The Lake Lothing (Lowestoft) Third Crossing Order 201[*]

Lake Lothing THIRD CROSSING

Document 7.5: Design Report

Appendix 11

Author: Suffolk County Council

Lake Lothing Third Crossing Fender Design Technical Note

Bridge Ref 10/67
Bridge Code 67

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Produced for
Suffolk County Council

Prepared by
Stephen Horne

T +44 15 1243 9970
E Stephen.Horne@wsp.com

1.1 Codes, Standards and Guidelines

The following design standards and reference documents have been used in the preparation of the fender design;

[1] BS6349-4:2014 – Code of practice for design of fendering and mooring systems

[2] PIANC "Ship Collisions due to the Presence of Bridges" INCOM report of WG19, 2001

[3] PIANC "Guidelines for the design of Fender Systems", 2002

1.2 Bridge Data

The bridge has been envisaged as an elevated (12m clear height over water) twin leaf bascule bridge with fixed spans over the remaining waterway and operational quay areas of the port. The clear width between supports on the bascule section is set at 35m.

1.3 Services Data

An underground service tunnel is located approximately 20m east of the eastern edge of the proposed bridge deck, it is understood to be a 2m diameter circular culvert of brick construction carrying multiple HV electric cables. There are notes of a number of abandoned HV electric cables lain on the lake bed a further 15m east of the service tunnel, the presence of these has not yet been confirmed. There is potentially a fibre communications cable situated approximately 20m east of the service tunnel, its location and construction are at present unconfirmed.

The exact locations of fender piles may need to be adjusted following confirmation of the services precise locations.

1.4 Vessel Data

The following design vessels, taken from the Kongsberg vessel simulation models catalogue, have been considered for the fender design. These vessels are those previously agreed with Associated British Ports as representative of the type of vessels which call at the Port of Lowestoft and used in the navigation simulation trials undertaken.

Vessel Designation	Vessel Description	Displacement (T)	Length between perpendiculars (m)	Length Overall (m)	Beam (m)	Draught (m)
BARGE03L	Towed flat top barge	2200.00	73.40	76.20	17.07	1.83
BULKC11L	Typical small laden CCP coastal bulker	5906.00	84.98	89.99	14.00	5.68
CNTNR24B	Small coastal container in ballast	7022.00	108.20	121.40	20.80	4.67
FERRY50	Medium size ferry	5415.00	108.00	117.00	20.00	4.39
DREDG05L	Laden trailer suction dredger	7247.00	88.45	96.10	18.00	5.10

SUPLY10L	Large laden offshore supply vessel	6550.00	75.40	86.20	19.00	6.00
TUG05A	Harbour class tugboat	550.00	30.50	32.00	10.97	2.50
TUG09	Deep draughted tug	668.00	30.02	32.66	9.45	4.12
SUPLY05L	Medium laden offshore supply vessel	2302.00	57.80	66.00	14.00	4.55
TUG15	High performance ocean tug	575.00	28.00	29.50	11.00	2.78

1.5 Navigation Data

The existing navigation channel within Lake Lothing is 73m wide and, under the current proposals, this is to be narrowed in the vicinity of the new bridge to allow supports to be located at 35m face to face. The design criteria for the minimum navigation channel between the supports has been set as 30m. The existing bascule bridge provides a clear navigation channel of 22.778m.

The maximum speed of vessels within the harbour is restricted to 4 knots under regulation 9 of the Lowestoft Harbour Bye-laws 1993.

Vessel simulations were undertaken in October 2016 and May 2017 to confirm the navigational impacts of the bridge design as proposed. The outcomes of these simulations have been used to refine the fender designs, see Mouchel Document Ref:1069948-MOU-MAR-LL-RP-MA-003.

1.6 Fender capacity design

The impact energy of a vessel during a collision (that which has to be absorbed by the fender) is calculated in accordance with BS6349-4.

1.7 Impact Velocities

For the support passage fenders the impact velocity has been taken as;

$$V_B = V \cdot \sin(\alpha)$$

Where

V Vessel velocity, taken as 4 knots.

α Vessel impact angle, taken as the lesser of a 35m bow to stern misalignment or 20°, as shown below.

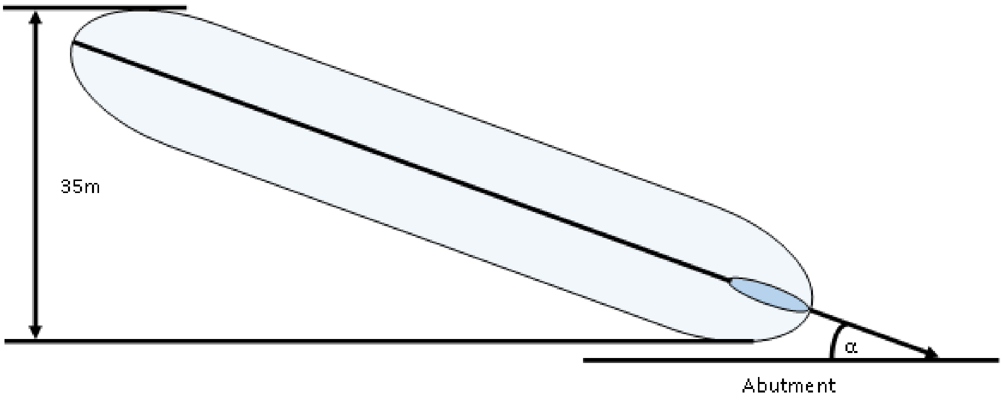

Figure 1 - Passage Fender Impact Velocity

For the angled channel approach dolphin fenders the impact velocity is taken as;

$$V_B = V \cdot \sin(\alpha)$$

Where

V Vessel velocity, taken as 4 knots.

α Angle of fender line from straight ahead course less 2.5° course correction, shown below.

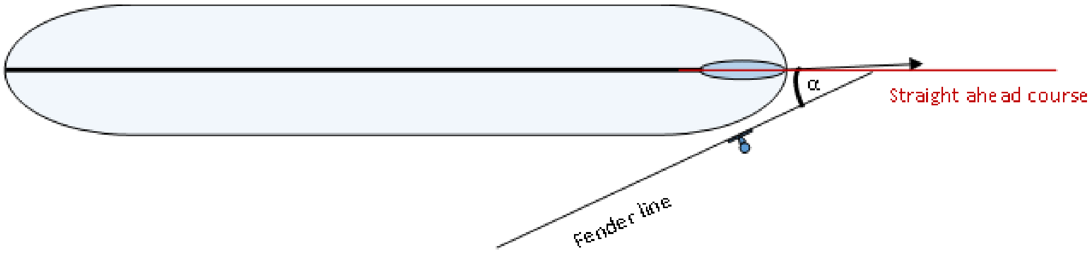

Figure 2 - Approach Dolphin Fender Impact Velocity

For the perpendicular approach fenders, the impact velocity has been taken as 0.905m/s for vessels over 2,500T M_D and 1.03m/s for vessels below this, equating to 50% of the typical transit speeds recorded during the navigation simulations.

The navigation assumptions above have been shown to be conservative following the undertaking of the vessel simulations. See Mouchel document 1069948-MAR-MISC-003 Vessel Simulation Report for details.

1.8 Fender Locations

The design of the fender locations has been undertaken with regard to the level of protection afforded to the bridge supports and the constraints that the fenders would place on the operation of the port when constructed. In particular consideration of the loss of usable berth length east and west of the bridge has been considered. The proximity of the HV electric service tunnel to the east of the bridge and associated clearance requirements limit the locations for siting fenders on this side of the bridge.

A variety of options for positioning of fenders on and approaching the supports have been considered. The fendering within the bridge passage is limited by the structure of the bridge supports and has been design accordingly. Potential variants for the approach fendering were developed and one of these taken forward for inclusion within the vessel simulation. Following this simulation a refinement of the layout has been developed, based on feedback from ABP port pilots, to lessen the impact on navigation.

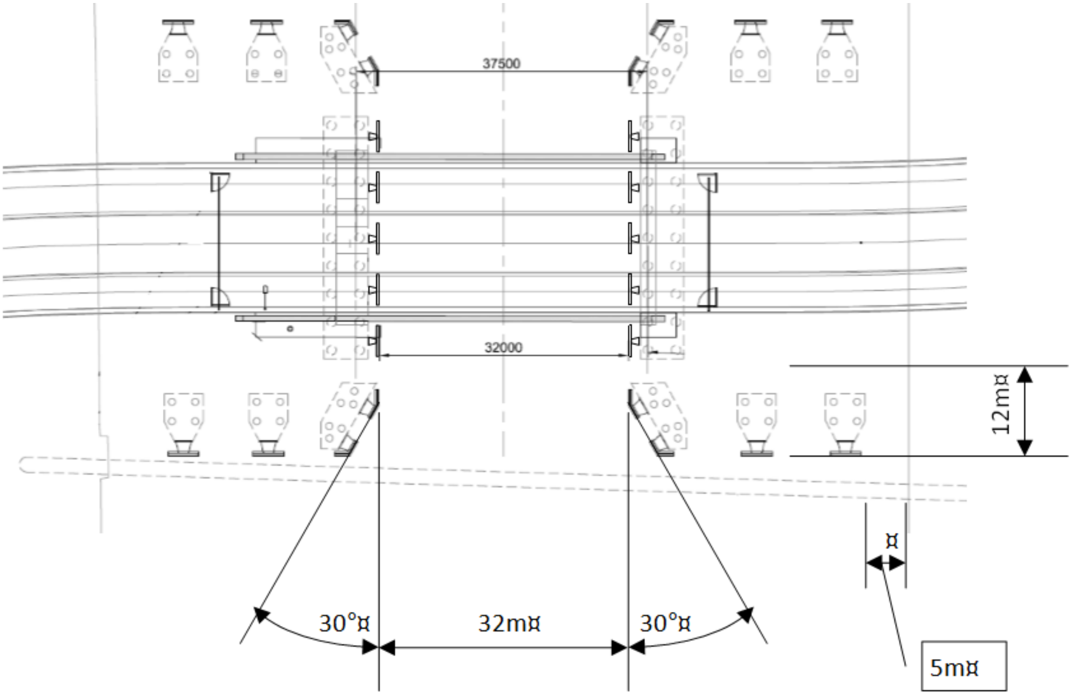

Figure 3 - Revised 30° Approach Dolphin Fenders

1.9 Energy Calculations

Energy calculations have been undertaken, in accordance with BS6349pt4, the calculated energies for each fender type based on the above principles are abnormal loads and are therefore not factored for design.

1.10 Fender Rubber Design

1.10.1 *Passage Fenders*

The passage fenders are required to absorb an impact energy of 997.5kNm. Using the Fendercare Marine product catalogue and considering the other design factors a grade G4 1200 cone fender with a rated energy absorption capacity of 1,124kNm satisfies the requirements. This fender will have a maximum operational reaction force of 2,193kN, this force must be considered during the design of the support foundations.

1.10.2 *30° Approach Dolphin Fenders*

With the 30° fender alignment an energy absorption of 3,466kNm is required. A grade E2 SCN2000 cone fender from Fentek Marine with a rated energy absorption of 3,800kNm satisfies the requirements. This fender unit would have an operational reaction force of 4,575kN which would be the design load for the dolphin piles.

1.10.3 *Perpendicular Approach Dolphin Fenders*

For the perpendicular fenders an energy absorption of 3,466kNm is required. A grade E2 SCN2000 cone fender from Fentek Marine with a rated energy absorption of 3,800kNm satisfies the requirements. This fender unit would have an operational reaction force of 4,575kN which would be the design load for the dolphin piles.

1.11 Fender Panel Design

In plan, the fenders must be close enough to minimise the risk that a vessel could pass between units and collide with the structure. For the passage fenders a spacing of 6m with panels of 4m is considered to give suitable coverage, giving exposed gaps of 2m between panels. The plan length of the dolphin panels is partially dictated by the potential torsional effect of an acute impact on the outer edge of a large panel and for this reason we propose that the approach fender panels should be restricted to a similar length.

In elevation the fender panels must provide an impact face at a suitable level for all states of the tide. We consider that a lower panel level of LAT + 0.5m and an upper level of HAT+1.5m will provide sufficient height range for the anticipated vessels. This would give a total panel height of 4m.

Suitable chamfers should be allowed for in the panel designs to reduce the likelihood of a vessel becoming either trapped under or hung up on the fender panels.