Swing bridge general earlier bridge

The river Esk has been crossed for centuries and it has been maintained by Edward III in 1353, and has been repaired with hard wood from the Oak by John Sehlboty in 1407.

In 1926 Riding justices decided that the bridge should be change to new structure bridge with movable parts. 96 years later the bridge was in very impoverished condition and was needed to be repaired, See Figure 1

earlier bridge whitby. png

Figure 1 Earlier bascule bridge

First Swing Bridge.

The bridge was built in 1835 until 1908. The swing part was made from wood and the opening was by manned winches to allow the ships to pass through. After years opening system has been changed by water-driven opening engine. The problem was that the bridge gives limit pass to the ships by 13. 72 meters, See Figure 2.

scscsc. bmp

Figure 2 first swing bridge

Swing Bridge.

The existing Swing Bridge was built after the First Swing Bridge by a year in 1909; it’s the third crossing bridge over the river Esk within the Habour zone of heart of Whitby. The bridge just turned 100 in 8th of August 2009. During 1966 to 1970, were 25 accidents recorded on 76. 2 meters long. In addition the bridge has to open approximately every half an hour to let the ships

passing through and this causes delay to both traffic and pedestrians around 5 minutes.

The bridge carries (A171) that comes from Meddilsborough to Scarborough. Its one Way Bridge for traffic and two ways for large number of pedestrians, the bridge has insufficient dimensions regards to the traffic and pedestrians nowadays, its 4. 2672 meters carriageway wide and footpath width of 1. 05 meter. Throughout the high season the footpath it will be exceedingly packed and the people have to step out into the carriageway due to the restriction of footpath wideness without paying attention of oncoming vehicles. Even though sometimes the traffic indecisive to cross the bridge against other cars. As well as the when two big vehicles crossing along the bridge one of them has to mount on to the pavement to let the other vehicle pass through, see Figure 3.

exesting swing bridge. png

Figure 3 existing swing bridge

Current condition of the bridge.

The bridge has age of 100 years old and it’s over the expected age, at present time the Swing Bridge has annually maintenance of £60, 000. The main maintenance was carried in 1985 with cost of £400, 000. The major refurbishment was carried due to the bad condition as following:

The superstructure was seriously corroded.

Poor state of operating machines and it’s placed with electrically hydraulic system.

At present time the bridge causes problems due to its position which is close to the North Sea. The surface layer of the paint being de-bonded, the flakes fallen into the river damaging the flora and fauna of marina. Moreover, the chloride is extremely high and causes serious corrosion to the steel plate of the bridge.

New bridge.

Movable Bridge.

This type of bridge that moves in order to allows the ships and boats etc, to pass through. This design is economical because it reduces the cost of construction and this can be achieved by building it on the ground, evading the disbursals of high piers and the long approaches. Therefore this provides the ease of passages for the ships and reducing the constructions expense.

Movable bridges is operating by different methods such as electrical motors like gearing and hydraulic pistons etc. these bridges also cause traffic delay because the traffic has to be stop to let the sea traffic to pass. Basically, there are 13 types of movable bridges and the common types are Swing Bridge and Bascule Bridge.

Types of bridges.

Name

Description

Design

Drawbridge.

“ The bridge deck is hinged on one end.”

Drawbridge.. jpg

Figure 4 Drawbridge

Bascule bridge.

“ A drawbridge hinged on pins with a counterweight to facilitate raising.”

bascule bridge. jpg

Figure 5 Bascule bridge

Folding bridge.

“ A drawbridge with multiple sections that collapse together horizontally”.

Folding bridge. jpg

Figure 6 Folding Bridge

Curling bridge.

“ A drawbridge with multiple sections that curl vertically”.

Curling bridge. jpg

Figure 7 Curling bridge

Lift bridge.

“ The bridge deck is lifted up by counterweighted cables mounted on towers”.

Lift bridge. jpg

Figure 8 Lift bridge

Table bridge.

“ A lift bridge with the lifting mechanism mounted underneath it”.

Table bridge. jpg

Figure 9 Table bridge

Retractable bridge (Thrust bridge).

“ The bridge deck is retracted to one side”.

Retractable bridge. jpg

Figure 10 Retractable bridge (Thrust bridge)

Rolling bridge.

“ An unhinged drawbridge which is lifted by the rolling of a large gear segment along a horizontal rack”.

Figure 11 Rolling bridge

Submersible bridge.

“ The bridge deck is lowered down into the water”.

Submersible bridge 4. jpg

Figure 12 Submersible bridge

Tilt bridge.

“ The bridge deck, which is curved, is lifted up at an angle”.

Tilt bridge. jpg

Figure 13 Tilt bridge

Swing bridge.

“ The bridge deck rotates around a fixed point, usually at the centre, but may resemble a gate in its operation”.

Swing bridge. jpg

Figure 14 swing bridge

Transport bridge.

“ A structure high above carries a suspended, ferry-like structure”.

Transporter bridge 1. jpg

Figure 15 Transport bridge

Jet bridge.

“ A passenger bridge to an airplane. One end is mobile with height, yaw, and tilt adjustments on the outboard end”.

AdelaidJetBridgeS7386. jpg

Figure 16 Jet bridge

Bascule Bridge.

Bascule Bridges are the most popular of opening bridges, the main part of bascule bridges is the counterweight, which is designed to be overhead counterweight or counterweight below the deck as shown in figure 17 and 18. Counterweight is continuously balance the leaf (span)

This kind of bridge is to balance the bridges that rotate about the horizontal axis at right angle to its longitudinal centerline. Bascule severely implements to these kind that consist of a single moving element, which turns about the horizontal line close to its centre of gravity in order that the weight on one side that rotate on an axis mostly balance the weight on the other side, however the balance usually not precise.

The movement of the bascule bridge mostly is up and down, when it moves keeping the bridge closed, it’s called as span heavy, or if it’s moving to keep the bridge to open its called counterweight heavy. Bascule Bridge can possibly be a single or double leaf that moves up and down to allow sea traffic to pass through.

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29. png

Figure 17 single bascule bridge with overhead counterweight

Figure 18 single bascule bridge with counterweight below the deck road

Double leaf Bascule Bridge.

It comprises of two leaves pointed opposite each other and connected together at their ends where they attach over the navigation channel as

shown in figure19. The distinction between the single and double is the double leaf has advantages as following:

It’s higher above the water level with the same span.

Rapidly opening

Large navigation headway while it’s closed.

Provide less wind resistance.

Require small counterweight.

Require small machinery.

The disadvantage is that the double bascule bridge requires two times as much of every part.

Untitled. png

Figure 19 Double bascule bridge with counterweight below the deck road

Many types of bascule bridges have many failures, where as the Rolling lift type “ Scherzer type” invention solved these problems with distinct advantages:

As it rotates it pulls itself out of the way of navigation.

Provide more clearance to ships compared with other types from the same class.

It does not have to open at wider angel as the other type of bridges to give a clear way for the ships.

Rolling bascule Lift Bridge has one disadvantage such as it does not pivot about a hinge point, instead utilizing a rack and pinion mechanism to maintain the support and alignment.

Figure 20 Fixed-trunnion Bascule design

Figure 21 Rolling Bascule

The common type of design is called “ Chicago Bascule” this structure of it is much better than the others where it is a fixed-trunnion bascule design, the bridge pivoted around a large axel when trunnion slopes upward, see figures 20, 21 and 22.

rackpinion. gif

Figure 22 Rack and Pinion mechanisms

The difference between Double-leaf Bascule Bridge and Swing Bridge.

Double leaf bascule bridge with overhead counterweight

Advantages

Disadvantages

It works as a cantilever for both dead/live load and it’s simply supported for live load.

Overhead-counterweight is exposed to vandalism and perhaps blocks aspect of view.

The mechanisms can be avoided from the bad weathering and risks of vandalism by place them underneath the road deck.

2. The power required from the machinery to move the span is proportional to the max wind speed over large area of deck.

Provide great opening and closing compared with swing beiges.

Provide clearance to small boasts without fully opening.

Swing bridge

Advantages

Disadvantages

The power required from machinery to move the span is not great as for bascule bridge

It’s required more time for opening and closing compared with Bascule Bridge.

The machinery is under the deck but part of them dipped into the water.

Long pier required to protect the span and this block the scene of the view.

Does not require building cofferdam for piers and foundation construction and protection.

The old Bascule Bridge of Whtiby.

The earlier bridge was Bascule Bridge constructed before the existing swing bridge in the heart of Whitby. The bridge was manually operated before replacing it by hydraulic operated swing bridge. Therefore, proposing to build

new modern bascule bridge can bring back Whitby’s historical heritage and remember the local people to their history.

Improving or Replacing the Swing Bridge.

General.

As a result from the current condition of the swing bridge must be maintained by £60, 000 annually. On the other hand after few years it might to be carry maintenance with high cost. Therefore to construct new bridge with good specifications won’t be maintained at least for the first decades. Basically it’s suitable to construct new bridge that might cost around £350, 000 thousand instead of using it for maintenance on the current swing bridge. The new design will avoid all the environmental effects, high cost of maintenance, and traffic congestion within the bridge and greatly reduce the risk exposed to pedestrians.

Therefore, it is highly recommended that the Whitby should have a new bridge rather than spending money on providing maintenance to the swing bridge.

The Viable Solution.

The viable solution, whichever to improve or replace the Swing Bridge has been decided to replace it with new bascule bridge in the same location. The new bascule bridge will be used just by pedestrians and freight cars due to the area surrounding the current swing bridge it will be pedestrianized refer to New Development.

As for the traffic, new bascule bridge will be constructed in the upper Harbour zone from New Quay Road to Church Street Car Park, refer to New

Crossing. It will be used by traffic and pedestrians in order to reduce the traffic congestion and danger/risk exposure to pedestrians.

The good advantages of this viable solution are:

The new bascule bridge between the Church Street and New Quay Road will be constructed first and use the current Swing bridge as temporary bridge in order to reduce the cost of the construction.

When construction is finished the current swing bridge will be replace with new bascule bridge which is just for pedestrians, and bring back old memories of first bascule bridge.

When the construction of new pedestrians Bascule Bridge will be finished, so the tourist and local in peak season they will be comfortable to walk along the bridge without any congestion, no fear from traffic and enjoy the scene of the Harbour zone centre.

Proposed location of new bridge.

General.

The locations are important to verify the reason of chosen bridge type, as well as proposing locations are useful to choose the appropriate position for the bridge. The location should be reasonable to match with other locations and suggestion of New Developments. Therefore, it should be easy to access and satisfy the users.

All locations that will be proposed must not ruin other places and

New Quay road to Church Street via Bridge Street.

This proposal shows where the new pedestrian's bascule bridge will be constructed which is in the same location of current swing bridge. When the new bascule bridge will be used by pedestrians the narrow road on both side will sufficient for them and enjoy the scene the Harbour zone, there won't be any demolishing required, no affect to ships owners and their parks and the old swing bridge can be placed in museum as memorial, as shown in figures 23 and 24.

Figure 23 new pedestrians Bascu7le Bridge

Untitled. jpg

Figure 24 new pedestrians Bascule Bridge

New Quay Road to Church Street.

New bascule bridge for traffic and pedestrians, Refer to New crossing.

Deck design of new pedestrians Bascule Bridge.

The deck design of the bridge will be formulated to fit the maximum possible amount of pedestrians without any risk. In order to comply with the safety of the pedestrians the dimensions as the following:

The comprehensive width of the deck is 6m.

The total length of the deck will be the same as the total length of the bridge which is 43m as shown in figure 25.

The overall thickness of the deck from the centre is 200mm and it descends to 190mm to both side ends of the bridge. This inclination counted for the drainage system.

Concrete slab thickness is 0. 15 meter.

Historical brick thickness 0. 05 meter. See figure 26.

Handrails will be in the same dimensions for both sides. The recommended material that can be used for the Handrails is aluminum alloy which is can resist the corrosion from chloride spread from the air.

Street lights will be installed on the bridge to enjoy the view during night time.

The deck pavement will be brick covering the layer of the concrete to match with surrounding building and protect the history of the town. As well as for the piers.

The material that will be used for the deck is composite concrete, this type will be used because it takes time to reach the certain rigidity in order to steel deck can serve as bracing for all horizontal forces.

The beams that will be used to carry the load of the deck are I-beams; the design contains two beams parallel to each other along the length of the deck.

The best steel beams type can be used that can resist the corrosion is galvanized steels beams and also can be painted to prevent it from revealing to chloride attack.

Figure 25. Front elevation

Figure 26. Section of deck and pier

General assumption calculation for the pedestrian's bascule bridge attached with next sheet.

New crossing

Proposed location of new bridge

General

The locations are important to verify reason of chosen bridge, as well as proposing locations are useful to choose the appropriate position for the bridge. The location should be reasonable to match with other locations. Therefore, it should easy to access, comfortable size and satisfy the users.

From the viable solution of swing bridge that will be pedestrianized and the area around. So new crossing must be provide to solve the matter of traffic, it's have been decided that new bascule bridge will be constructed for both traffic and pedestrians as a part of the viable solution. The best location of the bridge has been decided to be build between New Quay road and Church Street.

New Quay Road to Church Street

This proposal illustrates the location of the bascule bridge that will be constructed almost parallel to the swing bridge. This location has good advantages due to non narrow road, there is no demolishing required except on the river banks where the bridge is connected to the both sides. Having look at to the site, on the side of New Quay Road the pedestrians pathway

has adequate space can be widen in order to construct the two lane new bascule bridge, in the other side the traffic and pedestrians can easily get access to Church Street throughout car park, the main advantages of these two sides are:

It’s easy to construct.

No demolishing required to any houses, historical building or shops.

Won’t affect any boats, ships parking

Won’t have any objection from locals, or vessel owners.

Figure: shown traffic from New Quay Road to Church Street

Deck design of new traffic and pedestrians Bascule Bridge.

The deck will be designed for pedestrian and traffic, this design should accommodate both of them without having any traffic congestion and avoid pedestrian from risk. Therefore, the design must comply for both of them. The dimensions will be as following:

13 meters overall width.

4 meters wide for each lane.

2. 5 meters wide for pedestrian’s pathway for each side.

0. 29 meter total thickness from the center of the deck sloping down to 0. 28 meter to the ends parallel to pathways. This allows water to drift sideways to drainage system.

Concrete slab thickness is 0. 15 meters.

Two layers of tar thickness are 0. 12 meters.

0. 02 meter bitumen thickness will be covering the concrete deck.

Handrails will be design

The Handrails design will be on both sides to prevent pedestrians to step out on the road. Therefore, the hazard will be greatly reduced for pedestrians. The perfect design of Handrails should comply with the decrease of risk. So the design of handrails on the side next to the road will be 500mm height concrete barrier and 500mm handrails above the concrete.

As for the material used, composite concrete will be used in the deck because before the concrete reaches certain rigidity, steel deck is needed to serve as bracing for all horizontal forces.

The best of handrails material it’s recommended to use galvanized steel handrails.

The assumption calculation procedure for the new crossing is the same as new pedestrian’s bridge but the structural dimension will be different depending on the load because it has different material such as Asphalt, bitumen and concrete etc

Abutment: for both bascule bridges.

The abutment is the structure that conveys the load from deck to the pile cap. Thus, the size of the abutment is 3mÃ-3m on the top part, and 2Ã-2 on the lower part, as shown in figure

Cofferdam: Construction for both bascule bridges.

Before construction the foundation, essentially required a cofferdam to be constructed to prevent the water from entering into foundation construction area. Sheet of steel plates that are joined together is commonly used type due to ease of penetration and pull out of the ground.

Therefore after construction of the cofferdam the water need to be pumped out.

Construction of counterweight: for both bascule bridges.

The counterweight duty is to balance the closing and opening of the bridge which are called counterweight heavy and heavy span or held on position , the design of counterweight usually 1. 5 – 1. 7 times of the overall weight of the deck. It’s recommended to choose 1. 6 to provide appropriate counterweight for opening and closing.

The recommended type of counterweight mechanism is Rack and pinion rather than using hydraulic pistons system. The Rack and pinion is more economic and easy to maintain comparing with hydraulic pistons system.

Calculation of counterweight weight of Pedestrians Bridge.

Total load of the deck Ã- 1. 6 = 0

Therefore: 1856 Ã- 1. 6 = 297 KN.

Calculation of counterweight weight of traffic and pedestrians Bascule Bridge will be the same as above.

Foundations and geology: for both bascule bridges

In accordance with boreholes data, the following boreholes 22, 26 and 113 around the area of Swing bridge location are representing different characteristics.

The information of borehole 22 shows the following:

The depth from the surface up to 4. 90 meters, the soil consists of made ground.

Starting from 4. 90 meters down to 15. 00 meters deep, the soil composed of alluvium.

The made ground and alluvium soil layers contains of coarse gravel, Sandy silty, Sandy clay, & Alluvium soil, these types of soils have different status and properties such as the unit weight, void ratio, low shear strength and high ability to be compacted/condensed.

The information of Borehole 113 illustrates the following.

Starting from surface down to 2. 45 meters deep, the soil composed of alluvium.

From 2. 45 meters down to 12. 20 meters deep, the soil is mainly sand and gravel.

From 12. 20 meters, countdown to depth of 3. 80 meters, the soil made up of alluvium.

Starting from 3. 80 meters depth layer of alluvium to depth of 16. 85 meters, the soil consists of sandstone and glacial.

The information of borehole 26 has the same characteristics, properties and condition of borehole 22 and 113.

Footing.

Based on the soil condition and the deck load the appropriate recommended size of footing of the pedestrians bascule bridge dimensions will be 3m Ã- 3m width and length.

Piles

Recommended type that can be used is steel tubular piles.

Specification

Steel tubular piles (rounded piles).

Closed-ended, this means that the toe of the pile is welded with a piece of steel plate, and poured into it with concrete in order to strike the concrete with hummer.

Stiffeners can be installed within the piles to enlarge buckling and bending resistance.

The propose from using this type because it has common use in marina structure nowadays.

Therefore the number of piles to be constructed for pedestrians Bascule Bridge as following:

Four piles for each pier.

The diameter of each pile is 400mm.

As for the new crossing bridge:

The footing size and number of piles to be constructed will be different than the pedestrian’s bridge because the new crossing has two lanes, different deck dimensions and two piers next to each other as shown in figure..

Method statement

Introduction

This method statement illustrates how all activities or special duties will be carried out. It shows the possible hazard connected with specific works and how to control it, in order to manage the work safely.

Scope of works

This document act toward with the constructions of three bridges over the river Esk of Whitby. The first bridge is new bascule bridge for pedestrians will be located in the same location of the existing Swing bridge, second bridge is the another new bascule bridge for both traffic and pedestrians will be located on the upper Harbour zone, and the third is to construct new Arch bridge will be situated in the same place of the high level bridge.

Health and safety welfare and facilities

Impermanent welfare facilities will be provided by the contractor or sub-contractor which will be accepted by the both. Welfare facilities should satisfy all staff which will include canteens, toilets etc. capable qualified personnel and a suitable number of first aid kits should be available during work period. All staff must undergo implement working rules, wearing

personal protective equipment that will protect them against all different risks such as safety jackets, helmets, gloves, eye protection, shoes and good quality clothes that can clearly seen etc.

General Approach.

The construction preparation of the three new bridges will engage activities on the site for new development. The construction of the bridges will be in sensitive places which are important connection between two sides of Whitby in the centre of the Harbour zone. The majority of people and traffic need to move along to get on the other side and it’s significant especially in the peak season for tourists to enjoy the scene of the Harbour zone and traffic crossing Whitby coming from Tess to Scarborough. Therefore, the construction should be finished in short time. Hence the work duration for both bascule bridges will be as following:

Weekdays, 7: 00 – 19: 00.

Weekends, 9: 00 – 13: 00.

Irregular works at night if it’s required.

As for the new Arch bridge will be two shits per day as following:

First shift

Weekdays, 7: 00 – 14: 00.

second shift, 14: 00 – 21: 00

Weekends.

Saturday will be at the same time as weekdays.

Sunday, one shift from 7: 00 to 14: 00.

Prefabrication of bridge will be carried out off-site if needed.

Construction activities on the new two Bascule Bridges will include.

Site set up, including offices, services and facilities. Container offices are the economics and fast to build or remove.

container_staircase_construction_office_02. jpg

Figure 25 Containers offices

Construction of piles support abutments of the bridge for both leafs.

yourfile. jpground-pile-caps. jpg

Figure 26 Steel tubular piles Figure 27 pile caps

Construction of footing and piers for the bridge.

Namibia_Caprivi_ZambeziBridge_Construction-Pier_1. jpg

Figure 28 bridge piers

Construction of impermanent fencing and entry gates, provisional noise and dust reduction devices around the site compounds.

gates. jpguntitled. JPG

Figure 29 Entry gates Figure 30 fences

bnb. jpgccccc. jpg

Figure 31 Permenant niose reduction Figure 32 Dust reduction devices

Construction of impermanent environmental defense works, along with stormwater management and cars, vans, heavy machineries and trucks wheel washer.

5369_ss100_Round[2]. JPGwheelwashbig2. jpg

Figure 33 environmental protections Figure 34 Wheel washers

Construction of cofferdams, the appropriate types for rivers is sheet piles due to it’s their ability of penetration to many different types of ground, water tightness given by its interlocking sections.

cc. bmp

Figure 35 Cofferdams

Provide special machineries for river bed cleaning, and disposal all the rubbish to unauthorized areas or use it for filling.

untitledb. bmpclean. jpg

Figure 36 Excavator for river cleaning Figure 37 clam shale for river cleaning

Provide pile drive machinery for piles installations.

pile-driver-image1. gif

Figure 38 Pile drive machines

Constructions of temporary structures and footing demanded for the launch of the bridge for both sides if required. Activity includes preparation of hardstand areas for crane access and a long steel structure for the fabrications and set up of the bridge.

Setting up and testing of establishing equipments.

Proper lights should be installed in right places that will be used during night works.

trip_kashaf. jpg

Figure 39 site lights

Provide appropriate cranes that can carry all parts of the bridge and arrange locations for standing whether if it on either sides or using barge crane.

crane_page4. jpgBargeCrane. jpg

Figure 40 heavy crane Figure 41river heavy crane

Installation of security guards to separate the site construction from live roads such as NJ-barriers or fences or others.

P145-01. jpguntitled. bmp

Figure 42 NJ-barriers Figure 43 cones

Site survey of the area designed for the passage and location of the cranes to be having a part in the setting of the bridge.

Rearrangement or construction of protection works of existing services probably to be affected by the setting operations.

Removing the Swing Bridge.

Set up the method to remove it with any damages to the swing bridge.

Provide cranes for uplift each span whether from sides of the bridge or by barge carne.

Demolishing the foundation and recycled if it’s in proper condition or use it for land filling.

All staff must have an experience about removing heavy structure to ensure that the bridge will be in the same condition after removing.

Provide trucks or ships that can carry the weight of each span.

Clean/wash the spans and all parts from any impurities that can affect the environment.

Construction works during weekends for the launching of the bridges.

Working together with energy company staff respecting power failure and other safety routines.

Formal approval that the lanes, paths, roads surrounding area of launching to be closed for the weekends and first night for people safety and avoid any vandalism actions.

Installation of floodlights and other possibility measures determined by the risk analysis.

Setting operation.

Installation of the bridge on its permanent bearing.

Construction time period.

The duration of the project depends on the obtainability of tracks to accomplish the removing and construction of the bridge.

Removing of Swing Bridge depends on the plan, equipments and labours. Construction of foundation and piers can be fulfilled in normal times.

The construction of the bridge will be divided into different stages:

Stage 1:

Consists of construction of the pile installation, footing, piers, impermanent structure and prefabrication of the bridge and precast elements if it will be provided.

Stage 2:

Launching of the new bascule bridge, which won’t to take long time.

Stage 3:

Two day plan to check bridge deck