US Army Corps of Engineers®

Appendix B3: Structural Engineering

Oakland, CA Harbor Navigation Improvement Integrated Feasibility Report

April 2023

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1. INTRODUCTION

The purpose of this appendix is to describe the new in-water structures and design parameters required for the Oakland Harbor Turning basin improvements and bulkhead design required for the Oakland Harbor Navigation Improvement (-50 Foot) Project, Phase 1A Supplemental Documentation Report (SDR), dated March 2001. This appendix design summary includes general design parameters, assumptions, and preliminary calculations to be used in further expansion of the turning basin. Due to the increased diameter of the proposed turning basin, localized demolition and modifications to the adjacent structures will be required. Expansion (in diameter) of the existing inner turning basin will require partial demolition of 2 wharfs (1 at Howard Terminal, Oakland, and 1 at Alameda (Warehouse) Wharf, Alameda) as well as requiring installation of a new, submerged bulkhead near the existing Schnitzer Steel Wharf (Oakland). Schnitzer Steel did not want any impacts to their wharf from the proposed work. Engineering work for this feasibility study included preliminary investigations of existing structures, alignment options, and evaluation of new structural needs to keep the two modified wharfs operational as well as protect the integrity of the Schnitzer Steel operations. Geotechnical properties were used from past San Francisco District (SPN) projects. Preliminary structural analyses were performed using computer software as noted within.

The future design will include the following new in-water retaining structures (see Figure 1 below):

- a below-grade, in-water bulkhead in front of the Schnitzer Steel property (Oakland) in the northwestern portion of the Inner Turning Basin.
- A bulkhead at the perimeter of the partially removed wharf of Howard Terminal (Oakland).
- A bulkhead at the perimeter of the partially removed Alameda Wharf (Alameda)

More description of the new in-water structures will follow in this appendix.

2. DESIGN CRITERIA AND REFERENCES

The design criteria were taken from the original design parameters gleaned from previous reports and data provided. No new soil investigations were conducted; see Geotechnical Appendix B2 for design soil properties and pressures used. The engineering evaluation is based on assumed geotechnical design parameters at all design locations. These assumptions and parameters will require further investigation for more detailed design.

Soil properties for bulkhead retaining walls:

- Soil density: 120 pcf (dry)
- Soil density: 57.6 pcf (submerged)
- Surcharge: 250 psf
- Active earth pressure Coefficient: 0.35
- Passive earth pressure Coefficient: 3.0
- Point of Fixity: Elevation -36.00 (assumed 10 feet below sheet pile embedment elevation, i.e. “Wall Bench”)
- Wall Bench: Elevation -26.0’
- Water elevation is same at front and back face of the retaining wall

Design Standards:

- ACI 318-19: Building Code Requirements for Structural Concrete and Commentary (2019 or newer)

- ASCE 7-22: Minimum Design Loads for Buildings and Other Structures (2022)
- AISC 360-16: Specifications for Structural Steel Building
- EM 1110-2-2502 Retaining and Flood Walls (1989)
- ETL 1110-2-584, Design of Hydraulic Steel Structures (June 2014)
- Sheet Pile Design by Pile Buck Steel Manual (latest version)
- Engineering for Port and Harbor Structures (John Gaythwaite, 2015)

Design and Inspection References:

- ER 1110-2-1806 Earthquake Design and Evaluation for Civil Works Projects (May 2016)
- USGS 2018 Seismic Hazard Map
- "Design of Earth Retaining Structures for Dynamic Loads," Seed, H.B. and Whitman, R.V. (1970)
- UFC 3-301-01: Structural Engineering (2016)
- ASCE Manual of Practice No. 130: Waterfront Facilities Inspection and Assessment (2015)
- Oakland Harbor Navigation Improvement (-50 Foot) Project, Phase 1A Supplemental Documentation Report (SDR), dated March 2001

3. GENERAL LAYOUT OF IMPROVEMENTS

The main structures that will be constructed as a part of this improvement are shown below, in Figure 1.

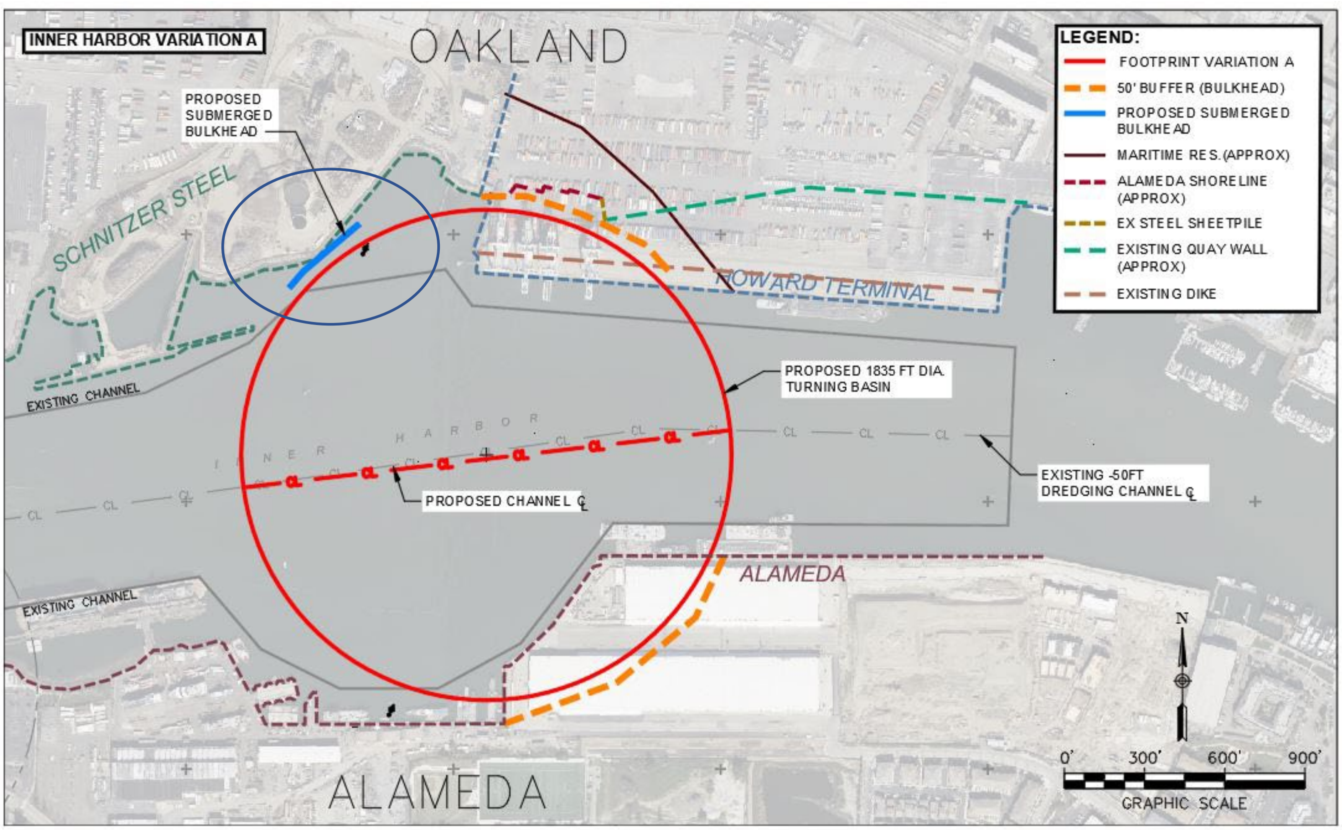

Figure 1: Inner Harbor Basin Improvements

4. NEW STRUCTURES

Schnitzer Steel: Proposed Submerged Bulkhead

See Geotechnical Appendix B2 for a description of the existing wall and proposed cross-section. The wall will be approximately 300 to 400 feet long and will be entirely submerged. The wall will likely be a drive- pile structure with steel sheetpiles and batter piles. The wall will be offset 10 to 20 feet from the existing Schnitzer Steel wall in the direction of the turning basin and will be designed so that soil removed as part of the turning basin project will not have any structural effects on the Schnitzer Steel wall. The top of the wall will be near the existing grade (mudline) at the base of the Schnitzer wall. The proposed wall will retain approximately 20 to 25 feet of soil that will be needed to create the necessary depth of the turning basin.

Alameda Warehouse Wharf: New Bulkhead

The bulkhead structure that was evaluated was a generalized version of a former design used at the site. The design is a sheet pile wall braced with batter piles, similar to past designs for harbor improvements. The preliminary design consists of AZ 52-700 sheet pile and 24" diameter battered steel piles, filled with concrete; a 10-foot spacing was considered for this analysis.

The bench elevation for both sheet pile and batter piles were assumed to be -26 feet; the point of fixity of the sheet pile and the batter piles were assumed to be at elevation-36 feet. See Figure 2 below for a general design feature cross section.

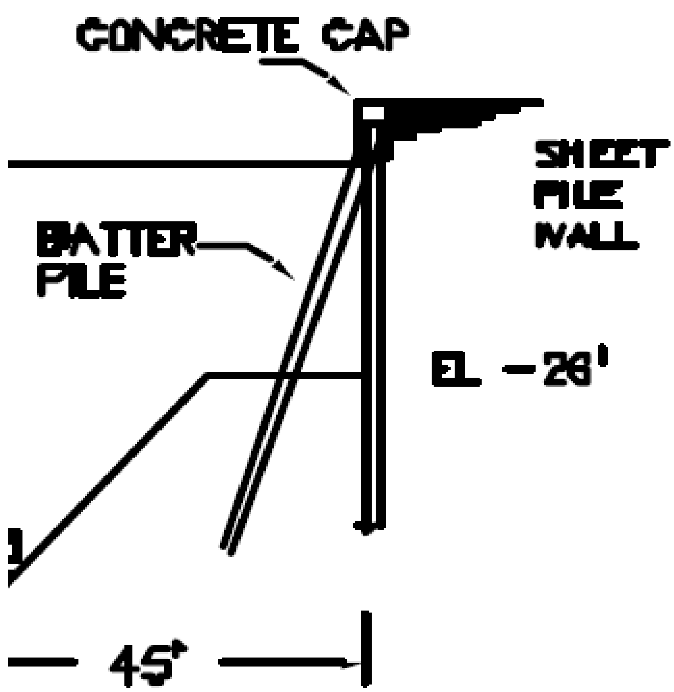

Figure 2: General Design feature Cross Section

5. DESIGN LOADING

Seismic criteria:
The sheet pile and batter piles to be designed and constructed to resist the effects of earthquake motions, at a minimum, equivalent to the Operational Basis Earthquake (OBE) per ETL 1110-2-584. For this project, a return period of 975 years was considered as the Maximum Design Earthquake (MDE). This return period differs from that recommended in the Supplemental design report, which used a return period of 475 years.

USGS 2018 Seismic Hazard Map was used to obtain the information below:
Location: Latitude, 37.791297, Longitude: -122.287034
Peak Ground Acceleration (PGA): 0.619g
Spectral Acceleration Parameter at Short Period: 1.441g
Spectral Acceleration Parameter at a Period of 1 second: 0.454

Design Loads:
A STAAD computer model was developed to perform analysis. The loads considered were as follow:

1. Dead load: D = Fa + Fp + Fs
   Gravity loads of sheet pile, battered steel piles, and 5'X7' concrete cap.
2. Active soil pressure: Fa
3. Passive soil pressure: Fp
4. Surcharge load: Fs
5. Seismic load: E

ASD Load Combination (ASCE 7-22):

1. D
2. D + L
3. D + (Lr or S or R)
4. D + 0.75L + 0.75(Lr or S or R)
5. D + 0.6W
6. D + 0.75L + 0.75(0.6W) + 0.75(Lr or S or R)
7. 0.6D + 0.6W
8. D + 0.7Ev +0.7Eh
9. D + 0.525Ev + 0.525Eh + 0.75L + 0.75S
10. 0.6D – 0.7Ev + 0.7Eh

Critical load combination: Fa + Fp + Fs + 0.7E

6. SUMMARY OF ANALYSIS

Analysis was performed for AZ 52-700 sheet pile and 24" diameter battered steel piles, filled with concrete at a 10-foot spacing. Due to the increased seismic load applied to the wall, the sheet pile size had to be increased from what was assumed to be installed currently. The analysis confirm that these elements are adequate for the assumed loads mentioned above. The tip elevations the sheet pile and the batter piles are required to be determined by a geotechnical engineer based on the developed skin friction and other geotechnical parameters.

7. RECOMMENDATIONS

The design as presented in this appendix is preliminary and is based on limited information and generalized assumptions available at the time of analysis. This should be considered a proof of concept, and a verification of the design currently in place at this location. As noted in the report, the new wall design will need to be updated based on project specific geotechnical and seismic considerations. The sheet pile wall size may be able to be reduced should the seismic return period be reduced from that used in this analysis.