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Bridge Options Report

Proposed Bridge over Leeds Liverpool Canal at Cawder Lane, Skipton

Horse Close Bridge

For

Lovell

June 2015 DRAFT – D1

13308L/D/AB

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Revision	Comments	Date
-	Draft - Initial issue for comment	17-06-15
D1	Draft – Second Issue for comment	22-06-15

1. Introduction.

Mason Clark Associates have been commissioned by Lovell to prepare an option report for a new bridge over the Leeds Liverpool canal. The Canals and Rivers Trust (CaRT) reference for the scheme is: TPW-NOR-1415-1506 Horse Close Bridge, Skipton.

The proposed road bridge will span the Leeds Liverpool Canal in Skipton between Keighley Road and Cawder Lane and will replace an existing stone arch bridge. The existing bridge is to be retained but used only for pedestrian/cycle access in the future. The proposed bridge will be located a minimum of 5m to the southeast of the existing bridge. The new bridge will carry a single two way carriageway with a 2m wide footway on one side and a 600mm access strip on the other side. The initial bridge options that have been assessed comprise a single span fully integral composite steel and concrete bridge and a reinforced concrete structure with pre-stressed concrete beams.

There is an existing tow path that runs to the west side of the canal with a maximum head room below the existing bridge of 2.5m reducing to 0.0m as the arch comes down to meet the tow path.

It is envisaged that the new structure will comprise either steel beams bent to a radius of 150m or pre-cast concrete beams, with a reinforced concrete deck topped with a bituminous surface course.

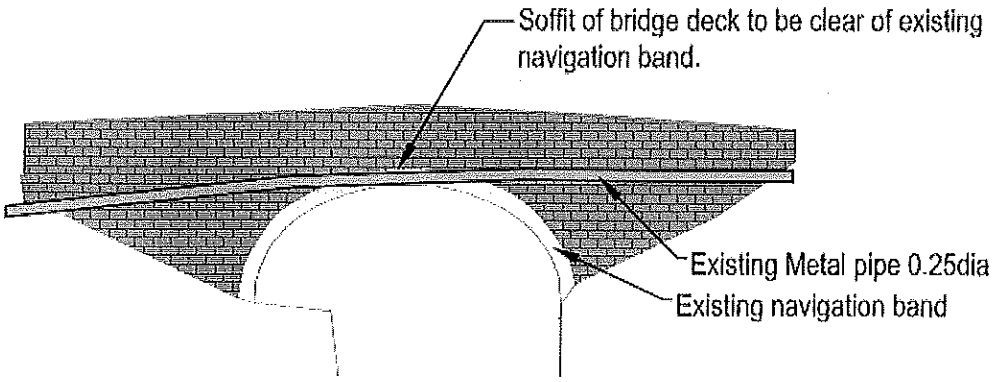
MCA are developing the bridge layout but the traffic studies which will determine the junction layout are being developed by Curtins for Lovell.

2. Location, Levels and Size

We understand that it has been agreed with the Canals and Rivers Trust (CaRT) that the gap between the existing and new structures will be a minimum of 5m at the centre of the bridge with the new bridge located to the southeast of the existing and slightly further towards the brow of the hill on Keighley Road.

Due to the location of the new bridge the existing bus stop on Keighley Road would require relocating further south along Keighley Road, this would require the consent of the local highway authority North Yorkshire County Council (NYCC) together with the details of the road junction. The traffic related issues are being addressed by Curtins.

The Canals and Rivers Trust have stated that the navigation band on the arch of the existing bridge must be visible below the deck of the new bridge. However the existing navigation band is currently partially obscured by a pipe that runs along the side of the existing bridge.



South Elevation of Existing Bridge

There are a number of constraints to the levels of the new bridge that have been considered and these are summarised below:

- We have initially assumed a width of tow path of 2m with a minimum vertical clearance to the tow path of 2.4m. This is to be confirmed by CaRT.
- The soffit of the new bridge has to be above the navigation band on the existing bridge.
- Initially we have assumed that the road levels on Keighley Road will be as existing.
- The existing gradient from Keighley Road to the existing bridge is around 1:11 and this has been used on the new proposals.

We have considered two main options for the bridge, firstly a steel beam and concrete composite bridge and an all concrete bridge deck with concrete beams. The construction depth of the proposed steel/concrete composite bridge deck and the concrete deck have been estimated as follows:

Steel/Concrete Composite Bridge Deck		All Concrete Bridge Deck	
Estimated road surfacing depth (min)	100mm	Estimated road surfacing depth (min)	100mm
Steel girder depth (min)	700mm	Concrete beam depth (min)	655mm
Reinforced concrete deck depth (min)	200mm	Reinforced concrete topping depth (min)	75mm
Total deck depth (min)	**1000mm**	Total deck depth (min)	**830mm**

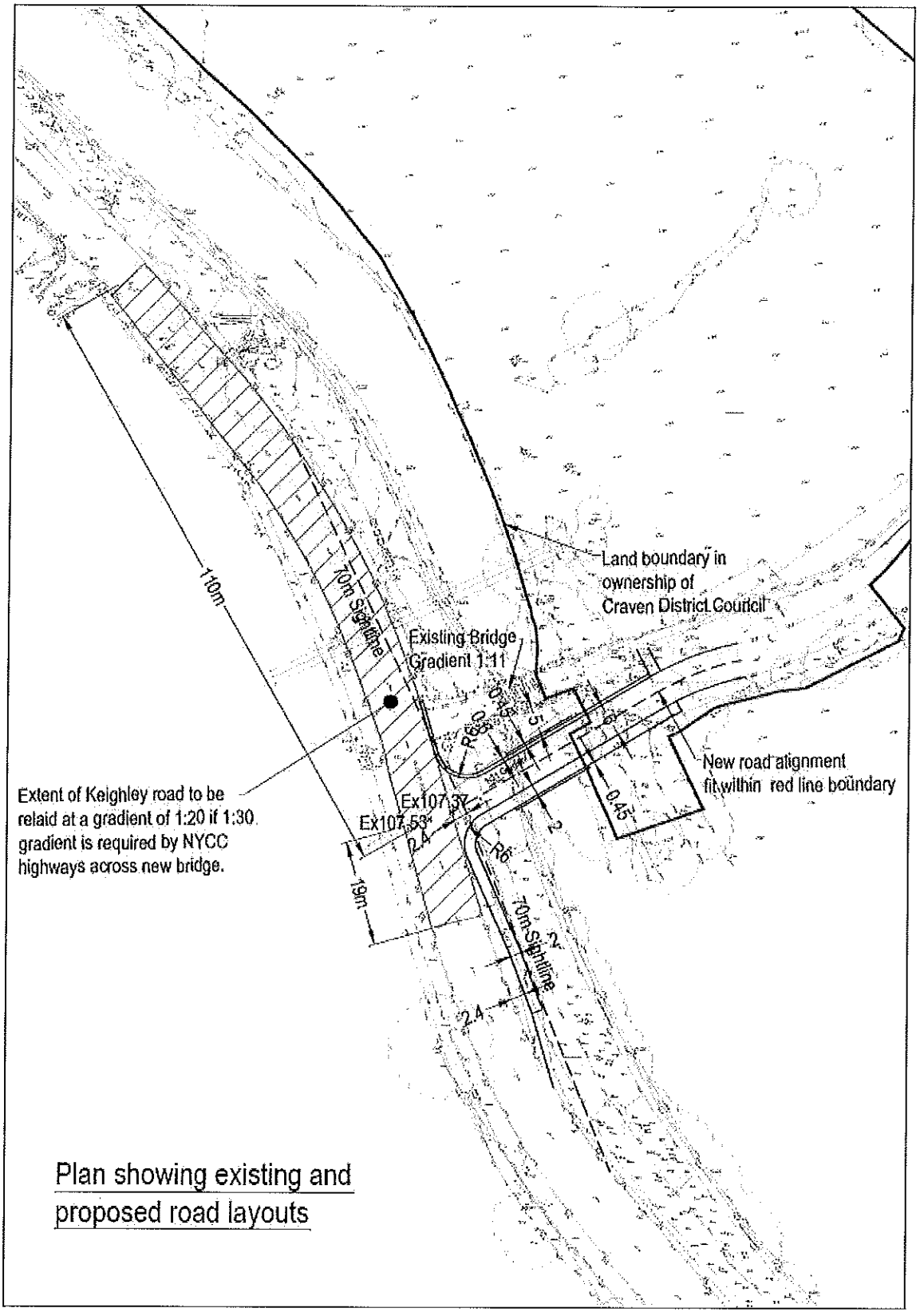
It can be seen from the above that the all concrete bridge deck has a reduced construction depth compared to the composite alternative.

The clearance required for the tow path and the canal coupled with the construction depth of the bridge deck effectively fix the road level at the bridge abutment adjacent to Keighley Road. It is important to keep this level as low as possible to manage the gradient down to Keighley Road. Considering the above, the road level at the start of the composite bridge will be approximately 108.44m AOD and the concrete bridge 108.34m AOD with the existing road level at the tie in point with Keighley road being 107.36m AOD. The distance from Keighley road to the 'start' of the bridge is 11.5m which gives a gradient of 1:11 and 1:12. These gradients do not meet current NYCC standards, although this is the same gradient as the current situation.

NYCC standards state that on approach to a junction there should be a constant gradient of a maximum of 1:30 for 10m. NYCC standards also state that for a 30mph road a 30m vertical curve should be used to link to the gradient.

An agreement with NYCC for a departure from their standards would be required for the new proposed bridge layout to be adopted by them. Discussions to determine the extent of relaxation/departure that NYCC would accept should be entered into at the earliest time possible.

The advantage of the composite steel bridge option is that the bridge beams can be curved and this allows the road alignment over the bridge also to be curved. The curved alignment of the composite bridge has the effect of lowering road levels on the east approach to the bridge.

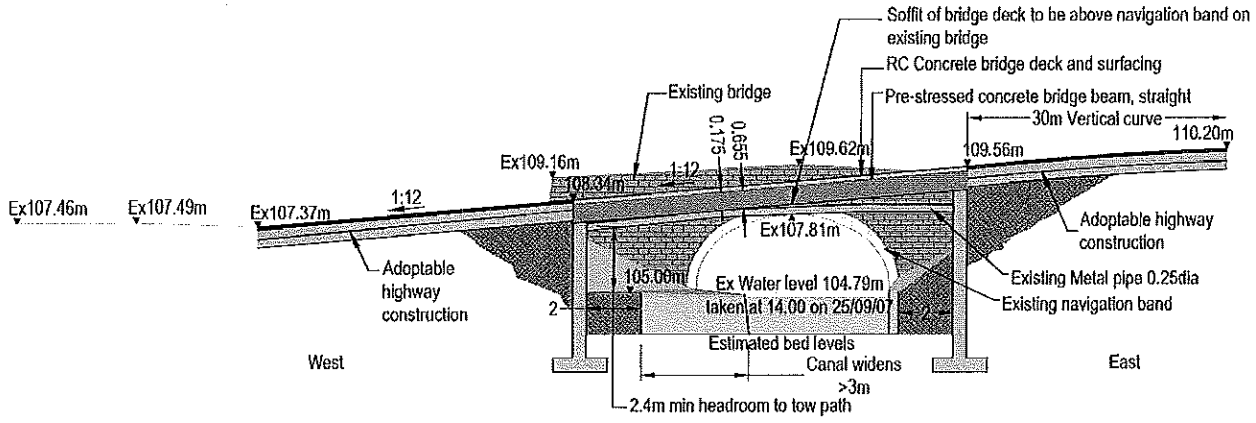


Plan showing existing and proposed road layouts

3. Options

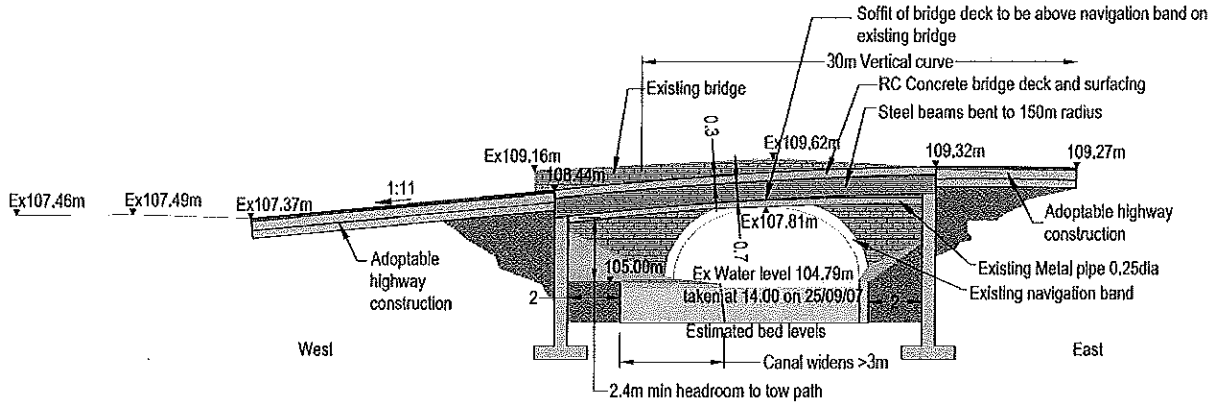
In order to reduce the level of the road surface and relax the gradient on the approach to the junction with Keighley road, some of the following options should be considered:

- Concrete bridge beams – Using a concrete bridge beam would give a minimum depth of the bridge deck of 830mm, 170mm less than the composite steel beams. However the concrete beams would be generally straight and this will result in a constant gradient across the bridge. This would mean that to achieve the minimum head height on the tow path and keep the existing navigation band visible the gradient of the bridge deck would be approximately 1:12. This would also mean that the road levels on the eastern side of the bridge would be significantly higher than the existing road. This could be mitigated slightly by increasing the thickness and profiling of the asphalt over the bridge. This will result in increased dead load and therefore cost.



Section through Concrete Bridge Option

- Steel bridge beams – steel bridge beams would result in a minimum bridge deck depth of 1000mm but they could be pre-bent to a given radius which would allow the vertical curve required by the highway authority to begin earlier, therefore reducing the levels on the eastern side of the bridge.



Section through Composite Bridge Option

- Reduce the width of the canal – At present, as the canal exits the southern end of the existing bridge it widens significantly on the western side. If the narrower profile could be extended to beyond the southern side of the proposed bridge this will provide several benefits:

    - The gradient of the road coming away from Keighley Road could be significantly shallower.
    - The span of the bridge would be less. Therefore the overall construction depth will be reduced, again allowing a shallower gradient coming away from Keighley Road.

  Additionally the white band could be transferred, potentially, to the new bridge. If agreement could be sought from the Canals and Rivers Trust this would allow the proposed bridge to be lowered at its apex by approximately 300mm, which will have a positive effect on the vertical alignment as the carriageway leaves the bridge.

- Relocate the existing Navigation band – even if the width of the canal could not be reduced, relocating the Navigation band to the new bridge would allow the proposed bridge to be lowered at its apex by approximately 300mm.

- Diverting the Existing tow path up and over the bridge – If the tow path was diverted up and across the bridge there would be no need for the minimum head height in this area.

- Reduce the speed limit of Cawder Lane locally to the bridge/junction – The existing Cawder Lane already has traffic calming measures in place in the form of speed humps. If the speed limit on Cawder Lane is reduced to 20mph this would mean that the required Highways Standards are less onerous hence less of a departure from NYCC standards is required.

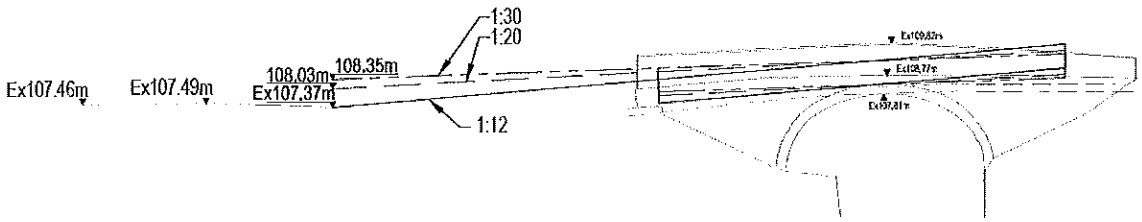
- Raised table bridge deck – ramping up to a raised table that spanned the length of the bridge would add to the existing traffic calming measures and reduce the speed of vehicles approaching the junction with Keighley Road. This would also mean that the gradient of the approach to the bridge from Keighley Road could be shallower before the raised table ramps up onto the bridge itself.

- Raising the levels of Keighley road - The existing levels of Keighley road local to the proposed junction could be raised such that the gradients stated in NYCC highways standards for the bridge approach could be met. The finished road level in the vicinity of the proposed junction on Keighley Road would need to be raised by approximately 980mm to achieve a 1:30 gradient on the west approach to the bridge.

  If a departure from NYCC standards was allowed on the west approach to the bridge and a proposed new road gradient of 1:20 was used Keighley road would still need to be raised by approximately 660mm.

  This is in the absence of any other of the previously mentioned measures and keeping the soffit level of the bridge deck above the navigation band on the existing bridge.

  The sketch below shows the raised levels at the tie in with Keighley Road if 1:30/1:20 gradients are required.



4. Maintenance Considerations

Following construction it is envisaged that the bridge will be adopted and the inspection and maintenance regime will be carried out by the Highway Authority to comply with the Design Manual for Roads and Bridges (DMRB). In general terms the inspection regime and costs of inspection will be the same for a composite bridge (steel beams and concrete deck) as for a concrete bridge (concrete beams and a concrete deck).

The bridge options that have been considered are essentially the same but one has a composite steel and concrete deck and the other a concrete deck. In both of these types the top of the deck is an insitu concrete slab but in one case the slab is supported on steel beams and in the other case on concrete beams. Both options require the same areas to be inspected.

The composite bridge deck will comprise of painted steel I Beams with shear studs welded to the top flange of the steel beam. There will be permanent formwork between the beams which is likely to be GRP. The steel beams will be painted with a standard corrosion protection system in accordance with the Specification for Highway Works. The system will be specified to be virtually maintenance free for 25 years. The I Beams will be exposed below the concrete deck and will be easily accessible for inspection and maintenance.

The concrete bridge deck will comprise of precast, pre-stressed concrete bridge beams that will be cast in factory conditions by a specialist manufacturer. There may be permanent formwork between the beams which is likely to be GRP or there may be solid concrete infill between the beams. The concrete beams will be specified to have adequate concrete cover and strength to ensure that the concrete does not crack and spall. With the correct specification and installation the concrete beams will be virtually maintenance free for upwards of 25 years. The concrete beam soffit is the only part of the beam that will be visible and this is easily accessible for inspection and maintenance.

The design life of the bridge is 120 years and over that period maintenance will be required to ensure that the bridge is maintained to a good standard. The regular maintenance of items such as the carriageway surfacing, the waterproofing and parapets will be common and very similar with the composite and concrete alternatives. These maintenance items that are common to both bridge types will comprise the bulk of the sum for the whole life cost of maintaining the bridge.

The differences of the maintenance requirements for the steel and concrete beam alternatives will be limited to the whole life cost of maintaining the steel beam paint system compared to the concrete repairs that may be required to the concrete beams. These costs will be small in comparison to the maintenance of the general items as discussed above.

Modern paint systems are very durable and even though specified as lasting for 25 years between major maintenance works are likely to last much longer. In our opinion it is likely that the bridge will require repainting possibly twice during the 120 year life with perhaps two intermediate minor maintenance painting works.

The precast beams are constructed under controlled factory conditions and we would expect the concrete to be very durable and not require any maintenance for upwards of 35 to 40 years. In our opinion it is likely that the bridge will require significant concrete repair works possibly once during the 120 year life with perhaps two intermediate minor maintenance concrete repair works.

The above beam maintenance costs are a small part of the whole life maintenance cost for the whole structure and in our opinion there will be very little difference between the steel and concrete alternatives. If anything we consider that the concrete bridge deck will have the lower whole life cost.

5. Replacement and Decommission

The composite and concrete bridge options are very similar in their overall construction. The main difference being that the concrete option contains pre-stressed concrete bridge beams. These beams need to be carefully demolished due to the inbuilt load in the steel tendons in the beams. The presence of the pre-stressed beams should not significantly affect the cost of replacement or demolition.

6. References.

The following documents have been used in preparing this report:

i. Kingfisher Consulting conceptual design drawing – 2250.01

ii. Jacobs 'Canal Bridge Elevation' drawing – B0761000/ELEV/2D/01 Rev A

iii. Survey Operations topographical survey data/drawing – A0 15E035

iv. Land Registry Title plan NYK309902

7. Scope.

This report has been commissioned by Lovell to assess the viability of a proposed bridge across the Leeds Liverpool Canal in Skipton, North Yorkshire, known as Horse Close Bridge.

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