Lochaline Ferry Terminal Alignment Structure

Design Criteria Document

Caledonian Maritime Assets Limited

22 April 2016
Draft Report
PB4151

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Enhancing Society Together

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Source/Reference/
Comment

1 INTRODUCTION

1.1 Project Background

Lochaline Ferry Terminal is located within the Morvern area on the Ardnamurchan peninsula on the West coast of Scotland and owned by Caledonian Maritime Assets Limited (CMAL). A regular ferry service operates between the slipway at Lochaline and Fishnish on the Isle of Mull.

The existing aligning structure at Lochaline is believed to have originally been constructed in the early 1970's. The structure comprises a series of timber piles at 2.1m centres with longitudinal walings and raking timber struts to the rear of every other pile. The structure has been upgraded several times in the past including the addition of an inner dolphin circa 1980 and the construction of the outer dolphin in 1998. The vessels operating on this route have increased in size considerably since the structure was first built and consequently the structure is now continuously being damaged through 'normal use'. It is therefore considered to have reached the end of its serviceable design life.

1.2 Project Scope

The project will consist of the replacement of the existing timber alignment structure with a new continuous twin wall sheet pile alignment structure with a single layer of tie rods. The existing alignment structure will be demolished in 14.5m long sections commencing from the landward end. Temporary braced piles will be driven at the seaward end of each cell to protect the works from the ferry during construction of the new facility. The new structure will be built some 2.0m behind the existing berthing line and will consist of 4 cells. The new alignment structure will be protected by MV600 element type fenders. The recently constructed access walkway linking the current inner dolphin to the outer dolphin will be removed and stored during the construction works. This structure will be adapted such that it can be reintroduced linking the outer dolphin to the new alignment structure.

Other works included within the scope are:

a) Upgrading and extension of slipway
b) Provision of power pedestals to the rear of the alignment structure
c) Provision of a power supply for a hybrid ferry charging point
d) Upgrading of the lighting throughout the site (includes marshalling etc)
e) Increasing the size of the marshalling area
f) Provision of a potable water supply
g) Demolition and replacement of the existing building with a new purpose designed ferry terminal

1.3 Scope of this Document / Objectives of this Report

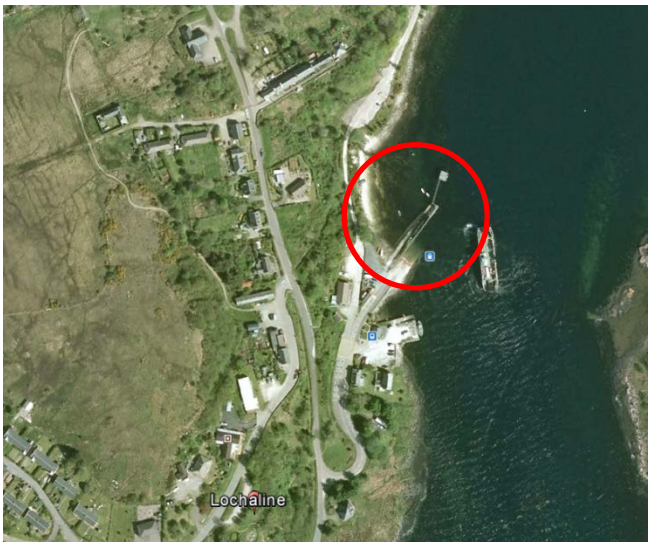
This report forms the Design Basis for the redevelopment of the Lochaline Ferry Terminal. It is intended that this report is a "live" document and will be updated as the project is progressed to incorporate the latest requirements and developments.

This Design Basis comprises the specific conditions and criteria for the design of the marine civils works. The conditions relating to landside development, building works and the M&E works associated with lighting, power supply and potable water supply will be added during the design process.

2 GENERAL SITE DESCRIPTION

2.1 Site Location

Lochaline Ferry Terminal is located within the Morvern area on the Ardnamurchan peninsula on the West coast of Scotland at Grid Ref. NM 679447 (O.S. Landranger Map 49). The ferry terminal is located at the end of a small access road which joins onto the A884 road running North to Strontian.



2.2 Site Boundaries

Details of the Land ownership are provided in CMAL drawing GB8428/MM/113 dated 28/11/11. This is attached in Appendix A.

3 PROJECT DATUM

3.1 Units

SI metric units shall be used throughout.

3.2 Co-ordinate System

The co-ordinate system is based on Ordnance Survey National Grid, datum OSGB36 Transverse Mercator Projection.

3.3 Elevation Datum

The level datum to be used shall be Chart Datum (CD).

The relationship between Chart Datum (CD) and Ordnance Datum (OD) is:

- +0.00 mCD = -2.10 mOD

Admiralty Tide Tables NP201 Vol. 1.

4 STANDARDS, CODES & REGULATIONS

4.1 Design Codes / Standards / Regulations

The structural design and materials selected for the marine facilities shall comply with the latest versions of the codes, standards and guidelines listed below.

Supplementary codes and standards will also be adopted as required.

- Eurocode 0, Basis of structural design
- Eurocode 1, Actions on structures
- Eurocode 2, Design of concrete structures
- Eurocode 3, Design of steel structures
- Eurocode 7, Geotechnical design
- BS6349-1:2000, Maritime structures: Code of practice for general criteria
- BS6349-1-1:2013, Maritime Works: General – Code of practice for planning and design for operations
- BS6349-1-3:2012, Maritime Works: General – Code of practice for geotechnical design
- BS6349-1-4:2013, Maritime Works: General – Code of practice for materials
- BS6349-2:2010, Maritime Works: Code of practice for the design of quay walls, jetties and dolphins
- BS6349-4:2014, Maritime Works: Code of practice for design of fendering and mooring systems

5 SITE CONDITIONS

5.1 Bathymetry

The bathymetry in the area is taken from a bathymetric survey undertaken by Aspect Land & Hydrographic Surveys dated June 2013.

A5117 Lochaline Sheets 1-3 2013

5.1.1 Sedimentation/Siltation

The closed nature of the proposed structure may result in additional accretion of material within the harbour area. The level of accretion is not assessed under this scope of work and it is assumed that future mitigation measures will be implemented as necessary.

Assumption

5.2 Topography

The topography in the area is taken from a topographic survey undertaken by Aspect Land & Hydrographic Surveys dated May 2012.

A4900 21 Lochaline Infrastructure Survey 2012

5.3 Geotechnical Conditions

5.3.1 Geology

The British Geological Survey 1:50,000 series geological map Sheet 44W and part of 44E indicates the following geological succession at the site:

Quaternary	Marine Beach Deposits - gravel, sand and silt
Paleogene	Mull Lava Group - Basalt
Upper Cretaceous	Loch Aline Glass Sand
	Morvern Greensand
Lower Jurassic	Pabba Shales
	Blue Lias

5.3.2 Mining

An active mine operated by Lochaline Quartz Sand Ltd is located immediately landward of the ferry terminal. The mine, which was opened in 1940, mines an 18ft thick seam of Cretaceous white sandstone running inland from the shore of Lochaline. The mineral is a virtually pure silica sand (99.8% silica dioxide and almost free from iron) which is suitable for the production of high quality glass. The mining is carried out by a room and pillar system. The sandstone is drilled and blasted, loaded onto dump trucks and taken to the surface plant, where it is crushed and washed to remove impurities. The sand is transported by ship from an adjacent pier. A mine plan (dated December 2002) indicates that three adits are located approximately 140m north west of the Ferry Terminal outer dolphin. The plan indicates that the mine workings follow the mineral seam inland from the shore of Lochaline i.e. the mine workings do not seem to extend beneath the loch and should not have any influence on the proposed ferry terminal development.

5.3.3 Ground Conditions

The following ground investigation factual/interpretive information is available:

Ref.	Report title	Contractor	Date	Contents
1	Ground investigation Lochaline Ferry slipway improvements	Holequest	September 2007	Factual report on four land-based boreholes carried out by cable percussion and rotary open hole and rotary coring techniques
2	Lochaline Ferry Berth Replacement Ground Investigation	Holequest	December 2014	Three marine boreholes and two land-based boreholes carried out variously by cable percussion, rotary open-hole and rotary coring techniques
3	Lochaline Ferry Terminal Redevelopment Ground Investigation Report	Atkins	April 2015	Interpretation of the ground investigation information and preliminary geotechnical design recommendations

The exploratory holes indicate the following ground conditions at the site:

Stratum	**Level of top of stratum (mCD)**	**Level of base of stratum (mCD)**	**Thickness**	**Description**
Made Ground	+3 to +4.15mCD	0 to -3 mCD	4.1m to 6.6m	Slightly sandy GRAVEL with cobbles and boulders
Marine Beach Deposits	+1 to -3 mCD	-12.4 to -14.8 mCD	10.2m to 15.3m	Med. dense to very dense sl. silty gravelly SAND, sl. silty sandy GRAVEL with COBBLES and BOULDERS of granite, basalt and sandstone. Occasional bands of firm sandy gravelly CLAY.
Rock strata of Cretaceous Age	-12.4 to -14.8 mCD	Not proven	Not proven	Medium strong to very strong fine to coarse calcareous SANDSTONE interbedded with occasional bands/laminae of weak to medium strong SILTSTONE

5.3.4 Cofferdam Fill

It is assumed that the fill placed within the twin-wall cofferdam will be clean well-graded coarse grained fill with a fines content <15% (i.e. less than 15% of particles by mass passing the 63µm sieve). It is assumed that the sand fill will be uncompacted below mean tide level and will be compacted by conventional plant above mean tide level.

5.3.5 Characteristic geotechnical parameters

The following characteristic geotechnical parameters will be adopted:

Stratum	Weight Density (kN/m^3)		Effective stress Analysis			Total stress Analysis	
	Above water γ_m	Below water γ_{sat}	Effective angle of shearing resistance Φ'_{peak} (°)	Effective cohesion c' (kPa)	Effective Young's Modulus E' (MPa)	Undrained shear strength c_u (kPa)	Undrained Young's Modulus E_u (MPa)
1. Cofferdam Fill	**19.0**	**21.0**	**35**	-	**15**	-	-
2. Existing Made Ground	**19.0**	**21.0**	**34**	-	**25**	-	-
3. Marine Beach Deposits	**20.0**	**22.0**	**40**	-	**80**	-	-

The unit weight of water is 10 kN/m3

5.3.6 Contamination

There are no contaminated materials or ground within the project area. *Assumption*

5.4 Water Levels

5.4.1 Tidal Levels

Predicted tide levels are:

Based on Admiralty Tide Tables NP201 Vol.1

Tidal Levels	Abbreviation	Level (mCD)	Level (mOD)	
Highest Astronomical Tide	HAT	+5.1	+3.0	*Table V Part 2*
Mean High Water Springs	MHWS	+4.5	+2.4	*Part II*
Mean High Water	MHW	+3.9	+1.8	*Part II*
Mean High Water Neaps	MHWN	+3.2	+1.1	
Mean Sea Level	MSL	+2.6	+0.5	*Interpolated between standard ports*
Ordnance Datum	OD	+2.1	+0.0	
Mean Low Water Neaps	MLWN	+1.9	-0.2	*Interpolated between standard ports*
Mean Low Water	MLW	+1.3	-0.8	
Mean Low Water Springs	MLWS	+0.7	-1.4	*Interpolated between standard ports*
Lowest Astronomical Tide	LAT	+0.0	-2.1	*Interpolated between standard ports*

Table 5-1: Tidal Level Data

5.4.2 Sea Level Rise

Predicted sea level rises over the design life (50 years) are:

	Low (5^{th} Percentile)	Medium (50^{th} Percentile)	High (95^{th} Percentile)	
Relative Sea Level Rise (m)	0.019	0.132	0.244	*UKCP09 Climate Projections*

50^{th} percentile values are adopted for design.

5.4.3 Storm Surge

Contact Dave McHardie (CMAL Harbourmaster) for information based on his records.

5.4.4 Ground Water Levels

Ground water levels in the area under consideration are assumed to effectively mirror the tide levels.

5.5 Wind Conditions

No specific wind data for the site has been provided.

The fundamental basic wind velocity will be assessed in accordance with BS EN 1991-1-4 and UK NA to BS EN 1991-1-4.

5.6 Wave Conditions

TBC

5.7 Current Conditions

West of Scotland Pilot (published by Hydrographer of Navy)

Tidal streams within the entrance to Loch Aline are recorded at 2½ knots at Springs. It should be noted that these streams pass between the existing inner and outer dolphins and at Springs they can result in difficulties for the Ferry whilst berthing as the current forces the vessel of the berth.

5.8 Temperature

No specific temperature data for the site has been provided.

The maximum and minimum air temperatures will be assessed in accordance with BS EN 1991-1-5 and UK NA to BS EN 1991-1-5.

5.9 Snow

No specific snowfall data for the site has been provided.

The characteristic ground snow will be assessed in accordance with BS EN 1991-1-3 and UK NA to BS EN 1991-1-3.

5.10 Constraints

5.10.1 Environmental

Marine Scotland – Marine Construction Licence: The marine works at Lochaline would require a Marine Works Licence to be granted by the Scottish Ministers under the Marine (Scotland) Act 2010. The Marine Licencing (Pre-application Consultation) (Scotland) Regulations 2013 came into force on 6th April 2014. These regulations require applicants for certain activities to carry out a public pre-application consultancy. The footprint of the proposed marine works at Lochaline are below the 1000m^2 threshold.

Crown Estate – Marine Works Licence: From the exisiting land ownership plan provided by CMAL it is apparent that an agreement exists with Crown Estates for the foreshore area curently occupied by the existing alignment structure. It is likely therefore that this existing agreement would be sufficient for the proposed alignment structure. A Marine Works Application Form would be submitted to the

agents acting on behalf of the Crown Estate seeking confirmation.

Argyll and Bute Council - Planning Permission: All proposed works at Lochaline would be subject to a Planning Application and to Argyll and Bute council planners. Should the proposed building be constructed this will be subject to a building warrant and discharge consents may also be required for the foul water system. Further guidance will be sought at an early stage from the planning department once a proposed scheme has been agreed.

5.10.2 Operational

During construction of the new ferry berthing facility the disruption to ferry movement is to be minimised. A closure period of 2 – 4 weeks is anticipated for piling works at the toe of the slipway.

5.10.3 Social

TBC

6 GENERAL DESIGN CRITERIA

6.1 Design Life

Generally all marine structures shall have a design working life of 50 years

Where the design working life of a structure is the assumed period for which a structure or part of it is to be used for its intended purpose with anticipated maintenance but without major repair being necessary.

Components of the structure where this design working life cannot be realistically achieved shall be designed to be replaceable.

Table 6-1: Design Working Life

Element	Design Working Life	Maintenance Interval
Marine Structures - Concrete	50 years	None
Marine Structures – Steel Piling	50 years	None
Structural Steelwork (other than piling)	50 years	None
Steelwork (handrailing, ladders, etc.)	25 years	10 years
Bollards	50 years	None
Fenders	25 years	10 years
Cathodic Protection	25 years	10 years

6.2 Design Conditions

6.2.1 Operational Design Conditions

Operational conditions adopted for design are:

- Water levels in the range MHWS to MLWS
- Environmental actions with return period of 1 year or that impose restrictions on port operations
- Normal berthing operations

6.2.2 Extreme Design Conditions

Extreme conditions adopted for design are:

- Water levels in the range HAT to LAT
- Environmental actions with return period equal to the design life of the structure
- Abnormal berthing operations

6.3 Design Water Level

6.3.1 Design High Water Level

The design high water levels adopted for design shall comprise a combination of high tide level positive surge and sea level rise over the design life of the facility:

The design high water levels elevation adopted for design are:

Table 6-2: Design High Water Levels

	Operational Condition (mCD)	Extreme Condition (mCD)
Tide Condition	MHWS	HAT
Tide Level	+4.5	+5.1
Positive Surge	TBC	TBC
Sea Level Rise	+0.132	+0.132
Design Water Level	TBC	TBC

6.3.2 Design Low Water Level

The design low water levels adopted for design shall comprise a combination of low tide level and negative surge:

The design low water levels elevation adopted for design are:

Table 6-3: Design High Water Levels

	Operational Condition (mCD)	Extreme Condition (mCD)
Tide Condition	MLWS	LAT
Tide Level	+0.7	+0.0
Negative Surge	TBC	TBC
Design Water Level	TBC	TBC

6.4 Fendering

The fendering system shall allow for the safe berthing of the above design vessels over the range of design water levels. Fender sizing and spacing will be undertaken in accordance with the recommendations of BS6349-4.

As per Client requirements (related to standardisation across their facilities) the fender element type will be MV type by Trelleborg. Fendering facilities for leisure craft on the harbour side will not be designed as part of this scope of work.

6.5 Design Vessel Parameters

The various design vessels have been grouped based on similar parameters (sister ships).

Parameter	Loch Fyne / Loch Dunvegan	Loch Alainn	Loch Tarbert	Lochinavar / Catriona
Deadweight (t) DWT	224	119	72	135
Displacement (t) Disp.	724	559*	305	570*
Length Overall (m) LOA	73.80	43.54	34.50	43.50
Length Between Perpendiculars (m) LBP	49.50	37.20	29.54	39.99
Beam (m) B	13.00	13.40	10.00	12.20
Draught (m) D	1.64	1.75	1.65	1.70
Depth (m) H	3.00	3.00	2.70	3.00

Parameter	Hallaig	Loch Linnhe / Loch Ranza	Loch Bhrusda
Deadweight (t) DWT	200	65	80
Displacement (t) Disp.	562	287	330*
Length Overall (m) LOA	43.50	35.74	35.40
Length Between Perpendiculars (m) LBP	39.99	30.21	33.00
Beam (m) B	12.20	10.00	10.40
Draught (m) D	1.70	1.55	1.40
Depth (m) H	3.00	2.62	2.50

NOTE:

**Estimated based on known parameters and block coefficients of the other design vessels.*

Leisure craft using the harbour side of the berthing structure are not considered to represent significant loading on the structure and are not considered in the design.

6.6 Mooring

The operator has confirmed that the existing provisions for mooring are adequate. Therefore mooring facilities (position and capacity) as per the existing structure shall be provided to the new berthing structure.

7 MARINE STRUCTURE DESIGN CRITERIA

7.1 General / Function

The new structure comprises a set of parallel sheet pile walls extending out over the extents of the existing berth structure. This solid pier structure will provide a berthing face for the ferry as it positions itself at the slipway.

The existing outer dolphin and the end of the new berthing structure will be used to moor the ferry overnight. The existing walkway structure to the outer dolphin is to be incorporated into the new berth structure.

The harbour side of the structure shall be used to provide a local amenity for leisure craft and power units will be installed to the deck of the structure for the provision of electrical power to these vessels.

7.2 Requirements

7.2.1 Structure Elevation

The elevation of the new berthing structure shall be determined based on design water levels and wave heights to minimise overtopping of the structure during operational periods.

7.2.2 Furniture

Anticipated deck furniture comprises:

- Handrailing
- Mooring facilities
- Small vessel power units
- Lighting columns
- Navigation light
- Lifebuoys

7.2.3 Services

Anticipated services to be incorporated along the structure comprises:

- Electrical services to feed the power units, lighting columns and navigational lights;
- Water supply for use by ferry;
- Hybrid ferry shore power pedestal.

7.2.4 Drainage

Drainage of the berthing structure shall be provided by drainage falls to discharge rainfall directly into the watercourse.

7.3 Loadings

The development of the berth structure shall make consideration of, but not be limited to, the following loads:

- Selfweight
- Ground Loads / Earth Pressures
- Superimposed Dead Loads
- Vehicle Loads
- Pedestrian Loads
- Berthing Loads
- Mooring Loads
- Hydrostatic Loads
- Wind Loads
- Wave Loads
- Current Loads
- Temperature Loads
- Construction Loads

7.3.1 Selfweight

Selfweight loads shall be calculated in accordance with BS EN 1991-1:2000, taking into account buoyancy effects where applicable.

7.3.2 Ground Loads / Earth Pressure

Earth pressures acting on the wall structure as a result of the retained fill material will be considered in accordance with appropriate standards and guidance.

7.3.3 Superimposed Dead Loads

Superimposed dead loads such as paving/surfacing, fenders assemblies, handrailing, lighting columns, mooring equipment will be considered and applied in design as considered appropriate.

7.3.4 Vehicle Loads

Uniform live load allowance of 10kN/m2 to include for access and maintenance along the berth structure.

7.3.5 Pedestrian Loads

Uniform live load allowance of 5kN/m2 to include for pedestrian access along the berth structure.

7.3.6 Berthing Loads

Berthing loads resulting from vessel contact with the structure, applied through the fendering system, will be calculated in accordance with the recommendations of BS6349-4. See 6.5 for Design Vessels.

7.3.7 Mooring Loads

Mooring loads to be equivalent to the mooring element capacity applied in all relevant directions will be calculated in accordance with the recommendations of BS6349-4. See 6.5 for Design Vessels.

7.3.8 Hydrostatic Loads

Hydrostatic loading resulting from tidal lag between water levels in front of and behind the wall structure will be taken into account in accordance with relevant standards and guidance.

Hydrostatic uplift acting on the submerged part of the structure will be taken into account in the design.

7.3.9 Wind Loads

Wind loads acting on the structure to be calculated in accordance with BS EN 1991-1-4.

7.3.10 Wave Loads

Wave loads acting on the structure to be calculated in accordance with BS6349-1.

7.3.11 Current Loads

Current loads acting on the structure to be calculated in accordance with BS6349-1.

7.3.12 Temperature Loads

Thermal loads acting on the structure to be calculated in accordance with BS EN 1991-1-5.

7.3.13 Construction Loads

Uniform live load allowance of 20kN/m2 to include for construction plant and equipment along the berth structure.

7.4 Load Combinations

Load combinations shall be developed in accordance with BS6349-2 utilising appropriate partial and combination factors.

8 DURABILITY OF CONSTRUCTION MATERIALS

8.1 Corrosion Rates

Corrosion rates shall be considered in accordance with the recommendations of BS EN 1993-5 and NA to BS EN 1993-5.

8.2 Reinforced Concrete

Description			Source of Data
The specified concrete cover to reinforcement in in-situ and precast concrete will be as follows:			
Reinforced Concrete			
Exposed face (in-situ)	75mm		
Precast Unit internal face	50mm		
Precast Unit external face	65mm		Table 7.1 of BS EN 1992-1-1:2004
Crack width at nominal cover for in-situ and precast concrete		0.3mm	
Structural concrete will have a minimum strength class of:			
• Precast and In-situ concrete	C32/40		
Reinforcement Grade will be 500B with characteristic yield strength of 500MPa.			BS EN 1992-1-1
The exposure condition for structural concrete shall be taken as XS3 in table A13 of BS 8500-1.			
Surface finish to the Pier and Pier Approach deck concrete will be transverse brush finish with the exception of the cope units which are formed or a float finish			Table 4.1 of EN1992-1

8.3 Structural Steelwork

Description	Source of Data
All steel tubular piles and fender steelwork will be unpainted.	
Sacrificial thickness to mitigate environmental corrosion will be based upon the corrosion rates of 0.075mm / year = 3.75mm for 50 years in splash and low tide zones.	NA BS EN 1993-5:2007, NA.4 Table NA.1
Cathodic protection using sacrificial anodes will be provided to protect all steelwork below mid tide level against MIC	
No allowance will be made for internal corrosion. Piles and structural steel grade will be S355 or equivalent. All fender piles will be filled with concrete.	

8.4 Protective Systems

Consideration will be given to protection systems for steelwork elements as necessary.

8.4.1 Corrosion Allowances

Sacrificial corrosion allowances to steelwork will be provided where alternate protection systems are not specified.

8.4.2 Protective Coatings

Protective coatings shall be considered as appropriate.

8.4.3 Cathodic Protection

A sacrificial anode cathodic protection system shall be specified for all steelwork directly exposed to sea water in the low water region to protect against ALWC/MIC.

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