Auckland Harbour Bridge Shared Path, SeaPath (AHBSP)

Construction Methodology

Client	**NZTA**
Report prepared by	**Construction Logic**
Date	**22 February 2020**

Rev 1

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s 9(2)(a)

1 Introduction

This project is part of the planned Cycleway from ..... to ..... etc etc.

This section to be completed by s 9(2)(a) *for completeness.*

This document describes the construction methodology of the Auckland Harbour Bridge (AHB) Sea Path section which links from Westhaven and connects on to Northcote Point over a length of approximately 1.6 km.

There are essentially 4 connected bridges which form the overall AHB:

- The Southern Approach Viaduct (76m)
- The Main Viaduct Truss Bridge (1020m)
- The Northern Approach (over residential properties) Viaduct (198m), and
- The Northern Approach (Sulphur Beach) Viaduct (308m)

This is a realistic and likely construction methodology from which the anticipated effects on the environment from these activities can be identified. It is expected that the NZ Transport Agency's (NZTA's) selected construction contractor will refine and develop this (or a similar) approach within the constraints of the conditions in place to manage the environmental effects of the construction. The selected contractor may well devise a different methodology which will also need to comply with the Consent conditions.

Insert an overall plan of AHBSP here

1.1 Scope of Works

The scope of works on AHBSP includes the following construction activities:

Temporary fencing

Installation of erosion and sediment control measures

Installation of waterway spill control measures

Wildlife relocation (*potentially at Sulphur Beach ? Need enviro input here*)

Work over the Coastal Marine Area (CMA):

- Piling (permanent works on land)
- Piling (temporary works over water)
- Steel jetty construction (temporary works)
- Coring/drilling holes in concrete
- Concreting
- Structural steel erection
- Towing/tugging heavy steel bridge sections on barges
- Heavy lifting from floating plant
- Transparent canopy erection on completed bridge

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Traffic Management

Bridge construction (on land)

1.2 General Philosophy of the Construction Methodology

The main construction challenges, which will largely determine the type and extent of effects on the environment, are

- the method of delivering large tonnages and long lengths of fabricated structural steel to the bridge site
- the method of extending the existing piers of the Main Bridge
- the method of assembling and erecting the steelwork into final position over water
- the piling and pier construction work to be done in residential properties for the Northern Approach bridge
- the method of erecting the steel deck over these residential properties
- the method of extending the existing piers and deck erection of the bridge over Sulphur Beach

The bulk weight of structural steel for the Main Bridge is approximately 4000 tons.

The weight of steel for both Northern Approach bridge decks, and pier brackets is approximately 700 tons

Fabricated structural steel can be cost-effectively delivered by the following alternative means, or by a combination of them:

- **by sea** – ex Asia or from suitable fabricators within New Zealand
- **by road** – from suitable fabricators within New Zealand

NZTA's Contractor is likely to devise a construction method which will utilise one or both of the above delivery means.

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2 Project Management Plan (PMP)

Prior to commencement of any work on site the Project Management Plan (PMP) will be compiled incorporating:

- Health and Safety Plan – including a full Hazard Identification and Mitigation Plan. Over the entire length of the bridge being worked on, *anti-gawk screens* will be fixed to the edge of the existing bridge for safety reasons.
- Environmental Management Plan – including regular field assessments/audits by the contractor's company Environmental Manager.
- Quality Management Plan – including an Inspection and Test Plan to provide a documented trail verifying compliance with the project specifications in terms of workmanship and permanent materials, and a Non Conformance and Rectification process

Regular audits of the project to verify working in compliance with this PMP will be scheduled and conducted by the relevant Compliance Managers.

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3 Construction Program

3.1 Sequencing

The general sequencing of works will be as follows, with the four bridges overlapping in time:

3.1.1 Main Viaduct

3.1.1.1 Procure and fabricate (offsite) bridge structural steelwork

3.1.1.2 Divert Curran Street behind the intended construction yard

3.1.1.3 Establish construction yard and facilities and install the temporary steel assembly jetty off Curran Street

3.1.1.4 Install the reinforced and prestressed concrete "jacket" strengthening to the existing piers

3.1.1.5 Install the steel cantilever extensions to the existing piers

3.1.1.6 Install the steel bridge piers

3.1.1.7 Assemble the bridge spans on the temporary jetty, tow to bridge positions and lift into final position with either crane on JUB or by strand jacks.

3.1.1.8 Erect the viewing platform canopies

3.1.2 Southern Approach Viaduct

3.1.2.1 Install traffic management and clear trees/bush from work area

3.1.2.2 Install piles and caps

3.1.2.3 Erect structural steel piers

3.1.2.4 Erect structural steel box girder beams between piers

3.1.2.5 Complete continuous welding of girders and painting

3.1.3 Northern Approach Viaduct (Sulphur Beach)

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3.1.3.1 Install temporary staging adjacent to bridge extension alignment

3.1.3.2 Install cantilever extensions to the existing bridge piers

3.1.3.3 Erect structural steel box girder beams by crane from the staging bridge

3.1.3.4 Complete continuous welding of girders and painting

3.1.4 Northern Approach Viaduct (over residential properties)

3.1.4.1 Relocate residents from affected properties

3.1.4.2 Install piles and caps in properties, reserve and other areas

3.1.4.3 Erect structural steel piers

3.1.4.4 Install temporary works (launching nose, bearings, guides, pulling jacks) for deck launching, as well as temporary piles in water and scaffold props at Te Onewa Pa.

3.1.4.5 Assemble structural steel box girder spans on completed deck of Sulphur Beach Northern Approach Viaduct ready for launching, including full welding and bolting to launching nose

3.1.4.6 Launch steel girder spans and deck complete (from Sulphur Beach end southwards)

3.1.4.7 Remove temporary works and place permanent bearings

On completion of the four bridges, the temporary assembly jetty and construction yard will be removed.

Curran Street will hen be reconstructed in its original position

3.2 Construction Program

Should there be a presence of native breeding birds (e.g. dotterels) at the Sulphur Beach area, it is anticipated that prior to construction commencement a period of several months will be required to survey and potentially relocate them. (See Section 16.2 below)

This will be detailed in the Environmental Management Plan which forms part of the PMP (see Section 2 above)

The construction period is expected to be 30 months.

The overall construction sequence and activity periods is depicted in Appendix 2.1 (*not part of this commission)*

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6 Construction Equipment

The large equipment expected to be on the construction site is as follows:

7.1 Southern Viaduct

- Piling rigs
- Vibro-hammers and hydraulic hammers
- Excavators
- Tipper trucks
- Jinker trucks (bridge beam deliveries)
- Mobile cranes
- Crawler cranes
- Readymix Concrete trucks
- Concrete pump

7.2 Main Viaduct

- Jack up Barge/s (JUB) with crawler crane/s
- Service barges
- Tug boat/s
- Workboats
- Readymix Concrete trucks
- Concrete pump
- Hydraulic strand jacks
- Large Floating Barge/s with crawler crane/s

7.3 Northern Approach Viaduct (over residential properties)

- Mobile cranes
- Crawler cranes
- Piling rig
- Vibro-hammers and hydraulic hammers
- Excavators
- Tipper trucks
- Readymix Concrete trucks
- Concrete pump
- Hydraulic pump (for launching jacks)

7.4 Northern Approach Viaduct (Sulphur Beach)

- Barges
- Tugboats
- Workboats
- Temporary staging bridge
- Crawler cranes
- Piling hammers
- Vibro-hammers
- Readymix Concrete trucks
- Concrete pump

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10 Main Viaduct

See Appendix 10.1

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11 Northern Approach Viaduct (Sulphur Beach)

See Appendix 11.1

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12 Northern Approach Viaduct (over residential properties)

See Appendix 12.1

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13 Southern Approach Viaduct

See Appendix 13.1

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Appendix 10.1 Main Viaduct

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AHBSP Main Viaduct

Construction Methodology

Scope

This methodology covers the construction of the AHBSP Main Viaduct which is essentially over the harbour waters along its full length.

The design is still in development stage but the philosophy is determined and is in general accordance with NZTA/Beca drawing series 3910806-SE

- 230 Rev A
- 400 Rev B
- 401 Rev B
- 551 Rev B
- 552 Rev B

General Philosophy of Construction Methodology

The bulk weight of structural steel for the Main Bridge is approximately 4000 tons.

Fabricated structural steel is likely to be delivered

- **by sea** – ex Asia or from suitable fabricators within New Zealand, and/or
- **by road** – from suitable fabricators within New Zealand

NZTA's Contractor is likely to devise a construction method which will utilise one or both of the above delivery means.

Fabricated bridge sections in 15m lengths can be transported by heavy haulage vehicles on the road and delivered to the southern establishment area described in the main report. Sections of up to approximately 30m can be delivered by sea to the jetty at the establishment area.

Should bridge sections be delivered faster than they are being erected, the establishment yard is large enough to store several sections on land until required. In these cases triple-handling of the sections off delivery barges onto the temporary jetty, then onto road trailer/jinker trucks, and onto land to storage - then back onto jinkers, jetty and barge for erection – will be required.

The 15 – 30m sections will be welded together (and joints re-painted) on the temporary jetty platform adjacent to Curran Street. This work will be done under weather-proof cover to control rainwater, temperature and humidity. Appropriately shrouded containment measures will be put in place to prevent shot-blast material and/or paint from entering the water. From the jetty the completed span assemblies will be transferred to barge/s and towed to the bridge position from where they will be lifted into final position on the already constructed pier widenings

Span lifting will be done using strand jacks from pre-erected cantilever sections (spans over 150 ton in weight), or by heavy lift cranes positioned on Jack Up Barges (JUB) for stability (spans less than 150 ton).

The canopies to the viewing platforms will be erected after the bridge spans are in place. Depending on their final detailed design, it may be possible to erect the canopies from the shared pathway deck itself with Hi-ab crane trucks. If not, erection will be from crane and barge/s on water below.

All concreting for the four bridges will be done at night during off-peak periods from the adjacent motorway, with a dual lane closure. Closures can be obtained from 10pm to 4-5 am.

Piling

There is no permanent piling work required for this portion of the project.

Pier Strengthening

Piers 5 and 6 – work below water level

The reinforced and post-tensioned concrete blades cast onto the existing piers extend below the water level on these two piers.

To enable work to be done in dry conditions, temporary steel "limpet" coffer dams with closed bases will be purpose-made to seal onto the pier walls. The contact faces of the limpets will be lined with a suitable compressible waterproof material (such as rubber) to facilitate a watertight seal when the limpet clamps onto (or around) the pier walls. As the water is pumped out of the so formed coffer dam, the increasing hydraulic pressure of the external seawater forces the limpet harder onto the pier faces thereby increasing the effectiveness of the watertight seal.

On the shallower pier 5 the limpet may extend into the insitu marine muds by a metre or two. This material will be required to be removed to construct the new blades. It will either be excavated out by a small digger on a small barge (to fit under the bridge), with material deposited into skips on the barge for removal to a spoil site on land – or jetted clear with

compressed air lances if its depth is minimal. Floating silt curtains will be deployed around the pier in order to contain the resulting plume created from this operation.

Construction of the blades is then done from within the limpet coffer dam as described in the section below for piers 1 – 4.

Piers 1 – 4

Man access is required to the full faces of the blade area on the pier walls. This will be achieved by hanging scaffold platforms from steel beams placed transversely across the top of the concrete of the existing piers. Scaffold material will either be delivered to the workface by

- using the existing bridge maintenance underslung travelling trolley and winch, or
- crane and barge below

The scaffold platforms will be fully contained as described in Section 8.3 of the main report.

From these platforms the

- concrete faces will be roughened by water cutting,
- dowel and tie-holes drilled into/through the concrete walls, and
- steel dowels and ties epoxied or grouted into position

The soffits to the formwork will then be fixed to the walls, pre-assembled reinforcing steel cages (with post-tensioning ducts and strand tied onto the cages) are lifted onto the soffits by crane-barge, premanufactured timber or steel formwork panels are then lifted into position from the crane barge and clamped or tied to the concrete piers, and finally the special grade concrete (non-shrink) is pumped into position from the bridge deck at night (see Section 1.2 of the main report). It will not be desirable to deliver concrete in mixer trucks on a barge, as potential time delays can occur with this method thereby compromising the concrete quality through risks of an early "initial set". Concrete is poured in several lifts to control the rate of shrinkage and creep, with the tops of each lift joint being waterblasted to expose aggregate prior to the next pour. Contaminated jetting water s handled as per Section 8.3 of the main report.

It may be necessary to tie reinforcing and assemble formwork in place under the bridge, if a crane and barge that is low enough cannot be secured for the project.

Forms will be left in place for a minimum of 7 days curing time prior to stripping. Concrete is then left unstressed for 3 months to allow creep shrinkage to occur, after which the post tensioning is completed.

The structu al steel pier extension boxes are then slung at an angle and lifted into position from the crane barge (JUB for stability and accuracy of box and pin positioning), offered up to the steel pin bracket positioned on the newly constructed concrete ledge, and the pin is then installed to fix the base of the box. The top of the box is then tied back to the top of the existing concrete pier with two strands or threaded bars through centre-hole jacks mounted on tilting base plates. The strand jacks then pull/rotate the box upright into its final position where it is then bolted permanently onto the new concrete blades.

With the pier extensions fixed, the new steel piers are then lifted into final bolted position on the pier extensions with crane on JUB. The steel piers have pinned bearing connections top and bottom, so for temporary stability before the girders lock them into rotational stability, a temporary locking pin at the bottom bearing is installed through the bearing which will be accordingly designed.

Steel stiffening/bracing beams are required to span across between the concrete walls of the hollow sections of the existing piers. These will be lowered in 2 halves down into the upper open-topped pier section, and from there through the drain manhole in the intermediate slab down into the lower chamber of the pier. Work in this area will require lighting and confined space training and procedures will be required. Once each half of the steel brace is bolted onto the respective sidewalls of the inner pier, the 2 halves will be fully welded together where they meet in the middle and painted for corrosion protection.

Box Girder erection

Placing of the box girder will be done in sections generally in accordance with the sequence shown on drawing number 3910806-SE- 230 Rev A.

Temporary supports

Temporary props are required to stabilise cantilevering and balanced-cantilevering sections in their interim state until locked into stability - which occurs when the whole girder is assembled over its full length and fully welded.

Vertical temporary supports will be in the form of steel tube piles vibro-hammered and then hydraulically hammered to a pre-determined set in the sandstone formation. They will be installed with a crane on barge. Two piles per position may be required for stability. They will be extracted on completion of the girder erection.

The horizontal component of temporary restraint supports are steel brackets fixed to the steel pile top at one end, and bolted to the concrete pier at the other end. They are installed with the crane on barge, and removed on completion.

Balanced cantilever girder sections over piers

The first girder erections will be those over the piers, by erecting balanced cantilever portions.

The 15-30m girder sections as delivered from the fabricator, will be pre-welded and painted into lengths up to 90m long on "locked load skates on the assembly jetty in the construction yard. Once painted, quality checked and signed off, the girder is then shifted laterally onto a single (or a pair of) barge/s adjacent the jetty by unlocking the load skates and jacking/pulling the girder laterally. The barge and jetty levels are maintained as the load shifts from jetty onto the barge, by adjusting ballast water within the barge/s.

Each of the pier balanced cantilever sections weighs from 125 tons (pier 6) to 500 tons (piers 1 and 2).

The barge/s with box girder on board, are then towed to the pier position and spudded into the seabed to secure their position against tidal flow. It may also be necessary to temporarily secure the barges to the existing pier if tidal flows are too strong.

The girder is then tandem lifted off the barge/s into position on top of the pier bearing with 2 no. 400 – 600 ton cranes each on its own JUB positioned as close as safely possible to the delivery barge which is positioned immediately adjacent to the pier.

See sketch A

Sketch A - AHBSP Methodology.pdf

The balanced cantilevering girder is secured to the temporary pile and bracket support prior to the crane hooks being released from the load.

Central girder sections spanning between the balanced cantilevers

These sections are assembled, welded and painted as described above and shifted by barge to their final position between the bridge and JUB/s.

The sections vary in weight from approximately 130 ton (pier 6 to abutment) to 470 ton (main span between piers 1 and 2.

The lighter sections will be lifted into position by either

- a single 400 - 600 ton crane on JUB, or
- a tandem lift with 2 no. 400 - 600 ton cranes on JUBs , or
- strand lifted with centre-hole strand jacks positioned off the ends of the previously erected balanced cantilever sections

Strand Lifts

Centre-hole strand jacks are fixed onto short steel platforms fixed to and cantilevering a short distance (up to 1m) from the ends of the cantilever girder sections already in position.

The pre-assembled full length girders are towed on barges which are spudded and secured into position immediately under their final position in plan.

Strand jacks are hydraulically linked and synchronised through a manifold which allows the jacks to be simultaneously or individually operated, permitting fine adjustments of strand tensions to facilitate keeping them within pre-determined variances.

Lifting points under the ends of the girders receive the strand (or connected high strength steel threaded bar) which is then locked off, and the strand/bar is hydraulically jacked vertically upwards through the jacks, lifting the span with it.

Once at final elevation after several hours of jack ng, connection bars are slid into position, welds are made and the connection is then fully welded and painted to specification.

Welding and painting is done off working platforms pre-attached to the cantilever ends and slid/pulled out over the connection once final lift position is reached. The platforms are fully contained to protect against weather, facilitate temperature and humidity controls for painting, and prevent any shotblast material and/or paint overspray from entering the water below.

Viewing Platform Canopy Erection

If the structural steel to the canopies is suitably designed and detailed in sufficiently short and light enough sections, it should be possible to erect the canopies with a Hi-ab crane truck driving along the completed bridge deck - similarly with the fibreglass cover.

Alternatively they can be erected from the water with a crane and barge/s.

Non-slip Deck Surfacing

This paint-on epoxy based finish is the final touch to the bridge/s and is done insitu after completion of structure and canopy erection.

Navigation and Working in the Auckland Harbour

This area of the harbour is traversed by:

- ferry services to Northcote and Birkenhead

- ships servicing the Chelsea Sugar refinery
- sailing race yachts, and
- casual fishermen and sailors

Navigation and working procedures will be developed in full liaison with, and to the approval of, the Auckland Harbour Master. It is expected that formal weekly planning meetings will be held with the Harbour Master and his staff to agree construction plans and water events for the week ahead. Direct radio contact with the Harbour Master will be maintained at all times by the Project Supervisor and the Marine Superintendent responsible for the vessels and work on the water.

Appendix 11.1 Northern Approach Viaduct (Sulphur Beach)

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AHBSP Northern Approach Viaduct (Sulphur Beach)

Construction Methodology

Scope

This methodology covers the construction of the AHBSP Northern Approach Viaduct at the Sulphur Beach area which is partly over a stretch of harbour water.

The design is still in development stage but the philosophy is determined. There are no drawings available at time of writing so the philosophy has been verbally described to the report writer by the Beca design engineers.

General Philosophy of Construction Methodology

The existing state highway bridge at this point consists of reinforced concrete blade piers at approximately 20m centres with reinforced concrete flat deck slabs.

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Piling

There is no permanent piling work required for this portion of the project.

Temporary Staging Bridge

The staging bridge is constructed by vibrohammering and impact hammering steel piles into the seabed. Steel crossheads are installed transversely over the pile tops, followed by longitudinal steel I-beams spanning 9-10m between the crossheads. Timber baulks or reinforced concrete slabs are placed over the I-beams to form the running surface for cranes, piling gear and personnel. Handrails are installed for safety.

Working from Sulphur Beach Reserve the staging bridge is built progressively out span by span with the crane walking forward onto each completed span to construct the following one.

The staging bridge is removed in reverse on completion. No piles are left in the water.

If working from the water from large service barges, the crane is likely to be positioned on one of the service barges. In this case the entire staging bridge is constructed from the water in any sequence.

Pier Extensions

Premanufactured working platforms will be craned up to the existing pier edge and bolted onto the pier. Pier extension brackets will then be bolted to the piers.

Box Girder erection

The box girder sections of the deck will be assembled in the construction yard at Sulphur Beach Reserve, trailered out on the staging (and back onto land at Gold Hole Reserve for the southernmost spans) to the crane/s and lifted into position with either a single crane or by tandem lift. Spans will be fully welded together and painted insitu on the pier extensions, within suitably contained surrounds as previously described.

If the Sulphur Beach Reserve is not used as a construction yard, the girders will be delivered to and assembled on the "floating island", painted etc and lifted into position with the crane on the staging as previous.

Non-slip Deck Surfacing

This paint on epoxy based finish is the final touch to the bridge/s and is done insitu after completion of structure erection.

Navigation and Working in the Auckland Harbour

The harbour is traversed by:

- ferry services to Northcote and ……..
- ships servicing the Chelsea Sugar refinery
- sailing race yachts, and
- casual fishermen and sailors

As for the Main Viaduct methodology, navigation and working procedures will be developed in full liaison with, and to the approval of, the Auckland Harbour Master. (see the same section of Appendix 10.1)

Appendix 12.1 Northern Approach Viaduct (over residential properties)

10 Feb 2020 Rev 0

AHBSP Northern Approach Viaduct (over residential properties)

Construction Methodology

Scope

This methodology covers the construction of the AHBSP Northern Approach Viaduct over the residential properties between Gold Hole Reserve and Te Onewa Pa site

The design is still in development stage but the philosophy is determined. The design is generally in accordance with drawing number 3910806-SE-501.

General Philosophy of Construction Methodology

This section of the new shared path bridge is structurally independent of the existing harbour bridge with its own piled foundations, piers and superstructure.

Piling in the nearby residential properties will be noisy and cause a degree of vibrations, which is likely to be unacceptable to the residents. For those houses which will not be purchased by NZTA and demolished, it is recommended that the affected residents are temporarily relocated for the duration of the relevant bridge section construction.

In order to maintain existing trees and minimise damage (pruning) to them (and other property), the deck of this steel viaduct will be assembled on, and launched from the deck of the pre-constructed southern section of the Sulphur Beach bridge deck (see Appendix 11.1).

Concreting of the piled foundations will be done during the daylight working hours (potentially starting before daybreak to avoid peak morning traffic delays)

Access to the site will be along Union Street towards Te Onewa Pa site and then under the harbour bridge. Headroom is limited under the bridge. It may be necessary to offload crane and piling rig onto the road on the western side of the bridge and "walk" them under the bridge to reach the eastern-side positions of the new piers. Readymix concrete trucks will fit under the bridge.

Piling and Pilecap

A single 1500 or 1800mm diameter (depending on locality on the bridge) bored pile will be installed at each pier position. Piers are at approximately 30m centres and access to these positions will be required through some residential properties.

Fences and/or gates will be carefully removed and stored for later reinstatement on completion. It may be necessary to replace with new if the materials are too old to reuse.

The construction service crane and piling rig required to install the piles are likely to be 60 – 80 ton machines. Some damage to the gardens and driveways of the properties is inevitable, but care will be taken to minimise it. All damage will be reinstated on completion and grass replanted.

It is likely that temporary steel casings will need to be installed to prevent the sidewalls of the bore from collapsing. These will be vibrohammered and potentially impact hammered into (and out of) the ground, depending on the stiffness of the material overlying the founding sandstone material.

The drillings from the piles will be stockpiled adjacent to the piling works, loaded into trucks and carted away to an approved disposal site on the North Shore.

Reinforcing steel cages are then inserted into the pilebore with the crawler crane, ready mixed concrete delivered by road and pumped into the pile.

An excavation is then made 1.5m deep to the top of the pileshaft. A circular steel former for the pilecap is then installed over the pileshaft, and the bolts for the pier stem are suspended within a template off the formwork. Concrete is then placed as before.

Piers and Crossheads

The piers are fabricated from steel plate to form an internally stiffened rectangular box section with a base plate through which the foundation bolts protrude. The crosshead is also fabricated steel. The pier and crosshead are pre-welded together prior to erection.

The assembly is lifted by crane from the delivery truck, placed over the bolts and secured into position.

Temporary Props under the Northern Span of the Main Viaduct

The deck launch of this bridge section extends 88.5m past the north abutment of the Main Viaduct southwards, mostly overland across Te Onewa Pa with the last 10m being over water, where land is exposed at low tide.

At this southernmost end of the launch, a temporary prop, likely to be 2 no. cross braced 900mm diameter steel tubes, are driven into the seabed. If sufficient lateral support of

these piles is not attained by driving into the weathered sandstone it may be necessary to predrill or bore out the pileshafts before driving further into the sandstone.

Access to install these piles will be by barge at high tide. If there is insufficient draft for the barge to get close enough for installation, it will be necessary to install a temporary staging bridge from the closest barge access position to the prop position to carry a crane (and potentially a drill rig) up to the required position. Construction of this staging bridge is as per Appendix 11.1 staging bridge over the Sulphur Beach waterway.

In order to reduce the unsupported length of the final span of the launch (88.5m from the Main Viaduct north abutment to the temporary prop described above), temporary scaffold tower props will be installed in the open reserve area of Te Onewa Pa with consent from the Iwi. This will reduce the unsupported final launch span to approximately 45m.

Box Girder launching

The box girder sections of the deck will be assembled on top of the already completed deck of the Sulphur Beach bridge immediately north of it. Prefabricated 15m long box sections, along with the launching nose described below, will be delivered to the Sulphur Beach Reserve construction yard or staging bridge either

- By road with entry to the yard as described in Section 4.2, or
- By barge to the temporary staging bridge linking Sulphur Beach Reserve with Gold Hole Reserve.

The launching nose and box sections will then be lifted onto the completed bridge deck by crane positioned on the temporary staging bridge (or in the yacht yard at Gold Hole Reserve) and strung out for welding (and painting) together. The launching nose is bolted to the leading edge of the forward box section. Suitable enclosed containment over the welders and painters at the weld joints will manage temperature and humidity controls as well as prevent water contamination from shot blast material and/or paint overspray.

Once the bridge deck is fully welded up, launching occurs as follows:

- The bridge sections are positioned and welded together on top of load-skate rollers
- A launching nose (potentially 20 – 25m long) is attached to the front pulling end of the bridge deck in order to reduce interim hogging stresses in the deck during launching over the piers and especially the final 88.5m span.
- Temporary suitable low friction sliding bearings (e.g. Teflon coated rubber) are placed on the new crossheads
- A fabricated "pulling point" is attached to a temporary bracket bolted onto the underside of the bridge box girder near the northern end of the deck
- Pulling strand jacks are fixed onto the side of the pier at the north anchorage of the Main Viaduct.
- Strand cables are attached to the pulling head and through the strand jacks
- The box girder is pulled forward along and over the Sulphur Beach bridge deck
- The box girder, as positioned on the supporting Sulphur Beach bridge deck, is approximately 1m higher than its final level, where it transitions down off the supporting deck onto the new crosshead bearings.
- This transition of 1m vertical difference takes place over a 30m span. The box girder will be designed to accommodate the temporary bending stresses induced through

this action. If it is not possible to accommodate these stresses in the box girder, a temporary removable support 0.5m high can be placed on the northernmost first pier to reduce the overall 1m transition to take place over a 60m length. On completion of the launch the temporary support is removed by jacking the girder up (say 10mm) in order to slide the support out, and lower the 2 northern spans onto their permanent bearings.

- Depending on its weight, the launching nose, which is now cantilevering out over (and past) the temporary prop, is removed either by crane on JUB, or if too heavy it can be lowered onto a barge (at high tide) as a "tandem lift" with crane on JUB on one end and a strand jack mounted on the southern end of the launched box girder lowering the other end.
- The final 56m long girder lift of the Main Viaduct (approximately 270 tons) can then be completed as per Appendix 10.1

Non-slip Deck Surfacing

This paint-on epoxy based finish is the final touch to the bridge/s and is done insitu after completion of structure erection.

Navigation and Working in the Auckland Harbour

The harbour is traversed by:

- ferry services to Northcote and Birkenhead
- ships servicing the Chelsea Sugar refinery
- sailing race yachts, and
- casual fishermen and sailors

As for the Main Viaduct methodology, navigation and working procedures will be developed in full liaison with, and to the approval of, the Auckland Harbour Master. (see the same section of Appendix 10.1)

Appendix 13.1 Southern Approach Viaduct

11 Feb 2020 Rev 0

AHBSP Southern Approach Viaduct

Construction Methodology

Scope

This methodology covers the construction of the AHBSP Southern Approach Viaduct immediately south of the southern abutment of the Main Viaduct. All of the work is on land.

The design is still in development stage but the philosophy is determined. The design is generally in accordance with drawing number 3910806-SE-501.

General Philosophy of Construction Methodology

This section of the new shared path bridge is structurally independent of the existing harbour bridge with its own piled foundations, piers and superstructure.

The trees between the 2 sliplanes leading onto Shelly Beach bridge will need to be removed. It is likely that the sliplane from Westhaven Marina end onto the Shelly Beach flyover bridge will be closed to traffic during construction.

Piling will be noisy with vibrations, which is likely to cause a degree of disturbance to the commercial properties adjacent to the Westhaven Marina

Piers, crossheads and deck will be installed with craw er or mobile cranes positioned adjacent to the bridge works.

Concreting of the piled foundations will be done during the daylight working hours (potentially starting before daybreak to avoid peak morning traffic delays)

Access to the site will be along Curran Street or from the road skirting the Westhaven Marina.

Piling and Pilecap

A single 1500 or 1800mm diameter (depending on locality on the bridge) bored pile will be installed at each pier position. Piers are at approximately 30m centres.

The construction service crane and piling rig required to install the piles are likely to be 60 – 80 ton machines. Some damage to the roadway is inevitable, but care will be taken to minimise it by using crane pads and/or steel plates. All damage will be reinstated on completion and landscaping plantings.

It is likely that temporary steel casings will need to be installed to prevent the sidewalls of the bore from collapsing. These will be vibrohammered and potentially impact hammered into (and out of) the ground, depending on the stiffness of the material overlying the founding sandstone material.

The drillings from the piles will be stockpiled adjacent to the piling works, loaded into trucks and carted away to an approved disposal site on the North Shore.

Reinforcing steel cages are then inserted into the pilebore with the crawler crane, ready mixed concrete delivered by road and pumped into the pile.

An excavation is then made 1.5m deep to the top of the pileshaft. A circular steel former for the pilecap is then installed over the pileshaft, and the bolts for the pier stem are suspended within a template off the formwork. Concrete is then placed as before.

Piers and Crossheads

The piers are fabricated from steel plate to form an internally stiffened rectangular box section with a base plate through which the foundation bolts protrude. The crosshead is also fabricated steel. The pier and crosshead are pre-welded together prior to erection

The assembly is lifted by crane from the delivery truck, placed over the bolts and secured into position.

Box Girder installation

The box girder sections of the deck will be assembled into 30m engths as per drawings, in the construction yard adjacent to Curran Street. Prefabricated 15m long box sections will be delivered to the construction yard either

- By road with entry to the yard as described in Section 4.2, or
- By barge to the assembly jetty adjacent to Curran Street

It is possible that fully completed 30m sections may be delivered by barge.

The completed 30m sections (either as delivered or welded together from 15m sections) will then be loaded onto a jinker truck unit for shifting by road via Curran Street to the bridge site.

It is probable that Westhaven Marina road will be closed during this operation, which is likely to be conducted at night during off peak traffic periods and with no disturbance to commercial businesses.

The box sections will then be tandem lifted onto the completed bridge deck by two cranes (or by a single large mobile crane) positioned on the road. Butting ends of the girder sections at the piers will then be fully welded. Suitable enclosed containment over the welders and painters at the weld joints will manage temperature and humidity controls as well as contain shot blast material and/or paint overspray.

Non-slip Deck Surfacing

This paint-on epoxy based finish is the final touch to the bridge/s and is done insitu after completion of structure erection.