CLIENT: City of Vancouver

OWNER: City of Vancouver

PROJECT: Seawall Inspection and Rehabilitation Project

2015 - 2018

Prepared by: Marina Marti Lopez

Engineer / Designer

Reviewed by: Patrick Devlin, CP. Eng.

Marine Structures Group Lead

Approved by: Keith Dunbar, P. Eng.

Project Manager

REVISION INDEX

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Prepared</th>
<th>Reviewed</th>
<th>Approved</th>
<th>Date</th>
<th>Remarks</th>
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<tr>
<td>00</td>
<td>MML</td>
<td>PD</td>
<td>KJD</td>
<td>2016-Dec-02</td>
<td>Final Report</td>
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</table>

Marine and Coastal Structures Design Reference
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1.0 INTRODUCTION

1.1 Background

This Marine and Coastal Structures Design Reference is intended to establish a standardized approach to the design, rehabilitation and construction of waterfront structures for the City of Vancouver.

This Design Reference presents design standards relating to marine and coastal structures in a generalized form only. Application of these guidelines for specific projects, which include new, remediated, upgraded, or transformed waterfront structures, requires qualified engineering professionals to develop site specific designs and facilitate agency approvals.

This Design Reference does not alleviate the Engineer’s responsibility in any way for ensuring the works are designed in accordance with all applicable codes and standards, and constructed in a cost effective and prudent manner, compliant with all applicable Federal, Provincial, and Municipal laws and regulations.

Certain sections of relevant guidelines, codes and standards, including numeric values, are summarized in this Design Reference for convenience. The Engineer shall consult the referenced guideline, code or standard for complete information and to verify the information provided in this Design Reference is in accordance to the latest version in effect at the time of design.

1.2 Scope

This Design Reference is intended to assist the Engineer in the design of Waterfront Structures for the City. Waterfront Structures include both Coastal and Marine Structures, such as seawalls, bulkheads, revetments, coastal dikes, pile-supported decks, wharves and piers. This Design Reference does not specifically address “non-structural” shoreline protection works, such as protective beaches, for which site-specific sediment transport processes govern the design.

1.3 Terms and Definitions

Terms and definitions used throughout this document, and their abbreviations if applicable, are presented in Table 1. Where possible, the definition provided in the reference document is used. The reference document is indicated in brackets next to the definition.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>City of Vancouver</td>
</tr>
<tr>
<td>Coastal Structures</td>
<td>Structures for which coastal guidelines, codes, standards and regulations are most applicable for their design. Such structures include, but are not limited to, revetments and coastal dikes.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Design Reference</td>
<td>This Marine and Coastal Structures Design Reference</td>
</tr>
<tr>
<td>Design Life</td>
<td>Period of time specified by the City during which a structure is intended to remain in service (Ref. [9])</td>
</tr>
<tr>
<td>Engineer</td>
<td>A member or licensee of the Engineering Association who carries out the design, rehabilitation design, or evaluation of a bridge or structure (Ref. [9])</td>
</tr>
<tr>
<td>Flood Construction Level (FCL)</td>
<td>Minimum elevation of the underside of a floor system, or the top of a concrete slab of a building used for habitation, business or storage of goods damageable by flood water (Ref. [4])</td>
</tr>
<tr>
<td>Force-Based Design (FBD)</td>
<td>A design philosophy using minimum lateral earthquake load (Ref. [9])</td>
</tr>
<tr>
<td>High Consequence Dike</td>
<td>Flood protection dike where the economic and/or life safety consequences of failure during a major flood are very high. These dikes typically protect urban or urbanizing areas, and failure could result in large economic losses and/or significant loss of life (Ref. [12])</td>
</tr>
<tr>
<td>Lifeline Bridge</td>
<td>A large, unique, iconic, and/or complex structure that is vital to the integrity of the regional transportation network, the ongoing economy, and the security of the region and represent significant investment and would be time-consuming to repair or replace (Ref. [9])</td>
</tr>
<tr>
<td>Major-Route Bridge</td>
<td>A structure on or over a route that will be required to facilitate post-earthquake emergency response, security and defense purposes, and subsequent economy recovery. These routes are key components of the regional transportation network (Ref. [9])</td>
</tr>
<tr>
<td>Marine Structures</td>
<td>Structures for which structural guidelines, codes, standards and regulations are most applicable for their design. Such structures include, but are not limited to, seawalls, bulkheads, pile-supported decks, wharves and piers.</td>
</tr>
<tr>
<td>Other Bridge</td>
<td>A structure that does not fall into the importance categories of Lifeline or Major-Route Bridges (Ref. [9])</td>
</tr>
<tr>
<td>Performance-Based Design (PFD)</td>
<td>A design philosophy based on meeting specific structural, functional and service performance criteria under specified seismic hazard (Ref. [9])</td>
</tr>
<tr>
<td>Regular Bridge</td>
<td>A bridge as specified in Clause 4.4.5.3.2 of CSA-S6, 2014 (Ref. [9])</td>
</tr>
<tr>
<td>Return Period</td>
<td>The average time in years between the equaling or exceeding of an event. Note that the inverse of the return period is approximately the probability of equaling or exceeding the event in one year (Ref. [9])</td>
</tr>
</tbody>
</table>
Table 1 - Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Level Rise (SLR)</td>
<td>An allowance for increases in the mean elevation of the ocean associated with future climate change, including any regional effects such as crustal subsidence or uplift (Ref. [1])</td>
</tr>
<tr>
<td>Waterfront Structures</td>
<td>Coastal and Marine Structures</td>
</tr>
</tbody>
</table>

1.4 Acronyms

Acronyms used in this document are presented in Table 2 below.

Table 2 - Acronyms

<table>
<thead>
<tr>
<th>Acronyms</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCBC</td>
<td>British Columbia Building Code</td>
</tr>
<tr>
<td>BS</td>
<td>British Standards</td>
</tr>
<tr>
<td>CHS</td>
<td>Canadian Hydrographic Service</td>
</tr>
<tr>
<td>CIRIA; CUR; CETMEF</td>
<td>European agencies sponsoring the “Rock Manual”</td>
</tr>
<tr>
<td>CGSB</td>
<td>Canadian General Standards Board</td>
</tr>
<tr>
<td>CSA</td>
<td>Canadian Standards Association</td>
</tr>
<tr>
<td>DFO</td>
<td>Department of Fisheries and Oceans</td>
</tr>
<tr>
<td>EA; ENW; KFKI</td>
<td>European agencies sponsoring the “EurOtop” Manual</td>
</tr>
<tr>
<td>HHWLT</td>
<td>Higher High Water Large Tide</td>
</tr>
<tr>
<td>HHWMT</td>
<td>Higher High Water Mean Tide</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>LLWLT</td>
<td>Lower Low Water Large Tide</td>
</tr>
<tr>
<td>LLWMT</td>
<td>Lower Low Water Mean Tide</td>
</tr>
<tr>
<td>MWL</td>
<td>Mean Water Level</td>
</tr>
<tr>
<td>NBC</td>
<td>National Building Code of Canada</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>PGA</td>
<td>Peak Ground Acceleration</td>
</tr>
<tr>
<td>PGV</td>
<td>Peak Ground Velocity</td>
</tr>
</tbody>
</table>
### Table 2 - Acronyms

<table>
<thead>
<tr>
<th>Acronyms</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMV</td>
<td>Port Metro Vancouver</td>
</tr>
<tr>
<td>UFC</td>
<td>United Facilities Criteria</td>
</tr>
<tr>
<td>USACE</td>
<td>US Army Corps of Engineers</td>
</tr>
<tr>
<td>VBBL</td>
<td>Vancouver Building By-law</td>
</tr>
</tbody>
</table>

#### 1.5 Reference Documents

The following reference documents were consulted during the preparation of this Design Reference:


7. CHS, Chart 3491: Fraser River - North Arm.

8. CHS, Chart 3493: Vancouver Harbour - Western Portion.


11. Department of Fisheries and Oceans, Fisheries Act.

Several other guidelines, reports and technical studies have been completed by the B.C. Government to assist local governments, land management authorities and engineers on Sea Level Rise adaptation strategies, land use planning and sea dike design. Many of these reference documents are available at the following website:


For more information regarding planning related to Sea Level Rise at the City of Vancouver please visit the following website:


Key City studies include:

- DOC/2015/028166 - Coastal Flood Risk Assessment Phase 1 Report
- DOC/2016/320384 - Coastal Flood Risk Assessment Phase II Report
2.0 DESIGN GUIDELINES, CODES, STANDARDS AND REGULATIONS

2.1 General

The design of Waterfront Structures for the City shall be in accordance with the latest revision of all relevant guidelines, codes, standards and regulations in effect at the time of design.

The design of marine and coastal structures is normally based on the most relevant code or standard to the specific type of structure and function being considered, and is supplemented, as required, by other relevant codes and standards. The Engineer shall be aware that, in some cases, the comparison of reference codes and standards will reveal differences on design methodologies. These differences will need to be taken into consideration during the design process. Where conflicts exist between two or more relevant codes and standards, the more stringent requirements shall prevail.

In the absence of other codes and standards, all work shall conform to or exceed the minimum requirements of the CGSB, the CSA, the NBC, the BCBC, and the VBBL, whichever is applicable. When none of these codes and standards are applicable, the design shall conform to or exceed the minimum requirements of recognized international institutions, such as ISO and BS, or be conducted using internationally established and accepted procedures and methods of analysis approved by the City.

2.2 Coastal

- Codes and Standards
  - BS 6349, Code of Practice for Maritime Structures.
  - City of Vancouver, Flood Plain Standards and Requirements.
  - ISO 21650, Action from Waves and Currents on Coastal Structures.
- Guidelines
  - City of Vancouver, Flood Construction Levels Council Report RTS 10576.
2.3 Structural and Geotechnical

- Codes and Standards
  - British Columbia Building Code.
  - CSA-A23.3, Design of Concrete Structures.
  - CSA-O86, Engineering Design in Wood.
  - CSA-S16, Design of Steel Structures.
  - CSA-S6, Canadian Highway Bridge Design Code.
  - Vancouver Building By-laws.

- Guidelines
  - UFC, Design: Piers and Wharves.
  - City of Vancouver Street Restoration Manual

2.4 Environmental

- Regulations
  - Canadian Environmental Protection Act, 1999.
  - Dike Maintenance Act.
  - Fisheries Act.
  - Navigation Protection Act.
  - Water Act.
  - Wildlife Act.
• Codes and Standards
  - Canadian Standards Association.
  - Occupational Safety and Health Administration.

• Guidelines
  - Fisheries and Oceans Canada, Guidelines to Protect Fish and Fish Habitat from Treated Wood Used in Aquatic Environments in the Pacific Region.
  - Fisheries and Oceans Canada and Ministry of Environment, Lands and Parks, Land Development Guidelines for the Protection of Aquatic Habitat.
  - Transportation Association of Canada, Transportation Construction and Maintenance and the Protection of Fish Habitat.

2.5 Health and Safety

• Regulations
  - BC Worker’s Compensation Act.
  - Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations.

• Standards
  - Canadian Standards Association.
  - Occupational Safety and Health Administration.

2.6 Accessibility

• Standards

• Guidelines
  - Draft Guidelines for Universal Access to New Public Docks in False Creek
3.0 DESIGN METHODOLOGY

3.1 Design Life

The Design Life of a new Waterfront Structure shall be as follows:

- Marine Structures: 50 years.
- Coastal Structures: 75 years.

The Design Life for a repair to an existing Waterfront Structure shall be 10 years, unless otherwise stipulated by the City.

3.2 Design for Durability

The Engineer shall select structural forms, materials and details that ensure the serviceability of the structure during its Design Life. The properties and performance of the selected materials shall be specified while taking into account the design loads and the environmental conditions expected during the Design Life of the structure. The Engineer shall consider the environmental conditions existing, or likely to exist, during the Design Life of the structure, and shall determine potential mechanisms of deterioration of the structure. Site investigations may be required in order to determine the influence of aggressive soils, groundwater, local runoff water, seawater, etc.

Concrete elements shall use cover and mix designs appropriate to the exposure conditions expected. Steel elements shall use suitable corrosion allowance and coating specifications to achieve the intended Design Life. Detailing shall avoid any cracks or crevices, or areas where water and salt can pool / accumulate. Dis-similar metals shall be isolated where necessary to prevent galvanic action. Timber structures shall use treated or untreated materials with sufficient durability to remain in service for the Design Life.

3.3 Design for Seismic Events

3.3.1 Marine Structures

Marine Structures and their components shall be designed to meet seismic requirements in accordance with the Canadian Highway Bridge Design Code and Commentary, for an importance category of Other Bridges and assuming equivalence to a Regular Bridge.
Two different design approaches are recognized within CSA-S6, 2014 (Ref. [9]):

- **Performance-Based Design**: a design philosophy based upon meeting specific structural, functional, and service performance criteria under a specified seismic hazard. Three (3) earthquake Return Periods are to be investigated: 475-year, 975-year and 2475-year. Structures shall meet the minimum performance levels and criteria of Table 4.15 and Table 4.16 of CSA-S6, 2014 (Ref. [9]), respectively. For an importance category equivalent to Other Bridges, the performance levels and general performance criteria to obtain the specified performance levels are summarized in Table 3 below.

<table>
<thead>
<tr>
<th>Probability</th>
<th>Service Level</th>
<th>Service Criteria</th>
<th>Damage Level</th>
<th>Damage Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/475 years or</td>
<td>Service Limited</td>
<td>• Structure shall be usable for emergency traffic, if applicable. • Structure shall be repairable without closure. • If structure damaged, normal service shall be restored within a month.</td>
<td>Repairable</td>
<td>There may be some inelastic behaviour and moderate damage may occur, however, primary members shall not need to be replaced, shall be repairable in place, and shall be capable of supporting the dead load plus full live load.</td>
</tr>
<tr>
<td>10% in 50 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/975 years or</td>
<td>Service Disruption</td>
<td>• Structure shall be usable for restricted emergency traffic after inspection, if applicable. • Structure shall be repairable. • Repairs to restore structure to full service might require closure.</td>
<td>Extensive</td>
<td>Inelastic behaviour is expected. Members may have extensive visible damage, such as spalling of concrete, but strength degradation shall not occur. Members shall be capable of supporting the dead plus 50% the live loads, excluding impact, including P-delta effects, without collapse.</td>
</tr>
<tr>
<td>5% in 50 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2475 years or</td>
<td>Life Safety</td>
<td>• Structure shall not collapse. • Structure shall be possible to evacuate safely.</td>
<td>Probable Replacement</td>
<td>Members shall remain in place but the structure might be unusable and might have to be extensively repaired or replaced. Members shall be capable of supporting dead load plus 30% live loads, excluding impact, but including P-delta effects, without collapse.</td>
</tr>
<tr>
<td>2% in 50 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Force-Based Design**: a design philosophy using a minimum lateral earthquake load based on the 2475-year Return Period seismic event. Force-Based Design is permitted only in certain cases, one of those being Regular Other Bridges. The performance of structures designed with this approach is expected to be consistent with Performance-Based Design at the 2475-year Return Period. The minimum lateral earthquake force for elastic analysis is to be calculated in accordance with Clause 4.4.7.4 of CSA-S6, 2014 (Ref. [9]).
3.3.2 Coastal Structures

Coastal Structures shall be designed in accordance with the Seismic Design Guidelines for Dikes (Ref. [12]), which provide guidelines for seismic stability and integrity of High Consequence Dikes in Southwestern British Columbia and Vancouver Island.

Similarly to seismic design of highway bridges, seismic design of dikes has evolved in recent years to include Performance-Based Design criteria, which investigates the damage associated to different earthquake levels. The Seismic Design Guidelines for Dikes (Ref. [12]) defines three performance categories associated to three earthquake Return Periods: namely 100-year, 475-year and 2475-year. High Consequence Dikes are to meet the requirements shown in Table 2 of the Seismic Design Guidelines (Ref. [12]), which are summarized below in Table 4.

Table 4 - Performance Level and Criteria for Dikes

<table>
<thead>
<tr>
<th>Performance Category</th>
<th>Probability</th>
<th>Damage Level</th>
<th>Damage Criteria</th>
<th>Maximum Allowable Vertical Displacement</th>
<th>Maximum Allowable Horizontal Displacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1/100 years or 40% in 50 years</td>
<td>Not significant</td>
<td>• No significant damage to the dike body. • Post-seismic flood protection ability is not compromised.</td>
<td>Small (&lt;0.03 m)</td>
<td>Small (0.03 m)</td>
</tr>
<tr>
<td>B</td>
<td>1/475 years or 10% in 50 years</td>
<td>Repairable</td>
<td>• Some repairable damage to the dike body. • Post-seismic flood protection ability is not compromised.</td>
<td>0.15 m</td>
<td>0.3 m</td>
</tr>
<tr>
<td>C</td>
<td>1/2475 years or 2% in 50 years</td>
<td>Significant</td>
<td>• Significant damage to the dike body. • Post-seismic flood protection ability is possibly compromised.</td>
<td>0.5 m</td>
<td>0.9 m</td>
</tr>
</tbody>
</table>

3.3.3 Liquefaction of Soils

Liquefaction is the process by which the sediments below the water table temporarily lose strength as a result of the application of earthquake-induced cyclic shear stresses, and behave as a viscous liquid rather than soil (Ref. [10]). Liquefaction can lead to slope instability, lateral spreading of ground, settlement, increased lateral loads on retaining walls and piles, and loss of foundation support.
Preliminary assessment on liquefaction susceptibility, i.e. the ability of the soil to liquefy when subjected to an applied stress, can be carried out through existing literature and maps, for example the GeoMap Vancouver (Ref. [13]), or the Liquefaction Susceptibility map included in the Seismic Design Guidelines for Dikes (Ref. [12]).

Generally, because of the type of sediments found in Burrard Inlet, False Creek, and the Fraser River, the potential for soil liquefaction should be investigated. The Commentary on the Canadian Highway Bridge Design Code (Ref. [10]), and the Seismic Design Guidelines for Dikes (Ref. [12]), describe several methodologies to determine the potential for soil liquefaction under a seismic event of a certain magnitude. Where necessary, the design of Waterfront Structures shall allow for the effects of liquefaction.

3.4 Design for Sea Level Rise and Coastal Flooding

A 2008 study on Sea Level Rise in British Columbia (Ref. [2]) estimates Sea Level Rise in Vancouver will be between 0.89 m to 1.03 m by the year 2100 (based on extreme high estimate of global sea level rise).

As a result of expected Sea Level Rise, the Flood Construction Levels in Vancouver, which define the minimum elevation of the underside of a floor system or top of concrete slab of any building used for habitation, business or storage of goods, are being raised in flood-prone areas. Around Burrard Inlet, English Bay, False Creek and Fraser River Flood Plains, the new flood construction level requirements are:

- For buildings located within the areas shown shaded on Figure 1, the flood construction level 4.6 m Greater Vancouver Regional District datum.
- For buildings located in the areas shown shaded on Figure 2, an additional elevation allowance above 4.6 m may be required for wave run-up.
Figure 1 - Burrard Inlet, English Bay, False Creek and Fraser River Flood Plains (Ref. [4])
Marine and coastal structures need to be designed to protect Vancouver’s heavily urbanized environment against Sea Level Rise and coastal flooding. As such, new Waterfront Structures for the City shall have a design crest elevation equal or greater than the Flood Construction Level (4.6 m), plus an appropriate allowance for wave run-up, which is dependent on site-specific wave-structure interaction.

If the City approves a lower top elevation than the Flood Construction Level, the design of new Waterfront Structures shall address:

- The frequency of inundation, i.e. the minimum recurrence interval of events which will cause flooding.
- Public safety implications of flooding / overtopping including safe access and egress from the flooded / overtopped areas.
- Potential damage to property as a result of overtopping or flooding.
- How floodwater will be dealt with. Where possible, positive drainage paths will exist to return floodwater to the river / sea without reliance on pumping systems.

Figure 2 - Burrard Inlet, English Bay, False Creek and Fraser River Flood Plain Wave Effect Zone (Ref. [4])
3.4.1 Dikes

Although the City is not currently a diking authority, all structures that perform as a dike in a manner as defined by the Ministry of Forests Land and Natural Resource Operations (MFLRNO) shall have all necessary reports and documents prepared to satisfy Dike Maintenance Act approvals. Please refer to the following MFLRNO website for further detail:


The City will determine timing and or requirement for DMA approval.

3.5 Design for Scour, Washout and Accretion

A primary consideration for coastal and marine structures is the dynamic nature of sea and riverbed and beach material. Scour can result in loss of support for structural footings, resulting in movement, cracking and failure. Conversely, deposition of material can have adverse impacts for operation and maintenance of marine facilities. Design of marine and coastal structures shall take account of the potential for scour, washout, and / or accretion at the site by considering the site sediment / bed material regime and expected water flow above and below ground level.

For structural design, where no other information is available, a scour allowance of one (1) meter shall be included in design bed levels unless scour protection is provided.

3.6 Design for Safety

All areas with unrestricted access shall be designed to appropriate safety standards for public areas, including but not limited to:

- Railings at level differences and vehicle barriers where appropriate.
- Elimination of trip hazards in accessible areas.
- Emergency egress from the water (e.g. stairs / ladders) for “man overboard” situations.
- Where practical, public access should be excluded from enclosed areas such as under suspended decks.
- Appropriate lighting for areas accessible at night.
4.0 DESIGN LOADING AND LOAD COMBINATIONS

4.1 Dead loads

Dead loads consist of the effective weight of all fixed structural elements, including wearing surface, earth cover and utilities, having either a dry weight (in air) and / or a buoyant weight (if submerged in water).

In the absence of more precise information, the unit material weights specified in Table 3.4 of CSA-S6, 2014 (Ref. [9]) shall be used in calculating dead loads.

In the absence of more precise information, a superimposed dead load of 2.4 kPa of surface treatments shall be assumed. Specific allowances may be required for superimposed dead loads such as material storage or stockpiles.

Specific allowances shall be made to accommodate future dead loads as determined through the completion of the feasibility assessment as required in Section 3.4 Design for Sea Level Rise and Coastal Flooding.

4.2 Live Loads

Live loads consist of movable and moving loads imposed on structures due to use and occupancy. These will consist of cyclic, impulsive, random, static and long-term cyclic types of loads. The following live loads shall be considered as appropriate and shall be confirmed with the City (Equipment Services Branch) prior to detailed design phase:

- Pedestrian: all waterfront structures shall be designed for a pedestrian load of 7.2 kPa.
- Garbage pickup: all waterfront structures shall be designed for a Mini Packer 10 yard rear loader, single rear axle with the characteristics presented in Table 5.

<table>
<thead>
<tr>
<th>Vehicle Weight (lbs)</th>
<th>Axle Load (lbs)</th>
<th>Wheel Base (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Front Axle</td>
<td>Single Rear Axle</td>
</tr>
<tr>
<td>19,500</td>
<td>6,581</td>
<td>12,919</td>
</tr>
</tbody>
</table>

- Maintenance vehicle: all waterfront structures shall be designed to allow for maintenance to adjacent building facades and be designed for a CL-3 truck as per CSA-S6 (for loading and unloading) and manlifts of 85ft to 100ft.
- Fire access: requirement for access of fire trucks shall be determined by adjacent land uses and emergency response requirements. For example, fire access needs to be considered where developments are located immediately adjacent to waterfront structures and fire trucks utilize pathway for access. The characteristics presented in Table 6 shall apply:
Table 6 - Fire Truck Characteristics

<table>
<thead>
<tr>
<th>Vehicle Weight (lbs)</th>
<th>Axle Load (lbs)</th>
<th>Wheel Base (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Front Axle</td>
<td>Single Rear Axle</td>
</tr>
<tr>
<td>Engine</td>
<td>50,000</td>
<td>21,000</td>
</tr>
<tr>
<td>Rescue Engine</td>
<td>50,000</td>
<td>21,000</td>
</tr>
<tr>
<td>Ladder</td>
<td>80,000</td>
<td>23,000</td>
</tr>
<tr>
<td>Special Ops</td>
<td>50,000</td>
<td>21,000</td>
</tr>
</tbody>
</table>

For specific live load (e.g. crane pad loads during lifting), appropriate design criteria shall be derived to suit the circumstances.

4.3 Soil and Differential Water Loads

Soil and differential water loads consist of loads that affect the stability of earth-retaining structures. The design water head differences across a retaining structure shall be based on the tidal water levels and information regarding the groundwater regime at the site. Where no information exists, the design head difference across the structure should be the greater of one (1) meter or one-third (1/3) of the retained height.

4.4 Environmental Loads

Environmental loads consist of statically applied long-term loads such as temperature, wind, tide, waves and currents. Loads resulting from these effects shall be derived in accordance with the design guidelines, codes and standards listed in Section 2.0, and as described below.

4.4.1 Thermal Loads

Thermal loads consist of temperature change and temperature gradient, and include all strains and deformations / displacements, and their effects on the structures. Thermal loads shall be calculated in accordance with Clause 3.9.4 of CSA-S6, 2014 (Ref [9]), and shall be based on the Maximum and Minimum Mean Daily Temperatures at Vancouver, presented in Table 7 below.
### 4.4.2 Wind Loads

Wind loads on structures shall be calculated in accordance with Clause 3.10 of CSA-S6, 2014 (Ref. [9]) and shall be based on the Hourly Mean Wind Pressures at Vancouver for the relevant Return Period indicated in Table 8 below.

#### Table 8 - Hourly Mean Wind Pressure

<table>
<thead>
<tr>
<th>Return Period</th>
<th>Vancouver</th>
<th>False Creek</th>
<th>Point Grey</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-year Return Period</td>
<td>360 Pa</td>
<td>430 Pa</td>
<td>480 Pa</td>
</tr>
<tr>
<td>25-year Return Period</td>
<td>430 Pa</td>
<td>480 Pa</td>
<td>530 Pa</td>
</tr>
</tbody>
</table>

### 4.4.3 Tidal Levels

Tidal water levels presented in Table 9 below shall be considered in the design of marine and coastal structures for the City. All elevations are in meters and are referenced to Chart Datum.

#### Table 9 - Tidal Water Levels (chart datum)

<table>
<thead>
<tr>
<th>Water Level</th>
<th>Year 2016</th>
<th>Year 2100*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vancouver</td>
<td>False Creek</td>
</tr>
<tr>
<td></td>
<td>Vancouver</td>
<td>False Creek</td>
</tr>
<tr>
<td>HHWLT</td>
<td>5.0</td>
<td>4.9</td>
</tr>
<tr>
<td>HHWMT</td>
<td>4.4</td>
<td>4.3</td>
</tr>
<tr>
<td>MWL</td>
<td>3.1</td>
<td>3.0</td>
</tr>
<tr>
<td>LLWMT</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td>LLWLT</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

* Design 2100 water levels involve future sea level rise of 1 m, as recommended by the BC Ministry of Environment (Ref. [2])

Please refer to Section 3.4 of this document for more information regarding design of marine and coastal structures for Sea Level Rise and coastal flooding.

### 4.4.4 Berthing and Mooring Loads

Facilities where vessels may berth or moor shall be designed using appropriate loads, load factors and load combinations as per BS 6349. Where loading of people and/or materials on and off vessels is required, safe access shall be provided for all expected water levels.
4.4.5 Wave Loads

Waves can be generated by both wind and vessels. Where significant wave action can occur, wave loads shall be evaluated in accordance with site-specific conditions. In the absence of such evaluations, wave loads shall be taken in accordance with Clause 3.11.5 of CSA-S6, 2014 (Ref. [9]).

Please refer to Section 3.4 of this document for more information regarding design of marine and coastal structures for Sea Level Rise and coastal flooding.

4.4.6 Current Loads

Current loads on structures shall be calculated in accordance with Clause 3.11.4 of CSA-S6, 2014 (Ref. [9]). Where appropriate, allowance shall be made for debris loading.

4.5 Seismic Loads

Seismic loads consist of shear forces applied during the design earthquake event, and lateral soil movements due to liquefaction, if applicable.

Seismic forces on Marine Structures shall be calculated in accordance with the Canadian Highway Bridge Design Code and Commentary, for an importance category of Other Bridges and assuming equivalence to a Regular Bridge, unless specified otherwise.

The PGA, PGV and the 5% damped horizontal spectral response acceleration values, Sa(T), for the reference ground conditions (Site Class C) for periods T of 0.1 s, 0.2 s, 0.3 s, 0.5 s, 1.0 s, 2.0 s and 5.0 s for the 100-year, 475-year, 975-year and 2475-year return period for Vancouver are given in Table 10 below.

Table 10 - Seismic Hazard Values for Vancouver, BC

<table>
<thead>
<tr>
<th>Probability</th>
<th>Sa(0.1)</th>
<th>Sa(0.2)</th>
<th>Sa(0.3)</th>
<th>Sa(0.5)</th>
<th>Sa(1.0)</th>
<th>Sa(2.0)</th>
<th>Sa(5.0)</th>
<th>PGA</th>
<th>PGV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/100 years or 40% in 50 years</td>
<td>0.149</td>
<td>0.188</td>
<td>0.189</td>
<td>0.156</td>
<td>0.079</td>
<td>0.043</td>
<td>0.0094</td>
<td>0.081</td>
<td>0.096</td>
</tr>
<tr>
<td>1/475 years or 10% in 50 years</td>
<td>0.338</td>
<td>0.427</td>
<td>0.432</td>
<td>0.374</td>
<td>0.200</td>
<td>0.115</td>
<td>0.028</td>
<td>0.185</td>
<td>0.257</td>
</tr>
<tr>
<td>1/975 years or 5% in 50 years</td>
<td>0.469</td>
<td>0.589</td>
<td>0.595</td>
<td>0.520</td>
<td>0.288</td>
<td>0.170</td>
<td>0.047</td>
<td>0.255</td>
<td>0.371</td>
</tr>
<tr>
<td>1/2475 years or 2% in 50 years</td>
<td>0.676</td>
<td>0.835</td>
<td>0.838</td>
<td>0.742</td>
<td>0.419</td>
<td>0.254</td>
<td>0.080</td>
<td>0.362</td>
<td>0.544</td>
</tr>
</tbody>
</table>

Source: [www.earthquakescanada.ca](http://www.earthquakescanada.ca), values for 2015 National Building Code of Canada using Site Coordinates: 49.2827°N, 123.1207°W, and 7 points for interpolation. All values are given in units of g (9.81 m/s²)
The site-specific design spectral acceleration values, $S(T)$, shall be determined in accordance with Clause 4.4.3.4 of CSA-S6, 2014 (Ref. [9]). This design spectrum incorporates site coefficients which depend on site-specific soil properties.

Each structure under CSA-S6, 2014 (Ref. [9]) is assigned a Seismic Performance Category, 1 to 3, based on the site-specific spectral acceleration for a 2475-year return period and the fundamental period of the structure ($T$). Table 11 below summarizes the Seismic Performance Category requirements for Marine Structures for the City in Vancouver.

<table>
<thead>
<tr>
<th>Site Class</th>
<th>Seismic Performance Category for $T &lt; 0.5s$</th>
<th>Seismic Performance Category for $T &gt; 0.5s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>F</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

*Site-specific evaluation is required to determine Seismic Performance Category for Site Class F.

All values are based on a 2475-year return period event, and have been determined in accordance to Clause 4.4.3 and Clause 4.4.4 of CSA-S6, 2014 (Ref. [9]) for an importance category of Other Bridge. Site classifications for ground shall conform to Clause 4.4.3.2 and Table 4.1 of CSA-S6, 2014 (Ref. [9]).

4.6 Load Factors and Load Combinations

Design of Waterfront Structures shall be based on limit states, in which, at the ultimate limit state, the factored resistance exceeds the total factored load. Structural components shall be designed to comply with the following limit states:

- **Fatigue Limit State (FLS):** a limit state in which the effects of fatigue on the strength or condition of a structure are considered.
- **Serviceability Limit State (SLS):** the limit state in which the effects of vibration, permanent deformation, and cracking on the usability or condition of a structure are considered.
- **Ultimate Limit State (ULS):** a limit state that involves failure (including rupture, fracture, overturning, sliding, and other instability).
FLS, SLS, and ULS load factors and load combinations shall be in accordance to Clause 3.5 and Tables 3.1, 3.2 and 3.3 of CSA-S6, 2014 (Ref. [9]). Resistance factors required to check ultimate limit states criteria shall be in accordance to the relevant sections of CSA-S6, 2014 (Ref. [9]). For facilities where vessels may berth and / or moor, additional load combinations which incorporate berthing and / or mooring loads shall be considered. SLS and ULS load factors and combinations shall be developed in accordance with Annex A of BS 6349-2 (Ref. [3]). Partial factors, factors for combinations, and formulae for combinations of actions shall be in accordance with Table A.1, Table A.2 and Table A.3 of BS-6349-2 (Ref. [3]), respectively.

Further guidance on the development of load combinations is provided in Appendix A.
5.0 DESIGN GENERAL REQUIREMENTS

Upland works shall be in accordance to the standards, specifications and procedures included in the City of Vancouver Street Restoration Manual (Ref. [6]).

For marine works, the Engineer shall refer to the Canadian National Master Construction Specification (NMS) and edit the relevant sections as required to produce project-specific design requirements.

The Engineer shall also consult with the City for general design requirements and exclusions. As an example, pedestrian railing that uses stainless steel cables that are not multi span are not accepted.

Submittal requirements are included in Appendix B.
6.0 PERMITTING PROCEDURES

Assessment of the necessary permits and approvals for marine and coastal projects should be considered as early as possible. A number of different organizations and stakeholders will often be involved and permitting requirements can dictate the project schedule. Permits may involve assessment of local environmental, navigational and archeological aspects as described below.

6.1 Environmental

Environmental impacts should be considered for all alterations to, or development of, City-owned marine facilities. The Fisheries Act requires that projects avoid causing serious harm to fish unless authorized by the Department of Fisheries and Oceans (DFO). This applies to work being conducted in or near water bodies that support fish.

6.1.1 Federal Fisheries Act Self-Assessment Process

Not all projects require a review by DFO. Effective November, 2013, proponents may determine if their projects meet DFO requirements under the self-assessment process. Full details of this process can be found at http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html.

Project activities where DFO review is not required is shown in Figure 3 below:\(^1\)

\(^1\) Source: http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html
6.1.2 DFO Project Review

If the self-assessment indicates that a DFO project review is required, the proponent is required to submit a request for review. Additional details on this process can be found at http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html.

6.1.3 Best Practices

It is the responsibility of the proponent to ensure avoiding serious harm to fish. DFO interprets serious harm to fish to mean:

- The death of fish,
- A permanent alteration to fish habitat as defined by DFO (see Ref. [11]),
- The destruction of fish habitat as defined by DFO (see Ref. [11]).

Regardless of whether the project is non-reviewable as indicated in the self-assessment, or is subject to DFO project review, the proponent must follow best practices. Measures to consider when conducting a project near or within water include, but are not limited to, the following:
• Project planning
  - Timing (fisheries windows apply during which works may not be permitted)
  - Site selection
  - Contamination and spill management
• Erosion and sediment control,
• Shoreline re-vegetation and stabilization,
• Fish protection,
• Operation of Machinery

Full details of these best practices are provided on the DFO website at http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html

6.1.4 Port Metro Vancouver

Some City-owned facilities are in close proximity or adjacent to Port Metro Vancouver’s jurisdiction. This includes certain properties in Burrard Inlet (including portions of Stanley Park). Port Metro Vancouver administers a Project and Environmental Review process to ensure all developments and activities meet applicable standards and minimize environmental impacts. Full details of Port Metro Vancouver’s review process is available online at http://www.portmetrovancouver.com/development-and-permits/project-and-environmental-reviews/

6.2 Navigable Protection Act (NPA)

Adherence to the requirements of the NPA may be required for development of City-owned marine infrastructure. Full regulatory details may be found at https://www.tc.gc.ca/eng/programs-621.html. A summary of the key points is provided below:

Transport Canada administers the NPA through the Navigation Protection Program (NPP). The NPA replaced the former Navigable Waters Protection Act (NWPA) in 2012.

The NPA is an Act of Parliament that authorizes and regulates interferences with the public right of navigation in specifically defined navigable waters. The waters adjacent to City-owned properties fall within this category.

Work is defined as anything, whether temporary or permanent, that is made by humans, and that is in, on, over, under, through or across any navigable water in Canada. It also includes the dumping of fill or the excavation of materials from the bed of any navigable water.

The NPA defines “likely to substantially interfere with navigation” as work which will, for example, significantly change the way vessels pass down a navigable waterway or may make passage dangerous to the public.
For work governed by NPA, the owners must provide notice to the Minister. The Notice must include a “Notice of Works” form and all required attachments and additional information. The detailed information submitted in the notice will identify likely interferences with shipping and boating activities.

The minimum information requirements for a Notice to the Minister include:

- Completed “Notice of Works” form (see reference provided),
- Location map (indicating the exact location of the work),
- Legal site description and work position,
- Plan view drawings,
- Profile view drawings,
- Project description,
- Construction methodology,
- Anticipated start and end dates.

When the NPP receives a notice it is assessed for the likelihood of interference with navigation. Following the assessment, the work may be issued an approval and / or deemed a permitted work. Approval may be denied if the impacts to navigation are unacceptable. Terms and conditions may apply to an approved work or a permitted work.

6.3 Archaeological

In some circumstances, alterations to, or development of, City facilities will require an archaeological review. Full details of the archaeological review process may be found at https://www.for.gov.bc.ca/archaeology/.

Projects which have the potential to disturb archaeological sites generally require an archaeological assessment prior to the project being conducted. The following phases are likely:

Phase 1 - Archaeological Overview Assessments (AOAs)

- Reviews ethnographic, archaeological, and historical documents and works pertinent to the study area,
- Undertakes a search of the Provincial Heritage Registry Database (PHRD) in Victoria for previously recorded sites,
- Identifies First Nation group(s) whose asserted traditional territories encompass the proposed development area,
- Provides a statement of archaeological resource potential within the proposed development area and the immediate surrounding area,
- Provides recommendations regarding the need for and the appropriate scope of future archaeological research for the proposed development area,
- May involve a Preliminary Field Reconnaissance to determine the potential for archaeological sites, if so may require First Nations permitting,
- If the AOA study shows that archaeological sites may be present, a field study is required.

Phase 2 - Archaeological Impact Assessments (AIA)
- Requires a permit issued by the Archaeology Branch under Section 14 of the Heritage Conservation Act,
- May require First Nations permitting to ensure awareness of any archeological work taking place within their area of aboriginal title,
- Will involve a detailed surficial survey of the property by a qualified professional archaeologist,
- May require subsurface testing, based upon surficial findings to determine if buried materials are present,
- AIA report must be prepared and submitted to the B.C Ministry of Forests, Lands and Natural Resources Operations Archaeology Branch.
- In some cases, if a project will cause significant damage to an important archaeological site additional detailed archaeological work may be required by the Archaeology Branch to mitigate the impacts,

Phase 3 - Site Alteration Permit (SAP) and Monitoring
- If ground disturbing activities (such as harvesting of trees) need to be conducted within the boundaries of a recorded archaeological site, a site alteration permit will be required (Provincial jurisdiction),
- Primary objectives of this phase is to:
  - Ensure impacts to an archeological site occurs after a systematic data collection and recovery process has occurred,
  - Minimize project impacts to archeological materials through ongoing monitoring,
  - To record the way and extent the archeological site is altered through the project impacts
  - Archaeological monitoring is expected to be required in all locations where project repairs/habitat enhancement poses a risk to known or potential archaeological materials.
END OF REPORT
APPENDIX A – ADDITIONAL GUIDANCE ON LOAD FACTORS AND LOAD COMBINATIONS
FLS, SLS, and ULS load factors and load combinations shall be in accordance to Clause 3.5 and Tables 3.1, 3.2 and 3.3 of CSA-S6, 2014 (Ref. [9]). For convenience, these have been summarized in Table A.1 below.

<table>
<thead>
<tr>
<th>LC</th>
<th>Permanent</th>
<th>Transitory</th>
<th>Exceptional</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
<td>P</td>
<td>E</td>
</tr>
<tr>
<td>FLS 1</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>SLS 1</td>
<td>1.00</td>
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<td>1.00</td>
</tr>
<tr>
<td>SLS 2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ULS 1</td>
<td>α_D</td>
<td>α_P</td>
<td>α_E</td>
</tr>
<tr>
<td>ULS 2</td>
<td>α_D</td>
<td>α_P</td>
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<td>α_D</td>
<td>α_P</td>
<td>α_E</td>
</tr>
<tr>
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<td>α_D</td>
<td>α_P</td>
<td>α_E</td>
</tr>
<tr>
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<td>α_D</td>
<td>α_P</td>
<td>α_E</td>
</tr>
<tr>
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<td>α_D</td>
<td>α_P</td>
<td>α_E</td>
</tr>
<tr>
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<td>α_D</td>
<td>α_P</td>
<td>α_E</td>
</tr>
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<td>α_D</td>
<td>α_P</td>
<td>α_E</td>
</tr>
<tr>
<td>ULS 9</td>
<td>1.35</td>
<td>α_P</td>
<td>α_E</td>
</tr>
</tbody>
</table>

Abbreviations are as per Table 3.1 of CSA-S6, 2014. Please refer to CSA-S6 for complete information on the generation of load combinations.

For facilities where vessels may berth and/or moor, additional load combinations which incorporate berthing and/or mooring loads shall be considered. SLS and ULS load factors and combinations shall be developed in accordance with Annex A of BS 6349-2 (Ref. [3]). Partial factors, factors for combinations, and formulae for combinations of actions shall be in accordance with Table A.1, Table A.2 and Table A.3 of BS-6349-2 (Ref. [3]), respectively.

For convenience, expected relevant SLS and ULS load combinations have been summarized in Table A.2 and Table A.3 below, respectively. These tables are not intended to be a comprehensive list of all load combinations that may be applicable, but rather a list of load combinations that the Engineer would likely need to develop. In a similar way, some of the load combinations listed below may not be relevant if a certain load does not exist or its effect is negligible. The Engineer shall refer to BS-6349 to develop project-specific load combinations.
### Table A.2 - Additional SLS Load Factors and Load Combinations for Mooring and Berthing Facilities (as per BS-6349)

<table>
<thead>
<tr>
<th>LC</th>
<th>Permanent</th>
<th>Pre-stress</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>P</td>
<td>E</td>
</tr>
<tr>
<td>SLS 3</td>
<td>1.00</td>
<td>1.00</td>
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</tr>
<tr>
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</table>

**Legend:**
- **D** = Dead
- **P** = Pre-stress
- **E** = Live
- **W** = Wind
- **K** = Temperature
- **S** = Differential Settlement
- **C** = Water Current
- **WV** = Wave
- **B** = Ship Berthing
- **M** = Mooring
- **E** = Earth and Geotechnical Water Pressures

**Notes:**
- For each load combination, the leading variable action is marked with an asterisk (*).
- Coefficient for live load considers traffic action. Other coefficients may apply for pedestrian only and/or for port cargo loading, please refer to BS 6349.
- For convenience, the applicable coefficient for ship berthing and mooring for each of the load combinations is provided. However, berthing and mooring loads generally don't act simultaneously and should not be combined. Unless simultaneous action is expected, separate load combinations should be developed for berthing and mooring of vessels.
Table A. 3 - Additional ULS Load Factors and Load Combinations for Mooring and Berthing Facilities (as per BS-6349)

<table>
<thead>
<tr>
<th>LC</th>
<th>Permanent</th>
<th>Pre-stress</th>
<th>Variable</th>
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<tr>
<td></td>
<td>D</td>
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<td>E</td>
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<tr>
<td>ULS 10</td>
<td>γ_G</td>
<td>γ_p</td>
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<td>γ_G</td>
<td>γ_p</td>
<td>1.50</td>
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<tr>
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<td>γ_G</td>
<td>γ_p</td>
<td>1.50</td>
</tr>
<tr>
<td>ULS 13</td>
<td>γ_G</td>
<td>γ_p</td>
<td>1.50</td>
</tr>
<tr>
<td>ULS 14</td>
<td>γ_G</td>
<td>γ_p</td>
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<td>γ_p</td>
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<td>γ_p</td>
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<td>γ_G</td>
<td>γ_p</td>
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<td>γ_G</td>
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<td>ULS 26</td>
<td>γ_G</td>
<td>γ_p</td>
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Legend:
D = Dead, P = Pre-stress, L = Live, W = Wind, K = Temperature, S = Differential Settlement, C = Water Current, WV = Wave, B = Ship Berthing, M = Mooring and E = Earth and Geotechnical Water Pressures

Notes:
- Coefficients γ_G are defined in Table A.1 of BS 6349-2.
- Coefficients γ_p are defined in BS EN 1992 or relevant Eurocode.
- Coefficients for variable loads consider the load as unfavourable. If the load is favourable, then the coefficient shall be zero.
- Coefficients for variable loads include partial factors for Set A and Set B ULS (as per Table A.1 of BS 6349-2) and combination factors (as per Table A.2 of BS 6349-2). Other coefficients may apply to Set C ULS, please refer to BS 6349.
- For each load combination, the leading variable action is marked with an asterisk (*).
- Coefficient for live load considers traffic action. Other coefficients may apply for pedestrian only and/or for port cargo loading, please refer to BS 6349.
- For convenience, the applicable coefficient for ship berthing and mooring for each of the load combinations is provided. However, berthing and mooring loads generally don't act simultaneously and should not be combined. Unless simultaneous action is expected, separate load combinations should be developed for berthing and mooring of vessels.
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<th>Marine and Coastal Structures Design Reference</th>
<th>Date: December 02, 2016</th>
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<td>DOCUMENT NO.: 632456-0000-41ER-0015</td>
<td>Revision No.: 00</td>
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<td>Appendix: B</td>
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**APPENDIX B – SUBMISSION REQUIREMENTS**
The following information is to be organized, collated and submitted to the City in the form of a Maintenance Manual. The submission is to be in both electronic (PDF) and hard copy formats and is to be signed and sealed by a Professional Engineer in good standing in the Province of B.C. All submissions are to be to the satisfaction of the General Manager of Engineering Services (GMES):

- Maintenance Manual

  Table of Contents
  Section 1  Design Information (code, performance criteria, loading data, design team information ...)
  Section 2  Asset Value (broken down by component)
  Section 3  Construction Material Information (material grades, specs, catalog data, mill certificates, shop drawings ...)
  Section 4  Recommended Maintenance and Inspection Items
  Section 5  IFC Drawings (11 x 17 format) and Construction Specifications
  Section 6  Construction Photographs
  Section 7  Construction Logs
  Section 8  Construction Field Review Reports / Site Instructions
  Section 9  Quality Reports
  Section 10  Permits
  Section 11  Background Reports (geotechnical, environmental ...)
  Section 12  Record Drawings (11 x 17 format)
  Section 13  Legal Agreements
  Section 14  Inspection Report (Post Construction)
  Section 15  As Built Survey (Post Construction – signed by a B.C.L.S.)
  Section 16  Final Letter Recommending Acceptance w/ signed Certificates (substantial and total performance) attached

In addition the following documents are to be submitted separately:

- Record Drawings

  Full size record drawings are to be submitted in both hard copy (1 full set) and soft copy formats (.pdf and .dwf).

- Inspection Report – (Post Construction)

  The report is to follow DOC/2015/012385 - Bridge Condition Index and Implementation Manual and User Guide or be consistent on format with the attached seawall inspection report.

- As-Built Survey (Post Construction – signed by a B.C.L.S.)

  Full size record drawings are to be submitted in both hard copy (1 full set) and soft copy formats (.pdf and .dwg). Survey is to be to the City of Vancouver’s Standard Datum NAD 83 (CSRS) 4.0.0BC.1.GVRD