Design for Wave Protection at Newport North Marina, Yaquina Bay, Oregon

by Robert R. Bottin, Jr.

Introduction

The Yaquina Bay Estuary is located on the Oregon coast about 185 km (115 miles) south of the Washington border. The major tributary to the estuary is the Yaquina River, which drains approximately 650 sq km (250 sq miles) of largely forested area on the west side of the Coast Range. Two rubble-mound jetties have been constructed at the mouth of the Yaquina River. The north jetty is 2,134 m (7,000 ft) long and the south jetty is 2,621 m (8,600 ft) in length. The distance between the jetties is 305 m (1,000 ft) at their outer ends.

Newport North Marina is situated on the north bank of the Yaquina River about 3.2 km (2 miles) upstream from the seaward ends of the Yaquina River jetties (Figure 1). The marina was constructed in 1946 and includes an 808-m (2,650-ft) timber breakwater that protects a small-boat marina from wave action. The crest of the timber structure was constructed to an elevation (el) of +4.3 m (+14 ft) relative to mean lower low water (mlw). The mooring areas in the marina were dredged to a depth of -3 m (-10 ft). A 1994 aerial photograph of the Newport North Marina is shown in Figure 2.

Newport North Marina experiences excessive wave energy due to waves from the Pacific Ocean propagating through the west entrance. The majority of the problems are experienced in the western one third of the marina during winter storms at high tide stages. Waves ranging from 0.9 to 1.2 m (3 to 4 ft) have been observed in the marina during storm events. In November 1981, a "3-year storm event" destroyed a port dock and caused $720,000 in damages to the marina. Another dock experienced damage to water and electrical lines during January 1990 storms. Overtopping of the existing, deteriorated timber breakwater may occur as often as four to six times during one winter. Little wave energy appears to enter from the marina's east entrance.

The Model and Appurtenances

At the request of the U.S. Army Engineer District, Portland, (NPP), a three-dimensional physical model was constructed at the Coastal Engineering Research Center to study wave conditions at Newport...
Figure 2. Aerial view of Newport North Marina

North Marina and determine the most economical breakwater modifications that would provide adequate wave protection during periods of storm wave attack. The model reproduced a portion of the Yaquina River from immediately west of the U.S. Highway 101 Bridge upstream and included Newport North Marina on the north bank as well as South Beach Marina on the south bank. It was constructed at an undistorted linear scale of 1:60, model to prototype.

Figure 3 shows detailed features included within the model limits. The total area reproduced in the model was approximately 930 sq m (10,000 sq ft), representing about 3.4 sq km (1.3 sq miles) in the prototype. A general view of the model is shown in Figure 4.

Model waves were generated by a 12.2-m-long (40-ft-long), unidirectional spectral, electrohydraulic, wave generator, which reproduced the required incident wave conditions. An automated data acquisition and control system was used to generate and transmit wave generator control signals, monitor wave generator feedback, and secure and analyze wave data at selected locations in the model. A water circulation system, consisting of a 20.3-cm (8-in.) perforated pipe water intake manifold, a 0.14-cms (5-cfs) pump, and sonic flow transducers with a multiprocessor transmitter, was used in the model to reproduce steady-state tidal flows through the lower reaches of the river. These flows corresponded
to maximum flood and ebb tidal

discharges measured in the proto-
type. The model was molded in
cement mortar (fixed-bed), and a
tracer material was selected to
qualitatively determine movement
and deposition of sediment in the
vicinity immediately adjacent to the
marina entrance. A solid layer of
fiber wave absorber was placed at
strategic locations along the inside
perimeter of the model to dampen
wave energy that might otherwise
be reflected from the model walls.

Test Conditions

Test waves with periods ranging
from 12.5 to 16.7 sec and signifi-
cant heights ranging from 0.9 to 2.4
m (3 to 8 ft) were selected for
reproduction in the model. Seis-
rometer wave gauge data, cover-
ing the period 1971 to present,
were available and utilized for wave
height analysis. In addition, during
previous studies of the Yaquina
jetties, statistical wave hindcast
estimates over a 20-year period
(1956-1975) were available at the
jettied entrance. To determine wave
conditions downstream and sea-
ward of the marina, historical
records, observations, and predic-
tions from a numerical model of
wave transformation in a channel
bounded by rubble-mound break-
waters were utilized. Incident wave
characteristics were reproduced in
the model at the approximate
location of the U.S. Highway 101
Bridge. Model contours then
transformed the wave characteris-
tics as they approached the
marina. Unidirectional wave spectra
were reproduced using a depth-
limited TMA (Texel-Marsden-
ARSLOE) spectral form for the
selected test conditions.

Still-water levels (swl's) of 0.0,
+1.5, +2.4, and +3.4 m (0.0, +5.0,
+8.0, and +11.0 ft) mhlw were
selected for use during model
testing. The 0.0- and +2.4-m (0.0
and +8.0-ft) swl's were representa-
tive of mhlw and mean higher high
water (mhhw), respectively. The
+1.5-m (+5.0-ft) swl was representa-
tive of the tidal elevation in the
river when maximum flood and ebb
velocities occur; therefore, tidal
flows were superimposed with the
+1.5-m (+5.0-ft) swl. The +3.4-m
(+11.0-ft) swl represented high tide
conditions (mhhw) with a 0.9-m
(3.0-ft) storm surge superimposed.
Prototype data indicated that
maximum flood and ebb tidal
velocities were 0.6 mps (1.9 fps)
near the Marine Science Center
(across the river from Newport
North Marina). Steady-state flows
with these velocities were used
during model testing with the 1.5-m
(+5.0-ft) swl. A crushed coal tracer
material was used to qualitatively
determine sediment movement
patterns and subsequent deposits
near the marina entrance, and an
injected dye tracer was utilized to
measure wave-induced current
patterns and magnitudes in the
model.

Experiments

Prior to studying various improve-
ment plans, comprehensive experi-
ments were conducted for existing
conditions to establish a base from
which to evaluate various alterna-
tives. Wave heights, sediment
tracer patterns, current patterns
and magnitudes, and wave pattern
photographs were obtained for the
selected test waves. Wave height
experiments revealed rough and
turbulent wave conditions in the
mooring areas of the marina.
Significant wave heights in excess
of 0.9 m (3.0 ft) were measured for
the +2.4- and +3.4-m (+8.0- and
+11.0-ft) swl's. Typical wave
patterns obtained for existing
conditions are shown in Figure 5.

Originally, three design alterna-
tives were proposed by NPP to
reduce wave energy by changing
the marina entrance configuration.
These included (a) straight exten-
sion of the existing breakwater to
the west along the existing align-
ment, (b) dogleg extension of the
existing breakwater to the north-
west, and (c) detached breakwater
positioned southwest of the existing
west entrance. For an improvement
plan to be acceptable, maximum
significant wave heights were not to
exceed 0.3 m (1.0 ft) in the existing
marina mooring areas for storm
wave conditions. Wave heights
proposed for the originally pro-
posed design alternatives indicated
that none of the test plans met the
established wave height criterion.
A comparison of the straight break-
water extension concept to the
angled breakwater extension
concept revealed that the angled
structure provided similar wave
protection in the mooring areas with
less breakwater length. The
detached breakwater concept
provided the least wave protection to the mooring areas relative to structure length versus the breakwater extensions.

Wave height experiments were conducted for 12 additional test plan configurations, with variations involving changes in lengths and alignments of the rubble-mound breakwater extensions. Solid vertical structures also were included adjacent to the existing wharves for some plans. After NPP conducted an assessment of economic benefits, an optimum improvement plan was selected considering wave protection afforded the harbor mooring areas, ease of navigation, and costs of construction. This plan consisted of a 54.9-m-long (180-ft-long) rubble-mound breakwater extension originating at the western end of the existing timber breakwater and extending in a northwesterly alignment (311-deg azimuth). This orientation resulted in a 38.1-m-wide (125-ft-wide) entrance opening. Wave patterns obtained for the optimum improvement plan are shown in Figure 6.

Additional experiments with the optimum improvement plan revealed similar circulation patterns throughout the marina as those obtained for existing conditions. Current magnitudes in the marina indicated slightly decreased velocities for the improvement plan; however, no stagnant areas were observed. Sediment tracer patterns and subsequent deposits for existing conditions were compared to the improvement plan, and indicated that sediment placed adjacent to the existing timber breakwater migrated easterly for each condition. It was concluded that if material were available for movement in the area, the breakwater extension plan would improve sedimentation conditions since material did not enter the entrance to the degree that it did for existing conditions. Comparisons of wave height data west of the existing entrance also were conducted.
Results indicated that the rubble-mound extension would have no adverse impacts on wave conditions along the existing docks and wharves in this location.

Summary

Through the application of the three-dimensional model of Newport North Marina, Yaquina Bay, Oregon, the optimum length and alignment of the breakwater extension were determined to reduce wave heights in the mooring areas to acceptable levels. The model also indicated that the improvement plan will have no negative impacts on harbor circulation, sedimentation, and wave conditions in adjacent areas. The Corps of Engineers can now construct breakwater improvements with an added degree of confidence that the project will perform as needed and that the most economical design is being used.

For additional information, contact Mr. R. R. Bottin, Jr., at (601) 634-3827, or email (r.bottin@cern.wes.army.mil).

Mr. Bottin is a research physical scientist and principal investigator in the Wave Processes Branch, Wave Dynamics Division, Coastal Engineering Research Center, WES. He has been employed at WES since 1972 and has extensive experience managing three-dimensional hydraulic model investigations involving wave action (both long- and short-period), river discharges, tidal flows, and/or the movement of sediment. He has authored or coauthored over 100 technical publications. Mr. Bottin has a B.S. degree from the University of Southern Mississippi and is an Engineer officer with the U.S. Army Reserves.

Notes from the Front Line...

CERC/Hydraulics Labs Merge

Effective 19 October 1996, the WES Coastal Engineering Research Center (CERC) and Hydraulics Laboratory (HL) merged to form the Coastal and Hydraulics Laboratory (CHL). CHL is now the largest water-resources-development laboratory in the world. Dr. James R. Houston, former Director of CERC, has been named Director of the newly formed CHL. CERC, created by Act of Congress, has been retained as a technology center within CHL. Missions of the former CERC and HL remain unchanged within CHL.

IAPSO Homepage

The International Association for the Physical Sciences of the Oceans (IAPSO) has established a homepage at: http://www.olympus.net/IAPSO/

The homepage contains information about IAPSO and has links to universities, institutes, and laboratories, and links to oceanographic information including ocean experiments, models, and data sources. Links to other scientific organizations, government agencies, and World Wide Web pages of interest are also included on the homepage.

Upcoming ICCE Conferences

At the recent International Conference on Coastal Engineering (ICCE) held in Orlando, FL, information was provided on the next three ICCE conferences. The 1998 ICCE conference will be held in Copenhagen, Denmark, on 22-26 June 1998. Information on plans for that conference can be found on the ICCE conference homepage at: http://www.dhi.dk/icce98/index.htm

The ICCE conference in the year 2000 will be held in Sydney, Australia, on 16-21 July. Information about that conference can be obtained from the conference secretariat at: capcon@ozemail.com.au

The ICCE conference in the year 2002 will be held in Cardiff, Wales.

New Director of USACE Research and Development

Effective 1 September 1996, Dr. Lewis E. (Ed) Link, former Assistant Chief of CERC, became the new Director of Research and Development for the U.S. Army Corps of Engineers (USACE). Immediately prior to his new assignment, Dr. Link was Director of the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), in Hanover, NH.
The 63rd meeting of the Coastal Engineering Research Board (CERB) was held on 11-12 June 1996, in San Diego, CA. The CERB is congressionally mandated to advise the Chief of Engineers on all matters related to coastal engineering. The Board meets twice a year in different geographical areas. The spring meeting is a full meeting of the Board, while the fall meeting format allows the civilian members to have a better understanding of the workings and problems of the host Division.

The Board is comprised of seven members. The President of the Board is MG Stanley G. Genega, Director of Civil Works. The other three military members are MG Milton Hunter, Commander, North Atlantic Division; BG Henry S. Miller, Jr., Commander, Southwestern Division; and BG Bruce K. Scott, Commander, South Pacific Division (SPD). The three civilian members are Dr. Paul D. Komar, Oregon State University; Dr. Robert G. Dean, University of Florida; and Dr. Edward K. Noda, Edward K. Noda and Associates, Inc., Honolulu, HI. The Commander of the U.S. Army Engineer Waterways Experiment Station (WES), COL Bruce K. Howard, acts as the Executive Secretary of the CERB and is responsible for all administrative functions of the board.

The theme of this meeting was "The Direction of Coastal Engineering in the Corps and the Resulting Impact on R&D." Speakers and panelists were from the Board; Headquarters, U.S. Army Corps of Engineers; SPD; Los Angeles District; academia; and the private sector. Presentations were made and discussions held on various topics pertaining to the theme of the meeting, as well as the Marine Board Study of Beach Nourishment and Protection and the Report to the Office of Management and Budget (OMB) on Shore Protection. Board members, MG Milton Hunter and Dr. Robert Dean, presented the Task Force Report entitled "Coastal Engineering into the 21st Century, a Strategic Plan for the Coastal Engineering Program of the U.S. Army Corps of Engineers," which the Board approved.
Proceedings of the meeting are located on the World Wide Web at http://bigfoot.cerc.wes.army.mil/6301.html. Since the proceedings are on the Internet, hard copies will no longer be routinely sent to Corps offices or attendees. Hard copies may be obtained from Ms. Sharon L. Hanks, WES, Coastal Engineering Research Center, (601) 634-2004.
Calendar of Coastal Events of Interest

A more complete calendar will be found on the World Wide Web at http://bigfoot.cerc.wes.army.mil/event_cal.html

Dec 2 - 6, 1996  Natural and Technological Coastal Hazards, Tirupati, AP, India,  
POC: Dr. C. Rajasekara Murthy, FAX: 905-336-4989/6230

Dec 15 - 19, 1996  American Geophysical Union Fall Meeting, San Francisco, California,  
POC: AGU Meetings, (202) 462-6900

Mar 24 - 27, 1997  California and the World Ocean '97, Town and Country Hotel, San Diego, California,  
POC: Orville Magoon, (707) 987-0114, FAX: (707) 987-9351, e-mail: otmagoon@aol.com

Apr 21 - 25, 1997  European Geophysical Society, 22nd General Assembly, Vienna, Austria,  
E-mail: egas@lnax1.mpae.gwdg.de, Web: http://www.mpae.gwdg.de/EGS/EGS.html

May 25 - 30, 1997  Offshore and Polar Engineering Conference, Honolulu, Hawaii,  
POC: ISOPE-97, 303-273-3673, FAX 303-420-3760

Jul 1 - 9, 1997  IAMAS/IAPSO Joint Assembly, Melbourne, Australia, E-mail: mscarlett@peg.apc.org,  
Publications of Interest

The following publications and video are available from the sources indicated. They are not available from CERC.


*Laboratory Study of the Effect of Sea Walls on Beach Erosion*, MITSG-95-31, 1995, 158 pages, $16 plus $1.50 per domestic order or $3.00 per foreign order for shipping and handling. Order from Publications, Sea Grant Program, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139.


*A Diver's First Aid Reference to Potentially Hazardous Marine Life*, Report MASGP-94-002, 1995, free. Available from Mississippi-Alabama Sea Grant Consortium, PO Box 7000, Ocean Springs, MS 39566-7000, USA. E-mail: mdbutler@whale.st.usm.edu
The Corps' Coastal Vision Statement

We will, as the National Coastal Engineer:

- Continue our leadership in the protection, optimization, and enhancement of the Nation's coastal zone resources.
- Increase our contribution to the Nation's economy, quality of life, public safety, and environmental stewardship.

This bulletin is published in accordance with AR 25-30 as an information dissemination function of the U.S. Army Engineer Waterways Experiment Station. The publication is part of the technology transfer mission of CERC under PL 79-165 and PL 99-802. Results from ongoing research programs will be presented. Special emphasis will be placed on articles relating to application of research results or technology to specific project needs. Additional information is provided on the CERC Homepage at:


Contributions of pertinent information are solicited from all sources and will be considered for publication. Communications are welcomed and should be addressed to the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, ATTN: Dr. Lyndell Z. Hales, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call (601) 634-3207, FAX (601) 634-4253, Internet: l.hales@cerm.wes.army.mil

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