# Steensby Inlet Marine Structures

# Ore Dock Design Criteria

# Mary River Project

| | | | | | | |
|---|---|---|---|---|---|---|
| 21-Nov-2011 | F | Approved for Use-FEL3 Report | V. Lake | R. MacCrimmon | S. Perry | |
| 09-Nov-2011 | E | Approved for Use-Environment Permit | R. MacCrimmon | K. Skebo | J. Casson | |
| 22-Sept-2011 | D | Internal/Client Review | R. MacCrimmon | K. Skebo | J. Casson | |
| 09-Sep-2011 | C | Internal/Client Review | R. MacCrimmon | K. Skebo | J. Casson | |
| 22-Jul-2011 | B | Client Review | R. MacCrimmon | K. Skebo | J. Casson | |
| 06-Jul-2011 | A | Draft | R. MacCrimmon | K. Skebo | J. Casson | |
| DATE | REV. | STATUS | PREPARED BY | CHECKED BY | APPROVED BY | APPROVED BY |
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# 1. Introduction

Baffinland Iron Mines (BIM) plans to ship up to 18 million tonnes of iron ore per year from a new port at Steensby Inlet, Baffin island, Canada. The shipping operation will be year round, using ice breaking ore carriers.

The new port may require several marine structures:

- An ore loading dock which will be located at South location (also known as the Aker location)
- A link from the mainland to Steensby Island that will consist of a causeway
- A freight dock
- One or more floating construction docks.

The purpose of this document is to provide designers with information that is required for design of the ore dock. Refer to other design criteria documents for the other marine structures.

This document will be updated periodically as additional investigation becomes available.

*Note:* At time of the revision of this document:

- the ore dock will be at the south location which requires no approach trestle
- from trade-off studies, two shiploaders will be installed.

# 2. Project Objectives

The key objectives for this project are:

- provide a new ore dock to load iron ore on to Cape size bulk carriers up to 190,000 DWT year round, at a rate of up to 15,000 t/hr
- accommodate vessels as small as approximately 55,000 DWT
- provide designs that are appropriate for challenging arctic conditions
- at the end of the project life all components of the ore dock with the exception of rock fill must be removable.

# 3. Ore Dock Layout

In accordance with preliminary evaluations:

## 3.1 Dock Length

The dock length is approximately 390 m. This allows for a ship of up to 310 m long to be loaded at the dock without having to be warped during the loading operations.

## 3.2 Dock Width

To accommodate the ship loading equipment and for stability, the deck will be approximately 25 m wide.

## 3.3 Dock Elevation

Pending further study of effects of waves and ice, the surface of the dock will be at elevation 12 m Chart Datum (9.060 m CGD). For more information about clearance for ice pile-up, refer to H337697-3100-12-220-0001.

## 3.4 Water Depth

The minimum water depth is set at 23.0 m chart datum. This allows for a ship with 20 m of draft to dock at low water levels while keeping a minimum gap under the ship keel.

## 3.5 Deck Surface

The deck surface will be solid and suitable for maintenance equipment loads.

## 3.6 Ship Loader

Two new linear non-slewing ship loaders will be provided.

## 3.7 Conveyor

A conveyor system will be extended from the ore storage area to the dock. At the time of this revision, the conveyor will be located east of the dock, on its own foundations.

## 3.8 Ship Services and Access

- An access road will be provided along the conveyor route.
- There will be no provision for fresh water and fire protection lines for ship services.
- There will be no provision for sewage removal or fuelling of ships.
- There will be no service buildings on the dock.
- Access to ships will be via ship's ladders. There will be no specific provision in the design of the dock.

- Ladders will be provided on the dock face in accordance with Canadian regulations and industry practice (at least every 60 m).

## 3.9 Spill Protection

No specific measures for spill protection into the water during loading operations will be provided in the design; see the cost estimates by others for drains and treatment.

## 3.10 Lighting

Lighting will be provided on the dock; see the cost estimates by others.

## 3.11 Provision for Expansion

No specific provision will be made for future expansion or for dredging to increase the available draft. If possible, the orientation will be such that an extension to the north is possible.

## 3.12 Provision for Removal

At the end of the project life it must be possible to remove this facility with the exception of rock fill.

# 4. Design Proposal

## 4.1 Dock Structure

The proposed structure for the dock will be a form of gravity structure, open face or closed face. Docking will be only at one face.

### *4.1.1 Options*

At the time of this revision, the proposed structure for the ore dock reflects the designs of the Marine Partners. Both options include floating-in concrete caissons which will be sunk to rest on a mattress of crushed rock. The ore dock can be either open faced with supported spans or closed faced.

The solid face option includes concrete caissons for the full length of the dock, filled with rock.

The open face dock includes a series of concrete caissons (filled with material) supporting steel deck spans.

## 4.2 Berthing

In Canada, there is no legislated Standard for design of docking facilities. Current practice is reflected in publications such as “Port Designers Handbook”, 2003, by C. Thoresen, publications listed in Section 5, and literature by reputable berthing and mooring equipment manufacturers. In the absence of other information, these references will form the basis of the recommendations contained herein.

Docking of the ships will be assisted by ice management vessels (IMV) and tugs. Pending further study, it is recommended that docking velocity be assumed to be 150 mm/s for the larger ships. For further information, refer to Document Number H337697-3100-12-124-0006, Ice Management Study.

A fendering system for protection of the dock and ships’ hulls will be provided. The fenders nearest the ends of the dock may have to be sized for additional abnormal docking energy due to its vulnerability.

Fenders will be installed on the dock face at an appropriate height and spacing. Considerations will include the range of ships and risk of damage due to ice.

### *4.2.1 Vessel Laser Docking System*

A berthing aid system will be provided complete with dock mounted display boards.

## 4.3 Mooring

The reference for mooring arrangement and devices will be as for docking. At intervals along the docks length, bollards and 100 tonne quick release mooring hooks (QRMH) complete with capstans will be provided as required for bow, spring and stern lines. A combination of spring lines and breast lines will be provided for adequate mooring of long ships.

## 4.4 Permanent Ice Reducing Bubble System

A permanent bubble system for will be installed at the dock face in an effort to extend the summer operating season.

## 4.5 Drainage

The deck will be sloped to drains; see the cost estimates by others for drains and treatment.

## 4.6 Sound Control

Refer to Environmental Impact Study (EIS).

## 4.7 Marine Siltation Control

Adequate measures for construction of all components of the dock will be taken to minimize turbidity effects such as the use of a siltation curtain placed from surface to harbour bottom.

## 4.8 Attenuation of Marine Noise / Vibration

Not applicable

# 5. Design Criteria

The following design criteria will be followed for the design and construction of the dock.

## 5.1 Codes and Standards

Codes and Standards will include:

- National Building Code of Canada 2005 (NBCC)
- CAN / CSA-S6-06: Canadian Highway Bridge Design Code (S6)
- CSA A23.3-04: Design of Concrete Structures (A23.3)
- CSA S-16-1: Design of Steel Structures (S16)
- The Canadian Geotechnical Manual
- Canada Labour Code, Maritime Occupational Health and Safety Regulations.

*Note:* Design and construction of docks is not explicitly covered by any Canadian Standard. The proposed dock structural arrangement is more like a bridge than a building. The designers must use judgment and follow accepted practice for similar structures. Therefore the Codes and Standards listed above will be referenced only as deemed appropriate by the designers. Reference will be made to current publications such as "Port Designer's Handbook" previously referenced, and "Port Engineering", 2004, by G. P. Tsinker.

The return period for earthquakes in the NBCC has been changed from 1 in 500 years in former editions to 1 in 2,500 years. Associated design parameters that are necessary for design of wharves have not been adjusted accordingly, therefore CAN/CSA-S6 will be used which provides values for the 1 in 500 year seismic event, commonly used for design of these structures throughout North America:

## 5.2 Datum

Canadian Geodetic Datum (CGDV28) 0.0 has been calculated to be 2.94 m above Chart Datum (CD) 0.0.

## 5.3 Units

The SI (metric) system will be used. Important dimensions may also be shown in Imperial Units.

## 5.4 Climatic Data

Taken from Aker Kvaerner DFS, Appendix A unless noted otherwise.

### *5.4.1 Temperature*

- Minimum temperature: -50 °C
- Maximum temperature: +21 °C

### 5.4.2 Rainfall

- Maximum (1 in 10 yrs) 15 minutes rainfall: 4 mm
- Maximum (1 in 30 yrs) 24 hours rainfall: 45 mm
- Total annual precipitation: 251 mm

### 5.4.3 Snow

- Ss: 1.7 kPa
- Sr: 0.2 kPa

### 5.4.4 Ice

- Thickness (level ice): 2 m

### 5.4.5 Ice Accretion

Taken from CAN/CSA S6:

- 12 mm

### 5.4.6 Wind

Hourly wind pressure:

- 1/10 probability of exceeding in a year: undefined
- 1/50 probability of exceeding in a year: 0.66 kPa

### 5.4.7 Earthquake

Taken from CAN/CSA S6:

- Peak Ground Acceleration, 500 years return period: 0.08
- V: 0.10
- Za: 2
- Zv: 2

### 5.4.8 Water Characteristics, Steensby Inlet

- Water: saline
- Tides: yes, semi-diurnal
- Higher High Water Large Tide (HHWLT): +4.78 m CD
- High tide: +4.3 m CD (estimated from 33 days of recorded data)

- Mean sea level +2.26 m CD
- Low tide: +0.2 m CD (estimated from 33 days of recorded data)
- Lower Low Water Large Tide (LLWLT): 0.0 m CD
- Current: predominantly tidal, see separate report H337697-3100-12-124-0002
- Waves: see separate report H337697-3100-12-124-0003

## 5.5 Geotechnical Parameters

### *5.5.1 Site Conditions*

Geotechnical conditions as of the time of issue of this report are contained in Thurber Reports:

- Mary River Project, Steensby Inlet and Milne Inlet Port Offshore Geotechnical Investigation Summary of Results , File 19-1605-126, November 9, 2011;
- Mary River Project, Initial Geotechnical Recommendations Offshore Structures at Port Steensby, File 19-1605-126, November 11, 2011.

### *5.5.2 Friction Factors*

The following friction factors will be used (to be confirmed):

- Concrete caisson on crushed stone mattress: 0.5
- Steel caisson on crushed stone mattress: 0.3
- Crushed stone mattress on excavated rock: 0.5
- Crushed stone mattress on unexcavated rock: 0.5

### *5.5.3 Slope Protection Criteria*

Refer to H337697-3100-12-124-0007.

## 5.6 Design Ships

The ranges of design vessels considered as a basis for the design of the dock can be seen in Table 5-1.

**Table 5-1: Design Vessel Characteristics**

| | Conventional Ore Carrier | Double Acting Ship (DAS) | Market Vessel |
|---|---|---|---|
| **Vessel Classification** | **Cape Size** | **Cape Size** | **Panamax** |
| **Deadweight tonne (DWT)** | 190,000 | 155,000 | 55,000 |
| **Length overall (m)** | 330 | 290 | 190 |
| **Width (m)** | 52 | 45 | 32.3 |
| **Loaded Draft (m)** | 20 | 17.8 | 12.5 |
| **Loaded Freeboard (m)** | 7.0 | 6.5 | 6.0 |
| **Berthing Velocity (m/s)** | 0.15 | 0.15 | 0.15 |
| **Safety Factor** | 1.25 | 1.50 | 1.75 |

In Winter, Ore Carriers are assumed to arrive at the dock with full ballast at full 20 m draft displacing about 250,000 tonnes.

In Summer, Ore Carriers are assumed to arrive with about 1/3 ballast capacity and displacing about 110,000 tonnes with mean draft of about 9 m.

It is assumed that the distance from the water side rail of the shiploader to the front face of the fenders is approximately 9 to 10 m.

## 5.7 Design Loads

All loads are unfactored unless otherwise noted.

### *5.7.1 Dead Loads*

- Reinforced concrete density: 24 kN/m$^3$
- Steel density: 77 kN/m$^3$

### *5.7.2 Shiploader Loads*

- Unfactored dead weight: approximately 800 t each shiploader, excluding tripper (to be confirmed upon final selection of shiploader)
- Wheel loads: refer to Appendix A

### *5.7.3 Conveyor Loads*

If the conveyor is supported on the dock, the load is as follows:

- Unfactored dead weight : approximately 12 t/m (to be confirmed)

### 5.7.4 Tripper

The tripper will run behind the conveyor, which could be supported on the backside of dock, the load is as follows:

- Unfactored dead weight : approximately 100 t (to be confirmed)

### 5.7.5 Stockpile Loads

Not applicable

### 5.7.6 Accidental Ore Spills

The following accidental loads shall be considered:

- Emptying of dock conveyor: 400 t, assume 4.3 m high x 9.1 m diameter pile of ore (see Figure 5-1)
- Accidental lifting of boom: 37 t, assume 0.5 m high x 1 m diameter pile of ore (see Figure 5-2)

*Note:* These loads will not occur with an operating shiploader or the surcharge load.

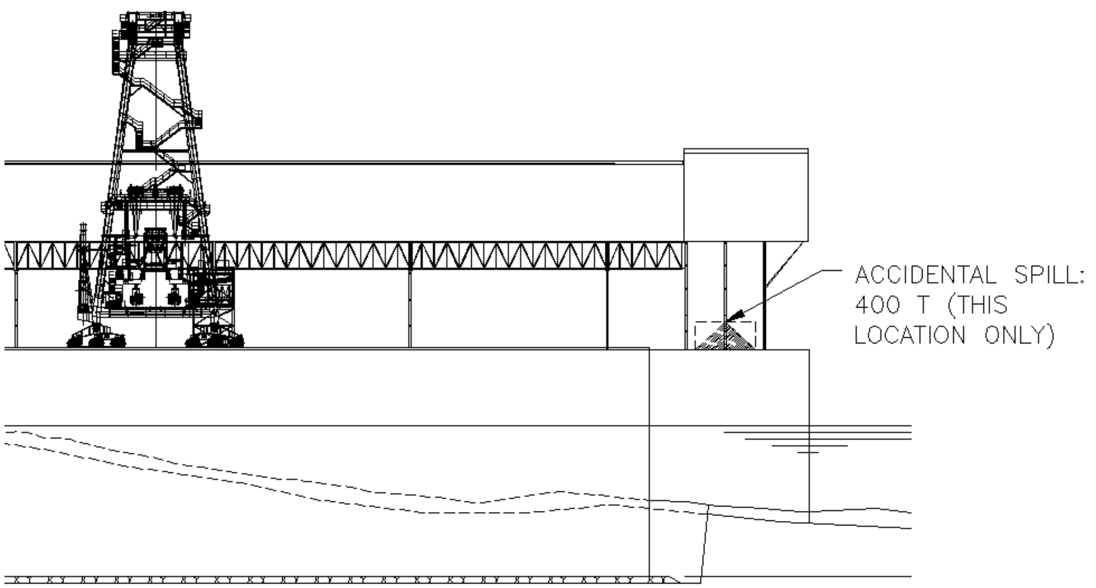


**Figure 5-1: Accidental Ore Spill at end of Conveyor**

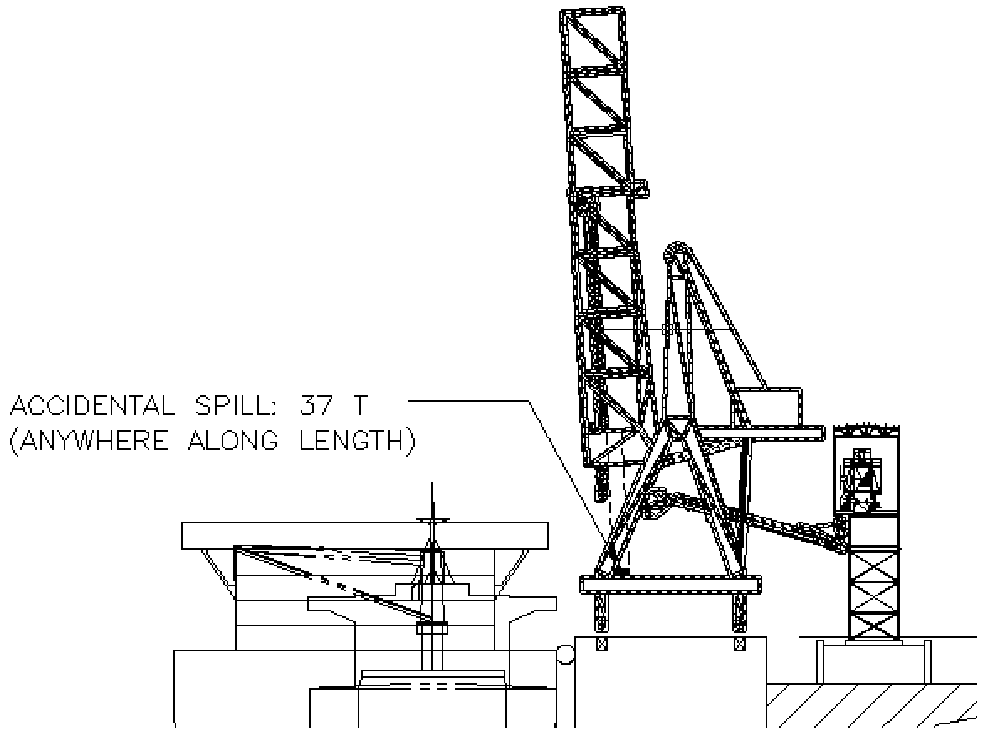


**Figure 5-2: Accidental Ore Spill from Boom**

### 5.7.7 *Surcharge Load*

A surcharge of 25 kPa on the deck shall be considered.

This load shall not be combined with an operating shiploader or an accidental ore spill.

### 5.7.8 *Crane Load*

- 200 t capacity rubber tired mobile crane, outrigger load: 1,200 kN

### 5.7.9 *Berthing Forces*

- Refer to vessel properties in Section 5.6
- Docking speed for Conventional Ore Carrier and DAS ship approaching at 5 degrees: 0.15 m/s
- Docking speed for market vessel approaching at 10 degrees: 0.15 m/s
- Sixth-point berthing for the Conventional Ore Carrier;
- Fifth-point berthing for the DAS and Market vessels;
- Kinetic energy to be absorbed by dock and fenders: Refer to H337697-3100-12-124-0006.

### 5.7.10 Mooring Forces

- Forces on dock: 60 kN/m perpendicular to the dock and 40 kN/m parallel to the dock
- Tying forces: 150 tonnes per QRMH
- Refer to Refer to H337697-3100-12-124-0006.

### 5.7.11 Ice Loads

Refer to H337697-3100-12-124-0004.

## 5.8 Load Combinations

See Appendix B.

## 5.9 Deflection

Deflection if suspended spans under normal operating loads will be limited to L/800 or 50 mm, whichever is less.

## 5.10 Life Expectancy

- All components of the dock extension will be designed for a life expectancy of 25 years.

## 5.11 Erosion / Scour Protection

Ships equipped with powerful engines and bow thrusters can cause severe erosion. Parameters for design can be seen in Table 5-2.

As part of the design, mitigating measures such as mattress protection or assumed loss of support to the caissons will be required.

Refer to H337697-3100-12-124-0005.

**Table 5-2: Vessel Parameters for Scour Protection**

| Name | Conventional Ore Carrier | DAS | Ice Breaker |
|---|---|---|---|
| **Number of propellers** | 2 | 2 azipods | 2 azipods |
| **Number of rudders** | 1 for each | 0 | 0 |
| **Power** | 2 x 32 MW | 2 x 13 MW | 2 x 8 MW |
| **Propeller diameter (mm)** | 7400 | 5600 | 5000 |
| **Assumed elevation of propeller shaft above keel (m)** | 5 | 5 | 3 |
| **Type Propeller** | free or non-ducted | free or non-ducted | free or non-ducted |
| **Loaded Draft (m)** | 20 | 17.8 | 6.5 |

## 5.12 Steel Corrosion

- The water is sea water.
- The unprotected corrosion rate is expected to be in the order of 0.1 mm per year.
- The minimum thickness of exposed steel will be 8 mm.
- The cathodic protection will be provided where necessary.
- Reinforcing steel will be protected by proper cover and good construction practice.

## 5.13 Concrete Deterioration

Likely causes of damage and deterioration of concrete in the marine environment are:

- Poor quality concrete
- Improper placing procedures
- Inadequate cover to reinforcing steel
- Inadequate surface drainage.

Measures will be incorporated into the construction documents to address these issues.

In accordance with the recommendations of A23.1-09, Clause 4.1.1.5, Sea Water Conditions, pending further study, concrete will be classified C-1, minimum strength 35 MPa within 28 days in accordance with Table 2.

Minimum reinforcing steel cover will be in accordance with A23.1; except as follows:

- 100 mm cover will be provided at the berthing face

## 5.14 Technical Specifications

Refer to H337697-3220-12-123-0001 for Ore Dock Specifications.

## 5.15 Construction Procedures

To be considered as it may affect the design:

- Site preparation: blasting/excavation along shore line;
- Dredging: dredging of unsuitable material and dredged material placement on land or by sidecasting – to confirmed;
- Concrete caissons: can be shipped or floated in from a remote casting site. Contractor will be responsible for stability of the caissons while afloat and until filled;
- Schedule: Summer open water construction period from mid July to mid October.

# Appendix A:
# Ship Loader Wheel Loads

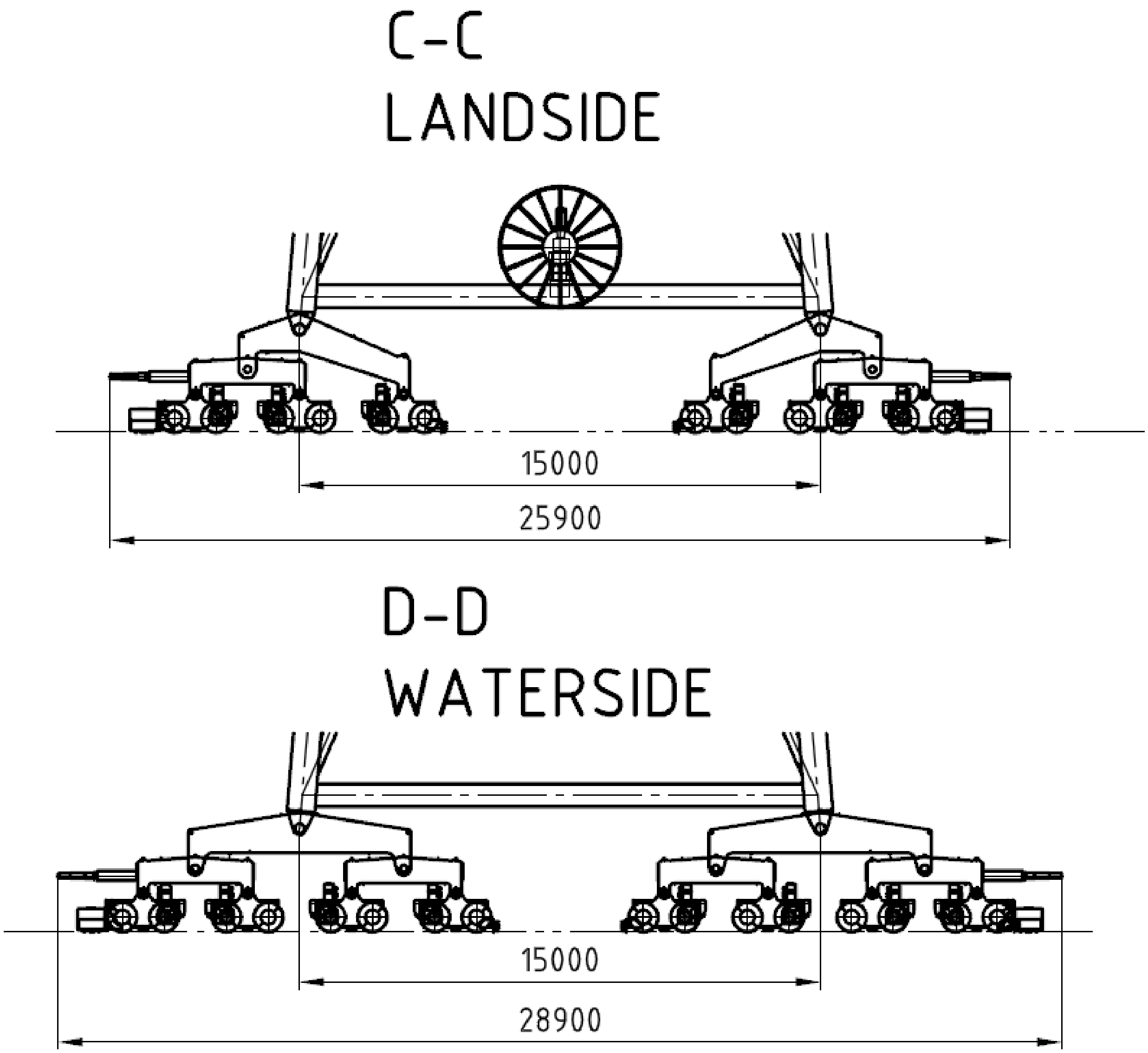


**Figure A-1: Elevation of Wheel Layout of Single Shiploader – assume minimum distance between 2 shiploaders is 2500 (Dimensions in mm) – to be confirmed**

**Table A-1: Shiploader Data - to be confirmed**

| | | |
|---|---|---|
| Wheelload Waterside in Oper. max. | 541 | kN |
| Wheelload Landside in Oper. max. | 229 | kN |
| Service weight Shiploader | appr. 768 | t |
| Service weight Tripper car | appr. 99 | t |

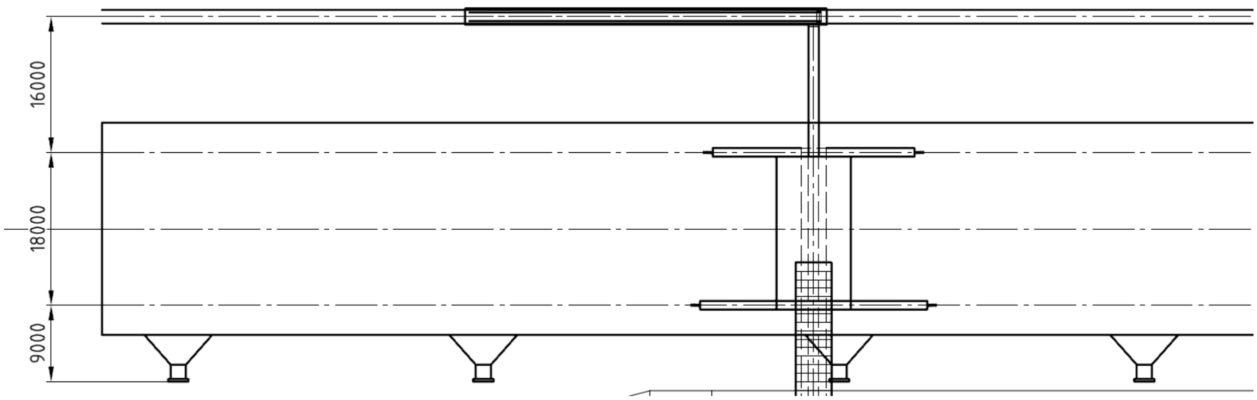


**Figure A-2: Plan of Single Shiploader (Dimensions in mm)**

# Appendix B:
# Load Combination Tables

## Table B-1: Load Combinations, Allowable Stresses and Load Factors for Wharves Limit States Design

| Load Type | Load Combinations - Limit State Design | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oper 1 | Oper 2 | Oper 3 | Oper 4 | Spill 1 | Storm 1 | Storm 2 | ShpLd Extr* | EQ 1 | EQ 2 | Extr. Moor 1 | Extr. Moor 2 | Extr. Berth 1 | Extr. Berth 2 |
| Dead Load | 1.2 | 1.2 | 1.2 | 0.9 | 1.2 | 1.2 | 0.9 | 1.2 | 1.2 | 0.9 | 1.2 | 0.9 | 1.2 | 0.9 |
| Dead Load (Shiploader) (single or multiple)** | oper $SL_i$ | oper $SL_i$ | oper $SL_i$ | lgt $SL_i$ | lgt $SL_i$ | strm $SL_i$ | lgt $SL_i$ | extr $SL_i$ | EQ $SL_i$ | EQ $SL_i$ | oper $SL_i$ | lgt $SL_i$ | oper $SL_i$ | lgt $SL_i$ |
| Live Load: Truck OR Lane Load on deck | 1.75 | 0 | 0 | 0 | 1 | 1 | 0 | 1.75 | 1 | 0 | 1 | 0 | 1 | 0 |
| Live Load: Crane operating OR outrigger loads | 0 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Live Load: Surcharge | 0 | 0 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Conveyor Live Loads (Phase 1 and/or Phase 2) | 1.6 | 1.6 | 1.6 | 0 | 0 | 1 | 0 | 1.6 | 1 | 0 | 1.2[$] | 0 | 1.2[$] | 0 |
| Accidental Ore Spill (governing) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wind Load (Operational) | 1.6 | 0 | 0 | 1.6 | 1.6 | 0 | 0 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wind Load (Extreme) | 0 | 0 | 0 | 0 | 0 | 1.2[$] | 1.2[$] | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Berthing Load (Normal) | 1.6 | 1.6 | 1.6 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Berthing Load (Extreme) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.2[$] | 1.2[$] |
| Mooring (Operational) | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 0 | 0 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mooring (Extreme) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.2[$] | 1.2[$] | 0 | 0 |
| Earthquake (Contingency Level) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| Waves (Normal) | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 0 | 0 | 1.2 | 0 | 0 | 0 | 0 | 1.2 | 1.2 |
| Waves (Extreme) | 0 | 0 | 0 | 0 | 0 | 1.2 | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Temperature | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Current Loads (Operational) | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 0 | 0 | 1.2 | 0.9 | 0.9 | 1.2 | 1.2 | 1.2 | 1.2 |
| Current Loads (Extreme) | 0 | 0 | 0 | 0 | 0 | 1.2 | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Earth Pressure | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.25 | 1.25 | 1.2 | 1.2 | 1.2 | 1.2 |
| Ice and Snow accretion (governing) | 0 | 0 | 0 | 1.3 | 1.3 | 1.3 | 1.3 | 0 | 0 | 0 | 0 | 1.3 | 0 | 1.3 |
| Buoyancy | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 0 | 0 | 1.3 | 1.3 | 1.3 | 1.3 |
| Ice Impact Forces | 0 | 0 | 0 | 1.3 | 0 | 1.3 | 1.3 | 0 | 1.3 | 1.3 | 0 | 1.3 | 0 | 1.3 |

| | |
|---|---|
| Temperature Loads = | Loads due to temperature, creep, and shrinkage |
| Live Load (Truck/Lane Load on Deck) = | Uniform live load |
| Live Load (Crane) (Operating/Outrigger Loads) = | Concentrated live load |
| Mooring = | Mooring loads, current loads on ship and wind loads on ship |
| Dead Load (Shiploader) (single or multiple) = | Where $SL_i$ is anyone of the shiploader combinations $SL_1$ to $SL_3$ (see Table 1) |
| Extreme load Combinations = | Worst case scenario combinations when the loads are exerted on the structure |

*In the case Shiploader Extreme, impact on the endstops to be considered

** Assuming that the shiploader manufacturer provides vertical, horizontal and impact/braking loads for shiploader

[$] Assuming that the extreme loads are known, the load factors can be 1.2, else a factor of 1.6 should be used

## Table B-2: Load Combinations, Allowable Stresses and Load Factors for Wharves
## Allowable Stress, Serviceability and Geotechnical Design

| Load Type | Load Combination - Working Stress Design | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oper 1 | Oper 2 | Oper 3 | Oper 4 | Spill 1 | Storm 1 | Storm 2 | ShpLd Extr* | EQ 1 | EQ 2 | Extr. Moor 1 | Extr. Moor 2 | Extr. Berth 1 | Extr. Berth 2 |
| Dead Load | 1 | 1 | 1 | 0.8 | 1 | 1 | 0.8 | 1 | 1 | 0.8 | 1 | 0.8 | 1 | 0.8 |
| Dead Load (Shiploader) (single or multiple)** | $SL_i$ oper | $SL_i$ oper | $SL_i$ oper | $SL_i$ lgt | $SL_i$ lgt | $SL_i$ strm | $SL_i$ lgt | $SL_i$ extr | $SL_i$ EQ | $SL_i$ EQ | $SL_i$ oper | $SL_i$ lgt | $SL_i$ oper | $SL_i$ lgt |
| Live Load: Truck OR Lane Load on deck | 1 | 0 | 0 | 0 | 0 | 0.5 | 0 | 1 | 1 | 0 | 0.5 | 0 | 0.5 | 0 |
| Live Load: Crane operating OR outrigger loads | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Live Load: Surcharge | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Conveyor Live Loads (Phase 1 and/or Phase 2) | 1 | 1 | 1 | 0 | 0 | 0.5 | 0 | 1 | 0.5 | 0 | 1 | 0 | 1 | 0 |
| Accidental Ore Spill (governing) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wind Load (Operational) | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wind Load (Extreme) | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Berthing Load (Normal) | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Berthing Load (Extreme) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.8 | 1 |
| Mooring (Operational) | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mooring (Extreme) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| Earthquake (Contingency Level) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| Waves (Normal) | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| Waves (Extreme) | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Temperature | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Current Loads (Operational) | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0.8 | 0.8 | 1 | 1 | 1 | 1 |
| Current Loads (Extreme) | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Earth Pressure | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ice and Snow accretion (Governing) | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Buoyancy | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0 | 0 | 0.8 | 0.8 | 0.8 | 0.8 |
| Ice Impact Forces | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |

| | |
|---|---|
| Temperature Loads = | Loads due to temperature, creep, and shrinkage |
| Live Load (Truck/Lane Load on Deck) = | Uniform live load |
| Live Load (Crane) (Operating/Outrigger Loads) = | Concentrated live load |
| Mooring = | Mooring loads, current loads on ship and wind loads on ship |
| Dead Load (Shiploader) (single or multiple) = | Where $SL_i$ is anyone of the shiploader combinations $SL_1$ to $SL_3$ (See Table 1) |

*In the case Shiploader Extreme, impact on the endstops to be considered

** Assuming that the shiploader manufacturer provides vertical, horizontal and impact/braking loads for shiploader

**Table B- 3: Load Combinations for Shiploaders, to be Used in Combination with Other Tables**

| | Table 1: Shiploader Load Combinations | | |
|---|---|---|---|
| | $SL_i$ | | |
| | $SL_1$ | $SL_2$ | $SL_3$ |
| $SL_{vs}$ | 1 | 0 | 1 |
| $SL_{vm}$ | 0 | 1 | 0 |
| $SL_{ss}$ | 1 | 0 | 0 |
| $SL_{sm}$ | 0 | 1 | 0 |
| $SL_{is}$ | 1 | 0 | 1 |
| $SL_{im}$ | 0 | 0 | 0 |
| $SL_{ls}$ | 1 | 0 | 0 |
| $SL_{lm}$ | 0 | 1 | 0 |
| $SL_{bs}$ | 0 | 0 | 1 |
| $SL_d$ | 0 | 0 | 0 |
| | Single shiploader on single rail | Two shiploaders in tandem on rails | Bumper impact |

$SL_{vs}$ = vertical load due to a single shiploader
$SL_{vm}$ = vertical load due to multiple shiploaders
$SL_{ss}$ = side thrust due to a single shiploader
$SL_{sm}$ = side thrust due to multiple shiploaders
$SL_{is}$ = impact due to a single shiploader
$SL_{im}$ = impact due to multiple shiploaders
$SL_{ls}$ = longitudinal traction due to a single shiploader in one aisle only
$SL_{lm}$ = longitudinal traction due to multiple shiploaders
$SL_{bs}$ = bumper impact due to a single shiploader
$SL_d$ = dead load of all shiploaders, positioned for maximum seismic effects