UAA University of Alaska Anchorage
School of Engineering

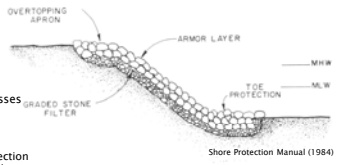
Revetments

Alaska Department of Natural Resources
Coastal Processes and Erosion Responses Seminar
6-7 October 2009 Anchorage

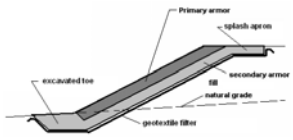
Revetments

Materials
- Quarry stone (riprap)
- Concrete armor
- Sand bags or gabions (mild conditions)
- Gravel (filter stone)
- Geosynthetic (filter) fabric
- Prefabricated marine mattresses

Design Considerations
- Functional
  - Wave dissipation and reflection
  - Wave runup and overtopping
- Structural
  - Armor stability (weight)
  - Toe scour
  - Drainage
  - Foundation
- Potential impacts to
  - Nearshore habitat
  - Adjacent shoreline



Shore Protection Manual (1984)



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Revetment design checklist

- Determine the water level range for the site (tides and storm surge)
  - Consider both extreme high and extreme low levels
- Determine the wave climate for the site
  - Consider 50- to 100-year return period for armor design
  - Choice of a less severe condition involves increased risk of future damage
- Identify an optimum armor configuration to resist the design wave conditions
- Determine the potential wave runup height to select the crest elevation and associated volume of wave overtopping
- Provide for local surface runoff and overtopping runoff, and make any required provisions for other drainage facilities such as culverts and ditches

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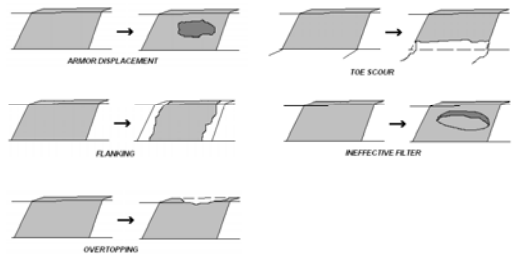
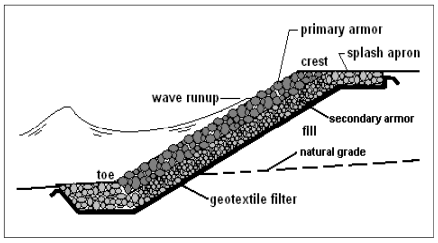
Revetment design checklist

- Consider end conditions to avoid failure due to flanking
- Design the toe protection
- Design the filter
- Provide for firm compaction of fill material
- Consider environmental impacts of
  - materials supply (*e.g.*, quarry and borrow pit operations)
  - effects on shoreline habitat and migrating species
  - changes of sediment supply to neighboring property that may be induced by revetment construction

Common modes of revetment failure



Rock revetment



Typical rock revetment cross-section with geotextile filter

Nome revetment

Coastal revetment at Nome, Alaska (photo by Mike Hendee).

Homer Spit Revetment

Cast concrete armor units

A revetment slope armored by precast concrete dolosse is topped by a rock splash apron at the airport in Unalaska (photo by Harvey Smith, Alaska Department of Transportation and Public Facilities).

Prefabricated concrete units

- **Pro's**
  - Transportable by barge
  - An alternative to larger rock or concrete elements
  - Requires modest construction skill
  - Conventional construction equipment is sufficient
  - Can be interlocked to form a wall or revetment
  - Moderately resistant to ice abrasion and pressure
- **Con's**
  - Salt-water corrodes interlocking hardware
  - Fine material can escape through gaps between modules (without a gravel or fabric filter below)
  - Once interlocking fails, the matrix comes apart
  - Impermeability causes wave reflection
  - Smooth surface allows maximum runup

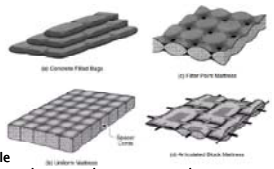
Photos from International Navigation Assn. (PIANC), 2005. *Catalog of Prefabricated Elements*, Working Group 36 Report

Cable-connected concrete blocks

Revetment of connected concrete blocks on Northstar Island in the Beaufort Sea. Inset shows assembled section lifted prior to placement on geotextile-lined slope. (June 2007, with permission of BP)

Endicott Revetments
Prudhoe Bay, Alaska

Concrete- or rock-filled fabric



Pro's
- Transportable
- An alternative to larger rock or concrete elements
- Requires minimal construction skill
- No specialized equipment required
- Common emergency measure

Con's
- Limited resistance to wave and ice forces
- An impermeable layer can fail from wave-induced pressures
- Sunlight degrades fabric, eventually spilling contents
- Synthetic (plastic) material of failed bags is hazardous to birds

Rock-filled synthetic mattress

Marine mattresses on a revetment at Cape May, NJ
(Corps of Engineers photo)

Articulating Concrete Mats (Shishmaref)

Articulated concrete block mat

Gabions

Wire-mesh baskets filled with cobbles or sand-bags

- **Pro's**
  - Transportable
  - An alternative to larger rock or concrete elements
  - Requires modest construction skill
  - No specialized equipment required
  - Can be wired together as an interlocked retaining wall
- **Con's**
  - Salt-water corrodes wire
  - Ice distorts shape and causes wires to fail
  - Sunlight degrades sand bag fabric
  - Wave forces distort baskets
  - Wire from failed gabions is hazardous

Failed Gabion Revetment Shishmaref, Alaska

Wire-mesh gabions

Failed wire-mesh gabion baskets at Shishmaref (2006 photo by Mike Hendee). Geotextile that lined the rock-filled gabions is intertwined with the rocks and wire.

Low-cost expedient options

Wire-mesh gabions, gravel-filled fabric tubes, and sand bags in disarray at Shishmaref (2006 photo by Mike Hendee).

Revetment Guidance

Technical guidance:

- *Coastal Engineering Manual* (USACE)
- *Revetments*, HEC-11 (Federal Highway Admin.)
- Various publications of PIANC (International Navigation Assn.)