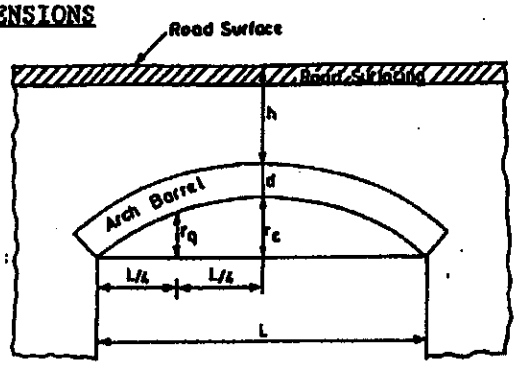
ESSEX HIGHWAYS CONSULTANCY

WP REF: CCDGWMEXE/ARC

ARCH ASSESSMENT TO MODIFIED MEXE (BA 16/93)

STRUCTURE: NO. 26 NAME: FINCHINGFIELD BRIDGE BRICK ARCH.

1. DIMENSIONS




L = 4.30 M

rc = 1.26

rq = 1.06

d = 0.33

h = 0.08

h+d = 0.41

2. PROVISIONAL ASSESSMENT LOADING (Fig 3/1) PAL = 18 TONNE

3. SPAN RISE FACTOR

$\frac{L}{rc} = \frac{4.30}{1.26} = 3.4$ (Fig 3/3) Fsr = 1.0

4. PROFILE FACTOR

$\frac{rq}{rc} = \frac{1.06}{1.26} = 0.84$ (Fig 3/4) Fp = 0.78

5. MATERIAL FACTOR

(Table 3/1 & 3/2) $Fm = \frac{Fbd + F\,h}{d + h} = \frac{1.0 \times 0.33 + 0.9 \times 0.08}{0.41} = 0.98$

6. JOINT FACTOR

(Tables 3/3 & 3/4 & 3/5) Fj = Fw Fd Fmo = 0.9 x 0.9 x 0.9 = 0.73

7. CONDITION FACTOR

Para 3.17 to 3.23 Fc = 0.9

8. MODIFIED AXLE LOAD: PAL x Fsr x Fp x Fm x Fj x Fc = MAL = 9.0 TONNE

18 x 1.0 x 0.78 x 0.98 x 0.73 x 0.9

9. AXLE LIFT-OFF: (Fig 3/5) Factor Af = 0.66

Allowable Axle Load = 9.0 x 0.66 = 5.9 te

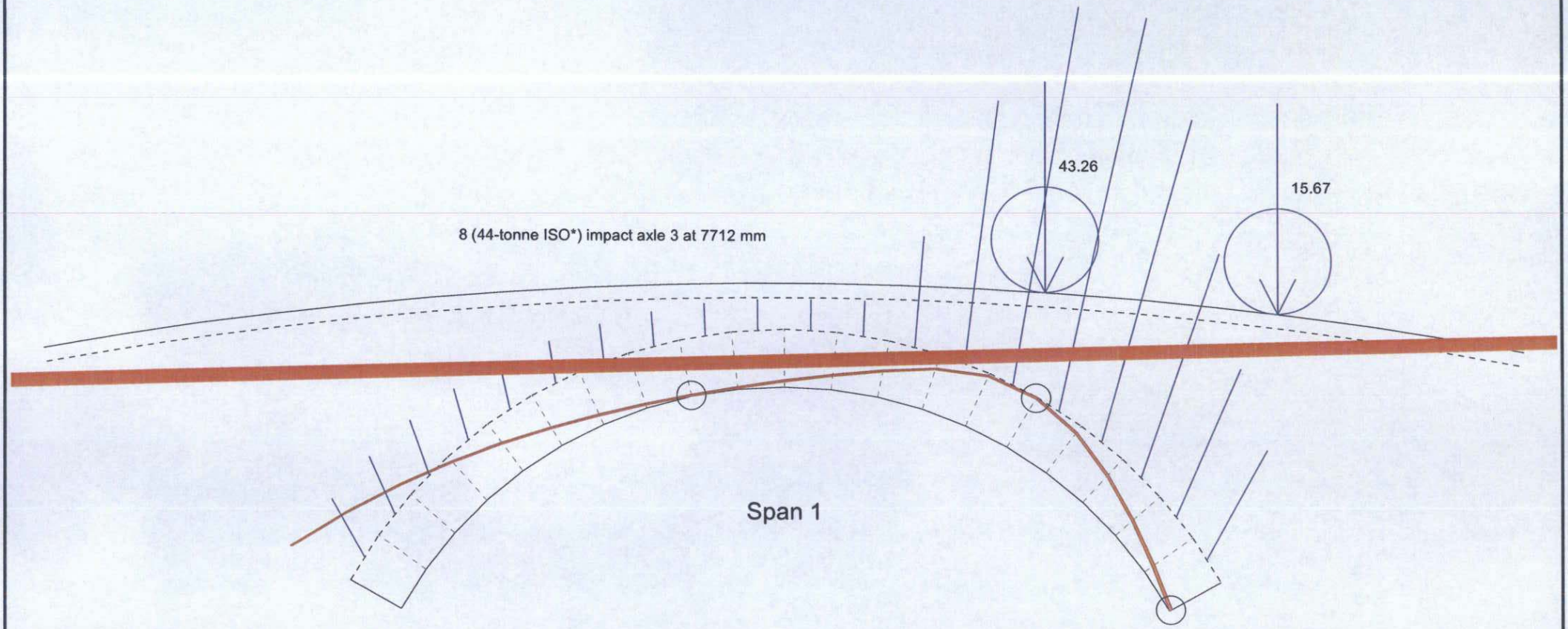
10. WEIGHT LIMIT ON ARCH (MAX GROSS VEHICLE WEIGHT) (Table 3/6) 7.5 TONNE

11. CONCLUSION: The modified MEXE method indicates that the brick barrel has a gross vehicle capacity of 7.5 te - CHECK CAPACITY USING AN ALTERNATIVE ANALYSIS.

Assessed by: [redacted] Date: 10/94

Signed: [redacted]

# Finchingfield Bridge




FAILS 44-TONE ISO

gammaFl dead load: 1.00
gammaFl superimposed: 1.00
gammaFl live load: 1.90
gammaF3 load effect: 1.10
gammaM material: 0.66

8 (44-tonne ISO*) impact axle 3 @ 7712 [mm]

File path: K:\Structures\Projects\ECC\2009-10 G Thomson\735765 Option Studies\Structures\Finchingfield 26\ArchieM\Structure2.brg

NAME: Finchingfield Bridge
LOCATION: Finchingfield, Essex (Nr Thaxted)
NUMBER: ECC Bridge No. 26
Mouchel Group
DATE: 24 November 2009
Printed on: Thursday, November 26, 2009 09:58:15

Bridge Name: Finchingfield Bridge  Bridge Location: Finchingfield, Essex (Nr Thaxted)
Bridge Number: ECC Bridge No. 26
Number of spans: 1

SAFETY FACTORS
Factor for deadload: 1.00  Factor for superimposed deadload: 1.00  Factor for surfacing: 1.00
Factor for live load: 1.90  Factor for load effect: 1.10  Factor for material strength: 0.66

APPLIED LOAD CASES
1. 8 (44-tonne ISO*) impact axle 3  Total weight: 431.64 [kN]  Position: 7712 [mm]

Applied distribution mode: Archie/Multi
Applied live load pressure: Active pressure

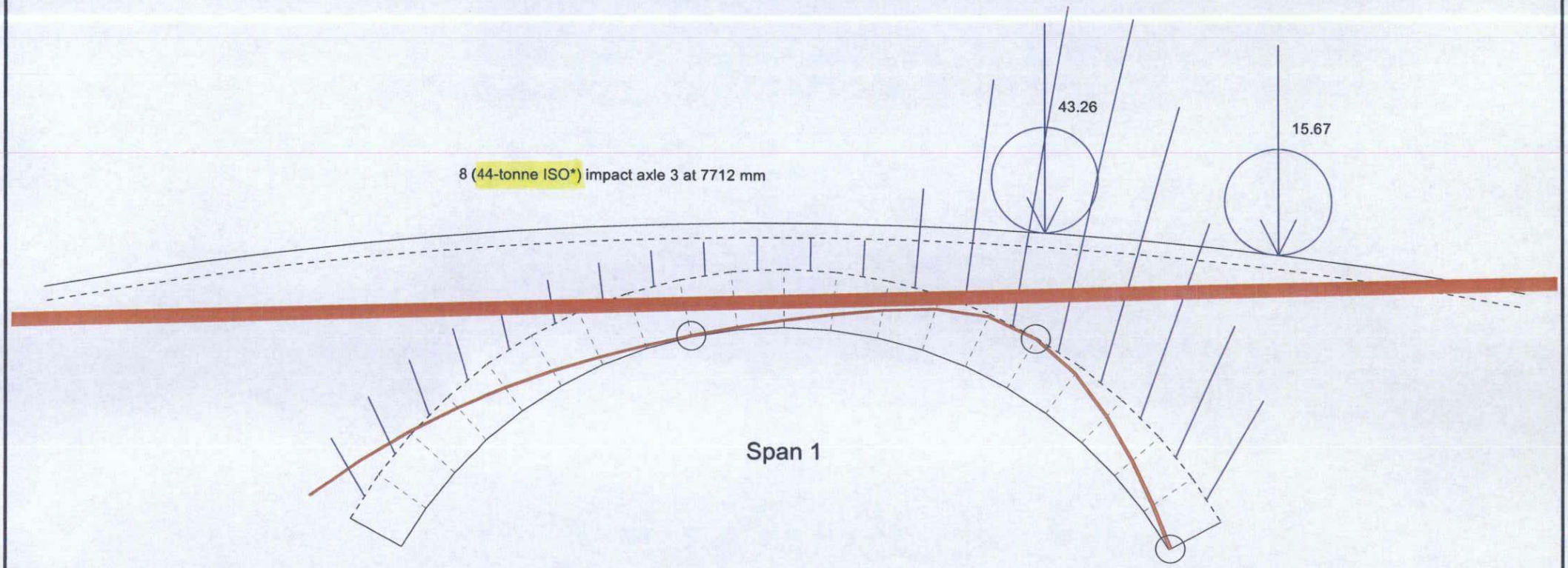
STRUCTURE PROPERTIES
Road shape: Curved (3-point method)
Road points: (-2000, -200)  (0, 80)  (6300, -200)
Depth of surfacing: 80  Depth of overlay: 0
Surface unit weight: 24.00 [kN/m^3]  Overlay unit weight: 22.00 [kN/m^3]
Lane width: 2500

Fill unit weight: 22.00 [kN/m^3]  Fill phi: 30 [degree]

SPAN 1
Shape Circular
Span: 4300 [mm]  Rise: 1260 [mm]  Quarter Rise: 1060 [mm]
Ring Thickness at crown: 330 [mm]  Ring Thickness at springing: 330 [mm]  Mortar loss: 0 [mm]
Masonry Unit Weight: 21.00 [kN/m3]  Masonry Strength: 9.00 [MPa]

| Segment | Intrados.x | Intrados.z | Extrados.x | Extrados.z | Roadlevel | Fx dead | Fz dead | My dead | Fx live | Fz live | My live | Fx passive | Fx total | Fz total | My total | Thrust in | Thrust out | Extra-Thrust | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -1670 | -288 | -1509 | 51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -117.53 | -71.58 | -85.92 | 712 | 721 | -391 | *** |
| 1 | 140 | -1449 | -130 | -1258 | 67 | 3.99 | -6.97 | -0.07 | 0.00 | -0.00 | 0.00 | 0.00 | -121.52 | -64.60 | -68.03 | 549 | 558 | -228 | *** |
| 2 | 302 | -1244 | 54 | -1026 | 85 | 3.13 | -6.88 | -0.04 | 0.00 | -0.00 | 0.00 | 0.00 | -124.65 | -57.72 | -51.82 | 408 | 417 | -87 | *** |
| 3 | 484 | -1058 | 261 | -815 | 103 | 2.38 | -6.59 | 0.02 | 0.00 | -0.00 | 0.00 | 0.00 | -127.03 | -51.13 | -37.51 | 288 | 297 | 33 | |
| 4 | 686 | -892 | 490 | -627 | 121 | 1.74 | -6.15 | 0.09 | 0.00 | -0.00 | 0.00 | 0.00 | -128.77 | -44.98 | -25.29 | 189 | 199 | 131 | |
| 5 | 904 | -748 | 737 | -463 | 138 | 1.22 | -5.64 | 0.17 | 0.00 | -0.00 | 0.00 | 0.00 | -129.99 | -39.34 | -15.34 | 111 | 121 | 209 | |
| 6 | 1136 | -628 | 1000 | -328 | 153 | 0.82 | -5.10 | 0.23 | 0.00 | -0.00 | 0.00 | 0.00 | -130.81 | -34.24 | -7.83 | 54 | 64 | 266 | |
| 7 | 1379 | -534 | 1276 | -220 | 165 | 0.52 | -4.60 | 0.29 | 0.00 | -0.00 | 0.00 | 0.00 | -131.33 | -29.64 | -2.90 | 17 | 27 | 303 | |
| 8 | 1631 | -465 | 1562 | -143 | 174 | 0.31 | -4.18 | 0.34 | 0.00 | -0.00 | 0.00 | 0.00 | -131.64 | -25.46 | -0.66 | -0 | 10 | 320 | |
| 9 | 1889 | -424 | 1854 | -96 | 180 | 0.16 | -3.88 | 0.39 | 0.00 | -0.00 | 0.00 | 0.00 | -131.79 | -21.58 | -1.16 | 4 | 14 | 316 | |
| 10 | 2150 | -410 | 2150 | -80 | 182 | 0.05 | -3.72 | 0.45 | 0.00 | -0.00 | 0.00 | 0.00 | -131.84 | -17.85 | -4.45 | 29 | 39 | 291 | |
| 11 | 2411 | -424 | 2446 | -96 | 180 | -0.05 | -3.72 | 0.52 | -0.00 | -0.00 | 0.00 | 0.00 | -131.79 | -14.13 | -10.48 | 76 | 86 | 244 | |
| 12 | 2669 | -465 | 2738 | -143 | 174 | -0.16 | -3.88 | 0.61 | -0.02 | -0.36 | 0.10 | 0.00 | -131.62 | -9.89 | -19.18 | 147 | 156 | 174 | |
| 13 | 2921 | -534 | 3024 | -220 | 165 | -0.31 | -4.18 | 0.73 | -0.82 | -9.11 | 2.09 | 0.00 | -130.49 | 3.40 | -30.07 | 236 | 245 | 85 | |
| 14 | 3164 | -628 | 3300 | -328 | 153 | -0.52 | -4.60 | 0.88 | -3.50 | -27.02 | 6.07 | 0.00 | -126.46 | 35.02 | -40.46 | 307 | 317 | 13 | |
| 15 | 3396 | -748 | 3563 | -463 | 138 | -0.82 | -5.10 | 1.05 | -6.96 | -40.42 | 9.42 | 0.00 | -118.68 | 80.54 | -46.48 | 320 | 330 | -0 | *** |
| 16 | 3614 | -892 | 3810 | -627 | 121 | -1.22 | -5.64 | 1.24 | -9.17 | -41.72 | 10.21 | 0.00 | -108.28 | 127.90 | -45.62 | 274 | 286 | 44 | |
| 17 | 3816 | -1058 | 4039 | -815 | 103 | -1.74 | -6.15 | 1.44 | -8.97 | -32.68 | 8.39 | 0.00 | -97.57 | 166.73 | -38.04 | 199 | 213 | 117 | |
| 18 | 3998 | -1244 | 4246 | -1026 | 85 | -2.38 | -6.59 | 1.63 | -6.93 | -20.38 | 5.49 | 0.00 | -88.26 | 193.70 | -26.19 | 121 | 136 | 194 | |
| 19 | 4160 | -1449 | 4430 | -1258 | 67 | -3.13 | -6.88 | 1.80 | -4.58 | -10.88 | 3.09 | 0.00 | -80.55 | 211.47 | -13.29 | 53 | 69 | 261 | |
| 20 | 4300 | -1670 | 4588 | -1509 | 51 | -3.99 | -6.97 | 1.93 | -3.21 | -6.09 | 1.87 | 0.00 | -73.34 | 224.53 | -1.96 | -0 | 17 | 313 | |

# Finchingfield Bridge




FAILS 44 TONE ISO

gammaFl dead load: 1.15
gammaFl superimposed: 1.20
gammaFl live load: 1.90
gammaF3 load effect: 1.10
gammaM material: 0.66

8 (44-tonne ISO*) impact axle 3 @ 7712 [mm]

File path: K:\Structures\Projects\ECC\2009-10 G Thomson\735765 Option Studies\Structures\Finchingfield 26\ArchieM\Structure2.brg

NAME: Finchingfield Bridge
LOCATION: Finchingfield, Essex (Nr Thaxted)
NUMBER: ECC Bridge No. 26
Mouchel Group
DATE: 24 November 2009
Printed on: Thursday, November 26, 2009 09:57:01

Bridge Name: Finchingfield Bridge  Bridge Location: Finchingfield, Essex (Nr Thaxted)
Bridge Number: ECC Bridge No. 26
Number of spans: 1

SAFETY FACTORS

Factor for deadload: 1.15  Factor for superimposed deadload: 1.20  Factor for surfacing: 1.75
Factor for live load: 1.90  Factor for load effect: 1.10  Factor for material strength: 0.66

APPLIED LOAD CASES

1. 8 (44-tonne ISO*) impact axle 3  Total weight: 431.64 [kN]  Position: 7712 [mm]

Applied distribution mode: Archie/Multi
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES

Road shape: Curved (3-point method)
Road points: (-2000, -200)  (0, 80)  (6300, -200)
Depth of surfacing: 80  Depth of overlay: 0
Surface unit weight: 24.00 [kN/m^3]  Overlay unit weight: 22.00 [kN/m^3]
Lane width: 2500

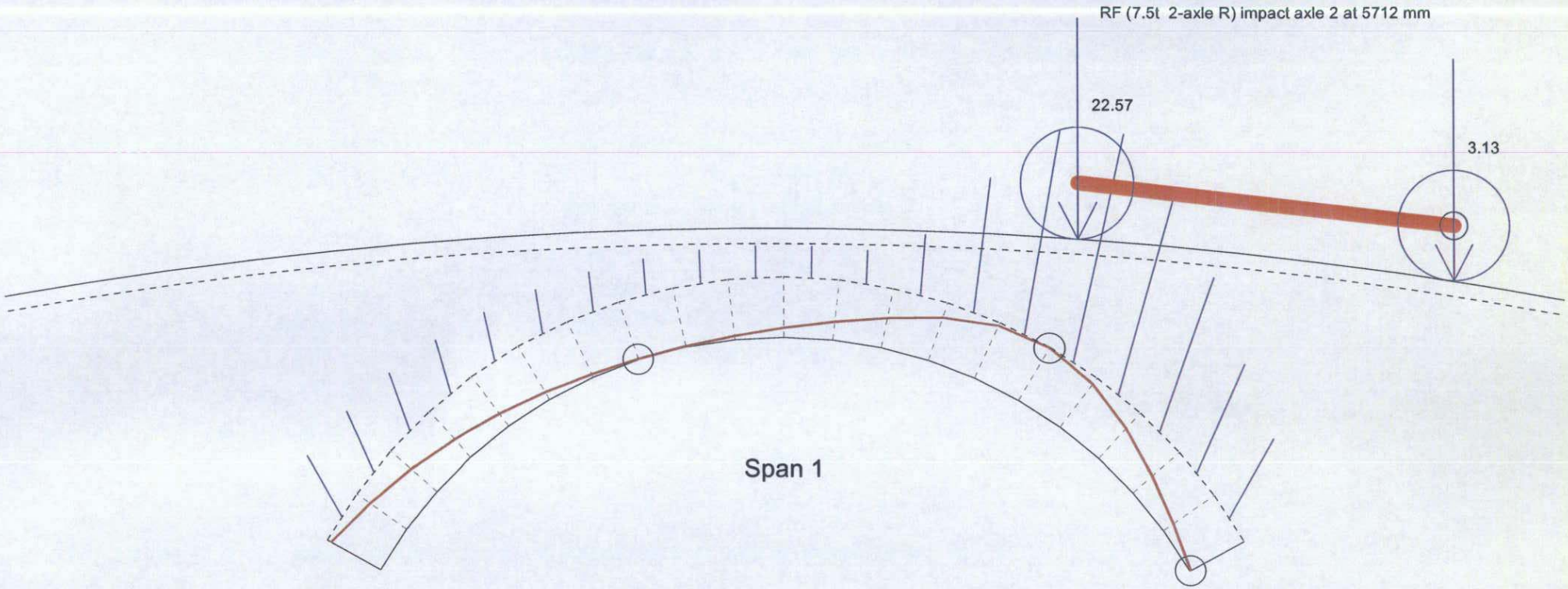
Fill unit weight: 22.00 [kN/m^3]  Fill phi: 30 [degree]

SPAN 1

Shape Circular
Span: 4300 [mm]  Rise: 1260 [mm]  Quarter Rise: 1060 [mm]
Ring Thickness at crown: 330 [mm]  Ring Thickness at springing: 330 [mm]  Mortar loss: 0 [mm]
Masonry Unit Weight: 21.00 [kN/m3]  Masonry Strength: 9.00 [MPa]

| Segment | Intrados.x | Intrados.z | Extrados.x | Extrados.z | Roadlevel | Fx dead | Fz dead | My dead | Fx live | Fz live | My live | Fx passive | Fx total | Fz total | My total | Thrust in | Thrust out | Extra-Thrust | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -1670 | -288 | -1509 | 51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -119.63 | -85.51 | -79.31 | 591 | 601 | -271 | *** |
| 1 | 140 | -1449 | -130 | -1258 | 67 | 4.92 | -8.44 | -0.08 | 0.00 | -0.00 | 0.00 | 0.00 | -124.56 | -77.07 | -62.48 | 458 | 468 | -138 | *** |
| 2 | 302 | -1244 | 54 | -1026 | 85 | 3.88 | -8.36 | -0.04 | 0.00 | -0.00 | 0.00 | 0.00 | -128.44 | -68.71 | -47.28 | 341 | 351 | -21 | *** |
| 3 | 484 | -1058 | 261 | -815 | 103 | 2.96 | -8.03 | 0.03 | 0.00 | -0.00 | 0.00 | 0.00 | -131.40 | -60.68 | -33.91 | 241 | 251 | 79 | |
| 4 | 686 | -892 | 490 | -627 | 121 | 2.19 | -7.53 | 0.12 | 0.00 | -0.00 | 0.00 | 0.00 | -133.59 | -53.15 | -22.56 | 157 | 167 | 163 | |
| 5 | 904 | -748 | 737 | -463 | 138 | 1.55 | -6.93 | 0.21 | 0.00 | -0.00 | 0.00 | 0.00 | -135.14 | -46.23 | -13.42 | 91 | 101 | 229 | |
| 6 | 1136 | -628 | 1000 | -328 | 153 | 1.06 | -6.30 | 0.29 | 0.00 | -0.00 | 0.00 | 0.00 | -136.20 | -39.93 | -6.64 | 42 | 52 | 278 | |
| 7 | 1379 | -534 | 1276 | -220 | 165 | 0.68 | -5.71 | 0.37 | 0.00 | -0.00 | 0.00 | 0.00 | -136.88 | -34.21 | -2.37 | 12 | 22 | 308 | |
| 8 | 1631 | -465 | 1562 | -143 | 174 | 0.41 | -5.22 | 0.43 | 0.00 | -0.00 | 0.00 | 0.00 | -137.29 | -28.99 | -0.72 | -0 | 10 | 320 | |
| 9 | 1889 | -424 | 1854 | -96 | 180 | 0.21 | -4.87 | 0.50 | 0.00 | -0.00 | 0.00 | 0.00 | -137.50 | -24.12 | -1.75 | 7 | 18 | 312 | |
| 10 | 2150 | -410 | 2150 | -80 | 182 | 0.07 | -4.68 | 0.57 | 0.00 | -0.00 | 0.00 | 0.00 | -137.56 | -19.44 | -5.48 | 35 | 45 | 285 | |
| 11 | 2411 | -424 | 2446 | -96 | 180 | -0.07 | -4.68 | 0.66 | -0.00 | -0.00 | 0.00 | 0.00 | -137.50 | -14.75 | -11.89 | 83 | 93 | 237 | |
| 12 | 2669 | -465 | 2738 | -143 | 174 | -0.21 | -4.87 | 0.77 | -0.02 | -0.36 | 0.10 | 0.00 | -137.27 | -9.52 | -20.88 | 153 | 163 | 167 | |
| 13 | 2921 | -534 | 3024 | -220 | 165 | -0.41 | -5.22 | 0.91 | -0.82 | -9.11 | 2.09 | 0.00 | -136.03 | 4.81 | -31.98 | 240 | 249 | 81 | |
| 14 | 3164 | -628 | 3300 | -328 | 153 | -0.68 | -5.71 | 1.09 | -3.50 | -27.02 | 6.07 | 0.00 | -131.85 | 37.55 | -42.48 | 308 | 318 | 12 | |
| 15 | 3396 | -748 | 3563 | -463 | 138 | -1.06 | -6.30 | 1.30 | -6.96 | -40.42 | 9.42 | 0.00 | -123.83 | 84.27 | -48.50 | 319 | 330 | -0 | *** |
| 16 | 3614 | -892 | 3810 | -627 | 121 | -1.55 | -6.93 | 1.52 | -9.17 | -41.72 | 10.21 | 0.00 | -113.10 | 132.92 | -47.52 | 273 | 286 | 44 | |
| 17 | 3816 | -1058 | 4039 | -815 | 103 | -2.19 | -7.53 | 1.76 | -8.97 | -32.68 | 8.39 | 0.00 | -101.94 | 173.12 | -39.70 | 200 | 214 | 116 | |
| 18 | 3998 | -1244 | 4246 | -1026 | 85 | -2.96 | -8.03 | 1.99 | -6.93 | -20.38 | 5.49 | 0.00 | -92.05 | 201.53 | -27.49 | 122 | 137 | 193 | |
| 19 | 4160 | -1449 | 4430 | -1258 | 67 | -3.88 | -8.36 | 2.19 | -4.58 | -10.88 | 3.09 | 0.00 | -83.59 | 220.78 | -14.10 | 53 | 70 | 260 | |
| 20 | 4300 | -1670 | 4588 | -1509 | 51 | -4.92 | -8.44 | 2.34 | -3.21 | -6.09 | 1.87 | 0.00 | -75.45 | 235.31 | -2.14 | -0 | 18 | 312 | |

# Finchingfield Bridge




PASSES
7.5 TONNE AXLE

gammaFl dead load: 1.00 RF (7.5t 2-axle R) impact axle 2 @ 5712 [mm]
gammaFl superimposed: 1.00
gammaFl live load: 1.90
gammaF3 load effect: 1.10
gammaM material: 0.66
File path: K:\Structures\Projects\ECC\2009-10 G Thomson\735765 Option Studies\Structures\Finchingfield 26\ArchieM\Structure2.brg

NAME: Finchingfield Bridge
LOCATION: Finchingfield, Essex (Nr Thaxted)
NUMBER: ECC Bridge No. 26
Mouchel Group
DATE: 24 November 2009
Printed on: Thursday, November 26, 2009 09:40:55

Bridge Name: Finchingfield Bridge  Bridge Location: Finchingfield, Essex (Nr Thaxted)
Bridge Number: ECC Bridge No. 26
Number of spans: 1

SAFETY FACTORS

Factor for deadload: 1.00  Factor for superimposed deadload: 1.00  Factor for surfacing: 1.00
Factor for live load: 1.90  Factor for load effect: 1.10  Factor for material strength: 0.66

APPLIED LOAD CASES

1. RF (7.5t 2-axle R) impact axle 2 Total weight: 73.58 [kN] Position: 5712 [mm]

Applied distribution mode: Archie/Multi
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES

Road shape: Curved (3-point method)
Road points: (-2000, -200) (0, 80) (6300, -200)
Depth of surfacing: 80  Depth of overlay: 0
Surface unit weight: 24.00 [kN/m^3] Overlay unit weight: 22.00 [kN/m^3]
Lane width: 2500

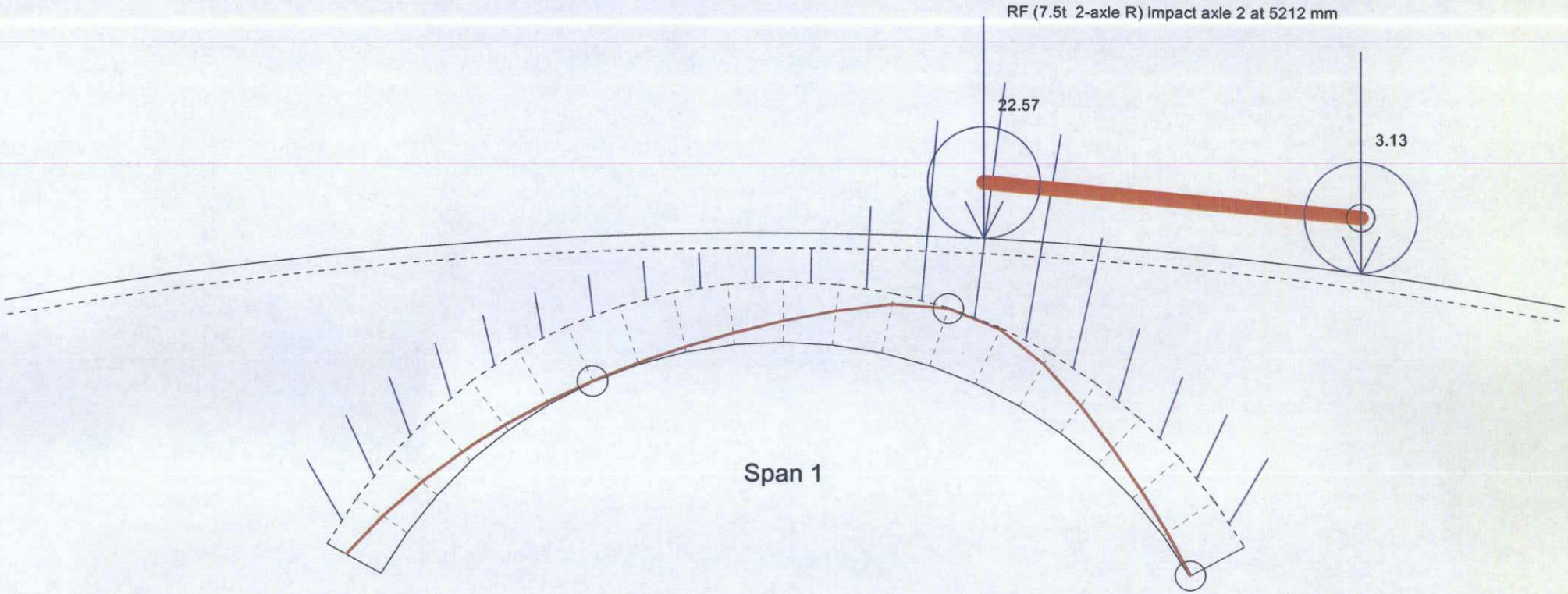
Fill unit weight: 22.00 [kN/m^3] Fill phi: 30 [degree]

SPAN 1

Shape Circular
Span: 4300 [mm] Rise: 1260 [mm] Quarter Rise: 1060 [mm]
Ring Thickness at crown: 330 [mm] Ring Thickness at springing: 330 [mm] Mortar loss: 0 [mm]
Masonry Unit Weight: 21.00 [kN/m3] Masonry Strength: 9.00 [MPa]

| Segment | Intrados.x | Intrados.z | Extrados.x | Extrados.z | Roadlevel | Fx dead | Fz dead | My dead | Fx live | Fz live | My live | Fx passive | Fx total | Fz total | My total | Thrust in | Thrust out | Extra-Thrust | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -1670 | -288 | -1509 | 51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -58.91 | -64.65 | -26.17 | 304 | 310 | 20 | |
| 1 | 140 | -1449 | -130 | -1258 | 67 | 3.99 | -6.97 | -0.07 | 0.00 | -0.00 | 0.00 | 0.00 | -62.90 | -57.68 | -20.26 | 240 | 246 | 84 | |
| 2 | 302 | -1244 | 54 | -1026 | 85 | 3.13 | -6.88 | -0.04 | 0.00 | -0.00 | 0.00 | 0.00 | -66.03 | -50.79 | -14.93 | 180 | 186 | 144 | |
| 3 | 484 | -1058 | 261 | -815 | 103 | 2.38 | -6.59 | 0.02 | 0.00 | -0.00 | 0.00 | 0.00 | -68.41 | -44.20 | -10.28 | 125 | 131 | 199 | |
| 4 | 686 | -892 | 490 | -627 | 121 | 1.74 | -6.15 | 0.09 | 0.00 | -0.00 | 0.00 | 0.00 | -70.15 | -38.05 | -6.39 | 78 | 84 | 246 | |
| 5 | 904 | -748 | 737 | -463 | 138 | 1.22 | -5.64 | 0.17 | 0.00 | -0.00 | 0.00 | 0.00 | -71.37 | -32.41 | -3.36 | 40 | 46 | 284 | |
| 6 | 1136 | -628 | 1000 | -328 | 153 | 0.82 | -5.10 | 0.23 | 0.00 | -0.00 | 0.00 | 0.00 | -72.19 | -27.31 | -1.28 | 14 | 19 | 311 | |
| 7 | 1379 | -534 | 1276 | -220 | 165 | 0.52 | -4.60 | 0.29 | 0.00 | -0.00 | 0.00 | 0.00 | -72.71 | -22.71 | -0.21 | -0 | 6 | 324 | |
| 8 | 1631 | -465 | 1562 | -143 | 174 | 0.31 | -4.18 | 0.34 | 0.00 | -0.00 | 0.00 | 0.00 | -73.02 | -18.53 | -0.23 | 0 | 6 | 324 | |
| 9 | 1889 | -424 | 1854 | -96 | 180 | 0.16 | -3.88 | 0.39 | 0.00 | -0.00 | 0.00 | 0.00 | -73.17 | -14.65 | -1.38 | 16 | 21 | 309 | |
| 10 | 2150 | -410 | 2150 | -80 | 182 | 0.05 | -3.72 | 0.45 | 0.00 | -0.00 | 0.00 | 0.00 | -73.22 | -10.93 | -3.67 | 47 | 53 | 277 | |
| 11 | 2411 | -424 | 2446 | -96 | 180 | -0.05 | -3.72 | 0.52 | -0.00 | -0.00 | 0.00 | 0.00 | -73.17 | -7.21 | -7.08 | 96 | 101 | 229 | |
| 12 | 2669 | -465 | 2738 | -143 | 174 | -0.16 | -3.88 | 0.61 | -0.00 | -0.03 | 0.01 | 0.00 | -73.02 | -3.29 | -11.57 | 161 | 166 | 164 | |
| 13 | 2921 | -534 | 3024 | -220 | 165 | -0.31 | -4.18 | 0.73 | -0.26 | -2.86 | 0.68 | 0.00 | -72.45 | 3.75 | -17.00 | 240 | 245 | 85 | |
| 14 | 3164 | -628 | 3300 | -328 | 153 | -0.52 | -4.60 | 0.88 | -1.40 | -10.82 | 2.47 | 0.00 | -70.53 | 19.17 | -22.36 | 307 | 312 | 18 | |
| 15 | 3396 | -748 | 3563 | -463 | 138 | -0.82 | -5.10 | 1.05 | -3.14 | -18.25 | 4.30 | 0.00 | -66.56 | 42.52 | -25.82 | 324 | 330 | -0 | *** |
| 16 | 3614 | -892 | 3810 | -627 | 121 | -1.22 | -5.64 | 1.24 | -4.50 | -20.48 | 5.05 | 0.00 | -60.84 | 68.64 | -25.89 | 285 | 292 | 38 | |
| 17 | 3816 | -1058 | 4039 | -815 | 103 | -1.74 | -6.15 | 1.44 | -4.72 | -17.18 | 4.43 | 0.00 | -54.38 | 91.97 | -22.25 | 214 | 221 | 109 | |
| 18 | 3998 | -1244 | 4246 | -1026 | 85 | -2.38 | -6.59 | 1.63 | -3.79 | -11.15 | 3.00 | 0.00 | -48.21 | 109.72 | -15.81 | 134 | 143 | 187 | |
| 19 | 4160 | -1449 | 4430 | -1258 | 67 | -3.13 | -6.88 | 1.80 | -2.35 | -5.57 | 1.56 | 0.00 | -42.73 | 122.17 | -8.11 | 61 | 70 | 260 | |
| 20 | 4300 | -1670 | 4588 | -1509 | 51 | -3.99 | -6.97 | 1.93 | -1.09 | -2.07 | 0.60 | 0.00 | -37.65 | 131.22 | -0.64 | -0 | 10 | 320 | |

# Finchingfield Bridge




PASSES 7.5TONNE AXLE

gammaFl dead load: 1.15
gammaFl superimposed: 1.20
gammaFl live load: 1.90
gammaF3 load effect: 1.10
gammaM material: 0.66

RF (7.5t 2-axle R) impact axle 2 @ 5212 [mm]

File path: K:\Structures\Projects\ECC\2009-10 G Thomson\735765 Option Studies\Structures\Finchingfield 26\ArchieM\Structure2.brg

NAME: Finchingfield Bridge
LOCATION: Finchingfield, Essex (Nr Thaxted)
NUMBER: ECC Bridge No. 26
Mouchel Group
DATE: 24 November 2009
Printed on: Thursday, November 26, 2009 09:55:00

Bridge Name: Finchingfield Bridge  Bridge Location: Finchingfield, Essex (Nr Thaxted)
Bridge Number: ECC Bridge No. 26
Number of spans: 1

SAFETY FACTORS
Factor for deadload: 1.15  Factor for superimposed deadload: 1.20  Factor for surfacing: 1.75
Factor for live load: 1.90  Factor for load effect: 1.10  Factor for material strength: 0.66

APPLIED LOAD CASES
1. RF (7.5t 2-axle R) impact axle 2 Total weight: 73.58 [kN] Position: 5212 [mm]

Applied distribution mode: Archie/Multi
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES
Road shape: Curved (3-point method)
Road points: (-2000, -200) (0, 80) (6300, -200)
Depth of surfacing: 80  Depth of overlay: 0
Surface unit weight: 24.00 [kN/m^3]  Overlay unit weight: 22.00 [kN/m^3]
Lane width: 2500

Fill unit weight: 22.00 [kN/m^3]  Fill phi: 30 [degree]

SPAN 1
Shape Circular
Span: 4300 [mm]  Rise: 1260 [mm]  Quarter Rise: 1060 [mm]
Ring Thickness at crown: 330 [mm]  Ring Thickness at springing: 330 [mm]  Mortar loss: 0 [mm]
Masonry Unit Weight: 21.00 [kN/m3]  Masonry Strength: 9.00 [MPa]

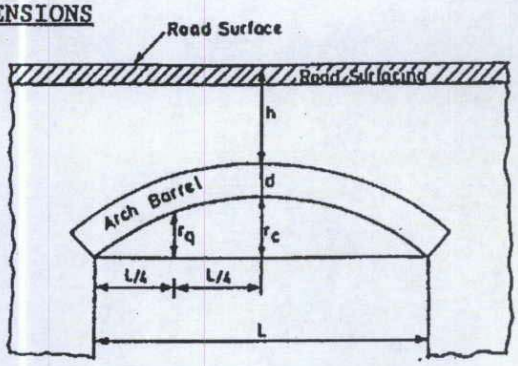
| Segment | Intrados.x | Intrados.z | Extrados.x | Extrados.z | Roadlevel | Fx dead | Fz dead | My dead | Fx live | Fz live | My live | Fx passive | Fx total | Fz total | My total | Thrust in | Thrust out | Extra-Thrust | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -1670 | -288 | -1509 | 51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -74.18 | -86.95 | -24.04 | 210 | 219 | 111 | |
| 1 | 140 | -1449 | -130 | -1258 | 67 | 4.92 | -8.44 | -0.08 | 0.00 | -0.00 | 0.00 | 0.00 | -79.10 | -78.51 | -17.45 | 155 | 163 | 167 | |
| 2 | 302 | -1244 | 54 | -1026 | 85 | 3.88 | -8.36 | -0.04 | 0.00 | -0.00 | 0.00 | 0.00 | -82.98 | -70.15 | -11.79 | 106 | 114 | 216 | |
| 3 | 484 | -1058 | 261 | -815 | 103 | 2.96 | -8.03 | 0.03 | 0.00 | -0.00 | 0.00 | 0.00 | -85.94 | -62.12 | -7.16 | 64 | 72 | 258 | |
| 4 | 686 | -892 | 490 | -627 | 121 | 2.19 | -7.53 | 0.12 | 0.00 | -0.00 | 0.00 | 0.00 | -88.13 | -54.60 | -3.65 | 32 | 39 | 291 | |
| 5 | 904 | -748 | 737 | -463 | 138 | 1.55 | -6.93 | 0.21 | 0.00 | -0.00 | 0.00 | 0.00 | -89.68 | -47.67 | -1.36 | 10 | 17 | 313 | |
| 6 | 1136 | -628 | 1000 | -328 | 153 | 1.06 | -6.30 | 0.29 | 0.00 | -0.00 | 0.00 | 0.00 | -90.74 | -41.37 | -0.36 | -0 | 7 | 323 | |
| 7 | 1379 | -534 | 1276 | -220 | 165 | 0.68 | -5.71 | 0.37 | 0.00 | -0.00 | 0.00 | 0.00 | -91.42 | -35.65 | -0.75 | 4 | 11 | 319 | |
| 8 | 1631 | -465 | 1562 | -143 | 174 | 0.41 | -5.22 | 0.43 | 0.00 | -0.00 | 0.00 | 0.00 | -91.83 | -30.43 | -2.57 | 23 | 30 | 300 | |
| 9 | 1889 | -424 | 1854 | -96 | 180 | 0.21 | -4.87 | 0.50 | 0.00 | -0.00 | 0.00 | 0.00 | -92.04 | -25.56 | -5.85 | 59 | 66 | 264 | |
| 10 | 2150 | -410 | 2150 | -80 | 182 | 0.07 | -4.68 | 0.57 | 0.00 | -0.00 | 0.00 | 0.00 | -92.10 | -20.88 | -10.59 | 112 | 118 | 212 | |
| 11 | 2411 | -424 | 2446 | -96 | 180 | -0.07 | -4.68 | 0.66 | -0.00 | -0.19 | 0.05 | 0.00 | -92.04 | -16.00 | -16.74 | 183 | 190 | 140 | |
| 12 | 2669 | -465 | 2738 | -143 | 174 | -0.21 | -4.87 | 0.77 | -0.35 | -6.48 | 1.36 | 0.00 | -91.48 | -4.65 | -23.85 | 266 | 273 | 57 | |
| 13 | 2921 | -534 | 3024 | -220 | 165 | -0.41 | -5.22 | 0.91 | -1.77 | -19.55 | 3.96 | 0.00 | -89.30 | 20.12 | -29.76 | 323 | 330 | -0 | *** |
| 14 | 3164 | -628 | 3300 | -328 | 153 | -0.68 | -5.71 | 1.09 | -3.47 | -26.73 | 5.60 | 0.00 | -85.15 | 52.56 | -31.72 | 316 | 323 | 7 | |
| 15 | 3396 | -748 | 3563 | -463 | 138 | -1.06 | -6.30 | 1.30 | -3.81 | -22.12 | 4.83 | 0.00 | -80.28 | 80.99 | -28.69 | 256 | 264 | 66 | |
| 16 | 3614 | -892 | 3810 | -627 | 121 | -1.55 | -6.93 | 1.52 | -2.44 | -11.08 | 2.48 | 0.00 | -76.29 | 99.00 | -22.08 | 179 | 188 | 142 | |
| 17 | 3816 | -1058 | 4039 | -815 | 103 | -2.19 | -7.53 | 1.76 | -0.71 | -2.58 | 0.56 | 0.00 | -73.40 | 109.11 | -14.60 | 109 | 119 | 211 | |
| 18 | 3998 | -1244 | 4246 | -1026 | 85 | -2.96 | -8.03 | 1.99 | -0.14 | -0.43 | 0.12 | 0.00 | -70.29 | 117.56 | -8.32 | 57 | 67 | 263 | |
| 19 | 4160 | -1449 | 4430 | -1258 | 67 | -3.88 | -8.36 | 2.19 | -0.26 | -0.61 | 0.19 | 0.00 | -66.16 | 126.53 | -3.73 | 21 | 32 | 298 | |
| 20 | 4300 | -1670 | 4588 | -1509 | 51 | -4.92 | -8.44 | 2.34 | -0.38 | -0.72 | 0.23 | 0.00 | -60.85 | 135.69 | -0.80 | -0 | 11 | 319 | |

ESSEX HIGHWAYS CONSULTANCY WP REF: CCDGWMEXE/ARC

ARCH ASSESSMENT TO MODIFIED MEXE (BA 16/93)

STRUCTURE: NO. 26 NAME: FINCHINGFIELD BRIDGE CONCRETE EXTENSION. (ESTIMATE)

1. DIMENSIONS




L = 4.30
rc = 0.84
rq = 0.70
d = 0.215 (SAY).
h = 0.475
h+d = 0.69

2. PROVISIONAL ASSESSMENT LOADING (Fig 3/1) PAL = 51 TONNE

3. SPAN RISE FACTOR

$\frac{L}{rc} = \frac{4.30}{0.84} = 5.1$ (Fig 3/3) Fsr = 0.84

4. PROFILE FACTOR

$\frac{rq}{rc} = \frac{0.70}{0.84} = 0.83$ (Fig 3/4) Fp = 0.80

5. MATERIAL FACTOR

(Table 3/1 & 3/2) $Fm = \frac{Fbd + F h}{d + h} = \frac{1.2 \times 0.215 + 1.0 \times 0.475}{0.69} = 1.06$

(CONC. BRICKS (SAY) 1.2; CONC. FILL 1.0)

6. JOINT FACTOR

(Tables 3/3 & 3/4 & 3/5) Fj = Fw Fd Fmo = $1.0 \times 1.0 \times 1.0$ = 1.0

7. CONDITION FACTOR

Para 3.17 to 3.23 Fc = 1.0

8. MODIFIED AXLE LOAD: PAL x Fsr x Fp x Fm x Fj x Fc = MAL = 36.3 TONNE

$51 \times 0.84 \times 0.80 \times 1.06 \times 1.0 \times 1.0$

9. AXLE LIFT-OFF: (Fig 3/5) Factor Af = 0.66

$36.3 \times 0.66 = 24.0$

10. WEIGHT LIMIT ON ARCH (MAX GROSS VEHICLE WEIGHT) (Table 3/6) > 40 TONNE

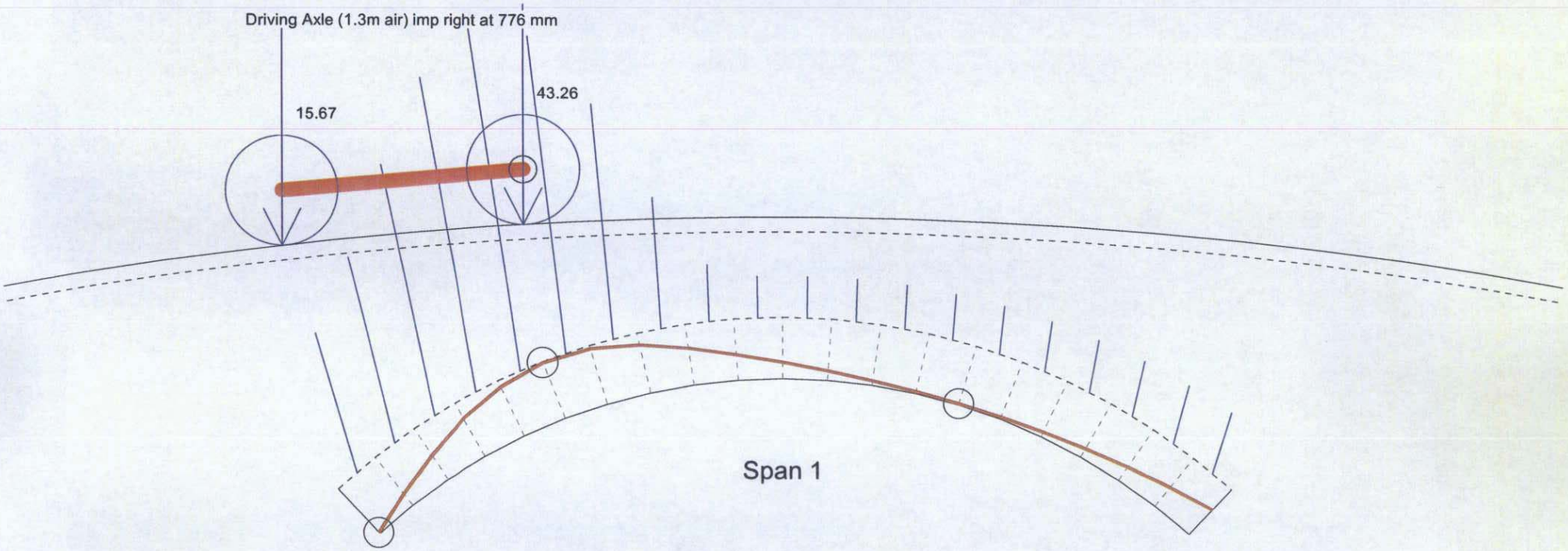
11. CONCLUSION: USING A MODIFIED MEXE METHOD OF ANALYSIS FOR THE EXTENSION INDICATES THAT IT IS CAPABLE OF 40t A.L.L

Assessed by: [redacted] Date: 10/94

Signed: [redacted]

NOTE:- ESTIMATED CAPACITY

# Finchingfield Bridge
(Concrete Extension)




PASSES 40TONNE AXLE

gammaFl dead load: 1.00
gammaFl superimposed: 1.00
gammaFl live load: 1.90
gammaF3 load effect: 1.10
gammaM material: 1.00

Driving Axle (1.3m air) imp right @ 776 [mm]

File path: K:\Structures\Projects\ECC\2009-10 G Thomson\735765 Option Studies\Structures\Finchingfield 26\ArchieM\Structure1.brg

NAME: Finchingfield Bridge
LOCATION: Finchingfield, Essex (Nr Thaxted)
NUMBER: ECC Bridge No. 26
Mouchel Group
DATE: 26 November 2009
Printed on: Thursday, November 26, 2009 11:13:39

Bridge Name: Finchingfield Bridge  Bridge Location: Finchingfield, Essex (Nr Thaxted)
Bridge Number: ECC Bridge No. 26
Number of spans: 1

SAFETY FACTORS
Factor for deadload: 1.00  Factor for superimposed deadload: 1.00  Factor for surfacing: 1.00
Factor for live load: 1.90  Factor for load effect: 1.10  Factor for material strength: 1.00

APPLIED LOAD CASES
1. Driving Axle (1.3m air) imp rightTotal weight: 186.39 [kN] Position: 776 [mm]

Applied distribution mode: Archie/Multi
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES
Road shape: Curved (3-point method)
Road points: (-2000, -200) (0, 80) (6300, -200)
Depth of surfacing: 80  Depth of overlay: 0
Surface unit weight: 24.00 [kN/m^3] Overlay unit weight: 22.00 [kN/m^3]
Lane width: 2500

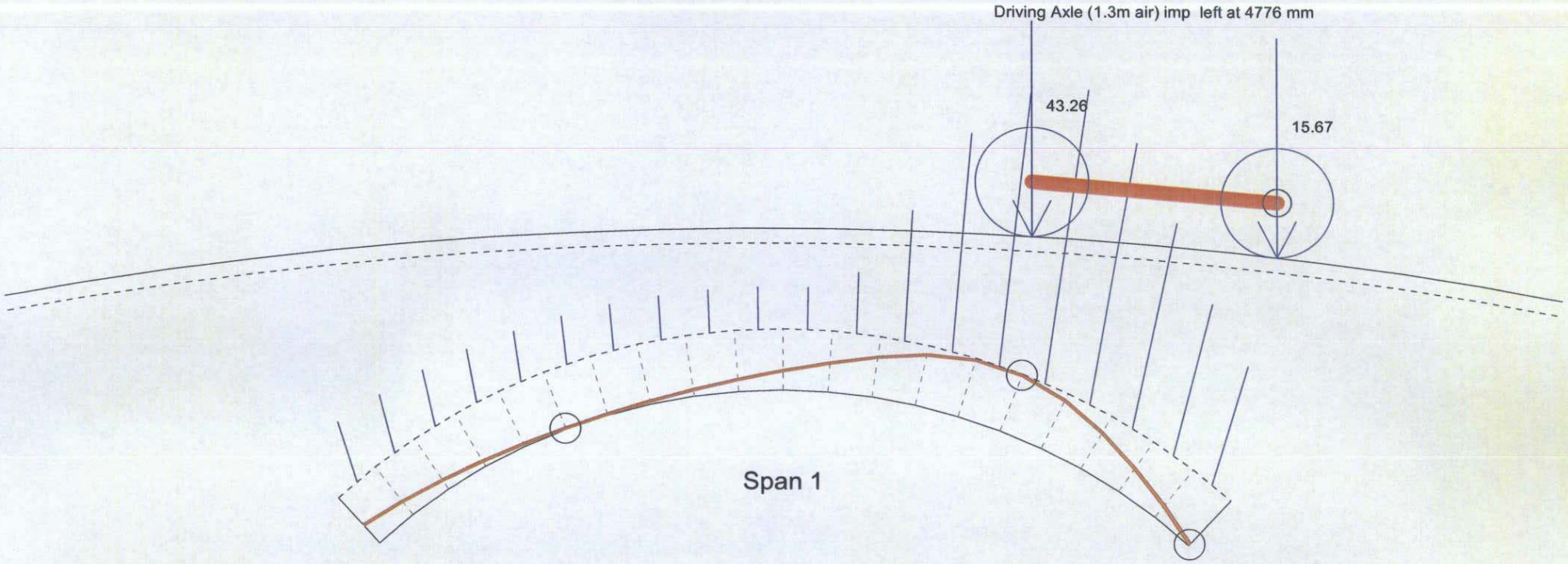
Fill unit weight: 22.00 [kN/m^3] Fill phi: 30 [degree]

SPAN 1
Shape Circular
Span: 4300 [mm] Rise: 840 [mm] Quarter Rise: 700 [mm]
Ring Thickness at crown: 330 [mm] Ring Thickness at springing: 330 [mm] Mortar loss: 0 [mm]
Masonry Unit Weight: 24.00 [kN/m3] Masonry Strength: 15.00 [MPa]

| Segment | Intrados.x | Intrados.z | Extrados.x | Extrados.z | Roadlevel | Fx dead | Fz dead | My dead | Fx live | Fz live | My live | Fx passive | Fx total | Fz total | My total | Thrust in | Thrust out | Extra-Thrust | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -1530 | -224 | -1287 | 58 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -124.50 | -220.46 | -1.93 | -0 | 16 | 314 | |
| 1 | 179 | -1376 | -26 | -1118 | 78 | 2.38 | -7.54 | 0.03 | 2.77 | -9.70 | -0.23 | 0.00 | -129.65 | -203.22 | -18.30 | 73 | 88 | 242 | |
| 2 | 370 | -1237 | 185 | -964 | 97 | 1.93 | -7.22 | 0.10 | 3.83 | -15.65 | -0.14 | 0.00 | -135.41 | -180.35 | -33.68 | 151 | 165 | 165 | |
| 3 | 570 | -1111 | 406 | -825 | 115 | 1.53 | -6.87 | 0.17 | 5.05 | -24.23 | 0.08 | 0.00 | -141.99 | -149.26 | -46.05 | 227 | 240 | 90 | |
| 4 | 779 | -1002 | 637 | -704 | 131 | 1.20 | -6.51 | 0.23 | 5.69 | -32.43 | 0.50 | 0.00 | -148.87 | -110.31 | -53.47 | 288 | 300 | 30 | |
| 5 | 996 | -907 | 876 | -600 | 146 | 0.91 | -6.17 | 0.29 | 5.27 | -36.42 | 1.00 | 0.00 | -155.05 | -67.73 | -54.84 | 319 | 330 | -0 | *** |
| 6 | 1219 | -830 | 1122 | -514 | 159 | 0.68 | -5.85 | 0.35 | 3.89 | -33.53 | 1.31 | 0.00 | -159.62 | -28.34 | -50.42 | 308 | 319 | 11 | |
| 7 | 1447 | -769 | 1374 | -447 | 169 | 0.48 | -5.58 | 0.41 | 2.11 | -23.68 | 1.15 | 0.00 | -162.21 | 0.91 | -41.89 | 260 | 270 | 60 | |
| 8 | 1679 | -725 | 1630 | -399 | 176 | 0.32 | -5.36 | 0.46 | 0.68 | -10.88 | 0.57 | 0.00 | -163.21 | 17.15 | -31.79 | 195 | 205 | 125 | |
| 9 | 1914 | -699 | 1889 | -370 | 180 | 0.18 | -5.21 | 0.51 | 0.07 | -1.81 | 0.05 | 0.00 | -163.46 | 24.18 | -22.38 | 133 | 144 | 186 | |
| 10 | 2150 | -690 | 2150 | -360 | 182 | 0.06 | -5.14 | 0.57 | 0.00 | -0.00 | -0.00 | 0.00 | -163.52 | 29.31 | -14.60 | 84 | 95 | 235 | |
| 11 | 2386 | -699 | 2411 | -370 | 180 | -0.06 | -5.14 | 0.64 | 0.00 | 0.00 | 0.00 | 0.00 | -163.46 | 34.45 | -8.55 | 46 | 57 | 273 | |
| 12 | 2621 | -725 | 2670 | -399 | 176 | -0.18 | -5.21 | 0.71 | 0.00 | 0.00 | 0.00 | 0.00 | -163.28 | 39.67 | -4.25 | 20 | 31 | 299 | |
| 13 | 2853 | -769 | 2926 | -447 | 169 | -0.32 | -5.36 | 0.80 | 0.00 | 0.00 | 0.00 | 0.00 | -162.96 | 45.03 | -1.72 | 5 | 16 | 314 | |
| 14 | 3081 | -830 | 3178 | -514 | 159 | -0.48 | -5.58 | 0.90 | 0.00 | 0.00 | 0.00 | 0.00 | -162.48 | 50.61 | -0.96 | -0 | 11 | 319 | |
| 15 | 3304 | -907 | 3424 | -600 | 146 | -0.68 | -5.85 | 1.01 | 0.00 | 0.00 | 0.00 | 0.00 | -161.80 | 56.46 | -1.95 | 6 | 17 | 313 | |
| 16 | 3521 | -1002 | 3663 | -704 | 131 | -0.91 | -6.17 | 1.13 | 0.00 | 0.00 | 0.00 | 0.00 | -160.89 | 62.62 | -4.65 | 21 | 33 | 297 | |
| 17 | 3730 | -1111 | 3894 | -825 | 115 | -1.20 | -6.51 | 1.26 | 0.00 | 0.00 | 0.00 | 0.00 | -159.70 | 69.14 | -9.01 | 46 | 58 | 272 | |
| 18 | 3930 | -1237 | 4115 | -964 | 97 | -1.53 | -6.87 | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | -158.16 | 76.00 | -14.99 | 81 | 92 | 238 | |
| 19 | 4121 | -1376 | 4326 | -1118 | 78 | -1.93 | -7.22 | 1.54 | 0.00 | 0.00 | 0.00 | 0.00 | -156.24 | 83.22 | -22.53 | 124 | 135 | 195 | |
| 20 | 4300 | -1530 | 4524 | -1287 | 58 | -2.38 | -7.54 | 1.69 | 0.00 | 0.00 | 0.00 | 0.00 | -153.86 | 90.76 | -31.55 | 175 | 186 | 144 | |

# Finchingfield Bridge

(Concrete Extension)




PASSES
40TONNE AXLE

gammaFl dead load: 1.15
gammaFl superimposed: 1.20
gammaFl live load: 1.90
gammaF3 load effect: 1.10
gammaM material: 1.00

Driving Axle (1.3m air) imp left @ 4776 [mm]

File path: K:\Structures\Projects\ECC\2009-10 G Thomson\735765 Option Studies\Structures\Finchingfield 26\ArchieM\Structure1.brg

NAME: Finchingfield Bridge
LOCATION: Finchingfield, Essex (Nr Thaxted)
NUMBER: ECC Bridge No. 26
Mouchel Group
DATE: 26 November 2009
Printed on: Thursday, November 26, 2009 11:19:57

Bridge Name: Finchingfield Bridge  Bridge Location: Finchingfield, Essex (Nr Thaxted)
Bridge Number: ECC Bridge No. 26
Number of spans: 1

SAFETY FACTORS
Factor for deadload: 1.15  Factor for superimposed deadload: 1.20  Factor for surfacing: 1.75
Factor for live load: 1.90  Factor for load effect: 1.10  Factor for material strength: 1.00

APPLIED LOAD CASES
1. Driving Axle (1.3m air) imp left Total weight: 186.39 [kN] Position: 4776 [mm]

Applied distribution mode: Archie/Multi
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES
Road shape: Curved (3-point method)
Road points: (-2000, -200) (0, 80) (6300, -200)
Depth of surfacing: 80  Depth of overlay: 0
Surface unit weight: 24.00 [kN/m^3] Overlay unit weight: 22.00 [kN/m^3]
Lane width: 2500

Fill unit weight: 22.00 [kN/m^3] Fill phi: 30 [degree]

SPAN 1
Shape Circular
Span: 4300 [mm] Rise: 840 [mm] Quarter Rise: 700 [mm]
Ring Thickness at crown: 330 [mm] Ring Thickness at springing: 330 [mm] Mortar loss: 0 [mm]
Masonry Unit Weight: 24.00 [kN/m3] Masonry Strength: 15.00 [MPa]

| Segment | Intrados.x | Intrados.z | Extrados.x | Extrados.z | Roadlevel | Fx dead | Fz dead | My dead | Fx live | Fz live | My live | Fx passive | Fx total | Fz total | My total | Thrust in | Thrust out | Extra-Thrust | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -1530 | -224 | -1287 | 58 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -164.36 | -108.05 | -25.41 | 124 | 137 | 193 | |
| 1 | 179 | -1376 | -26 | -1118 | 78 | 2.95 | -9.15 | 0.04 | 0.00 | -0.00 | 0.00 | 0.00 | -167.31 | -98.89 | -17.51 | 85 | 97 | 233 | |
| 2 | 370 | -1237 | 185 | -964 | 97 | 2.39 | -8.78 | 0.13 | 0.00 | -0.00 | 0.00 | 0.00 | -169.70 | -90.11 | -11.08 | 52 | 64 | 266 | |
| 3 | 570 | -1111 | 406 | -825 | 115 | 1.91 | -8.38 | 0.21 | 0.00 | -0.00 | 0.00 | 0.00 | -171.61 | -81.73 | -6.17 | 26 | 39 | 291 | |
| 4 | 779 | -1002 | 637 | -704 | 131 | 1.50 | -7.96 | 0.29 | 0.00 | -0.00 | 0.00 | 0.00 | -173.11 | -73.77 | -2.84 | 9 | 21 | 309 | |
| 5 | 996 | -907 | 876 | -600 | 146 | 1.15 | -7.55 | 0.36 | 0.00 | -0.00 | 0.00 | 0.00 | -174.26 | -66.22 | -1.16 | -0 | 12 | 318 | |
| 6 | 1219 | -830 | 1122 | -514 | 159 | 0.86 | -7.18 | 0.43 | 0.00 | -0.00 | 0.00 | 0.00 | -175.12 | -59.04 | -1.15 | 0 | 12 | 318 | |
| 7 | 1447 | -769 | 1374 | -447 | 169 | 0.61 | -6.86 | 0.50 | 0.00 | -0.00 | 0.00 | 0.00 | -175.73 | -52.18 | -2.86 | 10 | 22 | 308 | |
| 8 | 1679 | -725 | 1630 | -399 | 176 | 0.41 | -6.61 | 0.57 | 0.00 | -0.00 | 0.00 | 0.00 | -176.14 | -45.57 | -6.30 | 29 | 41 | 289 | |
| 9 | 1914 | -699 | 1889 | -370 | 180 | 0.23 | -6.43 | 0.64 | 0.00 | -0.00 | 0.00 | 0.00 | -176.38 | -39.14 | -11.47 | 58 | 70 | 260 | |
| 10 | 2150 | -690 | 2150 | -360 | 182 | 0.08 | -6.34 | 0.71 | 0.00 | -0.00 | 0.00 | 0.00 | -176.45 | -32.79 | -18.37 | 98 | 110 | 220 | |
| 11 | 2386 | -699 | 2411 | -370 | 180 | -0.08 | -6.34 | 0.79 | -0.00 | -0.01 | 0.00 | 0.00 | -176.38 | -26.44 | -26.95 | 149 | 161 | 169 | |
| 12 | 2621 | -725 | 2670 | -399 | 176 | -0.23 | -6.43 | 0.88 | -0.10 | -2.68 | 0.53 | 0.00 | -176.04 | -17.33 | -37.07 | 210 | 222 | 108 | |
| 13 | 2853 | -769 | 2926 | -447 | 169 | -0.41 | -6.61 | 0.98 | -0.81 | -12.98 | 2.34 | 0.00 | -174.82 | 2.26 | -47.51 | 272 | 284 | 46 | |
| 14 | 3081 | -830 | 3178 | -514 | 159 | -0.61 | -6.86 | 1.10 | -2.32 | -26.10 | 4.80 | 0.00 | -171.88 | 35.22 | -55.84 | 314 | 326 | 4 | |
| 15 | 3304 | -907 | 3424 | -600 | 146 | -0.86 | -7.18 | 1.24 | -4.09 | -35.19 | 6.76 | 0.00 | -166.94 | 77.58 | -59.51 | 318 | 330 | -0 | *** |
| 16 | 3521 | -1002 | 3663 | -704 | 131 | -1.15 | -7.55 | 1.38 | -5.32 | -36.75 | 7.43 | 0.00 | -160.47 | 121.89 | -57.01 | 282 | 295 | 35 | |
| 17 | 3730 | -1111 | 3894 | -825 | 115 | -1.50 | -7.96 | 1.54 | -5.51 | -31.42 | 6.66 | 0.00 | -153.46 | 161.27 | -48.37 | 220 | 234 | 96 | |
| 18 | 3930 | -1237 | 4115 | -964 | 97 | -1.91 | -8.38 | 1.71 | -4.68 | -22.44 | 4.98 | 0.00 | -146.87 | 192.09 | -34.98 | 145 | 160 | 170 | |
| 19 | 4121 | -1376 | 4326 | -1118 | 78 | -2.39 | -8.78 | 1.88 | -3.41 | -13.95 | 3.25 | 0.00 | -141.07 | 214.83 | -18.92 | 69 | 86 | 244 | |
| 20 | 4300 | -1530 | 4524 | -1287 | 58 | -2.95 | -9.15 | 2.05 | -2.50 | -8.78 | 2.18 | 0.00 | -135.61 | 232.76 | -2.20 | -0 | 17 | 313 | |